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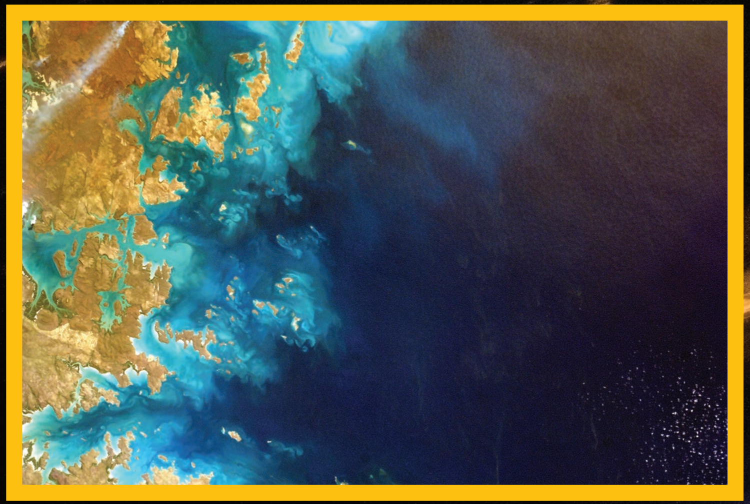

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Haec Credimus

For in six days the Lord made heaven and earth, the sea, and all that in them is, and rested on the seventh.—Exodus 20:11

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Send book reviews to the Book Review Editor: Don B. DeYoung, 200 Seminary Dr., Winona Lake, IN 46590, dbdeyoung@grace.edu.

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The Society Meetings: An Important Part of the Creation Research Society

Since taking the job of editor of the *Creation Research Society Quarterly*, I have written four editorials. For my fifth editorial, I return to the subject of my first one (Faulkner, 2014), the meetings of the Creation Research Society. In that first editorial, I described the fourth meeting of our society in the summer of 2014 at the Creation Museum, and I commented on the wonderful support by the staff of the Institute for Creation Research (ICR) in the form of their attendance and presentations. ICR supported our society in an even more meaningful way in the summer of 2015, as it hosted our fifth meeting. In Dallas we had more than 125 people in attendance, our highest total ever.

The two-day meeting kicked off the night before with a wonderful reception at ICR's headquarters. Besides the lavish food offered, it was a great time to tour ICR's offices and renew acquaintances, make new friends, or just attach faces to names. ICR's Jeff Tomkins gave one of our plenary presentations. The other plenary was delivered by Kevin Anderson. It was fitting that John Morris, son of the late Henry M. Morris, gave the Henry M. Morris Memorial Lecture. As with the previous meeting, the staff of ICR gave several presentations. The day before the meeting, ICR kindly hosted a meeting of creation astronomers, where two presentations were given, one on cratering in the solar system and the other on the *rāqîa‘* that God made on Day 2. We had much discussion. This was the first meeting of creation astronomers. I hope to continue the practice of astronomers meeting the day before the Society meeting.

Our sixth meeting will be July 29–30, 2016 (with a reception the evening before) at Concordia University in Ann Arbor, Michigan. It will be a great time of fun, fellowship, and learning more about God's creation. Why don't you join us?

To register online, please go to: http://www.crsbooks.org/index.php/creation-research-society-conference-2016.html?options=cart

Reference

Faulkner, D.R. 2014. The recent meeting of the Creation Research Society. *Creation Research Society Quarterly* 51:4.

Danny R. Faulkner
Editor
Creation Research Society Quarterly

Patriarchal Life Span Exponential Decay

Charles A. Glatt Jr.*

Abstract

The Biblical patriarchs' longevity from Noah through Joseph declines by logarithmic curve (exponential decay) given by

Lifespan (years) = $6664 \times e^{-dob/\tau}$

where e = 2.718... is nature's constant, and *dob* is the patriarchs' dates of birth since Adam, and

$\boldsymbol{\tau}$ = exponential time constant = 563 years.

The equation was obtained by the natural logarithms' linear regression

Ln (lifespan) = 8.804 – 0.00177· *dob*

The logarithmic graph's estimate of the standard deviation (s.d.) is 0.263; the correlation coefficient is (–0.850). Ten (71%) of the data fit within the first standard deviation; the other four within two. The life span equation predicts 68 years of longevity at the time of Moses 1500 years from the flood (2580 years after Adam). The effect of Shem's uncertain date of birth (not Noah's firstborn son) is evaluated for its effect on standard deviation, the time constant $\boldsymbol{\tau}$, and the correlation coefficient, which will be shown to not undermine this paper's compelling reason of using a logarithmic curve, i.e., as the most common curve in nature and, within nature, in engineering systems.

This single correlation between Genesis life spans and the years following the Flood is of interpretable value to report again to review the work that has been done on this subject since 1948, to incorporate RATE project results, present the time-based analysis's correlation coefficient, express the natural (Naperian, base e) curve as part of a family of the universe's most common curve, the logarithmic curve, introduce common knowledge of life span during Joseph's time, explore anomalies in relation to space expansion, and to present more information that discusses the statistical outliers and supports Moses' recorded life spans.

Patriarchal Life Span Exponential Decay

The fourteen biblical patriarchs' empirical longevity data from Noah to Joseph are investigated for the nature or properties of their formerly analyzed decay curve (Vis, 1948, 1950; Whitcomb and Morris, 1961; Armstrong, 1966; Patten, 1966, 1982; Strickling, 1973; Dillow, 1978; Seaver, 1983, 1985; Wieland, 1998; Brown, 2008; Sanford, 2008.) This paper presents details for Glatt's (2014) engineering model tying together this past research, modeling the human body as an engineering system. The numerical and statistical time analysis shows that

* Charles A. Glatt Jr., Knoxville, Tennessee, idnkoli@yahoo.com
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these biblical patriarchs' longevity follows a logarithmic curve (i.e., exponential decay) with tight standard deviation. A tight standard deviation means most of the data fall close to the longevity decay's linear regression (least squares) curve. The statistical analysis can be performed at any base. Brown (2008) calls the longevity decay a "downward declining curve." Vis (1948, 1950) was the first to publish the post–Flood longevity data in a downward declining graph, stating, "The scientific explanation is not evident…. Perhaps future scientific research will cast some light on this." Whitcomb and Morris (1961) launched the suggested scientific research. Strickling (1973), who is a statistician, and Dillow (1978) were the first to present equations, with Dillow the first to present a statistical correlation coefficient. Both Strickling and Dillow used base *e*, where *e* is the natural constant given by the Maclaurin/Taylor series

$$e = \lim_{x \to 0}(1+x)^{1/x}$$

(e = 2.718….) Dillow (1978) found Neugebauer's (1957, pp. 34, 48) archeological research and concluded that the longevity decay probably was not mathematically manufactured because these fourteen patriarchs' life spans have natural variations about a perfect curve. The same reasoning about natural variations about a perfect curve also applies to Hill (2003) and Northcote's (2007) describing the Genesis longevities as biblical pictures or ideas and to Young's (1988, 1990, 2004) quadratic equation exercises 700 years after Moses introduced the recorded life spans into Genesis. None of the three present a graph or mention exponential decay.

Strickling's predecessors Whitcomb and Morris (1961), Armstrong (1966), and Patten (1966) considered it a "biochemical curve" and researched post–Flood radioactivity–induced human defects. Brown (2008) wrote that the Deluge could have introduced what is now the heavy concentration of heavy hydrogen (deuterium) into the oceans (Brown stated, "Only nuclear reactions produce heavy hydrogen"). From water, this radioactive atom accumulated into the food chain over time. Wieland (1998) examined evidence for genetic factors affecting aging and proposed that through loss of genetic information, our bodies are now "programmed" to age and die much more quickly than in the past. Seaver (1983, 1985) twice statistically and mathematically analyzed for gaps in the Genesis 5 and 11 generations, while Niessen (1982) presented historical verification for tight chronology with no gaps. Seaver also evaluated whether the outliers (Shem, Shelah, Eber, and Nahor) could or should be removed, and he presented peculiarities of their post–Flood times that made them statistical outliers. Strickling (1973) and Seaver (1983), both statisticians, statistically contrasted Masoretic (Hebrew) versus Septuagint (Roman) records. Strickling showed the Septuagint more accurate but suggested further analysis. Seaver's further analysis showed tampered data in the Septuagint. Seaver concluded the Genesis 5 and 11 records are accurate as Moses presented them. Sanford (2008) showed that the Genesis life-span data is consistent with accumulated genomic mutation degradation. Hartnett (2010) explores a potential energy drop (i.e., opposite of kinetic energy) anomaly so that during the longevity decline, the life spans' dates of midpoint line up vertically. The above authors altogether have shown the accuracy of the Genesis 11 "downward declining curve" (Brown, 2008).

In other words, these patriarchs' life spans grew shorter by an exponential decay, following a logarithmic curve. Maor (1994, 2009) states logarithmic curves are nature's most commonly occurring curves. Logarithmic analysis applied to a graph of the Genesis patriarchs' life spans shows these patriarchs' life spans grew exponentially shorter each generation. This is not to say other equations don't fit the curve (e.g., by numerical analysis, the base translation formula, or with higher or lower correlation coefficients from other curve fits like linear, Ln, power, quadratic, cubic, logistic). Previous authors have suggested capacitive decay analysis, and that is expanded in this paper, i.e., that is the compelling reason to pick the exponential. A logarithmic curve forms the basis of the engineering model pursued in this paper, giving the math for Dillow and Patten's capacitor analogy.

This paper assumes the accuracy of the Genesis data based on the above research and provides references for the accuracy in Joseph and Nahor's cases. Given Moses' data accuracy, the statistically derived equation is presented for date of birth (DOB) versus longevity. The equation's independent variable (abscissa) is based on time (DOB) instead of generation (Vis; Whitcomb & Morris; Dillow; Seaver) and a base *e* equation (Strickling; Dillow; Seaver) is contrasted and recommended against other bases. Base *e* and time both better apply to Dillow and Patten's capacitor analogy than generation or other bases—in this case of longevity decay, we are speaking of the capacity for life instead of the capacity for electronic charge. As Niessen (1982, p. 65) wrote, "What are numbers for except to show dates?" More generally a numerical and statistical analysis versus date (time) opens up the graph's properties to common scientific knowledge of natural, time-decaying phenomenon. Dillow's longevity data versus generation analysis gave a statistical correlation coefficient of 0.95 that is 11% higher than the time analysis's coefficient reported here, and Seaver's goes as high as 0.9783. Sanford's curve for longevity versus century after Noah gives 0.90. Dillow and the author are not statisticians. The author's engineering education required one elementary statistics class using a textbook by Freund (1979.) It helps that previous writers chose generation as the independent variable so that a choice of independent variable can be stated. Strickling (1973) discussed and evaluated other independent variable options instead of DOB versus life span, including dates of maturity or first begetting, midpoint, and expiration. DOB is used here because it takes into account the number of years Noah and Shem lived before the Flood and the number of years Arpachshad, Shelah, and Eber lived before the earth's division at Peleg. The significance of these pre-event's years is borne out by the statistical outliers. The equation's standard deviation draws attention once again, as with previous authors, to the statistical outliers Shem, Shelah, Eber, and Nahor, who fell outside the first standard deviation and inside the second standard deviation. The outliers' reasons are summarized with new supporting information given for these patriarchs' anomalous life spans. Uncertainty is evaluated for Shem not being Noah's firstborn (Hodge, 2012), in Genesis 5:32, 6:10 and 11:10, which would have placed his birth date 100 years before the flood by Genesis 7:11. For the same reason of including pre-Flood years, the statistical evaluation begins with Adam versus beginning with the date of the Flood (Strickling, 1973), even though starting with Adam makes the coefficient A in $A \times e^{-(t/\tau)}$ less obvious, where constant A = 6664 instead of A $\approx$ antediluvian life span $\approx$ 950.

This paper reports only a single correlation that is yet of interpretable value to report for the following reasons. The correlation pulls together the properties of a data graph that have been reported a number of different ways for over sixty years. The analysis expands on the interpretable benefits a time evaluation (Sanford, 2008) gives instead of evaluation versus generation. The time–based correlation coefficient underpins the data's scientific validity and reinforces current research in related fields, such as tooth wear and dinosaur size (Dillow, 1978). Reinforced by Seaver's and Strickling's statistical analyses, the correlation coefficient given here supports further conclusions beyond but including Dillow's. More information is presented concerning Joseph and the statistical outlier Nahor. This paper's engineering model moves Genesis's longevity out of research and into tangible impact on human life span. Finally, the analysis hopefully stimulates further research into this area of science.

There are occasions in science where data trends have an observable curve, and it is sometimes important to know the nature of the curve, whether parabolic, exponential, second–order, third–order, etc. An example is discovering second–order and higher harmonics in electronic information theory (radio waves, etc.) The radio wave harmonics either carry or interfere with information, and the harmonics can be either controlled or have their information extracted.

Method

Participants

(Participants does not mean volunteers in this analysis, but rather this is an analysis of known and previously collected data.) As a sample, the fourteen biblical patriarchs represent their contemporary human populations because they lived near the region of and at the time of the cradle of civilization. All fourteen men were from one lineage, i.e., Noah. Two known macro population divisions took place during their lineage: first with Noah's sons and second at the tower of Babel (earth's division during Peleg's time?). Both divisions resulted in geographic scattering of the human population. Human population had a global longevity of around 900 years with the first data sample (Noah), and Pritchard (1969) reports that human population lived typically 110 years in the days of Joseph.

Design and Procedure

The fields of mathematics and statistics recommend a log–linear or semi–log test when exponential (logarithmic) change of empirical data is a possibility. Statistics analyzes a population sample's linear log–linear graph with linear regression (or least squares.)

The slope versus time is linear for an exponentially changing log–linear or semi–log graph in any base. The analysis begins by discovering that the fourteen patriarchs' life-spans'-logs-versus-time graph matches a least-squares linear slope with low variance. The least-squares (linear regression) analysis then computes to the graph of a logarithmic curve. The curve matches the patriarchal life-span decay. The regression curve's exponential equation is then translated to base e (by $x^r = y^{r\log_y x} = e^{r\ln x}$) under the assumption of natural phenomenon.

The linear-regression analysis of log-linear data investigative technique clearly relates to the longevity-versus-time variables considered because log-linear analysis applies to and is recommended for exponential change, base e exponential decay frequently occurs in biology, life span is a biological issue, and the technique provides an exponential curve matching Moses' recorded life span decay data.

Discussion and Conclusion

Least squares (linear regression) analysis

The population's true correlation coefficient ρ's 0.05 level of significance,

$$|\rho| = |\text{population's true correlation coefficient}| > 0.64$$

and ρ's 95% confidence interval,

$$0.58 < |\rho| < 0.95$$

together verify a logarithmic curve.

The 0.263 standard deviation shows that most of the data points lie close to the computed curve.

The true slope β's 95% confidence variation of +/–28% gives an equal uncertainty in the base *e*'s exponential time constant τ = 563 years, but that uncertainty has no effect on the correlation coefficient.

The looser standard deviations and different time constants for β's +/–28% variation result in at most four more life spans falling in the second standard deviation and no life spans beyond that; i.e., into third or higher standard deviations. An exponential decline still describes the nature of these patriarchs' life span changes even with +/–28% uncertainty in β.

If Shem's uncertain date of birth is moved to the least likely time, the date of the Flood, with the birthdate of those after him each shifted 100 years into the future, it turns out the fourteen patriarchs remain in their above standard deviations (i.e., the outliers remain the same and they remain in the second s.d.), τ increases by 15.3%, the s.d. increases by 4%, and the correlation coefficient changes from 0.85 to 0.84, which means it is definitely a logarithmic curve either way, with the data points fitting tightly about the curve.

Moses recorded empirical data that computes to an exponential decay in human life span. Human life span was stable at about 900 years for ten generations (with anomalies; i.e., Enoch). Then something happened that caused a decay by logarithmic curve in longevity of the individuals whom Moses recorded.

The close match between the linear least squares' log–linear graph and the actual life spans' log–linear graph implies an exponential decay in lifespan beginning 1656 years from Adam; i.e., when Methuselah died and when Noah was 602 years old and still living. Brown (2008, p. 381) speculates that Methuselah's name means "When he is dead, it shall be sent."

In the case of Moses' recorded longevity data, the match with an exponential decay does not indicate that time caused an exponential decay in longevity; i.e, it does not indicate a cause–effect relationship between date and life span. Rather it might imply that something in the earth's biochemical (Patten, 1966), climatic (Baker, 1980; Vis, 1948, 1950) or radiation (Vardiman, Snelling & Chaffin, 2005; i.e., the RATE Project; Humphreys, 1994; Whitcomb and Morris, 1961) environment, in nature or in human genetics (Sanford, 2008; Wieland, 1998) had an effect on human longevity. Human longevity then changed in a way that changes commonly occur in nature (Maor, 1994)—by logarithmic curve. Moses records a global flood occurring at that time, 1656 years after Adam.

The analysis was solved on the first attempt: Moses' empirical data matches an exponential decay. The analysis required no second order modeling or assumptions to achieve an equation (curve) fitting the data.

The Jews and also the Egyptians knew Joseph lived 110 years (Gen. 50:22), and there were Egyptians living just as long (Pritchard, 1969). Some Egyptians, including Pharaoh, knew Joseph's father Jacob (Gen. 47:9).

Anomalies in the lab are worth noting

A first anomaly is to investigate a link between the perceived age of the universe and exponential life-span decay. Suppose: First, speculate that light speed is slowing down (Brown, 2008, pp. 322, 326; Norman and Setterfield, 1986, 1987; but shown to be incorrect by Chaffin, 1992) by the same exponential time constant (τ = 563 years) by which human longevity decayed from Noah to Moses. Then:

$$SpeedNow = OriginalSpeed \cdot e^{\frac{-t}{\tau}}$$
$$= OriginalSpeed \cdot e^{\frac{-t}{563}}$$

and second that (speculation) the change in speed is inversely proportional to increasing time, then:

$$\frac{OriginalSpeed}{SpeedNow} = \frac{UniformitarianAge}{RealAge}$$

e = 2.718…, t is in years, then:

$$\frac{SpeedNow}{OriginalSpeed} = \frac{RealAge}{UniformitarianAge} = e^{\frac{-t}{\tau}}$$

$$e^{\frac{t}{\tau}} = e^{\frac{RealAge}{\tau}} = \frac{UniformitarianAge}{RealAge}$$

$$UniformitarianAge = RealAge \cdot e^{\frac{RealAge}{\tau}}$$
$$= RealAge \cdot e^{\frac{RealAge}{563}}$$

For *UniformitarianAge* = 4.53 billion years (Earth) then *RealAge* = 7500 years, or for the universe, 13.77 billion years vs. 8078 years. The anomaly is that these work out closely to uniformitarian standard ages.

Second, by the base translation formula ($x^r = y^{r(\log_y x)}$), this paper's exponential time constant τ = 563 years, by which human longevity decayed from Noah to Moses, equals within 7% of 365/Ln2 (527 years), i.e., $e^{\frac{-t}{563}} \cong 2^{\frac{-t}{365}}$, that is to say, life span decreased by a half-life of every 365 years (that is easy to remember, from 365 days in a year.) Half-life suggests radioactivity influenced Genesis human longevity decline, which brings to mind accumulation of heavy hydrogen into the food supply, coming from the ocean's heavy concentration of deuterium.

Finally, using data from the Supernova Cosmology Project (Knop et al. 2003), the Hubble Constant vs. distance (by stretched space red shift) has an exponentially varying change by τ_H = 534 years. These are presented as anomalies.

Recommendations

Parameters controlling human longevity

A logarithmic curve by exponential decay equates to a solution of certain differential equations. The natural constant *e*'s defining property is that the differential rate of change of e^x at any time *t* is directly proportional to the quantity of *x* at that particular time. The biological connection is:

> the instantaneous rate of growth of something being proportional to the amount of the something. That something can be a population of bacteria in a culture, or a population of cockroaches in a garbage dump. [For y = e^x then the rate of change of y with respect to x is given by] dy/dx = a·y, with initial conditions y = 1 when x = 0, is e^{ax} … Here, 'a' represents the fraction of them reproducing at any given time x. If 'a' is negative, it could represent the fraction of organisms dying at any given time. This is the model for radioactive decay of radium, uranium, and so on. (Drexel University, 1998)

In the case of human life span decay, the variable *y* is time duration or range in years of human life span. The variable *y* is not some physical substance like uranium or a biological population like bacteria. The obvious physical connection is that the human being dies exponentially sooner than earlier generations. Another physical connection is that during any five-year period every atom in the human body is replaced with a new atom (Swenson, 2000). This might be related to a change in the mix of air pressure and oxygen (Dillow, 1978), elements introduced that may have been harmful to us (Dillow, 1978), a stronger cosmic-ray period lasting until now (Whitcomb and Morris, 1961), or the effect on a population of losing rare alleles due to genetic drift following a genetic bottleneck (Wieland, 1998). Wieland (1998) proposed that alleles for longevity were lost in the small post-Deluge population, and new mutations accumulated. Kondalenko (1993) discusses research suggesting that there is/may be somatic cell genome programming that controls the number of their cell divisions. He did a literature review, not the actual lab research in this area. Hayflick (1965) researched the connection between finite diploid cell lifetimes to aging. Azbel′ (1997, pp. 566–567) writes that every animal metabolizes approximately 20 oxygen molecules' covalent bond energy for every body atom over the course of the animal's lifetime—"the universality is remarkable," he says. Azbel′ states that oxygen's metabolized energy exceeds an animal's needed energy. This could be related to Dillow's post-Flood change in the mix of air pressure and oxygen; i.e., Azbel′ speculates the excess oxygen-bond energy irreparably and vitally damages every animal's atoms, and the accumulated atomic damage causes natural death. Azbel′ further speculates that not all animals have a genetically coded life span, noting that few other species have been monitored for their natural death longevities. Per Azbel′, more body atoms (bigger animals) leads to greater life span. Work in these areas should focus on quantifying and identifying any increase in life–harming and life–destroying elements with one goal being to explain the dynamics behind the exponential nature of the longevity decay.

Human longevity analogous to capacitive circuit elements: Capacity for life instead of capacity for electronic charge

Dillow (1978) gave the example of a capacitor that discharges by the same exponential curve with different coefficients and time constants:

Electronic charge as a
function of time = q(t) = Initial charge $e^{-t/\tau} = Q_o\, e^{-t/\tau}$

where τ = exponential time constant = R·C in a resistive–capacitive network (no inductance L), R = resistance in ohms, and C = capacitance (capacity to store charge) in Farads. A capacitor's electronic charge decays by leaking through a resistive path to ground. Cosmic rays, additional harmful elements, and change of air pressure–versus–oxygen mix could all three reduce the "resistance to ground" or reduce the capacity for life by damaging biochemical components. Perhaps a speculation is appropriate that animals, including humans, are evaporating by nonreplacement of stored atoms that have moved on (i.e. from Swenson, 2000; during any five-year period every atom in the human body is supposed to be swapped out with a new atom). In electronics, instead of atoms but by analogy, the elements reducing electrons' electronic charge "resistance to ground" are leaky capacitors, resistors, and inductors. In the case of life, atoms do not move on to a ground that is a strong conductor like a metal surface but instead to the dust to which we return (although electronics can take advantage of earth ground for electrons moving on), and the leaky components are the items that accelerate the extinguishing of life: cosmic rays, additional harmful elements, change of air pressure-versus-oxygen mix, oxygen-metabolism's atom-damaging extra energy, telomere shortening, genetic entropy, a genetic bottleneck, and program limits on the number of cell divisions.

Engineering model

Human longevity-analogous elements that allow life to escape "to ground" can be analyzed in the form of an engineering circuit (Table 1). An example of a simple transfer function *T* (i.e.. cause-effect or input-output) based on compound interest is $T(s) = T(n) = {}^{\text{debt}}/_{\text{principal}} = D(n)/P(n) = [1+r(n)]^n$ (n = years). The intent of such a capacitive circuit would be first to draw

Parameter	Known parameters	Speculations	Needed information
Supply Limit	Genome coding for number of cell divisions, telomere shortening, atomic and chemical decay rates		
Proportional (resistive/conductive, damping) factors	Life-sustaining factors but also Vitality leaks like: damage rate *b* & damage time *1/b* against vital bonds by energy metabolism & oxygen consumption rate (Azbel′ 1997:567,568); Cosmic rays, radiation, additional harmful elements; & Change of air pressure-vs.-oxygen mix		
Integral (capacitive, mass) factors	tissue health, ozone layer		psychological factors
Differential (inductive, spring) factors	genetic bottleneck; genetic entropy; genetic factors that 'program' our bodies for shorter longevity	human stress & relief	
System inputs	food, air, companionship	tree of life; stellar influence on Earth's ambient environment	
Transfer function T(s)	five-year atomic replacement rate; cell division rate	entropy difference between 2.7°K outerspace and 98.6°F (37°C)	

Table 1. Engineering analysis model of human life as a system

the picture accurately and from that to analyze and make predictions of how the system can be modified or improved.

Take for example our universe's radius at one time equaled 10^{20} meters (Guth and Steinhardt, 1984). Assume it remained 10^{20} meters in size from Creation Day 4 until the Flood, and at the Flood the universe was unleashed to expand a million times in radius, to 10^{26} meters (13.77 billion light-years). Danny Faulkner (personal correspondence, 2014) calculated how the universe's temperature (constant today within 5 decimal places, just below the temperature of liquid helium everywhere) would change, if Eddington's (see Wright, 2006) *1000 equivalent stars* were moved one million times closer to the Earth; i.e., from today's universe of 10^{26} meter radius down to 10^{20} meters radius:

> That is relatively simple. The energy density would go as the square of the distance of the stars, so the energy density would change by a factor of a trillion. The energy density goes as the fourth power of the effective temperature, so the temperature would go as the 0.25 power of that trillion, so that ought to change by a factor of 1,000. Therefore, if I understand what you're asking, the Eddington temperature would have been 3,180 K, not 3.18 K. But, as I said, the problem isn't well defined in my estimation.

Not being *well defined* means the exceptions need to be worked out. Working out the exceptions provides avenues for further research. For example, Maxwell's transverse infinite phase velocity (Balanis, 1989, p. 176, problem 4.15d; as opposed to frontal or forward propagation, or energy phase velocity) for Lenz's law acting on universal (LANL, 2012; Vallée, 1990; Courtois et al. 2013) magnetic flux, may explain universally constant microwave background temperature (2.7°K constant to five decimal places in every direction for as far as can be detected), i.e., everywhere is in touch with everywhere by magnetic fields everywhere throughout the universe. The possibility of universal magnetic flux also addresses the horizon problem, aka light travel time across an extremely large universe, by Lenz's law creating light that travels perpendicular to a magnetic field line, i.e., a line of magnetic flux that crosses between galaxies — by Maxwell, the entire line moves together at any frequency, e.g. light frequencies included. Research should be initiated to understand any effect on the earth's crust (Brown, 1993, 2003) of 100 billion galaxies each with a hundred billion stars all moving a million times further away from earth, e.g., reducing gravitational tug on the planet.

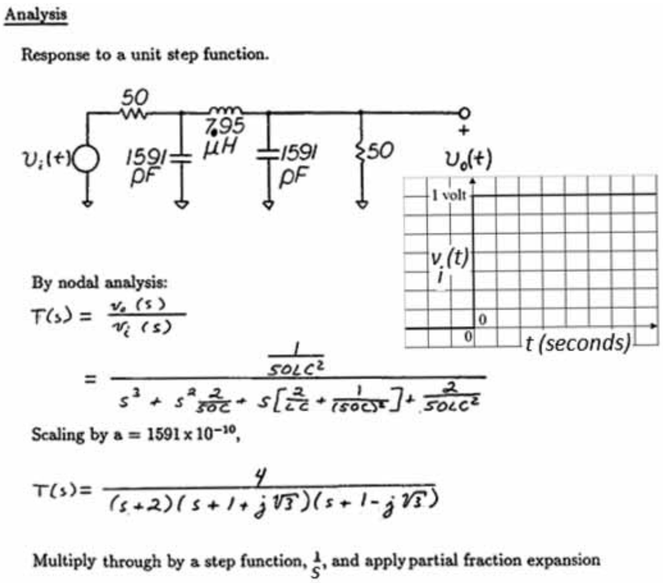

Figure 1. Analysis: Impulse response of low-pass filter

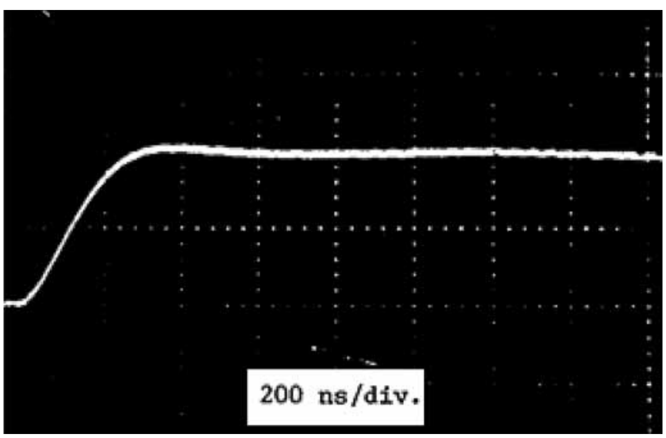

Figure 2. Large step in phase to the low-pass filter

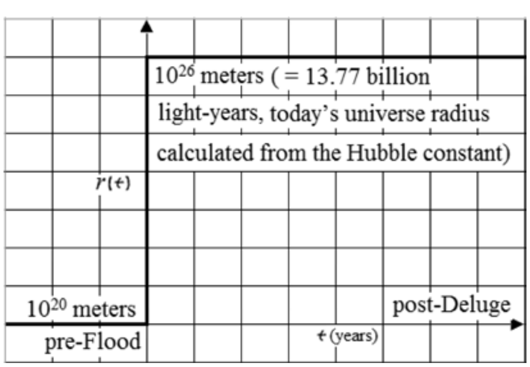

Figure 3. Step increase in Universe's radius

The effect of a stepwise change in universe diameter (Glatt, 2014, referencing Samec, 2013: the universe's expansion rate is unlimited) on human longevity gives an opportunity to evaluate Dillow's capacitor model suggestion. Figure 1 gives an example capacitor model, responding to a step function. Genesis records human life spans from Noah to Joseph that changed in the same manner as the capacitor circuit model changes to a step change in voltage (figures 1–5). Glatt (2014) laid out a scenario for a step increase in the universe's radius, based on graphs by Guth and Steinhardt (1984) and Steinhardt (2011), with Guth's (1981) math, i.e., $\cong 10^{15}$m/s space expansion rate. Working with reduced quality factor *Q*, i.e., low energy loss defines high *Q*, Hartnett (2010) speculates that near the time of the Deluge some decay process increased our bodies' losses, decreasing life span. Hartnett postulated an increase in entropy (or decay) at the time of the Flood based on plots of ages of patriarchs and mentions loss of a body's ability to efficiently generate heat with age may be a factor. Hartnett references genetic entropy (cf. Sanford, 2008). This paper poses the universe as an engineering system, where chemical entropy, i.e., dS/dT (temperature vs. entropy) accelerates where there's a difference in chemical equilibrium. Humphreys (1994, 2005, 2008b) speculated three times a space expansion at the Flood. Move a hundred billion galaxies, at the Deluge, each holding a hundred billion stars, a million times further away, and we receive less heat from them. Moving the stars (galaxies) 90,000 times closer (Figure 4) creates an 80°F universe, i.e., Caribbean. Animals live longer when they burn less energy (Mattson, 2015), so the author speculates that in a Caribbean universe, e.g., of 10^{21} meters radius, human life span increased to 900 years. Adams (1871), Brown (2008), and Hodge (2012) all present a bar-chart way of graphing human longevity decline coincident with the Deluge.

Analysis

The fourteen biblical patriarchs' birth dates from Adam versus lifespan (regression equation's life spans in brackets) occurred as follows: Noah (1056, 950 [1023]); Shem (1558, 600 [420]); Arpachshad (1659, 438 [351]); Shelah (1694, 433 [330]); Eber (1724, 464 [313]); Peleg (1758, 239 [294]); Reu (1788, 239 [279]); Serug (1820, 230 [264]); Nahor (1850, 148 [250]); Terah (1879, 205 [237]); Abraham (2009, 175 [188]); Isaac (2109, 180 [158]); Jacob (2169, 147 [142]); and Joseph (2260, 110 [121]), with Noah's Flood occurring 1656 years after Adam (Brown, 2008; Adams, 1871).

Figure 6's diamonds graph (Least Square) is linear but appears distorted because of x–axis compression. The diamond graph's equation is the computed least squares approximation to the fourteen patriarchs' life spans' natural logarithms from Noah to Joseph:

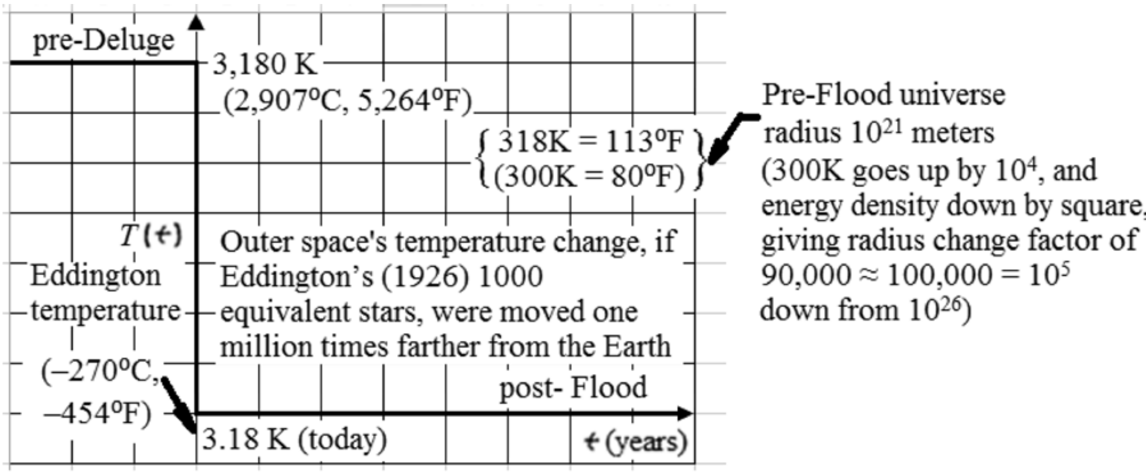

Figure 4. 80°F Pre-Flood universe—shrinking the universe radius by a factor of 10^5 to 10^{21}m gives Caribbean ambient environment

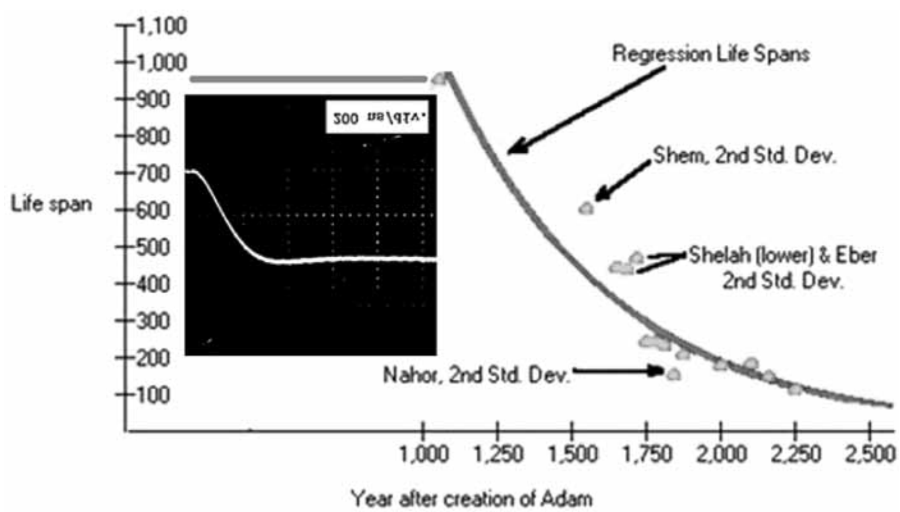

Figure 5. Life span versus date since Adam — Flood-date cosmic expansion evidence by patriarchal post-Deluge longevity exponential decay. (Insert: step decrease to capacitor model. Note the capacitive circuit produces the same shape curve, i.e., same time constant in response to either a step increase as for a step decrease.)

$$\mathrm{Ln(lifespan)} = 8.804 - 0.00177 \cdot dob$$

where

8.804 = a = estimate of the true y–axis intercept α;

0.00177 = b = estimate of the true slope β;

d.f. = degrees of freedom = 14–2 = 12 (n–2 d.f. because estimates are made of both α and β);

r = –0.850= estimate of the population correlation coefficient ρ

dob is the date of birth in years since Adam.

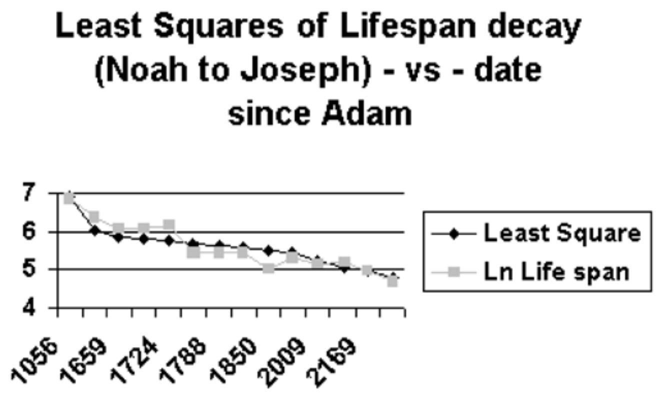

Figure 6. Least squares of life span decay (Noah to Joseph) versus date since Adam. The diamonds graph (least square) is linear but appears distorted because of x–axis compression.

The z statistic for ρ inferences indicates that:

$\rho < -0.64$ (0.05 level of significance; or $|\rho| > 0.64$)

and ρ's 95% confidence interval is:

$-0.58 > \rho > -0.95$

$(0.58 < |\rho| < 0.95)$

The *t* test for β (where β is the true slope which equals $^1\!/_\tau$ and where τ is the exponential time constant in years as given later below) with a 0.05 level of significance and twelve degrees of freedom gives

$0.00127 < \beta < 0.00227$

with

$t_{0.025} = 2.179$

(or for 95% confidence in β there is a +/–28% variation mainly due to small sample size and a few large variations). The range of α is not critical (y–axis intercept.)

The normal distribution statistics are:

$s_e^{\,2}$ = estimate of variance = 0.0690;

s_e = estimate of the common standard deviation = 0.263

(that is, the normal linear regression analysis's normal distribution standard deviation, or standard error of estimate.)

Ten of the fourteen longevity data points (71%) lay within one estimate of the standard deviation; the other four fit within two standard deviations (Shem, Shelah, Eber, Nahor).

Shem lived slightly longer than the curve would predict (he falls in the second standard deviation above the curve), and he lived part of his life before the Flood. Shelah and Eber also lived slightly longer than the curve would predict (they fall in the second standard deviation from the curve), and they lived before the earth's division during the time of Eber's son (Shelah's grandson) Peleg (Gen. 10:25). Nahor lived slightly fewer years than the curve would predict (he falls in the second standard deviation below the curve), and his was the first generation after the Flood to live entirely in a sin-immersed culture, which was brought by his father Serug (Charles, 1913; Charlesworth, 1983–1985; Davis, 1836–37; Epiphanius, 1987, 1994; Gibson, 1901; Ginzberg, 1913; Glycas, 1836; Hyde, 1700, 1760; Suda online, 2000–2016) The remaining 10 Genesis patriarchs' life spans fall in the curve's first standard deviation.

A +28% variation in β (= $^1\!/_\tau$) gives a standard deviation of 1.011 resulting in seven life spans instead of ten falling in the first standard deviation and the remaining seven in the second. A negative 28% variation in β gives a standard deviation of 1.024 with six life spans falling in the first standard deviation and eight in the second.

Figure 6's square boxes give the graph (Ln Life span) of these patriarchs' actual life spans' natural logarithms.

Figure 5 graphs the life spans from Noah to Joseph recomputed by the least squares (*e* raised to the least squares value):

Lifespan (years) = $e^{(8.804 - 0.00177 \cdot \mathrm{dob})}$

Lifespan (years) = $6664 \cdot e^{-\mathrm{dob}/\tau}$

where *dob* is the date of birth in years since Adam and:

τ = exponential time constant = 563 years

The life span equation is not good all the way to today 3500 years after Moses but does predict accurately out to 1500 years from the Flood at Moses' time as follows. Moses lived in the year 2580 after Adam for which the equation gives 68 years of longevity. In Psalm 90, the Psalm of Moses, Moses wrote in verse 10, "The days of our lives are seventy years; and if by reason of strength they are eighty years, yet their boast is only labor and sorrow" (NKJV).

Summary

On one hand, the statistical regression equation does two things a statistical model should do: it correctly predicts a 68-year life span by the time of Moses, and it fits the fourteen post–Flood patriarchs' life spans within understandable standard deviations. On the other hand, the statistical regression equation identified three anomalies, all tied to the longevity decay time constant. There are different time constants before and after Peleg, but these have no effect on the overall time constant. Before Peleg longevity was declining toward 120 years (Gen. 6:3). After Peleg life spans decayed to 70 years, as noted in the text.

The present analysis springboarded off the work of researchers since 1948, as listed in the introduction, with the following: additional correlation analysis of the outliers; post-Flood genetic bottleneck; genetic entropy, gigantisms; radioactivity and cosmic radiation; climate; tooth wear, common longevity knowledge at time of Joseph; and instead of generational-based, another (besides Sanford's) time-based correlation coefficient. Human life was modeled as an engineering system to support and encourage predictive research, analysis, and engineering control.

This paper hopefully encourages and promotes more participants and further research into how to proceed to find, or perhaps predict, a particular regression model for the cumulative effects on life span over the course of generations, from things like (1) radioactivity; (2) cosmic radiation; (3) genetic bottlenecks; (4) genetic entropy; (5) chemical entropy; and (6) climate.

References

CRSQ: *Creation Research Society Quarterly*

Adams, Sebastian. 1871. *Synchronological Chart or Map of History*. https://answersingenesis.org/store/product/adams-chart-history/?sku=10–2-301 (accessed October 17, 2015).

Armstrong, H.L. 1966. An attempt to correct radioactive carbon dating, *CRSQ* 2:28–30.

Azbel′, M.Y. 1997. Phenomenological theory of mortality. *Physics Reports*, 288(1–6): 545–574 (a review section of *Physics Letters*)

Balanis, C.A. 1989. *Advanced Engineering Electromagnetics*. John Wiley & Sons, Inc., Hoboken, NJ.

Baker, S. 1980. *Bone of Contention—Is Evolution True?* Creation Science Foundation Ltd., Queensland, Australia.

Brown, W.T. 1993. *God's Power & Scripture's Authority* (video). Center for Scientific Creation, Phoenix, AZ

Brown, W.T. 2003. What triggered the Flood? *CRSQ* 40:65–71.

Brown, W.T. 2008. *In The Beginning*, eighth edition. Center for Scientific Creation, Phoenix, AZ. www.creationscience.com/onlinebook/FAQ226.html#wp9933900 (Genealogy Chart; accessed October 17, 2015); http://www.creationscience.com/onlinebook/TechnicalNotes22.html (accessed October 19, 2015).

Chaffin, E.F. 1992. A determination of the speed of light in the seventeenth century. *CRSQ* 29:115–120.

Charles, R.H. 1913. The Book of Jubilees, *The Apocrypha and Pseudepigrapha of the Old Testament*, Volume 1. Clarendon Press, Oxford, England.

Charlesworth, J.H. 1983–1985. The Book of Jubilees, *The Old Testament Pseudepigrapha*. Doubleday, New York, NY.

Courtois, H.M., D. Pomarede, R.B. Tully, Y. Hoffman, D. Courtois. (2013). Cosmography of the local universe. *The Astronomical Journal* 146:69.

Davis, M.L. 1836–1837. *Memoirs of Aaron Burr*, Volume 1. Reprint Services Corp, New Brighton, MN. E-book may be downloaded from http://manybooks.net/titles/davismatetext058bur210.html, or http://www.gutenberg.org/ebooks/7850?msg=welcome_stranger.

Dillow, J.C. 1978. The canopy and ancient longevity. *CRSQ* 15:27–34.

Drexel University. 1998. History and Applications of the Natural Logarithm, *Dr. Rob*, *The Math Forum*: http://mathforum.org/library/drmath/view/52541.html (accessed October 17, 2015).

Epiphanius of Salamis. 1987, 1994. *The Panarion (Medicine Chest) of Epiphanius of Salamis*, Vols. 35, 36. Frank Williams (translator). E.J. Brill, Leiden, The Netherlands.

Freund, J.E. 1979. *Modern Elementary Statistics*, fifth edition. Prentice-Hall, Inc., Englewood Cliffs, NJ.

Gamow, G. 1948. The evolution of the universe. *Nature* 162:4122: p. 681.

Gibson, Margaret D (editor). 1901. *Apocrypha Arabica* 8 (Kitab al–Magall, or The Book of the Rolls). Cambridge University Press, London, England.

Gillings, R.J. 1972. *Mathematics in the Time of the Pharaohs*. The MIT Press, Cambridge, MA. Republished in 1982 unabridged with slight corrections by Dover Publications, Mineola, NY.

Ginzberg, L. 1913. *The Legends of the Jews*, Vol. 1, The Jewish Publication Society of America, Philadelphia, PA.

Glatt, C.A. 2012. Local engineering applications from large-scale cosmology parameters. *CRSQ* 48:250.

Glatt, C.A. 2014. Local engineering applications from large-scale cosmology parameters, part 2—standard cosmology's date for the Flood. *CRSQ* 51:58.

Glycas, Michael. 1836. *Chronicle (or Annals) of events from the creation of the world to the death of Alexius I. Cornnenus (1118)*. Ed. Bekker, Bonn, Germany; also in Migne, J. P. (1856–1866). *Patrologia Graeca*. J.–P. Migne Editorem, Paris, France.

Guth, A.H. 1981. Inflationary universe: a possible solution to the horizon and flatness problems. *Physical Review D* 23(2):347–356.

Guth, A.H., and P. Steinhardt. 1984. The inflationary universe. *Scientific American* 250:5: p. 117.

Hartnett, J.G. 2010. *Age as a quality factor of human life after the Flood*. http://creationrevolution.com/2010/11/age-as-a-quality-factor-of-human-life-after-the-flood/ (accessed October 17, 2015.

Hayflick, L. 1965. The limited *in vitro* lifetime of human diploid cell strains. *Experimental Cell Research* 37:614–636.

Hill, C.A. 2003. Making sense of the numbers of Genesis. *Perspectives on Science and Christian Faith* 55(4): 239–251.

Hodge. B. 2012. *Tower of Babel*, Master Books. Green Forest, AR.

Humphreys, D.R. 1994. *Starlight and Time*. Master Books, Colorado Springs, CO.

Humphreys, D.R. 2005. Accelerated nuclear decay: a viable hypothesis? In Vardiman, L., A.A. Snelling, and E.F. Chaffin (editors), *Radioisotopes and the Age of the Earth, Vol. I*, pp 333–379. Institute for Creation Research, Dallas, TX, and Creation Research Society, St. Joseph, MO. Book downloadable at no cost from www.icr.org/i/pdf/research/rate-all.pdf (accessed October 17, 2015).

Humphreys, D.R. 2008a. The creation of cosmic magnetic fields. In Snelling, A.A. (editor), *Proceedings of the Sixth International Conference on Creationism*, (technical symposium sessions), p. 228. Creation Science Fellowship, Pittsburgh, PA, and Institute for Creation Research, Dallas, TX. http://www.icr.org/i/pdf/research/ICC08_Cosmic_Magn_%20Fields.pdf (accessed October 17, 2015).

Humphreys, D.R. 2008b. New time dilation helps creation cosmology. *Journal of Creation* 22(3): 84–92. http://creation.com/images/pdfs/tj/j22_3/j22_3_84–92.pdf (accessed October 17, 2015).

Hyde, T. 1700. *Historia religionis veterum Persarum, eorumque magorum* (or *Hyde de Religione Persarum*; or *de Religione Veterum Persarum*). Oxford, England; also Hyde, T. (1760, 2nd ed.). *Veterum Persarum et Parthorum et Medorum religionis historia*. Oxford, England.

Kondalenko, V.F. 1993. The principle of preformism as a creationist approach in immunology and gerontology, *Acts and Facts* 22(9) *(ICR Impact Article No. 243)*, Institute for Creation Research, Dallas, TX

Knop, R.A. et al. 2003. New constraints on Ω_M, Ω_Λ, and ώ from an independent set of 11 high-redshift supernovae observed with the Hubble Space Telescope. *Astrophysical Journal* 598:102–137.

LANL (Los Alamos National Laboratory). 2012. http://public.lanl.gov/alp/plasma/AtHomeMag.html (accessed October 22, 2012).

Maor, E. 1994. *The Story of e*. The New York Academy of Sciences, New York, NY.

Maor, E. 2009. *e: The Story of a Number*. Princeton University Press, Princeton, NJ.

Matson, J. 2010. Star physicists trade barbs over cosmological model. *Scientific American*, a Division of Nature America, Inc. http://blogs.scientificamerican.com/observations/star-physicists-trade-barbs-over-cosmological-model/ (accessed October 17, 2015).

Mattson, M.P. 2015. Stress makes your brain stronger: try fasting. *Scientific American*, a Division of Nature America, Inc.: www.sciam.com/jul2015/mattson or http://www.scientificamerican.com/article/mattson-stress-makes-your-brain-stronger-try-fasting/?WT.mc_id=SA_printmag_2015–07 (accessed October 17, 2015).

Neugebauer, O., and A. Sachs. 1945. *Mathematical Cuneiform Texts*, American Oriental Society, New Haven, CT.

Neugebauer, O. 1957. *The Exact Sciences in Antiquity*, 2nd edition. Brown University Press, Providence RI. Republished 1996 unabridged with slight corrections by Dover Publications, Inc., New York, NY.

Niessen R. 1982. A biblical approach to dating the earth: a case for the use of Genesis 5 and 11 as an exact chronology. *CRSQ* 19:60–66.

Norman, T., and B. Setterfield. 1986. The atomic constants, light and time, *SRI International Invited Research Report*. Stanford Research Institute, Menlo Park, CA (as referenced in Hartnett, J. 2007. *Starlight, Time and the New Physics*, Creation Book Publishers, Powder Springs, GA).

Norman, T., and B. Setterfield. 1987. *The Atomic Constants, Light and Tim*. Self-published, Blackwood, South Australia (as referenced in Brown, 2008, and Chaffin, 1992).

Northcote, J. 2007. The lifespans of the patriarchs: schematic orderings in the chrono-genealogy. *Vetus Testamentum* 57:243–257.

Patten, D.W. 1966. *The Biblical Flood and the Ice Epoch*. Pacific Meridian Press, Seattle, WA, and Baker Book House, Grand Rapids, MI.

Patten, D.W. 1982. The longevity accounts in ancient history. *CRSQ* 19:40–52.

Pritchard, J.B. (editor). 1969. *Ancient Near Eastern Texts Relating to the Old Testament with Supplement*. Princeton University Press, Princeton, NJ.

Samec, R. 2013. Author's response: testing cosmologies. *Creation Matters* 18(5): 7.

Sanford, J.C. 2008. *Genetic Entropy and the Mystery of the Genome*, Third Edition. FMS Publications, Waterloo, NY.

Schroeder, G.L. 1997. *The Science of God*. Broadway Books, New York, NY.

Seaver, W.L. 1983. A Statistical analysis of the Genesis life-spans. *CRSQ* 20:80–87.

Seaver, W.L. 1985. A statistical analysis of the post-Flood gap possibility. *CRSQ* 22:39–47.

Steinhardt, P. 2011. The inflation debate. *Scientific American* 304(4): 39.

Strickling, J.E. 1973. A quantitative analysis of the life spans of the Genesis patriarchs. *CRSQ* 10:149–156.

Suda online. 2000–2016. http://www.stoa.org/sol/. The Suda ("stronghold of knowledge"), or Souidas, or Soudas, is an ancient encyclopedia and lexicon of the Medterranean world. The Medieval manuscripts have been edited and printed numerous times since the fourteenth century.

Swenson, R.A. 2000. *More Than Meets the Eye*. NavPress, Colorado Springs, CO.

Vallée, J.P. 1990. Detecting the largest magnets: the universe and the clusters of galaxies. *Astrophysical Journal* 360:1–6. (As cited in Humphreys, 2008).

Vardiman, L., A.A. Snelling, and E.F. Chaffin (editors). 2005. *Radioisotopes and the Age of the Earth, Vol. I*. Institute for Creation Research, Dallas, TX, and Creation Research Society, St. Joseph, MO. Book downloadable at no cost from www.icr.org/i/pdf/

research/rate-all.pdf (accessed October 17, 2015).

Vis, W.R. 1948. Chapter IX—Medical science and the Bible. In *Modern Science and Christian Faith*, 2nd printing, by members of the American Scientific Affiliation, pp. 185–187. Van Kampen Press, Wheaton, IL.

Vis, W.R. 1950. Chapter VII—Medical Science and The Bible. In *Modern Science and Christian Faith, 5th printing*, by members of the American Scientific Affiliation, pp. 240–242. Scripture Press, Wheaton, IL.

West, M.D, J.W. Shay, W.E. Wright, and M.H.K Linskens. 1996. Altered expression of plasminogen activator inhibitor during cellular senescence. *Experimental Gerontology* 31:175–193.

Whitcomb, J.C., and H.M. Morris. 1961. *The Genesis Flood: The Biblical Record and its Scientific Implications*. Presbyterian and Reformed Publishing Co, Phillipsburg, NJ.

Wieland, C. 1998. Living for 900 years. *Creation Ex Nihilo* 20(4):10–13.

Wieland, C. 1994. Decreased lifespans: have we been looking in the right place? *Creation Ex Nihilo* 8(2):138–141.

Wright, E.L. (Ned). 2006. *Eddington's Temperature of Space*, http://www.astro.ucla.edu/~wright/Eddington-T0.html, accessed 10/17/2015

Young, D.W. 1988. On the application of numbers from Babylonian mathematics to biblical life spans and epochs. *Zeitchrift für die Alttestamentliche Wissenschaft* 100:331–361.

Young, D.W. 1990. The influence of Babylonian algebra on longevity among the antediluvian. *Zeitchrift für die Alttestamentliche Wissenschaft* 102:332–335.

Young, D.W. 2004. The sexagesimal basis for the total tears of the antediluvian and postdiluvian epochs. *Zeitchrift für die Alttestamentliche Wissenschaft* 116(4): 506–527.

Author's Note

Bryce W. Self contributed the knowledge of Serug introducing post–diluvian idolatry leading to his son Nahor's abnormally short life span and that Ginzberg (1913) wrote about this. Rabbi Rodney Feinerman and Hebrew language teacher Rachel Levana provided the keyword search that yielded seven other sources discussing Serug's idolatry. Joel B. Robertson provided Pritchard (1969). Dr. Walter T. Brown (Colonel) provided Dillow's (1978) exponential decay analysis. Joe Bardwell brought heavy hydrogen (aka deuterium) to the author's attention, who then found Brown (2008, p. 426). The author thanks Paul Abramson, creationism.org, for discussions on related fields such as tooth wear and dinosaur size, the capacitor model and the mix of air pressure and oxygen. William Carey International University chancellor (and USCWM founder) Dr. Ralph D. Winter granted access to their graduate study center (limited access section of Latourette Library), where Schroeder's book, citing Maor was found. *CRSQ* physics editor Dr. Eugene Chaffin provided the following references: Azbel′ (1997); Hayflick (1965); Kondalenko (1993); Niessen (1982); Patten (1982); Seaver (1983, 1985); West et al. (1996); Strickling (1973); Wieland (1994, 1998). Sal Cordova provided the internet link to Wright's (2006) reference to Eddington. Dave Bradbury led to (Glatt, 2012) by bringing attention to Guth, from a comment made by Guth (Matson, 2010) about the universe's size increasing by doubling. Guy Forsythe called attention to literature that led to Gamow's (1948) graph for the universe's first 30 minutes of space expansion. Maarten t'Hart led to (Glatt, 2014), when he asked a question, the answer to which provided this paper's cosmology system input to the human longevity engineering model. Dr. Ted Siek described chemical relation to entropy increase. Dr. Manny Rios led the author to Courtois, et al.

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A Review of the Lynden-Bell/Choloniewski Method for Obtaining Galaxy Luminosity Functions

Part I

Jake Hebert and Jason Lisle*

Abstract

In the biblical worldview, Earth is not just another planet, but the unique world where God placed those who are made in His image. For this reason, some creationists have speculated that our world might have a privileged location in the physical universe. For example, some have suggested that the solar system may be near the center of a sequence of concentric shells of high galaxy number density, accounting for the "quantized redshifts" seen in cosmic surveys. In order to rigorously test for this possibility, it is necessary to first determine the true spatial distribution of galaxies in our local neighborhood. In order to do this, however, it is necessary to correct for the fact that some dim galaxies are too faint to be seen, an effect that becomes more severe with increasing distance. This correction is often obtained via a *luminosity function*, which gives the fraction of galaxies that fall within a selected intrinsic brightness range. Recently, the Institute for Creation Research has done additional work in this area. In order that the creation science community may be able to intelligently critique future galactocentric claims, this review presents a detailed description of one method for obtaining the luminosity function.

Introduction

The *cosmological principle* of secular cosmology is the assumption that on the largest distance and angular scales, there are no special places or directions in the cosmos (Gabrielli et al., 2010, p. 31; Humphreys, 1994, pp. 14–21). Moreover, as noted by Hartnett (2007, p. 75), secular scientists have in the past been adamant that neither Earth nor the Milky Way galaxy could be "special" in the cosmic scheme of things. In the biblical worldview, there is good reason to question this assumption, given the importance of Earth in God's plan of redemption. Hence, creation scientists do not uncritically accept the *cosmological principle* of big-bang cosmology. The

* Jake Hebert and Jason Lisle, Institute for Creation Research, Dallas, TX, contact@icr.org
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biblical worldview may well allow for this principle, but it does not require it.

There has long been interest within the creation community regarding the possibility that our Milky Way galaxy might be located within a special or preferred location in space (Humphreys, 2002; Hartnett, 2005). For instance, the evidence of concentric rings of high galaxy density roughly centered on the location of our Milky Way galaxy is very unexpected within big-bang cosmology. However, there is some question as to whether this effect is real. Maps of galaxy positions are generated from Earth-based observations, which may lead to observer-centered distortions giving the false appearance of Earth-centered structures, such as the "fingers of God" effect discovered in the late 1950s. Observer-centered biases must therefore be carefully quantified in order to assess the legitimacy of any galactocentric claims. One such effect is the *Malmquist bias*: the systematic drop in our ability to detect faint galaxies at progressively greater distances. The purpose of this paper is to clearly and concisely explain one of the techniques that may be used to determine the most likely true distribution of galaxies, given the galaxies that are actually observed. The Institute for Creation Research has recently done significant additional work in this area and one of us (Lisle) has devised a novel approach to determining galaxy luminosity functions (Lisle, 2016). Because these methods are often not clearly explained in the technical literature, it is our hope that this review will help familiarize the creation science community with these methods so that future results may be intelligently critiqued.

The Malmquist Bias

In a flux-limited (or magnitude-limited) survey, the number of galaxies included in the survey is determined by the minimum amount of light per unit area (flux) that can be detected by the survey instrument. In such a flux-limited survey, the observed number density of galaxies decreases with increasing distance from Earth (Strauss and Willick, 1995, p. 54). This is due to the fact that the apparent brightness of a galaxy diminishes with increasing distance. Thus, at close distances, both faint and bright galaxies are detectable. But at greater distances, only bright galaxies can be detected. Hence, bright objects tend to be overrepresented in the survey simply because they are easier to detect, and this effect becomes more pronounced with increasing distance. This Malmquist bias is named after the Swedish astronomer Gunnar Malmquist (Heydari-Malayeri, 2014). The Malmquist bias must be taken into account when attempting to determine the true distribution of galaxies.

To compensate for the Malmquist bias, one needs to obtain a selection function $S(r)$ that gives the fraction of galaxies that will be observed at a particular distance relative to the number that actually exist at that distance. Conceptually, this fraction is given by the observed number density of galaxies at a given distance divided by the true number density of galaxies:

$$S(r) = \frac{\rho_{obs}(r)}{\rho_{true}(r)} \tag{1}$$

The observed number density is known, since this is simply the number of galaxies detected in a volume of space in a given survey. If the selection function is also known, then it is possible to obtain the true galaxy number density as a function of distance, thereby removing the Malmquist bias.

In order to obtain this selection function, it is necessary to know something about the distribution of galaxy brightnesses so that we can estimate how many of the fainter galaxies we are missing at larger distances. Specifically, we must find what fraction of galaxies fall within a selected range of intrinsic luminosity. This histogram of galaxy brightnesses is called the *luminosity function*. We begin our discussion of galaxy luminosities by addressing the relevant terminology.

Luminosity and Magnitudes

The apparent magnitude m of an astronomical object is a measure of its apparent brightness as it appears in our sky. Apparent magnitudes use a logarithmic scale that allows astronomers to describe an enormous apparent brightness range with relatively small differences in magnitude values. For instance, the apparent magnitude of the Sun is -26.7, while the dimmest object that can be detected by the human eye has an apparent magnitude of about +6.0 (Freedman and Kaufmann, 2002, p. 427). As can be seen from these two examples, brighter objects have smaller apparent magnitudes, while dimmer objects have higher apparent magnitudes. The apparent magnitude scale has been defined in such a way that a magnitude difference of 5 corresponds to a brightness ratio of exactly 100 (i.e., an object with $m = 1.0$ is 100 times brighter than an object with $m = 6.0$). It should also be noted that m is frequency-dependent, since galaxies emit different intensities of light at different frequencies. In galaxy surveys, apparent magnitudes are generally measured for a given bandwidth.

The *absolute* magnitude M is a measure of an object's intrinsic brightness. Specifically, it is defined as the apparent magnitude that an object would have at a distance of 10 parsecs (1 parsec = 3.26 light-years). As is the case with apparent magnitudes, objects of greater intrinsic brightness have smaller values of M than do intrinsically dimmer objects.

The redshift z is the fractional change in the wavelength of a galaxy's light between emission and detection, which is generally attributed to the expansion of the universe.

The quantity $d_L(z)$ is the (redshift-dependent) luminosity distance to the galaxy, where the luminosity distance is a distance measurement for which light obeys the inverse-square law.

The relationship between the absolute and apparent magnitudes of an object and the object's luminosity distance (measured in parsecs) is given by Freedman and Kaufmann (2002, p. 429) and Hogg et al. (2002):

$$m = M + 5\log_{10}\left(\frac{d_L(z)}{10\ \text{pc}}\right) = M + 5\log_{10} d_L(z) - 5 \tag{2}$$

We define the distance modulus μ such that

$$\mu = 5\log_{10}\left(\frac{d_L(z)}{10\ \text{pc}}\right) = m - M \tag{3}$$

Eqs. (2) and (3) as written fail to take into account the need for a so-called *K-correction*. This complication is addressed later in the paper.

If the luminosity distance is expressed in mega-parsecs (Mpc), then Eq. (2) becomes

$$m = M + 5\log_{10} d_L(z) + 25 \tag{4}$$

The Luminosity and Selection Functions

The luminosity function is defined such that $\phi(M)dM$ is the estimate for the *true* (not just observed) number of galaxies per unit volume having absolute magnitudes between M and $M + dM$. At this point, it is necessary to briefly discuss the concept of comoving distances and volumes.

In cosmological studies, a *comoving distance* is one in which the expansion of the universe has been "factored out" (Bergström and Goobar, 2008, pp. 62, 200). Hence, if one were to imagine a hypothetical universe in which galaxies had no velocities other than those due to the expansion of the universe (i.e., no *peculiar velocities*), then the comoving distances between galaxies would remain constant. Since comoving distances (and volumes) remain unaffected by the expansion, comoving distances are optimal distance measurements for studying the large-scale distribution of galaxies. Hence, when determining the luminosity function, comoving volumes should be used when computing number density. Hogg et al. (2002) present a number of standard formulae for calculating comoving distances. However, it should be noted that these formulae have been derived under the assumptions of a homogeneous and isotropic universe (standard assumptions also used by big bang advocates). In a spatially "flat" universe, in which parallel lines never meet or diverge, the comoving line-of-sight distance d_C to a galaxy is related to the luminosity distance and redshift by

$$d_C(z) = \frac{d_L(z)}{(1+z)} \tag{5}$$

When attempting to discern possible patterns in the spatial distribution of galaxies, one would prefer to keep such an analysis as "assumption-free" as possible. Hence, it is understandable that one might object to the use of standard assumptions for the distance formulae in such an analysis. Unfortunately, it is simply not possible to convert redshifts to distances without making *some* assumptions. However, the use of standard parameters for the distance formulae in such an analysis is not as problematic for our purposes as one might initially suspect. For instance, suppose that one could somehow discern the true comoving distances to all the galaxies within a survey without making any cosmological assumptions whatsoever. Then suppose we were to calculate these comoving distances using Eq. (5). Even if these distances were to disagree somewhat, there would still be a one-to-one correspondence between the calculated and true comoving distances. Hence, any "peaks" in galaxy density that appear when the density is plotted as a function of redshift will *also* appear when the density is plotted as a function of comoving distance. So even if these calculated distances are distorted somewhat due to incorrect cosmological assumptions, concentric rings of high galaxy density, if they exist, should still be apparent when the galaxy density is plotted as a function of distance.

Once the luminosity function has been found, the selection function may be obtained. Since the redshift z is a proxy for distance, the selection function is often expressed in terms of redshift:

$$S(z) = \frac{\int_{M_{\min}}^{\min\left[M_{\max},\, M_{\lim(z)}\right]} \phi(M)dM}{\int_{M_{\min}}^{M_{\max}} \phi(M)dM} \tag{6}$$

The denominator in Eq. (6) is, for a given redshift z, the true number of galaxies per unit volume between the magnitude limits M_{min} and M_{max} of the survey, while the numerator is the observed number of galaxies per unit volume within those same magnitude limits and at that particular value of z. Hence Eq. (6) can be thought of as the fraction of galaxies we are detecting, at a particular redshift z, compared to the actual number that exist.

For the best estimate of the selection function, one should choose the upper and lower limits on the absolute magnitudes (M_{min} and M_{max}) to include as many galaxies as possible. For purposes of this explanatory paper, we will ignore certain complications that arise in real galaxy surveys, although these complications are addressed in follow-up papers (Hebert and Lisle, 2016; Lisle, 2016). For instance, real galaxy surveys sometimes contain a small number of outlying galaxies having anomalously high or low absolute magnitudes, magnitudes that are either extremely rare or perhaps even simply erroneous. Likewise, traditional methods of finding the luminosity function, including the Lynden-Bell/Choloniewski (LBC) method, assume a "hard" apparent magnitude limit cutoff; i.e., apparent magnitudes less than or equal to a limiting apparent magnitude m_{max} can be observed, while apparent magnitudes greater than m_{max} cannot. In real galaxy surveys, however, the apparent magnitude cutoff is "fuzzy"—the vast majority of galaxies within the survey have apparent magnitudes less than m_{max}, but a small fraction of galaxies have apparent magnitudes greater than this number. Since traditional methods presuppose a "hard" apparent magnitude cutoff, the best choice for m_{max} when using these methods is actually a number that is *less* than the very dimmest apparent magnitude in the survey. For purposes of this discussion, however, we ignore these complications. Instead, we assume that our hypothetical galaxy survey contains no anomalously high or low absolute magnitudes, and we assume the existence of a "hard" apparent magnitude cutoff of m_{max}. Once the basic theory behind the LBC method has been described, necessary modifications to the method demanded by conditions in real galaxy surveys are discussed in follow-up papers (Hebert and Lisle, 2016; Lisle, 2016).

The number $M_{lim(z)}$ in our expression for $S(z)$ is the absolute magnitude of the faintest galaxy that could in principle be detected at the redshift z. This is computed for each value of z by taking the upper limiting apparent magnitude of the survey (denoted as m_{max}) minus the distance modulus $\mu(z)$ corresponding to that redshift, as given in Eq. (3). This is expressed as follows:

$$M_{\lim(z)} = m_{\max} - 5\log_{10}(d_L(z)) - 25 = m_{\max} - \mu(z) \tag{7}$$

The limiting apparent magnitude m_{max} is determined by the limitations of the detector since it can obtain a reliable spectrum (necessary for redshift estimation) only over a particular range of apparent magnitudes. For galaxies to be included in the SDSS survey, their *r*-band Petrosian apparent magnitude must be lower than 17.77 (Strauss et al., 2002). Hence one might expect m_{max} to be equal to 17.77 for the SDSS survey. However, the final estimate for this limiting apparent magnitude is not exactly 17.77 due to some complicating factors. These factors, as well as more detailed discussions of different magnitude systems, are discussed in later papers (Hebert and Lisle, 2016; Lisle, 2016).

Assumptions of the Method

When doing any kind of scientific analysis, it is good to be aware of one's underlying assumptions. The LBC method involves a number of implicit assumptions. For instance, the denominator of Eq. (6) is said to give the true number of galaxies per unit comoving volume for any redshift z, even though the denominator is formally independent of z. This implies that the luminosity function is independent of redshift (or equivalently, of distance). Hence one does not expect galaxies of a particular brightness to be preferentially located at any particular distance or distances. Although dimmer galaxies are much more numerous than brighter galaxies (Sparke and Gallagher, 2010, p. 396), one does not expect dim galaxies to be any more or less likely to be located at a particular distance than galaxies of any other brightness. This assumption, though not strictly correct, is widely accepted as a good first approximation (Gabrielli et al., 2010, pp. 221, 291). It should also be noted that there are ways to test the validity of this assumption (Gabrielli et al., 2010, pp. 293–297).

Because the Lynden-Bell/Choloniewski method implicitly assumes a "hard" cutoff for the survey's limiting apparent magnitude, this implies that at a particular redshift z, any galaxy having an absolute magnitude less than $M_{lim(z)}$ will automatically be detected. To put it another way, the method assumes that there is a 100% probability that any galaxy at a redshift z having magnitude $M \leq M_{lim(z)}$ will be detected, but there is a 0% probability that any galaxy with $M > M_{lim(z)}$ will be detected. While this may seem perfectly reasonable, it is not necessarily true in real galaxy surveys, for reasons discussed in our follow-up papers (Hebert and Lisle, 2016; Lisle, 2016). Nonetheless, the approximation is workable. We have also assumed that no true galaxies have been misidentified as something other than a galaxy (100% survey *completeness*) and that no nongalaxy objects have been misidentified as galaxies (100% survey *efficiency*). This too is a good approximation, but it is not exact. A brief discussion of survey completeness and efficiency is proved in Ball and Brunner (2010).

One of the better-known methods for obtaining the luminosity function is the Lynden-Bell/Choloniewski (LBC) method, originally proposed by Lynden-Bell (1971) and later modified by Choloniewski (1987). Willmer (1997) has argued, on the basis of Monte Carlo simulations, that of the conventional methods for finding galaxy luminosity functions, the LBC method provides the most robust estimate of the luminosity function's shape, although another method, the stepwise maximum-likelihood method, devised by Efstathiou, Ellis, and Peterson (1988) seems to be more popular.

The LBC Method: Introduction

For purposes of this discussion, we are considering a galaxy survey consisting of N_{obs} observed galaxies. The absolute magnitude M, the apparent magnitude m, the redshift z, and the distance modulus μ are all assumed to be known for each of the N_{obs} galaxies. The survey's smallest value of μ is denoted by μ_{min} and the largest value of μ is denoted by μ_{max}.

From its original derivation, the LBC assumes that no two galaxies in the survey have exactly the same absolute magnitude. This is not true of the SDSS survey; due to its limited precision, a substantial fraction of galaxies share absolute magnitudes. For the time being, this complication is ignored as we present Lynden-Bell's and Choloniewski's original derivations. However, this complication does not affect their result, as shown in a second paper in this series (Hebert and Lisle, 2016). The galaxies are sorted by absolute magnitude in order of decreasing brightness, such that $M_{k+1} > M_k$. As noted earlier, we assume a "hard" cutoff for the survey's limiting apparent magnitude, which is denoted by m_{max}.

Consider a plot of the μ versus M values for each of the N_{obs} galaxies in the survey. Figure 1 illustrates this for a small hypothetical sample of ten observed galaxies. Of course, a real galaxy survey can contain many thousands of galaxies. The brightest galaxies (those with the smallest absolute magnitude values) are located toward the left-hand side of the figure. We have chosen the survey to have lower and upper distance modulus limits of μ_{min} and μ_{max}, respectively. Once these limits have been chosen, a particular galaxy within the survey will have the smallest absolute magnitude M_{min}, and another galaxy will have the largest absolute magnitude M_{max}. Note that galaxies above the diagonal m_{max} line cannot be detected because they are too faint to be seen. Also note that given the hard apparent magnitude cutoff m_{max} and the distance modulus limits of the survey, the largest absolute magnitude that can theoretically be contained within the survey is $M = m_{max} - \mu_{min}$. As noted earlier, however, a real galaxy survey can sometimes contain galaxies with absolute magnitudes greater than this theoretical upper limit. The reason for this counterintuitive result is presented in Hebert and Lisle (2016). For the time being, we consider only those galaxies that are brighter than this theoretical upper limit.

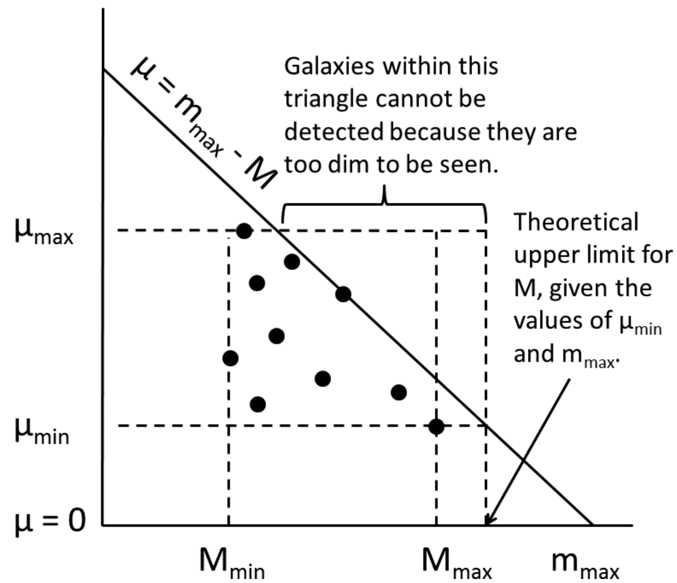

Figure 1. Plot of distance modulus μ versus absolute magnitude M for a simulated magnitude-limited survey containing ten observable galaxies. Of course, a real galaxy survey may contain many thousands of such galaxies. Note that the diagonal line is defined by the limiting apparent magnitude m_{max} of the survey, such that no galaxies are observed within the triangle above the diagonal line. As discussed in the text, it is assumed that these absolute magnitudes have been *K*-corrected, and that the distance moduli have already been transformed according to Eqs. (18) and (19).

Lynden-Bell's Original Method: The Basic Concept

The basic premise behind the method is that, as is usually assumed, the luminosity function $\phi(M)$ is independent of z (or equivalently, independent of μ).

Consider an arbitrary value of absolute magnitude M_k located between the bounds of the survey M_{min} and M_{max} (Figure 2). We can count the observed number of galaxies within the thin shaded rectangle centered at M_k. This thin shaded rectangle is itself contained within a large shaded rectangle, and we can count the number of observed galaxies within the large shaded rectangle, as well. We denote the number of galaxies within the small rectangle as $dX(M_k)$, and we denote the number of galaxies within the large shaded rectangle as $C(M_k)$. Note that all the galaxies we have counted are below the value of μ at the point where the diagonal line defined by $\mu = m_{max} - M$ intersects M_k, so that we are only considering galaxies between the horizontal lines defined by $\mu = \mu_{min}$ and $\mu =$

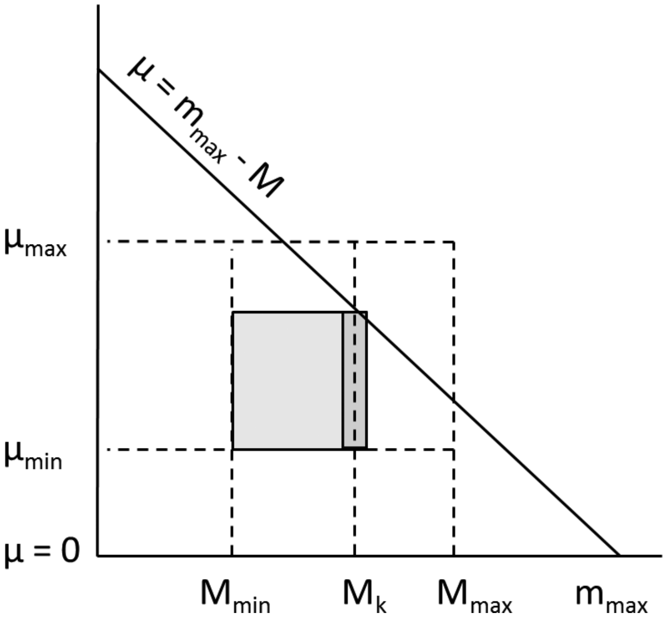

Figure 2. Because the tops of both the thin and large gray rectangles lie below the diagonal line, the counted numbers of observed galaxies in both rectangles should be equal to the true numbers of such galaxies. The number of observed galaxies within the thin rectangle compared to the number of observed galaxies within the large rectangle is denoted in this paper as *Fraction$_1$*.

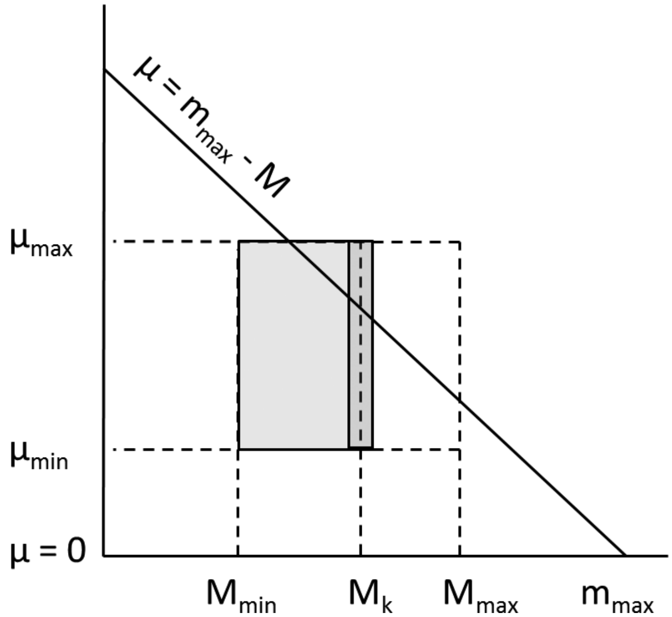

Figure 3. Although the true distribution of galaxies $\phi(M)$ is unknown, if one assumes that $\phi(M)$ is independent of distance (or μ), then the ratio of the true number of galaxies within the thin rectangle compared to the true number of galaxies within the large rectangle (denoted as Fraction2) should be equal to *Fraction$_1$*, as described in Figure 2.

$m_{max} - M_k$. Because all the galaxies we are counting are below the diagonal line (and hence should be visible), we should, in theory, not be overlooking any galaxies and should be counting 100% of the galaxies that are actually present within the two rectangles. In other words, the observed number of galaxies within the two rectangles should be equal to the true number of galaxies. Note also that both the thin and large rectangles have the same height, which means they are both defined by the same maximum and minimum distance moduli values. Or equivalently, they are characterized by the *same* comoving volumes in physical space. We can define the fraction (or percentage) of galaxies within the thin rectangle compared to the large rectangle as

$$\text{Fraction}_1(M_k) = \frac{\text{Galaxies/volume (thin rectangle)}}{\text{Galaxies/volume (large rectangle)}} = \frac{\text{Galaxies in thin rectangle}}{\text{Galaxies in large rectangle}} = \frac{dX(Mk)}{C(Mk)} \quad (8)$$

Now consider two similar rectangles, but which extend all the way from $\mu = \mu_{min}$ to $\mu = \mu_{max}$ (Figure 3). Remember that $\phi(M)dM$ is *defined* to be the true number of galaxies per unit volume between M and $M + dM$. Hence, we can define in a similar fashion a second fraction as

$$\text{Fraction}_2(M_k) = \frac{\text{Galaxies in thin rectangle}}{\text{Galaxies in large rectangle}} = \frac{\phi(M_k)dM}{\int_{M_{\min}}^{M_k} \phi(M)dM} \quad (9)$$

Remember also that $\phi(M)$ is assumed to be independent of z (or equivalently, of μ). This means that galaxies within the bin centered on M_k should make the same fractional (or percentage) contribution to the cumulative number of galaxies per unit volume (such that $M \leq M_k$) *regardless of the size of the comoving volume being examined*. In other words, we are assuming that however many galaxies in our survey have $M \approx M_k$, these galaxies are more or less uniformly distributed throughout the comoving volume of the survey. So if galaxies with $M \approx M_k$ contribute 0.5% to the cumulative number of galaxies per unit comoving volume (such that $M \le M_k$) for values of μ ranging between $\mu = \mu_{min}$ and $\mu = m_{max} - M_k$, then they should *also* contribute ~0.5% to the cumulative number of galaxies for μ between μ_{min} and μ_{max}. Hence, if this assumption is true, then $\text{Fraction}_1(M_k) = \text{Fraction}_2(M_k)$:

$$\frac{dX(M_k)}{C(M_k)} = \frac{\phi(M_k)dM}{\int_{M_{\min}}^{M_k} \phi(M)dM} \tag{10}$$

This is the fundamental assumption behind the method. Let us now define $\psi(M_k)$ to be the cumulative luminosity function for $M_{min} \le M \le M_k$:

$$\psi(M_k) = \int_{M_{\min}}^{M_k} \phi(M)dM \tag{11}$$

such that

$$d\psi = \phi(M)dM \tag{12}$$

is the differential contribution to this luminosity function. We may thus rewrite Eq. (10) as

$$\frac{dX(M_k)}{C(M_k)} = \frac{d\psi(M_k)}{\psi(M_k)} \tag{13}$$

Note that because M_k is an arbitrary value of M, it may be treated as a "dummy" variable should one integrate Eq. (13) up to some specific value of M_k, say $M_{k'}$. Performing this integration from $M = M_{min}$ to $M_k = M_{k'}$ yields

$$\psi(M_{k'}) = A\exp\left(\int_{M_{\min}}^{M_{k'}} \frac{dX}{C}\right) \tag{14}$$

After careful consideration of the manner in which a single galaxy would contribute to this integral, Lynden-Bell (1971) converted this expression into a discrete form. Replacing $M_{k'}$ with M' to match his notation we have:

$$\psi(M') = \int_{M_{\min}}^{M'} \phi(M)dM$$

$$= A \prod_{i:}^{M_{\min}<M_i<M'} \left(\frac{C^-(M_i)}{C^-(M_i)+1}\right) \tag{15}$$

Eq. (15) gives an expression for the (unnormalized) cumulative luminosity function in terms of $C^-(M_i)$, which is defined to be the number of points inside the large rectangle of Figure 2 but excluding the contribution of the i^{th} galaxy itself. Note that for $i = 1$, the way in which we have defined $C^-(M_i)$ implies that $C^-(M_1 = M_{min}) = 0$. To prevent ψ from being equal to 0, Lynden-Bell imposed the requirement that the quantity in parentheses in Eq. (15) be equal to 1 for $M_i = M_{min} = M_1$. Because Choloniewski's version of the method is in some ways more straightforward, we will not discuss this version of the method any further.

A Complication: The *K*-Correction

However, before discussing Choloniewski's modification to the Lynden-Bell method, it is necessary to address a complication when using Eqs. (2), (3), and (4) that was not explicitly addressed by either Lynden-Bell or Choloniewski. The apparent magnitude *m* in Eq. (2) has been determined through a bandwidth in the observer's reference frame. However, determination of the galaxy's true intrinsic brightness should be performed in the galaxy's rest frame. Since the light from the galaxy is being detected through a filter of limited bandwidth, red- or blue-shifting of this light will cause the portion of the galaxy's spectrum that can be detected by the filter to be shifted partly into or out of the filter's bandwidth, leading to a distortion in the calculated absolute magnitude *M*. In order to correct for this distortion, the *z*-dependent *K*-correction has been defined (Hogg et al., 2002) such that

$$m_{\text{observed frame}} = M_{\text{emitted frame}} + \mu + K(z) \tag{16}$$

A direct calculation of the *K*-correction requires integration of a galaxy's flux spectral density (energy per unit time per unit area per unit frequency). Such calculations are computationally unrealistic for galaxy surveys containing hundreds of thousands of galaxies. However, much faster analytical techniques can estimate the appropriate *K*-corrections. For instance, Chilingarian, Melchior, and Zolotukhin (2010) have published a technique (as well as an online *K*-calculator and codes at http://kcor.sai.msu.ru/

getthecode/) for such a purpose. Their technique requires the galaxy redshift z and the galaxy color, which is defined as the difference in apparent magnitudes measured in two different bandwidths. If one measures the luminosity distance in megaparsecs (Mpc), the expression for the K-corrected absolute magnitude becomes:

$$M_{\text{corrected}} = M_{\text{emitted frame}}$$
$$= m_{\text{observing frame}} - 5\log_{10} d_L(z) - 25 - K(z, \text{color}) \quad (17)$$

Furthermore, Eq. (16) is now the defining relationships between M, m, and μ, rather than Eq. (3). However, Choloniewski did not include a K-correction in his discussion of the method. This omission may be ameliorated by using Eq. (16) to obtain the K-corrected absolute magnitude for each galaxy and by making a coordinate transformation

$$\mu' = \mu + K_{\text{avg}}(z) = m_{\text{observed frame}} - M_{\text{emitted frame}}$$
$$= m_{\text{observed frame}} - M_{\text{corrected}} \quad (18)$$

where $K_{avg}(z)$ is the average K-correction of galaxies in our survey at redshift z. Details on obtaining K_{avg} are provided in Lisle (2016). Using the μ' coordinate frame, the K-correction appears to vanish as it is absorbed into the distance modulus. Hence the same relationship exists between μ', $M_{corrected}$, and m in Eq. (18) as between μ, M, and m in Eq. (16). Thus we may continue to use Choloniewski's method, despite this complication, provided that we use K-corrected absolute magnitudes and replace μ with μ'. Note that this coordinate frame transformation is an approximation that accommodates the average K-correction of all galaxies at redshift z, though individual galaxies may have somewhat different K-corrections due to their various colors.

We will follow Choloniewski's notation in this discussion of his method and will therefore omit the prime symbol from the distance modulus. But bear in mind that from this point on we are assuming that each absolute magnitude M has already been K-corrected and that each value of μ has been replaced by $\mu' = \mu + K_{avg(z)}$. Once these new values of μ have been determined, they may be plotted on a chart (as in Figure 1). Note that μ_{min} and μ_{max} must also be converted to the μ' coordinate system as follows:

$$\begin{aligned} \mu'_{\min} &= \mu_{\min} + K_{\text{avg}}(z_{\min}) \\ \mu'_{\max} &= \mu_{\max} + K_{\text{avg}}(z_{\max}) \end{aligned} \quad (19)$$

Choloniewski's Modification to the Method

Choloniewski (1987) modified Lynden-Bell's original method in order to obtain a normalized (noncumulative) differential version of the luminosity function. In considering Figure 1, note that the apparent number density of observed galaxies in the μ-M plane (actually, the $\mu' - M_{corrected}$) plane, which we shall call N_{app}, may be expressed as a sum of two-dimensional Dirac delta functions

$$N_{app}(M,\mu) = \sum_{k=1}^{N_{obs}} \delta(M - M_k, \mu - \mu_k) \quad (20)$$

such that the apparent galaxy number density at a given location in the M-μ plane is zero if a galaxy is not present, but infinite if one is. The apparent density may also be expressed as

$$N_{app}(M,\mu) = N_{\text{true}}(M,\mu)\Theta(m_{\max} - m) \quad (21)$$

where $N_{true}(M, \mu)$ is the true density of galaxies in the M-μ plane, multiplied by a Heaviside "step" function, defined as

$$\Theta\left[m_{\max} - m\right] = \Theta\left[m_{\max} - \left(\mu + M\right)\right]$$
$$= \begin{cases} 1 & m = \mu + M \le m_{\max} \\ 0 & \text{otherwise} \end{cases} \quad (22)$$

This step function "masks" the galaxies in the upper triangle in Figure 1 so that they cannot be observed, simulating the effect of the limiting apparent magnitude m_{max}. Per our assumption that absolute magnitude is independent of position, we can express N_{true} as the product of the one-dimensional functions $\varphi(M)$ and $D(\mu)$:

$$N_{true}(M,\mu) = \varphi(M)D(\mu) \quad (23)$$

Our expression for N_{app} then becomes

$$N_{app}(M,\mu) = \varphi(M)D(\mu)\Theta\left[m_{max} - (M+\mu)\right] \tag{24}$$

Because the right-hand side of Eq. (20) is a sum of two-dimensional Dirac delta functions, and because $\varphi(M)$ and $D(\mu)$ are independent of one another, it is reasonable to express the right-hand side of Eq. (24) in terms of sums of one-dimensional Dirac delta functions:

$$\begin{aligned} \varphi(M) &= \sum_{i=1}^{N_{obs}} \psi_i \delta(M - M_i) \\ D(\mu) &= \sum_{j=1}^{N_{obs}} d_j \delta(\mu - \mu_j) \end{aligned} \tag{25}$$

Hence, our expression for $N_{true}(M, \mu)$ becomes

$$N_{true}(M,\mu) = \left[\sum_{i=1}^{N_{obs}} \psi_i \delta(M - M_i)\right]\left[\sum_{j=1}^{N_{obs}} d_j \delta(\mu - \mu_j)\right] \tag{26}$$

Combining Eqs. (20), (24), and (26) yields

$$\sum_{k=1}^{N_{obs}} \delta(M - M_k, \mu - \mu_k) = \left[\sum_{i=1}^{N_{obs}} \psi_i \delta(M - M_i)\right] \left[\sum_{j=1}^{N_{obs}} d_j \delta(\mu - \mu_j)\right]\Theta\left[m_{max} - (M+\mu)\right] \tag{27}$$

Note that we can eliminate the mathematically awkward step function by judicious selection of the indices on the right-hand side of Eq. (27). This may be done by imposing the restriction that $M_i + \mu_j \le m_{max}$ for all i and j:

$$\sum_{k=1}^{N_{obs}} \delta(M - M_k, \mu - \mu_k) = \sum_{i:}^{M_i+\mu_j \le m_{\max}} \sum_{j:} \psi_i d_j \delta(M - M_i)\delta(\mu - \mu_j) \tag{28}$$

Determining the Weighting Factors

In order to obtain a practical solution, it is necessary to solve for the ψ and d weighting factors on the right-hand side of Eq. (28). One may solve for a particular d_j value, say d_p, by integrating Eq. (28) over all values of M but only over one particular value of μ (Figure 4). To ensure that the integral of a Dirac delta function is nonzero, the argument of the delta function should fall *inside* the limits of integration (Griffiths, 1989, p. 49). Hence, in this particular case, one should technically start the integration just a little to the left of M_{min} and end it just a little to the right of M_{max}. Likewise, the second integration should be performed from $\mu_p - \varepsilon$ to $\mu_p + \varepsilon$, where ε is a vanishingly small number such that ε is just a little smaller than the minimum possible difference between any two adjacent values of μ_j. Having done so, one obtains an expression for each of the N_{obs} individual d_p values:

$$1 = d_p \sum_{i:}^{M_i+\mu_p \le m_{\max}} \psi_i \quad p = 1,2,\ldots,N_{obs} \tag{29}$$

Likewise, one can integrate both sides of Eq. (28) from μ_{min} to μ_{max} and from $M_q - \sigma$ to $M_q + \sigma$, where σ is a vanishingly small number such that it is smaller than the smallest possible difference between any two adjacent values of M_i. This yields, for a particular choice of $i = q$,

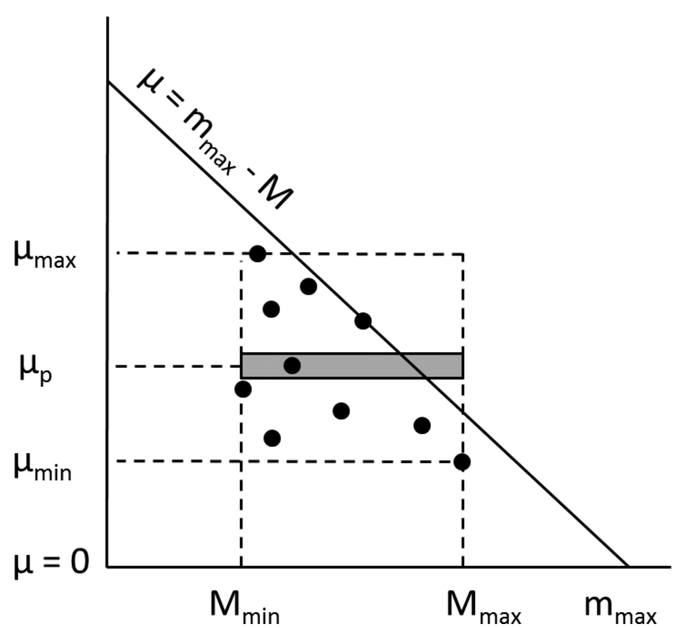

Figure 4. Area of integration used to obtain a specific weighting factor d_p.

$$1 = \psi_q \sum_{j:}^{M_q+\mu_j \le m_{\max}} d_j \quad q = 1,2,\ldots,N_{obs} \tag{30}$$

Relating the Weighting Factors to the C_k's

However, we still need some way of relating these weighting factors to the observed number of galaxies within the survey. To this end, we redraw Figure 2, but without the small shaded rectangle centered on M_k (see Figure 5). We then define $C_k = C(M_k)$ as the number of galaxies contained within this large shaded rectangle, or more precisely, as the number of galaxies having values of M and μ such that $M_{min} \le M < M_k$ and $\mu_{min} \le \mu \le m_{max} - M_k$. Note that, since $M_1 = M_{min}$, zero galaxies satisfy the requirement that $M_{min} \le M < M_1$. Hence no galaxies are inside the box when $M = M_{min}$ and $C_1 = 0$. We may use Eq. (28) to derive a useful relation between the C_k's and the ψ_i values. We again integrate Eq. (28), but this time from $\mu = \mu_{min}$ to $\mu = \mu_{max}$ and from $M = M_{min} - \sigma$ to $M = M_k + \sigma$. Upon doing so, the left-hand side of Eq. (28) yields the visible number of galaxies such that $M \le M_k$ (remember that there are zero visible galaxies above the diagonal line). Note that this number of visible galaxies is equal to $C_k + 1$, since C_k excludes, by definition, the galaxy for which $M = M_{min}$.

The result, combined with integration of the right-hand side yields

$$C_k + 1 = \sum_{i:}^{M_i+\mu_j \le m_{\max}} \psi_i \int_{M_{\min}-\sigma}^{M_k+\sigma} \delta(M - M_i)\,dM$$

$$\sum_{j:}^{M_i+\mu_j \le m_{\max}} d_j \int_{\mu_{\min}-\varepsilon}^{\mu_{\max}+\varepsilon} \delta(\mu - \mu_j)\,d\mu$$

$$= \sum_{i=1}^{k} \psi_i \sum_{j:}^{M_k+\mu_j \le m_{\max}} d_j \tag{31}$$

Eqs. (30) and (31) may then be used to obtain an extremely useful recursion relation. If one substitutes Eq. (30) into Eq. (31) in order to eliminate the summation over j and also obtains an expression for C_{k+1} by replacing k in Eq. (31) with $k+1$, one can derive:

$$\psi_{k+1} = \psi_k \frac{C_k + 1}{C_{k+1}} \quad k = 1,2,\ldots,N_{obs} \tag{32}$$

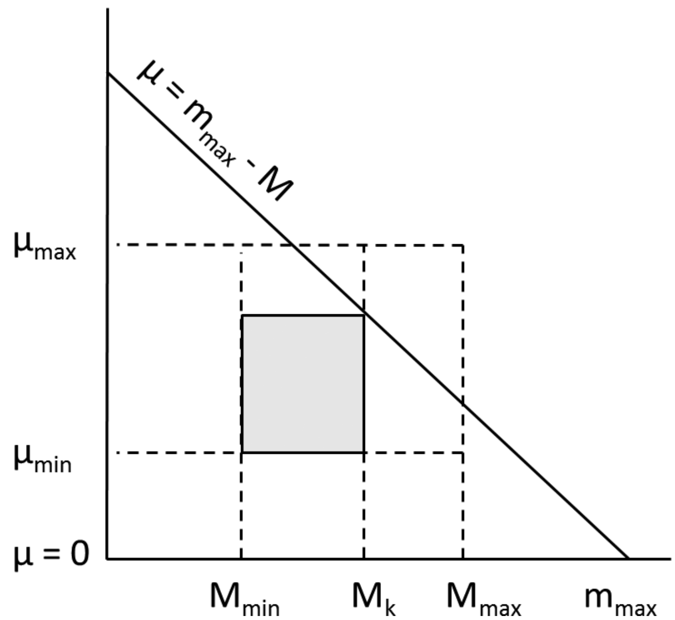

Figure 5. Geometry used to count the number of visible galaxies having absolute magnitudes between M_{min} and M_k. $C(M_k)$ is defined to be the number of galaxies within the rectangle but excluding the galaxy on the rectangle's right-hand edge.

Since the C_k values may be obtained via simple counting, knowledge of ψ_1 automatically determines all the other values of ψ. Generally, ψ is taken to be equal to 1. However, the actual choice of ψ_1 is not critical, since the true density of galaxies in Eq. (28) for a given M_i and μ_j actually depends on the product of $\psi_i d_j$, not just ψ_i. Hence, choosing ψ_1 to be some other value than 1 will just result in different d_j values, leaving the overall factor $\psi_i d_j$ unchanged.

Obtaining the Comoving Volume and the Total Number of Galaxies

In order to express the luminosity function in terms of galaxies per unit volume, it is expedient to calculate the comoving volume of the survey. From our definition of the distance modulus in Eq. (3), we see that each value of μ (or equivalently, each value of z) corresponds to a unique luminosity distance d_L. Eq. (5) may then be used to convert this luminosity distance into a comoving distance. Once the minimum and maximum distance moduli (or the minimum and maximum z values) for the survey are used to obtain the minimum and maximum comoving distances $d_{c,min}$ and $d_{c,max}$, the appropriate total comoving volume for the survey may be obtained via

$$V_t = \int_{d_{c,\min}}^{d_{c,\max}} r^2 dr \int_{\text{solid angle}} d\Omega = \int_{d_{c,\min}}^{d_{c,\max}} r^2 dr \int_{\theta} \sin\theta' d\theta' \int_{\phi} d\phi' \tag{33}$$

It should be noted that Choloniewski seems to have made an error in his original paper. His originally defined V_t that he used to obtain the luminosity function (Choloniewski, 1987, p. 275) was actually expressed in terms of luminosity distance, rather than comoving distance, which is more appropriate for this kind of analysis. Upon obtaining V_t, our expression for the luminosity function becomes

$$\begin{aligned}\phi(M) &= \frac{1}{V_t}\int_{\mu_{\min}-\varepsilon}^{\mu_{\max}+\varepsilon} N_{true}(M,\mu)d\mu \\ &= \frac{1}{V_t}\left[\sum_{i=1}^{N_{obs}} \psi_i \delta(M - M_i)\right]\left[\sum_{j=1}^{N_{obs}} d_j\right]\end{aligned} \tag{34}$$

The total number of galaxies within the survey may be obtained by integrating our expression for N_{true}, Eq. (26), over all values of M and μ:

$$\begin{aligned}N_{total} &= \int_{M_{\min}-\sigma}^{M_{\max}+\sigma} \int_{\mu_{\min}-\varepsilon}^{\mu_{\max}+\varepsilon} N_{true}(M,\mu)dMd\mu \\ &= \sum_{i=1}^{N_{obs}} \psi_i \sum_{j=1}^{N_{obs}} d_j\end{aligned} \tag{35}$$

Obtaining the Luminosity Function

Once V_t and all the values of ψ and d have been obtained, the problem has, in principle, been solved. However, our solution is undefined for values of M that fall "between" the absolute magnitudes of the N_{obs} galaxies in Figures 1 and 4. Since we will need to integrate the luminosity function in order to obtain the selection function $S(z)$, it is expedient to obtain a version of the luminosity function that is defined at regularly spaced intervals of M. We denote this more useful version of the luminosity function as $\langle\phi(M)\rangle$, and it is obtained by integrating Eq. (34) over a small bin width of ΔM and then dividing the resulting numbers by ΔM:

$$\begin{aligned}\langle\phi(M)\rangle &= \int_{M}^{M+\Delta M} \phi(M)dM \Bigg/ \int_{M}^{M+\Delta M} dM \\ &= \frac{\displaystyle\sum_{i:}^{M_i\in[M,M+\Delta M]} \psi_i \sum_{j=1}^{N_{obs}} d_j}{V_t \Delta M}\end{aligned} \tag{36}$$

Once this version of the luminosity function has been obtained, it may be integrated, as in Eq. (6) to obtain the selection function $S(z)$. In order to obtain an estimate for $M_{lim(z)}$ for each value of z in the integration, it is necessary to insert m_{max} and $K_{\text{avg(z)}}$ into Eq. (17). $K_{\text{avg(z)}}$ can be obtained by averaging all the different K-corrections for the galaxies within a small bin of width Δz centered on that particular value of z.

Demonstration of the Method

Of course, there are additional complications that must be addressed when finding the luminosity function for a real galaxy survey. These are discussed in an accompanying paper (Hebert and Lisle, 2016), along with a demonstration of the LBC method.

Conclusion

The possibility that our galaxy may occupy a special location within the universe is obviously of great interest to the creation science community. However, testing of such a possibility requires the true (not just apparent) distribution of galaxies in the vicinity of our own Milky Way galaxy. This in turn requires determination of the luminosity function. Because methods used to obtain luminosity functions are rarely explained clearly in the technical literature, we have provided a detailed discussion of one such method. It is our hope that such an explanation will (1) enable the creation science community to intelligently critique claims that our galaxy occupies a privileged location in space and (2) serve as a "stepping stone" for future creation researchers.

References

Ball, N.M., and R.J. Brunner. 2010. Data mining and machine learning in astronomy. *International Journal of Modern Physics D*, Vol. 19, 7:1049–1106. http://ned.ipac.caltech.edu/level5/March11/Ball/Ball3.html#3.1

Bergström, L., and A. Goobar. 2008. *Cosmology and Particle Astrophysics*, 2nd edition. Praxis Publishing, Chichester, UK.

Chilingarian, I., A. Melchior, and I. Zolotukhin. 2010. Analytical approximations of K-corrections in optical and near-infrared bands. *Monthly Notices of the Royal Astronomical Society* 405:1409.

Choloniewski, J. 1987. On Lynden-Bell's method for the determination of the luminosity function. *Monthly Notices of the Royal Astronomical Society* 226:273–280.

Efstathiou, G., R.S. Ellis, and B.A. Peterson. 1988. Analysis of a complete galaxy redshift survey—II. The field-galaxy luminosity function. *Monthly Notices of the Royal Astronomical Society* 232:431–461.

Freedman, R.A., and W.J. Kaufmann III. 2002. *Universe: Stars and Galaxies*. W. H. Freeman and Co., New York, NY.

Gabrielli, A., F.S. Labini, M. Joyce, and L. Pietronero. 2010. *Statistical Physics for Cosmic Structures*. Springer-Verlag, Berlin and Heidelberg, Germany.

Griffiths, D.J. 1989. *Introduction to Electrodynamics*, 2nd edition. Prentice-Hall Inc., Englewood Cliffs, NJ.

Hartnett, J. 2005. A creationist cosmology in a galactocentric universe. *Journal of Creation* 19(1):73–81.

Hartnett, J. 2007. *Starlight, Time, and the New Physics*. Creation Book Publishers. Atlanta, GA.

Hebert, J., and J. Lisle. 2016. A review of the Lynden-Bell/Choloniewski method of obtaining galaxy luminosity functions: part II. *Creation Research Society Quarterly* 52:189–199.

Heydari-Malayeri, M. 2014. *An Etymological Dictionary of Astronomy and Astrophysics*. Observatoire de Paris. http://dictionary.obspm.fr/index.php/index.php?showAll=1&formSearchTextfield=Malmquist+bias (accessed August 11, 2014).

Hogg, D.W., I.K. Baldry, M.R. Blanton, and D.J. Eisenstein. 2002. The K correction. http://ned.ipac.caltech.edu/level5/Sept02/Hogg/paper.pdf (accessed May 2014).

Humphreys, D.R. 1994. *Starlight and Time*. Master Books, Green Forest, AR.

Humphreys, D.R. 2002. Our galaxy is the centre of the universe, 'quantized' redshifts show. *Journal of Creation* 16(2):95–104.

Lisle, J. 2016. New method to assess the luminosity function of galaxies. *Answers Research Journal* 9:67–79. https://assets.answersingenesis.org/doc/articles/pdf-versions/arj/v9/luminosity_function_galaxies.pdf

Lynden-Bell, D. 1971. A method of allowing for known observational selection in small samples applied to 3CR quasars. *Monthly Notices of the Royal Astronomical Society* 155:95–118.

Sparke, L.S., and J.S. Gallagher III. 2010. *Galaxies in the Universe: An Introduction*, 2nd edition. Cambridge University Press, Cambridge, UK.

Strauss, M.A., and J.A. Willick. 1995. The density and peculiar velocity fields of nearby galaxies. *Physics Reports* 261, Issues 5–6: 271–731. http://ned.ipac.caltech.edu/level5/March01/Strauss/Strauss_contents.html (accessed August 11, 2014).

Strauss, M.A., D.H. Weinberg, R.H. Lupton, V.K. Narayanan, and J. Annis, et al. 2002. Spectroscopic target selection in the Sloan Digital Sky Survey: the main galaxy sample. *The Astronomical Journal* 124:1810–1824.

Willmer, C.N.A. 1997. Estimating galaxy luminosity functions. *The Astronomical Journal* 114(3): 898–912.

Creation Research Society Quarterly 2016. 52:189–199.

A Review of the Lynden-Bell/Choloniewski Method for Obtaining Galaxy Luminosity Functions

Part II

Jake Hebert and Jason Lisle*

Abstract

In order for cosmologists to discern the large-scale structure of the cosmos, it is necessary to determine the true distribution of galaxies in space. In order to do this, however, it is necessary to correct for the fact that some dim galaxies are too faint to be seen (the *Malmquist bias*). This correction is often obtained via a *luminosity function*, which gives the number density of galaxies (galaxies per unit of comoving volume) per bin of intrinsic brightness (or absolute magnitude bin). This review uses real data from the Sloan Digital Sky Survey to demonstrate one such method for obtaining the luminosity function, the Lynden-Bell/Choloniewski method.

Introduction

A detailed review of the theory behind the Lynden-Bell/Choloniewski (LBC) method was presented by Hebert and Lisle (2016). In the LBC method, one plots the distance moduli μ of the N_{obs} visible galaxies within a survey against the absolute magnitudes M for those same galaxies (a demonstration plot for a "survey" of galaxies with $N_{obs} = 10$ is shown in Figure 1). It should be noted that prior to using the method, each galaxy absolute magnitude should be K-corrected and each galaxy distance modulus μ should be replaced by $\mu + K_{avg}(z)$. Although this discussion follows the notation of Choloniewski (1987), it should be noted that neither Lynden-Bell (1971) nor Choloniewski (1987) explicitly mentioned the need to perform the K-correction in their papers.

Choloniewski (1987) showed that the number density of observed galaxies in μ-M space (actually, $[\mu + K_{avg(z)}]$-$M_{corrected}$ space, to be more precise) may be expressed as

$$\sum_{k=1}^{N_{obs}} \delta(M - M_k, \mu - \mu_k) =$$

$$\sum_{i:}^{M_i + \mu_j \le m_{max}} \sum_{j:} \psi_i d_j \delta(M - M_i)\delta(\mu - \mu_j) \qquad (1)$$

The weighting ψ and d factors may be obtained by integrating Eq. (1) subject to judicious choices for the limits of

* Jake Hebert and Jason Lisle, Institute for Creation Research, Dallas, TX, contact@icr.org
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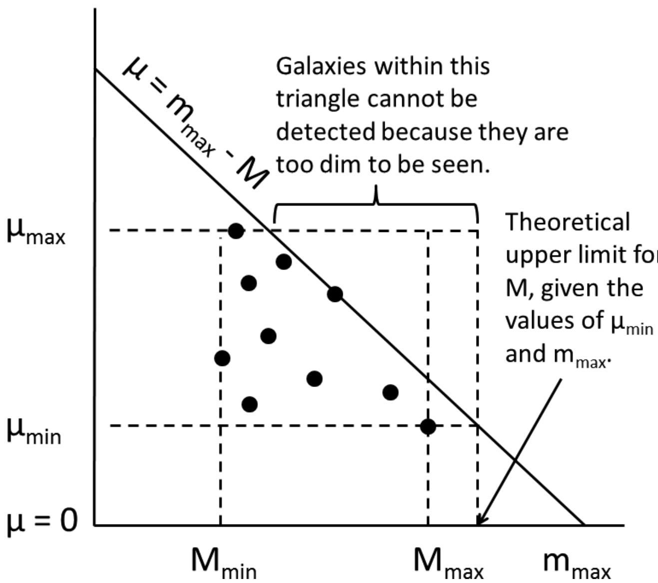

Figure 1. Plot of distance modulus μ versus absolute magnitude M for a simulated magnitude-limited survey containing ten observable galaxies. Of course, a real galaxy survey may contain many thousands of such galaxies. Note that the diagonal line is defined by the limiting apparent magnitude m_{max} of the survey, such that no galaxies are observed within the triangle above the diagonal line. Complications regarding m_{max} and M_{max} that are encountered in real galaxy surveys are discussed in the text.

integration, as discussed by Choloniewski (1987) and Hebert and Lisle (2016). Once these weighting factors have been obtained, the luminosity function is given by

$$\phi(M)=\frac{1}{V_t}\left[\sum_{i=1}^{N_{obs}}\psi_i\delta(M-M_i)\right]\left[\sum_{j=1}^{N_{obs}}d_j\right] \quad (2)$$

where V_t is the total comoving volume of the galaxy survey.

The Sloan Digital Sky Survey

The Sloan Digital Sky Survey (http://www.sdss.org/) is a major survey of celestial objects that covers about 35% of the sky. The survey utilizes a 2.5 meter wide-field telescope at the Apache Point Observatory in New Mexico (York et al., 2000, p. 1580). This telescope is equipped with a CCD camera that can image the sky in five optical bands, as well as two digital spectrographs. In addition to this 2.5-meter telescope, two other telescopes were used in the process of calibrating photometric magnitudes, a USNO 40-inch telescope and an SDSS photometric telescope (PT). More than 900 million unique objects (stars, galaxies, and quasars) have been detected at the time of the tenth data release in July 2013. Spectroscopic measurements have been made for 859,322 unique galaxies, permitting redshifts to be calculated for those galaxies (http://www.sdss3.org/dr10/scope.php#opticalstats). Helpful websites for downloading Sloan data are http://skyserver.sdss3.org/dr9/en/help/docs/default.asp and http://skyserver.sdss3.org/casjobs/.

The SDSS photometric system consists of five broad color bands, denoted as *u*, *g*, *r*, *i*, and *z*, which are designed to facilitate the detection of faint objects and provide coverage of the whole accessible range of optical wavelengths (3000 Å to 11, 000 Å).

SDSS Apparent Magnitudes

There are several different ways to estimate the apparent magnitude of a galaxy in a given filter. Hence, one question that must be resolved before analyzing patterns in galaxy spatial distribution is this: Which is the best apparent magnitude system to use for such an analysis?

The standard definition of apparent magnitude (or Pogson apparent magnitude) is given in terms of the flux (photons per unit area) within a specified wavelength range of a star or galaxy by the following formula:

$$m_P=-2.5\log_{10}\left(\frac{f}{f_0}\right) \quad (3)$$

where f_0 is a conventionally agreed-upon reference flux. The reference flux sets the zero point of the magnitude system and corresponds closely to the brightness of the star Vega. Though the apparent magnitude is easily estimated for stars, there is a problem with using this definition for galaxy surveys.

Because galaxies are extended objects, rather than point sources, there are complications in attempting to determine their total flux within a particular band (such as their lack of well-defined "edges"). The apparent magnitude of a galaxy is defined to be that which it would have if all of its light were concentrated into a point. This is perfectly well defined in principle. But in practice, this can be very difficult to estimate with high precision because the sky itself is not totally dark and it is difficult to disentangle sky flux from galaxy flux, particularly near the dark and ill-defined limb (edge) of the galaxy. So, a number of different methods have been developed to give a reasonable and pragmatically workable estimation of a galaxy's apparent magnitude.

One is by calculating the galaxy's so-called Petrosian flux (Petrosian, 1976). The Petrosian flux and magnitude systems were designed to measure a consistent fraction of the galaxy's total light, regardless of the galaxy's distance and location. This is achieved by measuring galaxy fluxes within a circular aperture whose radius is determined by the shape of the (azimuthally-averaged) surface brightness profile *I (r)*, which is the brightness for a standardized portion of the extended object. Surface brightness is usually measured in magnitudes per square arc second. Because radiative flux decreases with the square of the distance, while surface area increases with the square of the distance, the surface brightness is independent of distance. The SDSS survey uses a modified version of the Petrosian flux as described at http://ned.ipac.caltech.edu/help/sdss/dr6/photometry.html#mag_petro.

A second way is via the use of luminosity profiles. If one can fit a mathematical luminosity or brightness function, which describes the way in which the galaxy's (azimuthally averaged) brightness varies with radial distance from the galaxy's center, then one can obtain the total brightness (or equivalently, the total flux) of that galaxy by integrating this function over all possible brightnesses or luminosities (i.e., from zero to infinity). The radially averaged brightness of an elliptical galaxy (as a function of apparent distance *r* from its center) is given by a *de Vaucouleurs profile*:

$$I_{ellipse}(r) = \mathrm{I}_e \exp^{-7.669\left[\left(\frac{r}{re}\right)^{1/4} - 1\right]} \tag{4}$$

where r_e is the radius of the galaxy's inner disk contributing half the galaxy's brightness and I_e is the brightness at that radius. The brightness of the disk of a spiral or lenticular galaxy is described by a decaying exponential:

$$I_{disk}(r) = I_0 \exp(-r / r_e) \tag{5}$$

Note that these two equations assume that the galaxy's inclination to the observer has already been taken into account when obtaining these brightness functions.

Since spiral galaxies often consist of an ellipsoidal "bulge," as well as a disk, the composite flux of a spiral galaxy can be modeled as a superposition of the de Vaucouleurs and exponential brightness profiles. Moreover, such a superposition can be used, without loss of generality, for galaxies that are primarily elliptical or that are disklike and yet lack a prominent central bulge. The composite flux of a galaxy was thus defined by the SDSS team to be:

$$f_{composite} = fracDeVf_{deV} + (1 - fracDeV)\, f_{exp} \tag{6}$$

Where f_{deV} and f_{exp} are the de Vaucouleur and exponential fluxes, respectively, and *fracDeV* is the fraction of this composite flux due to the de Vaucouleur profile. Although one could conceivably generate more complicated models than this for certain extended objects, the SDSS team opted against this on the basis that such additional computational expense was not warranted for the bulk of detected objects.

Once the flux has been obtained via one of these methods, it may be used to obtain the galaxy's apparent magnitude *m* for a particular band. However, as noted earlier, there is a complication in attempting to use the traditional Pogson definition of apparent magnitude: calculated apparent magnitudes are subject to very large errors when *f* is comparable to the flux of the background sky. Because many galaxies are quite dim, this is a problem for galaxy surveys. In order to circumvent this problem, Lupton, Gunn, and Szalay (1999) devised a modified magnitude system based upon the inverse hyperbolic sine function. These "asinh" magnitudes are defined by

$$m_{asinh} = -\left[2.5 / \ln(10)\right]\left[\frac{asinh(f / f_0)}{2b} + \ln b\right] \tag{7}$$

where b is a "softening parameter" designed to minimize the noise in values of m. The value of b for the r-band is 1.2×10^{-10} (http://classic.sdss.org/dr7/algorithms/fluxcal.html#asinh_table). This is the apparent magnitude definition used by the SDSS survey after obtaining the galaxy flux (http://classic.sdss.org/dr7/algorithms/photometry.html#mag_psf) via the methods discussed above.

Once this flux was obtained, it was substituted into Eq. (7) in order to obtain the apparent magnitude. So-called *cmodel* magnitudes were calculated using a flux that was a best-fit superposition of the de Vaucouleurs and exponential profiles. A similar *model* magnitude was obtained by choosing the better fit of the de Vaucouleurs and exponential profiles to obtain the flux, rather than a superposition of the two.

The optimal magnitude system depends upon the task being performed, but the SDSS team noted that the cmodel apparent magnitude seems to be the best overall choice due to "close to optimal noise properties" that make it an even better choice than Petrosian magnitudes (http://classic.sdss.org/dr7/algorithms/photometry.html#mag_psf). However, the SDSS team noted that *model* magnitudes are the better choice for measuring the colors of extended objects such as galaxies.

In any case, the differences between the apparent magnitude systems are expected to be small. For instance, differences between cmodel and Petrosian magnitudes are only about 0.05–0.1 mag for bright galaxies.

Target Selection in the Main Galaxy Sample

This demonstration of the LBC method utilizes galaxies from the flux-limited main galaxy sample. The following is a brief summary of the main sample selection criteria provided in Strauss et al. (2002).

In order to simplify the selection process, only one limiting apparent (Petrosian) magnitude was used, rather than five. The SDSS team reasoned that this band should be either the *r* or *i* band, for the following reasons:

- *K*-corrections in an *r* (red) band or an *i* (far red) band tend to be smaller than those for other bandpasses.
- Galaxy fluxes are thought to be dominated by red stars.
- Inferred absolute magnitudes for the *i* and *r* bands are less affected by the phenomenon of galactic reddening than for other bands.

The *r* band was finally selected over the *i* band since the sky background is dimmer and less variable in the *r*-band, thus providing a better contrast to enable easier detection of galaxies against the sky background. The method of Schlegel, Finkbeiner, and Davis (1998) was used to correct for galactic extinction, the absorption and scattering of electromagnetic radiation due to the presence of galactic dust. After making this correction, Petrosian *r* magnitudes were calculated. Then saturated, bright, or blended objects were rejected, and the limiting apparent magnitude was set at $m_{\text{lim, Petrosian}} = 17.77$. This magnitude cutoff was chosen in order to obtain an average of at least 90 galaxies per square degree, as this angular galaxy density is believed to correspond to the depth at which galaxy number can vary substantially due to large-scale structure. Hence, this magnitude cutoff should facilitate the detection of large-scale galaxy structure that may exist.

However, surface brightness selection criteria were also imposed on the survey. Galaxies with a Petrosian half-width surface brightness (defined to be the average surface brightness within a circular radius containing half the Petrosian flux) less than or equal to 23.0 mag arcsecs^{-2} were included, although dimmer galaxies (higher surface brightness values) might also be included if they met other additional criteria. These surface brightness criteria were needed in order to ensure reliable spectroscopic results, which are necessary for an accurate determination of redshift. A schematic illustrating the selection process is provided in Figure 5 of Strauss et al (2002).

Completeness of a survey is defined to be the fraction of observed true galaxies that have been correctly identified as such (Ball and Brunner, 2010). By comparing galaxies identified by the SDSS survey to galaxies identified in the Zwicky catalog, the SDSS team estimated that the main galaxy sample had an overall completeness of more than 99% but that this completeness dropped to 95% for brighter galaxies, due to "blending" with saturated stars. Note that the concept of completeness refers to the percentage of correctly *identified* objects, *not* the percentage of objects that have been detected! In other words, even with a survey completeness of 99%, it is quite possible that the percentage of detected galaxies (compared to the true number of galaxies within the bounds of the survey) could still be quite small due to Malmquist bias. Hence, even a completeness of 99% does not remove the need for a luminosity function and selection function. The SDSS team estimated that nearly all (99.9%) spectroscopically observed galaxies in the main sample yielded successful redshift determinations. However, they estimated that 6% of galaxies were missed because of close angular proximity to a companion galaxy but that this could be accounted for by appropriate weighting of closely paired galaxies. Reproducibility of the sample was estimated at 94.5%.

A chart showing the galaxies in the main survey as a function of right ascension (RA) and declination (dec) is provided in Figure 2. Note that these celestial coordinates are given in the J2000.0 epoch (York et al., 2000, p. 1580; Hilton and Hohenkerk, 2004). The main ellipse of the main survey was chosen to maximize observing efficiency and to minimize the effects of galactic extinction (Strauss et al. 2002, p. 1811).

The Schechter Function

Galaxy luminosity functions are generally well characterized by a *Schechter function* (Schechter, 1976). Expressed in terms of absolute magnitude M, the number of galaxies per unit co-moving volume per absolute magnitude interval dM is given by

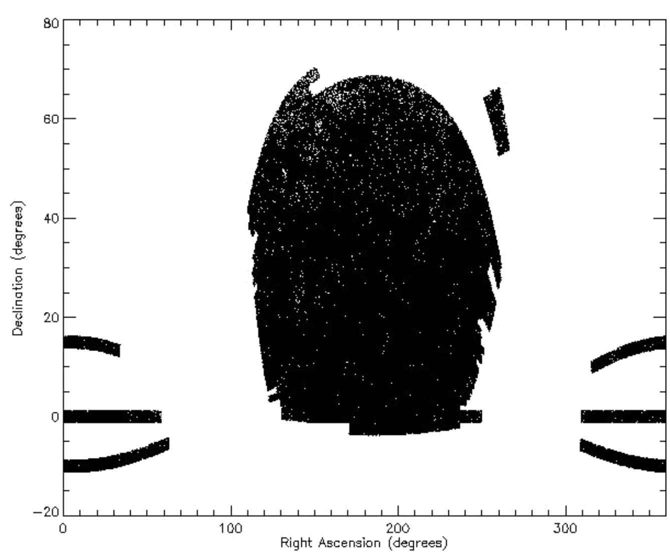

Figure 2. Sky plot of galaxies within the main galaxy portion of the SDSS survey (10th data release).

$$\phi(M)dM =$$
$$= 0.4\ln(10)\phi^*\left[10^{-0.4(M-M^*)}\right]^{\alpha+1}\exp\left[-10^{-0.4(M-M^*)}\right]dM \qquad (8)$$

Where ϕ^* is a normalization constant (in units of Mpc^{-3}), α is a dimensionless constant that defines the slope of the function for the dim (high magnitude) portion of the graph, and M^* is the absolute magnitude at which the Schechter function undergoes a rapid change in slope. Typical values of α are given by $-1.5 < \alpha < -1$ (Dickey 1988), although some luminosity functions have values of $\alpha > -0.1$ (Zucca et al., 2009, p. 1223). Simulated Schechter functions for various values of α are depicted in Figure 3.

In fact, one method of determining the galaxy luminosity function, the STY maximum likelihood method (Sandage, Tammann, and Yahil, 1979), simply assumes that the luminosity function has a Schechter form and then proceeds to find the values of the parameters α and M^* that provide the best fit to the data. The normalization ϕ^* may be obtained from galaxy number counts within a certain magnitude band. However, it should be noted that this normalization constant is not truly needed to obtain the selection function $S(z)$, since it is implicitly contained in both the numerator and denominator in Eq. (6) of Hebert and Lisle (2016) and thus cancels.

Solid Angles

In order to calculate a normalized luminosity function, one needs the comoving volume for the galaxy sample. This requires an appropriate solid angle Ω for the survey (but see note at the end of this section). Though physicists and mathematicians often measure solid angles in steradians (sr), the SDSS uses square degrees (see http://www.sdss3.org/dr10/), as this is more convenient for astronomers. The ratio between the two is given by:

$$4\pi \text{ steradians} \approx 41{,}253 \text{ deg}^2 \qquad (9)$$

The solid angle of the survey shown in Figure 2 can be computed by integration and is also provided by the SDSS website. Once the solid angle has been obtained, the comoving volume of the survey is easily computed. The total solid angle for the tenth data release of the SDSS is cited as 14,555 square degrees $\approx$ 4.43 sr, which is a little more than 35% of the sky. However, the actual value of the solid angle is not critical, as it, like the normalization constant of the luminosity function, will "divide out" when calculating the selection function $S(z)$; see Eq. (6) in Hebert and Lisle (2016).

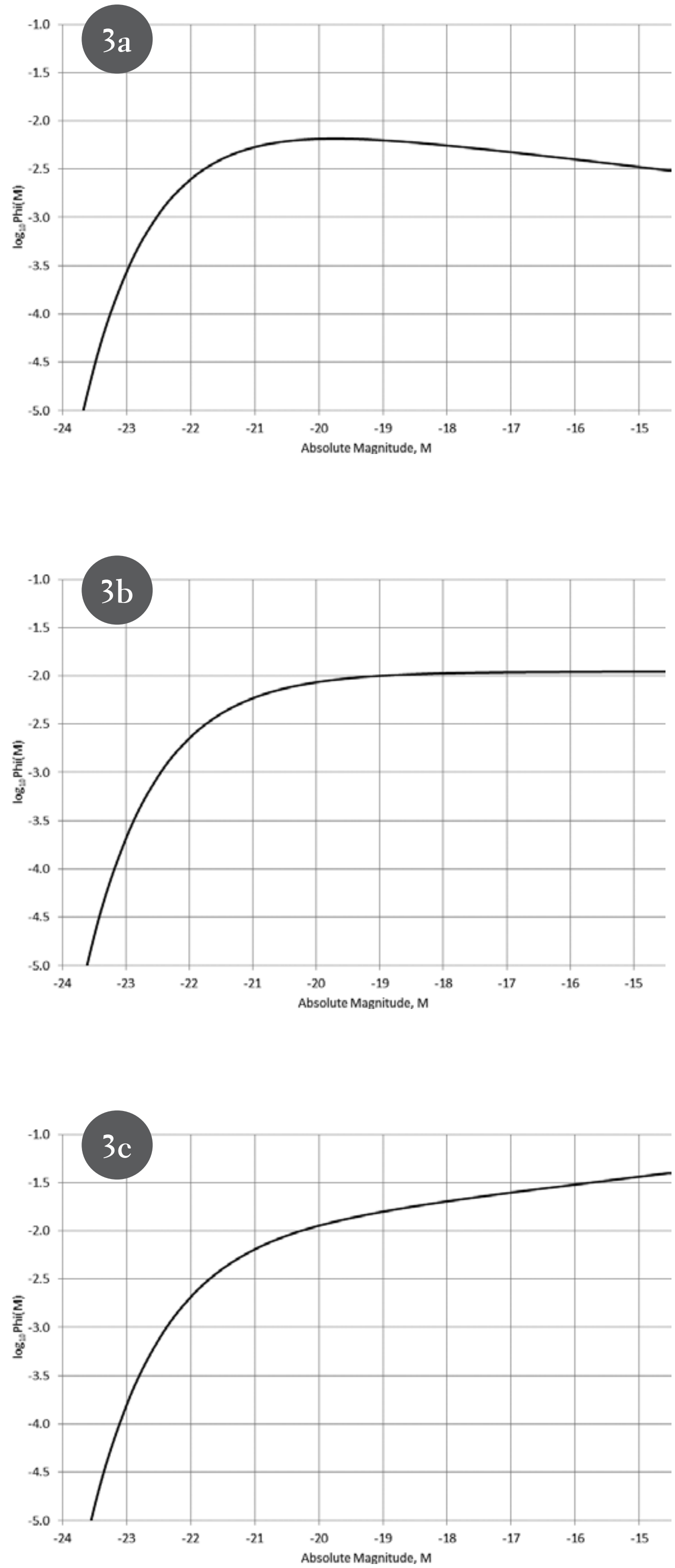

Figure 3. Simulated Schechter functions for M* = -21.5 and α equal to (a) -0.8, (b) -1.0, and (c) -1.2. Galaxy luminosity functions often have Schechter forms.

Demonstration of the Method

One of us (Lisle) has written an extremely efficient, fast, and versatile IDL code that can calculate the luminosity function for a set of galaxies via a number of different methods, including the LBC method. This demonstration uses galaxies from main Legacy survey of the tenth data release (http://skyserver.sdss3.org/dr10/en/credits/creditshome.aspx). To optimize accuracy, the code uses the *r*-band *model* apparent magnitudes when obtaining the color-dependent *K*-correction (Chilingarian, Melchior, and Zolotukhin, 2010) but *cmodel* apparent magnitudes when calculating distances. Redshift values were restricted to $0.05 \leq z \leq 0.28$ because this *K*-correction method had been tested for the *r*-band against direct *K*-corrections using galaxy flux spectra only for redshifts in this approximate range (Chilingarian, Melchior, and Zolotukhin, 2010, pp. 6–7). Galaxies having unreasonable color values (absolute value of the color greater than 3) were also excluded, as were quasars. In calculating comoving and luminosity distances, the standard values were used for cosmological parameters: $\Omega_m = 0.27$, $\Omega_\Lambda = 0.73$, and $H_0 = 71.0$. A small correction was applied to redshift values to account for the motion of our solar system relative to the CMB (implicitly accepting the assumption that the CMB is not a local phenomenon and represents an average reference frame of the visible universe). Before using the LBC method, one must first *K*-correct the survey's absolute magnitudes. This means that one must make the transformations $M \rightarrow M - K$ and $\mu \rightarrow \mu + K_{avg}(z)$ for each galaxy in the survey, as discussed in Hebert and Lisle (2016) and Lisle (2016). Once this has been done, it is possible to follow Choloniewski's original method.

Next, a plot of transformed μ values versus transformed *M* values should be produced (Figure 4) and inspected in order to decide upon reasonable values for m_{max}, M_{min} and M_{max}.

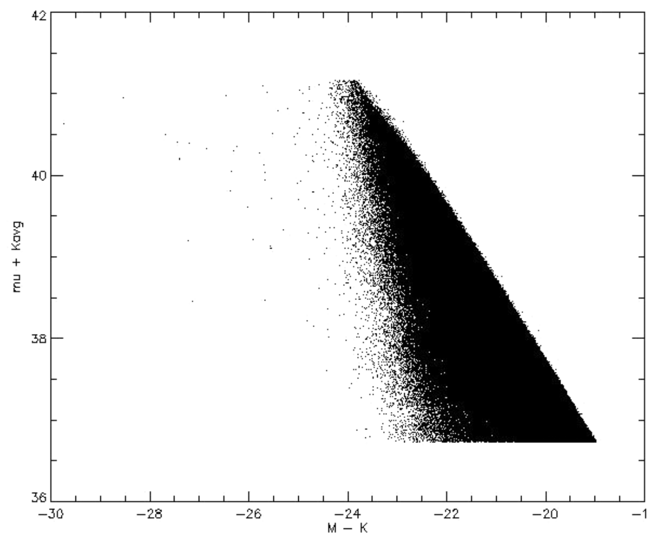

Figure 4. Plot of $\mu' = \mu + K_{avg}(z)$ versus $M_{corrected} = M - K$ for galaxies within the main survey meeting our selection criteria.

Determining m_{max}

Note that this plot differs from the basic form of Figure 1 in a number of significant ways. First, one might expect the diagonal line in Figure 4 to be very sharp and well defined, like the diagonal line in Figure 1. However, close inspection of Figure 4 reveals that this diagonal boundary is somewhat "fuzzy." This is due to the *K*-correction. The apparent magnitude cut must be applied before any *K*-correction, because it is the apparent brightness in Earth's reference frame that determines whether a galaxy can be detected. Thus, two galaxies at identical redshift and identical apparent magnitudes may have two slightly different absolute magnitudes, because they will have two different *K*-correction values. It may seem surprising that we would need to cut galaxies fainter than the limiting apparent magnitude, since these ideally should not have been included in the SDSS data set. But the SDSS cut is applied to the observed apparent magnitudes *before* any foreground contamination has been removed, whereas the final reported magnitudes have been adjusted to remove any such contamination. Thus, a galaxy significantly fainter than magnitude 17.77 could be included in the redshift survey if and only if it is very close in angle to a bright star, a nebula, or another brighter galaxy, causing the combined flux to exceed the threshold for inclusion. Since the LBC method tacitly assumes that no galaxies are detectable beyond the threshold, it has no way of dealing with these fainter galaxies. Therefore, they cannot be included in the analysis.

Because we are using cmodel rather than Petrosian fluxes to calculate galaxy apparent magnitudes, the value of m_{max} will not be exactly equal to the Petrosian cutoff of 17.77. However, we do expect it to be *close* to 17.77, due to the small differences between Petrosian and cmodel apparent magnitudes.

The optimal value of m_{max} may be estimated by preparing a histogram of cmodel *r*-band apparent magnitudes (Figure 5). From the histogram, one can see that most of the galaxies have cmodel apparent magnitudes less than ~17.8. The half-maximum value is a good choice for the brightness threshold to be used in the LBC method—a value that is clearly *less* than 17.77. An even more accurate analysis is possible that includes for observation bias (Lisle, 2016) yielding an optimal threshold of $m_r = 17.747$. Hence, for purposes of this demonstration, we set the value of m_{max} in Figures 1 and 4 to be 17.747.

Since the *K*-correction is used to estimate the absolute magnitude, both the distance estimate and apparent magnitude are unaffected; thus m_{max} is unaffected. Furthermore, since our

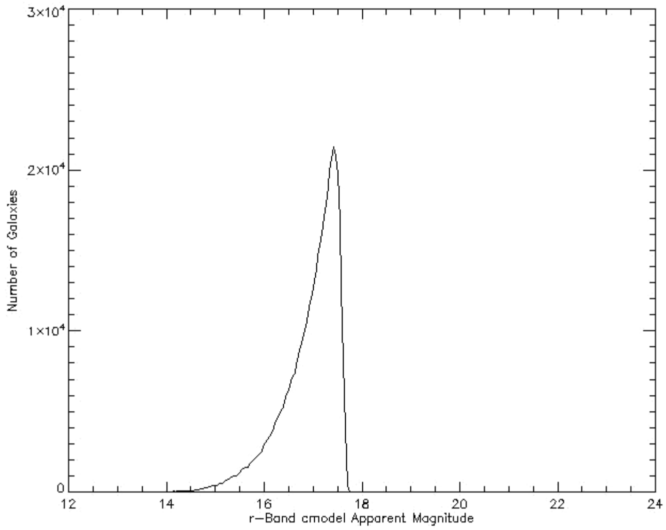

Figure 5. Histogram showing the number of galaxies in the main survey as a function of *r*-band *cmodel* apparent magnitudes. Since Petrosian apparent magnitudes are quite close in value to *cmodel* apparent magnitudes, it is not surprising that most galaxies have apparent magnitudes less than ~17.7, since the Petrosian magnitude selection cutoff was set to 17.77 (see text). Closer analysis of the data shows that the half maximum of the this sharp peak occurs at m_r = 17.747. Hence, for purposes of this demonstration of the LBC method, the value of m_{max} was set to 17.747.

transformation from μ to μ' affects only the distance coordinate, this also has no effect on m_{max}. When the limiting magnitude is plotted as a function of absolute magnitude and distance modulus, as in Figure 1, the *K*-correction (necessary to obtain the most accurate estimate of absolute magnitudes) causes the diagonal line to become a curve, due to the nonlinear response of *K* as a function of distance. Shifting to the μ' coordinate straightens this back into a diagonal line, allowing us to use the LBC method as is.

Note also that one cannot simply take m_{max} to be the very dimmest apparent magnitude of the survey. Because a significant number of galaxies have apparent magnitudes higher than this value, doing so would introduce a great deal of error into the determination of the luminosity function.

Selecting M_{min} and M_{max}

Now that m_{max} has been determined, we select appropriate values for M_{min} and M_{max}. This choice is somewhat arbitrary, though it makes sense to set these values to include most, if not all of the data. Note that it is conceivable that the survey may contain a small number of galaxies with anomalously low or high absolute magnitudes. There is no reason why these would have to be excluded from the analysis (providing they have survived the apparent magnitude cut), though we expect low statistical confidence in these extreme limits.

From Figure 4, we see that there are a small number of galaxies with absolute magnitudes less than ~ -25.0. There is no harm in setting M_{min} equal to the (*K*-corrected) absolute magnitude of the very brightest galaxy in the survey, since there is no theoretical lower limit on M_{min} and the LBC method is sufficiently robust to obtain an estimate for $\phi(M)$ even for very low (*K*-corrected) values of *M*. The solution in this magnitude range will be subject to very large errors, however, and should be considered unreliable. Likewise, M_{max} may be set to the intrinsically faintest galaxy, or to $m_{max} - \mu'_{min}$, though the paucity of extremely faint (observed) galaxies will result in low statistical confidence on this end as well.

Potential Complication: Galaxies with Equivalent Magnitudes

Choloniewski's original method assumed that no two galaxies in the survey will have exactly the same absolute magnitude. Many galaxies in the SDSS galaxy survey, however, violate this condition. Hence this complication must be considered.

One might worry that it would be necessary to completely re-derive the recursion relation between ψ_k and ψ_{k+1} found in Eq. (32) in our previous paper (Hebert and Lisle, 2016). However, this is not actually necessary. The fact that some galaxies in the SDSS survey have the same absolute magnitudes is a result of the limited precision of the survey; in reality, one does not expect any two galaxies to ever have *exactly* the same absolute magnitude. Hence, one could circumvent this difficulty by adding extremely tiny random numbers to the survey's *K*-corrected absolute magnitudes, random numbers that are much, much smaller than the precision of the recorded magnitude values. This would prevent any two galaxies in the survey from having exactly the same magnitude but without changing their values in any appreciable way. This would enable one to use the recursion relation as originally derived without modification.

However, even this is not really necessary. There are two keys to using the unmodified LBC method in this situation. The first key is to remember that the galaxies have already been sorted in order of increasing (*K*-corrected) magnitude. Hence C_k is not just equivalent to the number of galaxies inside the rectangle in our previous Figure 5; it is *also* equal to the number of galaxies that precede the k^{th} galaxy in this sorted list. This alternate definition of C_k will hold true regardless of whether or not any galaxies share the same magnitude.

The second key is to recognize that although two or more galaxies may happen to share the same magnitude, they are still

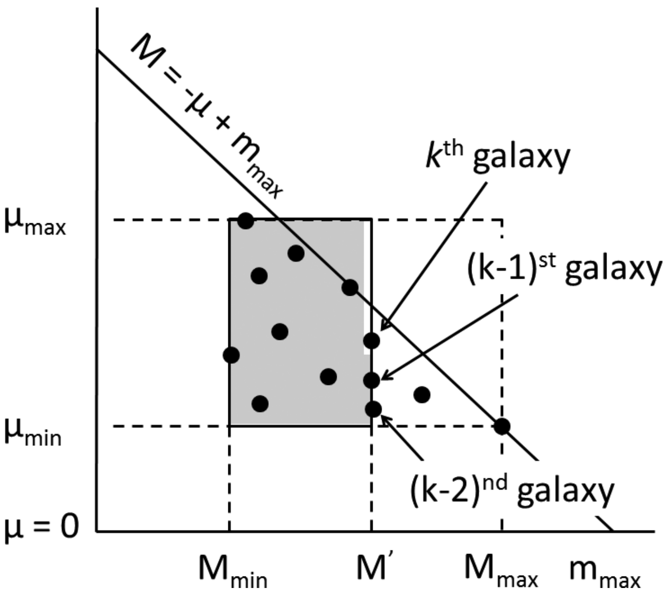

Figure 6. Diagram showing the geometry used to obtain *C (M')* when more than one galaxy has a magnitude of *M'*. Note that although we are here using Choloniewski's original notation, these are actually *K*-corrected absolute magnitudes. Likewise, the distance moduli have been transformed according to $\mu \rightarrow \mu + K_{avg}(z)$. Note also that our maximum absolute magnitude value M_{max} is very close to $m_{max} - \mu_{min}$, as one expects from Figure 4.

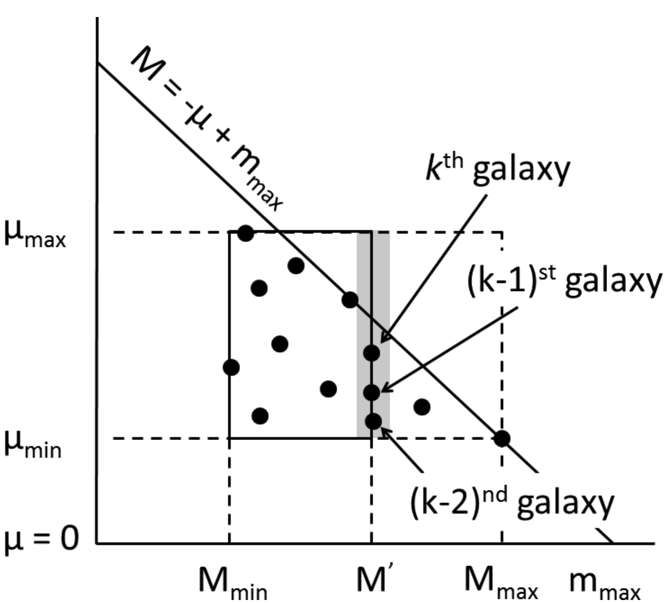

Figure 7. Geometry used to obtain Eqs. (10) and (11) in the text when multiple galaxies share the same magnitude.

characterized by *distinct* values of the index *k*. Hence, the sum on the left-hand side of Eq. (1) still contains N_{obs} terms, even though the magnitude values may not all be unique.

Now consider three galaxies (Figure 6) sharing the same magnitude M' (the reason why we are calling this magnitude M' rather than M_k as before is to prevent confusion, for reasons that should soon become apparent). We may integrate Eq. (28) in our previous paper (Hebert and Lisle, 2016) as we did before in order to obtain an expression for C_k, but this time we break the integration into two parts, the first part consists of the irregular gray region, while the second part consists of the thin, white vertical "sliver" at the upper right-hand side of our box. Integrating the left-hand side of Eq. (28) over the shaded region still gives us C_k, according to our new definition. Extending the area of integration to include the thin vertical sliver gives us one additional count due to the k^{th} galaxy. Hence, integration of the left-hand side of Eq. (28) gives us C_k+1 as before. When integrating the right-hand side of Eq. (28), we do so all at once. Because each galaxy is characterized by a unique value of *k* (even when it shares the same magnitude with another galaxy), we still get the same result as before, obtaining our previous Eq. (31). Hence, the derivation for our previous Eq. (31) is still valid, provided that we use this new, more general definition of C_k, rather than Choloniewski's old definition.

However, the derivation for our recursion relation also involved our previous Eq. (30), which contained a sum over *j*. Before we can be completely certain that our recursion relation will still hold, we must also make certain that the value of *this* sum is unaffected by galaxies with identical magnitudes. We do so by integrating this paper's Eq. (1) over the thin vertical rectangle shown in Figure 7. Integration of the left-hand side simply gives us the number of galaxies having a magnitude of M' (in this particular example, three). Integration of the right-hand side yields

$$\sum_{i:}^{M_i=M'} \psi_i \sum_{j:}^{M_i+\mu_j \le m_{\max}} d_j$$

$$= \psi_{k-2} \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j + \psi_{k-1} \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j + \psi_k \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j$$

$$= \left(\psi_{k-2} + \psi_{k-1} + \psi_k\right) \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j \qquad (10)$$

But since all three galaxies have the same magnitude M', we expect all three values of the magnitude-dependent weighting factor ψ to be equivalent. Hence we obtain

$$3 = 3 \cdot \psi_k(M') \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j \Rightarrow 1 =$$

$$= \psi_k(M') \sum_{j:}^{M'+\mu_j \le m_{\max}} d_j \qquad (11)$$

which is the same as our previous result. Hence, we can continue to use our previous recursion relation without loss of generality.

One can also look at it in another way. First, imagine that we have two consecutive galaxies (numbered k and k+1 respectively) that have *almost* the same magnitude, with galaxy number k+1 being ever so slightly *fainter* than galaxy number k. And recall that $C(M_k)$ is a count of all galaxies within the rectangle associated with galaxy k but excluding galaxy k itself. Now, if galaxy k+1 is only very slightly fainter than galaxy k, then it is highly probable that $C(M_{k+1}) = C(M_k) + 1$; that is, the rectangle associated with the $(k+1)^{st}$ galaxy will have exactly one more galaxy in it (galaxy number k) than the rectangle associated with the k^{th} galaxy. This is not a certainty, because there has been a very small change in distance modulus going from k to k+1, which implies that the top of the rectangle has been reduced slightly for k+1. So it is possible that one or more galaxies at the top of the rectangle for k are excluded from the rectangle for k+1. But since the change in M (or more precisely, the change in $M_{corrected}$) was tiny going from k to k+1, the probability is low that any galaxies were lost. Moreover, that probability goes to zero in the limit as M_{k+1} approaches M_k since the change in distance modulus goes to zero:

$$\lim_{M_{k+1} \to M_k} C(M_{k+1}) = C(M_k) + 1 \qquad (12)$$

Now consider two galaxies of equal magnitude. When sorted in order of decreasing magnitude, one will arbitrarily be placed in front of the other, such that one is assigned the number k and the next is assigned the number k+1. For these two galaxies $M_k = M_{k+1}$, meaning that they have the same horizontal coordinate. The key to using the LBC method with these galaxies is to use the above limit to ensure that the value of $C(M_k)$ goes up by one as k goes to k+1. In other words, when two or more galaxies share the same right edge of the rectangle, we count all galaxies within the rectangle and the edge up to but not including the k^{th} galaxy. The galaxy count $C(M)$ will therefore go up by exactly one for each consecutive galaxy of identical absolute magnitude.

Results

The LBC method was used to obtain the luminosity function via Eq. (2). The *K*-corrected absolute magnitude range was divided into 300 bins in order to obtain the result in Figure 8. Note that the luminosity function shows the least amount of noise in the middle of the magnitude range. This is expected, since galaxy counts within this magnitude region are highest. The random error increases away from the middle section, and becomes largest at either magnitude extreme since very few galaxies have these extreme magnitude values.

For the same reason, values of $\phi(M)$ for very low absolute magnitudes (< -24.5) are erratic and are not shown. This version of the LBC method does not permit a formal analysis of the errors in the luminosity function (although one could presumably use a jackknife method to do so), but another version of this method (Choloniewski 1986) does.

Potential "Pitfalls" for Future Research

A number of potential difficulties could complicate efforts to analyze galaxy patterns after compensating for the Malmquist bias using this method. First, there is the possibility that galaxies of different types may be characterized by different luminosity functions. In performing this exercise, we have used a single "global" luminosity function for all galaxies in the SDSS main

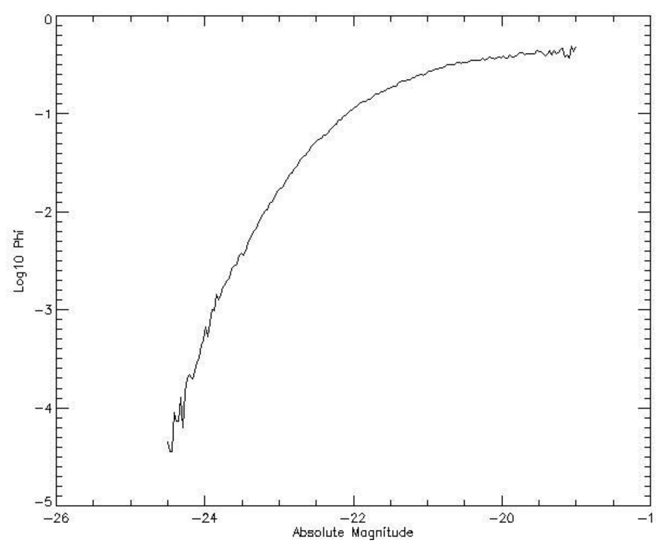

Figure 8. Luminosity function obtained using the LBC method and data from the 10th release of the Sloan Digital Sky Survey. The solution for $\phi(M)$ is not shown at values of M < -24.5, as this part of the solution is subject to large errors due to the very small numbers of galaxies within this magnitude range.

sample, regardless of galaxy type. However, Binggeli, Sandage and Tammann (1988) have noted that there are reasons to suspect that luminosity functions may vary with galaxy type. Even if this is the case, however, one would still think that it would be possible to obtain a single "global" luminosity function for all galaxies within our local vicinity. Another possibility is that the shapes of luminosity functions may vary with local density. Binggeli, Sandage, and Tammann (1988) generally reject this possibility, although they acknowledge that it might be valid for very bright galaxies.

Furthermore, most creation researchers have focused on the possibility of concentric shells of high galaxy density roughly centered on our own Milky Way galaxy, but it is also conceivable that more complicated, angular-dependent patterns might exist. These might also be indicative of design and suggestive that we occupy a special place in the cosmos.

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References

Ball, N.M., and R.J. Brunner. 2010. Data mining and machine learning in astronomy. *International Journal of Modern Physics D*, Vol. 19, 7:1049–1106. http://ned.ipac.caltech.edu/level5/March11/Ball/Ball3.html#3.1

Bergström, L., and A. Goobar. 2008. *Cosmology and Particle Astrophysics*, 2nd edition. Praxis Publishing, Chichester, UK.

Binggeli, B., A. Sandage, and G.A. Tammann. 1988. The luminosity function of galaxies. *Annual Review of Astronomy and Astrophysics* 26:509–560.

Chilingarian, I., A. Melchior, and I. Zolotukhin. 2010. Analytical approximations of K-corrections in optical and near-infrared bands. *Monthly Notices of the Royal Astronomical Society* 405:1409.

Choloniewski, J. 1986. New method for the determination of the luminosity function of galaxies. *Monthly Notices of the Royal Astronomical Society* 223:1–9.

Choloniewski, J. 1987. On Lynden-Bell's method for the determination of the luminosity function. *Monthly Notices of the Royal Astronomical Society* 226:273–280.

Dickey, J.M. 1988. A short introduction to luminosity functions of galaxies. *Astronomical Society of the Pacific Conference Series: Minnesota Lectures on Clusters of Galaxies and Large-Scale Structure* 5:9–18. http://ned.ipac.caltech.edu/level5/Dickey/Dickey2.html

Gabrielli, A., F.S. Labini, M. Joyce, and L. Pietronero. 2010. *Statistical Physics for Cosmic Structures*. Springer-Verlag, Berlin and Heidelberg, Germany.

Hebert, J., and J. Lisle. 2016. A review of the Lynden-Bell/Choloniewski method of obtaining galaxy luminosity functions: part I. *Creation Research Society Quarterly* 52:177–188.

Hilton, J.L., and C.Y. Hohenkerk. 2004. Rotation matrix from the mean dynamical equator and equinox at J2000.0 to the ICRS. *Astronomy and Astrophysics* 413:765–770.

Hogg, D.W., I.K. Baldry, M.R. Blanton, and D.J. Eisenstein. 2002. The K correction. http://ned.ipac.caltech.edu/level5/Sept02/Hogg/paper.pdf (accessed May 2014).

Lisle, J. 2016. New method to assess the luminosity function of galaxies. *Answers Research Journal* 9:67–79. https://assets.answersingenesis.org/doc/articles/pdf-versions/arj/v9/luminosity_function_galaxies.pdf

Lupton, R.H., J.E. Gunn, and A. Szalay. 1999. A modified magnitude system that produces well-behaved magnitudes, colors, and errors even for low signal-to-noise ratio measurements. *The Astronomical Journal* 118:1406–1410.

Lynden-Bell, D. 1971. A method of allowing for known observational selection in small samples applied to 3CR quasars. *Monthly Notices of the Royal Astronomical Society* 155:95–118.

Petrosian, V. 1976. Surface brightness and evolution of galaxies. *The Astrophysical Journal* 209: L1–L5.

Sandage, A., G.A. Tammann, and A. Yahil. 1979. The velocity field of bright nearby galaxies, I: the variation of mean absolute magnitude with redshift for galaxies in a magnitude-limited sample. *The Astrophysical Journal* 232:352–364.

Schechter, P. 1976. An analytic expression for the luminosity function for galaxies. *The Astrophysical Journal* 203:297–306.

Schlegel, D.J., D.P. Finkbeiner, and M. Davis. 1998. Maps of dust infrared emission for use in estimation of reddening and cosmic microwave background radiation foregrounds. *The Astrophysical Journal* 500:525–553.

Strauss, M.A., D.H. Weinberg, R.H. Lupton, V.K. Narayanan, and J. Annis, et al. 2002. Spectroscopic target selection in the Sloan Digital Sky Survey: the main galaxy sample. *The Astronomical Journal* 124:1810–1824.

York, D.G., J. Adelman, J.E. Anderson Jr., S.F. Anderson, J. Annis, et al. 2000. The Sloan Digital Sky Survey: technical summary. *The Astronomical Journal* 120:1579–1587.

Zucca, E., S. Bardelli, M. Bolzonella, G. Zamorani, O. Ilbert, et al. 2009. The zCOSMOS survey: the role of the environment in the evolution of the luminosity function of different galaxy types. *Astronomy and Astrophysics* 508:1217–1234.

On Creation Toward Scientific Explanation: A Directional Law

Jeffrey N. Howard*

Abstract

The various debates concerning man's origin have lingered on at least since Darwin's *On the Origin of the Species* was published in 1859. The crux of one such debate pits evolutionary theory against the theory of creation. Evolutionists have long argued evolution to be a more valid, logical, empirical, and scientifically credible explanation for man's origin. However, I argue that the very process of *creating* things, specifically whereby man's creations are designed to generate scientific data toward explanation and understanding, presents as a highly structured natural directional law—a law whose fundamental tenet is *the initiation of action by the creator (man) onto that which is created*, before the generation of data and subsequent explanation and/or understanding is possible.

Introduction

The longstanding argument between evolution theory (ET) and creation theory (CT) has been perpetuated for years. The lead objective of each perspective is the championing of the "creation of man" via its favored theories, data, and/or body of supportive scientific works. And though one might think a theory such as CT would shy away from debate on scientific methodology and empiricism (e.g., proof), the CT camp does not avoid such contention. Not only does CT look toward proof in support of its position, but it has been shown that the CT movement even surpasses ET at times with respect to addressing proof in support of its position (Barnes and Church, 2013).

However, be it ET or CT, the argument's historically intense focus on empirical support toward the same "end"—the origin of man—has clearly ignored the very means through which said empirical support is derived—man's participation in the act of "creation" itself. This paper puts forth the CT concept that the ubiquitous human act of *creating* things is of an unmistakable directional flow and that it is not what is created that best evidences CT but rather the patterned directional process of creation—a *creational paradigm* (CP)—that best evidences the active presence of CT within our world. Of particular importance is the application of the CP within scientific methodology whereby the objective is to generate data toward empirical support. Such application of the CP within scientific methodology manifests through the creation of "tools"—a fundamental component of science—a component where the demands of the CP are equivalent and inescapable for both ET and CT.

Tools and the Creational Paradigm

When it comes to the origin of man—be it via an ET- or CT-backed perspective, either side is intent on the goal of gener-

* Jeffrey N. Howard, Ph.D., Northern State University, Aberdeen, SD, jeffrey.howard@northern.edu

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ating explanation and understanding via measurement processes garnering data. Thus, scientifically speaking, the act of creation best interjects itself into the ET/CT argument in the form of man's creation of "tools"—tools of measurement such as physical instrumentation, tools of explanation such as theories, tools of insight such as knowledge, tools of calculation such as mathematical formulas, tools of communication such as language, tools of reference such as charts, maps, and drawings, and so on. It is the creation of tools that allows man to perceive himself as similar to God, and in doing so, he calls into existence those forms that have never before existed (Carus, 1893).

Such tools as *created* by those who use them (man) and said creation process and the application of these tools is always *directional* in nature—that is, the process of man creating a tool ultimately requires man (the creator) to act upon, apply, or use the tool in some manner, *a priori* to generating explanation and understanding via the data. And to do this is to operate within the framework of the CP. Thus, the CP is a fundamental requirement of scientific methodology, in that man is *required to create a priori* to any scientific explanation—by reason that mere explanation itself in its raw form must be created via application of knowledge as a tool.

The CP is most closely aligned with the causality concept known as "efficient-cause," as per the four causes from the *Posterior Analytics* by Aristotle in 350 BC (Falcon, 2014). According to Aristotle, it is this efficient-cause that specifies the creator's role in the production of the created, via manifest knowledge; and it is this knowledge and not the creator that is the most obvious candidate for specifying efficient-cause (Falcon, 2014). Aristotle exemplifies his doctrine of efficient-cause by referencing man's creation of objects—such as a statue. However, with respect to the CP and the creation of objects, Aristotle's example overlooks the layer of the CP— a layer *a priori* to creation of the statue that is comprised of man's *creation of tools* and man's *acting upon those tools* (e.g., a hammer and chisel). Falcon herself even endorses the knowledge of the four causes of Aristotle as "an indispensable tool for a successful investigation of the world around us" (Falcon, 2014, p. 1).

Examples abound with respect to the tools man utilizes to generate explanation and understanding of his world from data. Such tool examples fall into categories such as knowledge and theories, inanimate or animate objects, naturally occurring elements/organisms, or man-made elements and chemicals. However, one must point out that not all data obtained by man is generated by that which is man-made; biological organisms and/or naturally occurring elements can generate information of the surrounding world independent of the creative hand of man. It must be emphasized that although created independent of man's hand, naturally generated information is only understood and/or explained via application of tools man has indeed created—e.g., tools in the form of knowledge or knowledge assembled with predictive intent in the form of theories—and a lack of application of a tool on the part of man toward such phenomena, or any phenomena for that matter, yields nothing.

The Creational Paradigm: Knowledge and Theories

As the previous section introduced, knowledge itself is a tool—a tool that serves at times as an interactive liaison with other tools. The interpretation of information from tools such as the periodic table of the elements results from the application of knowledge as a tool to the periodic table as a tool. Thus, using knowledge as a tool to interact with and interpret another tool such as the periodic table is tantamount to a hammer driving a nail; both are tools whereby one acts upon the other via the applied action of man. Cook and Brown provide an elegant definition of knowledge as a tool:

> We hold that knowledge is a tool of knowing, that knowing is an aspect of our interaction with the social and physical world, and that the interplay of knowledge and knowing can generate new knowledge and new ways of knowing. (Cook and Brown, 1999, p. 381)

Similarly, few will doubt that theories are tools that man creates, and few will doubt the intimate connection of theories with knowledge. A simple search within an academic research database will yield hundreds of scientific papers and books making reference to both theories and knowledge as tools—both in title and in content (see Hacker, 2003; Woolnough, West, and Saunders, 2004). A theory that is not applied/utilized can never be validated to any degree. As a tool it must be put to the test against data so that it might be refined and honed, just as a knife edge is honed.

Despite ET and CT being theories with the same objective, they are fundamentally different in structure in that ET, via an inanimate *mechanism* of creation, does not follow the CP. In ET there is no creator entity, only an enduring systematic *process* of change (e.g., natural selection). And yet ET scientists (e.g., Darwin) themselves, as "creators," followed the CP to create ET and continue to follow the CP when applying ET as a tool. Thus, the issue of CP inconsistency with respect to man's creation of ET as a tool via the CP, and the non-CP process of evolution itself, places a great deal of drag on ET in its effort to diminish CT. CT has no such conflict with the CP. CT has always taken the position that:

1. Man has a creator entity (God) who created man.
2. God (the creator) acted upon that which He created (the bibli-

cal prophets) to generate "data" of Himself (the Bible).

3. Said "data" (the Bible) allows the created (man) to facilitate explanation and understanding of the Creator (God).

A man who creates a scale in his garage, steps on the scale, and thus allows the scale to calculate how much he weighs, has followed the CP in the same manner as 1–3 above; therefore:

1. A scale has a creator entity (man) who created the scale.
2. Man (the creator) acts upon that which he created (the scale) to generate data of himself (his weight).
3. Said data (the man's weight) allows the created (the scale) to facilitate explanation and understanding of the creator (man).

Examples of the CP in the surrounding world provide good insight into the CP and its ubiquitous presence. Such examples strongly indicate that our world, when explored by science, requires that science and all its investigative processes "unfold" in a specific, inherent way, with a creator (scientist) actively involved, when embarking on measurement toward the pursuit of scientific truth.

The Creational Paradigm: The Inanimate

The Paper Airplane

A paper airplane provides a simple mechanical example of the CP in action. In the most basic sense, one creates a paper airplane and then launches it so as to allow the airplane to recognize its intended utility—flight. The paper airplane will not launch itself without being acted upon by its creator. When laid on the floor, on a table, or other surface, the plane will not launch itself. Thus, when the objective is to create a paper airplane so as to generate explanation or understanding (via the data) about the airplane itself or its surroundings, one cannot avoid utilizing the CP in the process.

The Scale

The earlier-mentioned scale is perhaps the most basic example of tool/instrument creation and the CP in action. Although a seemingly obvious point, one must emphasize that a scale will never weigh anything on its own. Rather, its creator (man) must always step on it or place something on it before it will generate data toward directed explanation or understanding as per its intended utility. One cannot wait for a scale to act on its own to get work done. Its creator must intervene, and this action yielded by the creator in the direction of the created is inherently required.

The Thermometer

Man's creation of the digital, handheld thermometer provides a more modern example of the CP. As a tool created by man with the intent of generating explanation and understanding, the digital thermometer will not realize its intended utility in isolation. There is no digital thermometer that will, of its own volition, measure the temperature of a predetermined object. Man must intervene to achieve this result. Therefore, man, as creator of the digital thermometer, must act upon that which he created (e.g., pick it up, turn it on, insert batteries, use it) in order for the created to achieve its intended utility of generating data.

As an even more complex example, one can look at a mercury-filled thermometer. The mercury thermometer, being absent any electronics, is analog and therefore always functional no matter what environment it is in. This type of tool is continually generating data of its surrounding environment. Without electronics, there is no need to "activate" this tool, as it is continually activated. However, though there is no need for man to activate this type of tool in order for it to achieve its intended utility, for such a tool to generate scientific meaningfulness, it must be placed within an environment (*acted upon*) where an intended generation of explanation and understanding can be derived—and it will not do this of its own volition. The creator (man) must place said thermometer into the desired environment whereby it does its intended work.

Additionally, one can even trace back to the point at which man first "breathed life" into a mercury thermometer. This is the very point at which the mercury-filled tube was sealed and the thermometer began functioning on its own. Even if the process of sealing the tube is done mechanically or by automation, this mechanical process is the result of a man-made system having man's action initiated upon it, which subsequently applies that man-initiated action onto the tool, giving it "life." Again, one could easily trace such action back to the flick of a switch, setting of a timer, or plugging-in of a machine as the singular "life-activating" event for the tool.

Clearly, a mercury thermometer in isolation within a refrigerator can indeed unilaterally generate explanation and understanding of its own volition in an intended environment that is meaningful. In this scenario, again the question with respect to the CP is this: How does the thermometer get into the refrigerator in the first place? Or perhaps the thermometer is built into the refrigerator. The question with respect to the CP then becomes this: How does the refrigerator get plugged in so that the thermometer is activated? The answer to both of these questions is that activation of the tool cannot transpire outside of the CP, whereby initiating action on the part of the creator is a fundamental requirement.

Chemicals and Chemical Tools

Chemical tools, such as luminol, require the CP as well. Luminol is used by scientific crime-scene investigators due to its light-producing chemical reaction that highlights traces of biological components found in blood when that blood is not visible to the naked eye (Harris, 2002). There is some point in the luminol manufacturing process when the chemical "comes to life"; that is, when the proper chemicals are mixed by man or man-controlled machine, or a specific chemical is added at some point to catalyze the chemical, thus giving it its ability to achieve its intended utility. Additionally, luminol as a chemical tool will not perform its intended utility of its own volition. It is a tool man must apply (using his tools of knowledge, as well as other physical tools, such as a spray bottle) within environments where it can generate data to foster explanation and understanding of those environments.

The *Creational Paradigm:* The Animate

Biological Organisms/Natural Elements and Processes

Phosphorescent algae exhibiting a characteristic known as *bioluminescence* (Wilson and Hastings, 1998) is an example of that which is created *outside* of the hand of man and is capable of its own volition in generating data to foster understanding and explanation of its surrounding world. However, similar to the paper airplane example, theories and knowledge generated by man (tools) must be applied before the generation of explanation and understanding from the data can occur. Such algae and the environmental conditions required for its occurrence have to be explained by man through his theories, tools, and measuring devices before explanation and understanding is generated. The algae may be able to unilaterally produce the effect, but again the effect is meaningless unless measured by man's tools and interpreted by theories and explanations he has created (tools) to derive meaningfulness from it.

Similarly, naturally occurring elements/processes can provide data independent of the intervention of man. For example, the visible presence of oxidation in some naturally occurring elements such as pyrite provides data indicating a specific natural process is taking place and can even provide data that bespeaks the magnitude, speed, or other characteristics of the process. In short, man often exploits such naturally occurring biological phenomena or naturally occurring processes so as to incorporate them into his tools—a process that would require the CP on a number of levels. Once again, for meaningfulness to be derived from such phenomena and processes, such naturally occurring data must be subject to, at minimum, interpretation via man's application of his tools of knowledge and theory.

Artificial Intelligence

An example that extends to more futuristic technology is that of the "intelligent device," such as a robot, cyborg, android, or computer. Albeit not truly animate as per human form, here man creates a device that has artificial intelligence to some degree that is designed to approximate the human condition on some level, such as learning independently and self-progressing intellectually. Such a device would be unable to escape the CP, as there must be some initial activating point whereby man sets the device into motion to "give it life"—such as insertion of batteries, activation of a power generator, software activation, or other primary activating event. Again, such activating events do not occur in isolation—man-the-creator must be the activating agent. Thus, man's creation of smart robots, android-humans, or other independent-learning technology of the future would not be able to circumvent the CP. This artificial intelligence example brings the argument for the CP to perhaps its most salient part: man as creator of man.

Human Procreation

Neither ET nor CT denies the existence of some creational mechanism/entity however. At the point where man attempts to generate his own explanation and understanding of his own creation, man himself becomes a "tool" within the CP—a tool-wielding product of that which has created him. It is at this point the CP and how it applies to said explanation and understanding via both the ET/CT ideologies becomes of great interest. Man's procreation is clearly the ultimate example of man's application of the CP. Man's ability to create man is the experiential essence of creation and an important catalyst of ET and CT. With respect to man's procreation and the CP, one can easily understand the "activating" role man himself plays on that which he procreates. Without man acting upon the infant man as he grows—e.g., educating the infant man, nurturing the infant man—the infant man can never grow and mature into one who himself creates, gains knowledge, derives theory, and generates data aimed at explanation and understanding of his surrounding world—including himself. Thus within the scope of the CP, man's procreation of man unfolds, as did God's original creation of man, as does man's creation of the inanimate scale.

1. Man has a creator entity (man) who creates man (the infant man).
2. Man (the creator) acts upon (educates, nurtures) that which he created (the infant man) to generate "data" of himself (knowledge within the infant man).
3. Said "data" (knowledge within the infant man) allows the created (the infant man) to facilitate explanation and understanding of his creator (man—his father).

Few would disagree with such a reasonable sequence of development seeing that infants in isolation and devoid of all human contact and care do not survive. Infants who are denied certain developmental stimuli at certain ages never learn the range of necessary skills to function within society (see Fromki et al., 1974). Infants and children denied such opportunities do not develop on their own to learn to generate explanation and understanding of their surrounding world. They develop at a rudimentary pace at best, are retarded in normal skills and development, and become dependent on vigilant care.

The Creational Paradigm: Creation and Conservation

With respect to man creating things, it is important to detail the CP with not only the nature of human creation as a process, but also with the "scope" of this process in mind. When creating, there is always a creational act of "origin" where the original creative act and product transpire temporally. Said original creative act is followed by usage or application on the part of the creator (action)—such as when a map is made and then consulted thereafter and/or revised and maintained—but never created again as an originating act. Within theology such separation of the original creative act and the subsequent temporal, ongoing acting-upon, usage, or maintenance of the created is referred to as the "*creation/conservation*" doctrines, whereby there is an *originating* creation and a subsequent *continuing* process that acts upon the created (Craig, 1998). It is this continuing part of the CP, through application of knowledge and theories to that which the scientist creates (e.g., scientific instruments), that yields scientific progress.

It is also important to clarify the distinction between that which is *continuing* and that which is *continuous*—the former being intermittent and discrete, the latter being nondiscrete. Arguments exist for both camps of the creation/conservation doctrine with respect to God's creational involvement, one camp championing it as the traditional *extension* of the initial act of creation (continuous), and the other as God's acting upon entities that already exist (continuing) (Miller, 2009). When consciously assessing man's process of creating things (the CP) with top-of-the-mind awareness that "God created man in His own image," man as a creator of tools would expect to find that his fundamental creational process (the CP) in a world created by God, does indeed unfold consistently with that as documented of God. Such creational process—man following the CP—aligns more closely with Craig's (1998) "continuing creation" process, rather than a continuous process as endorsed by those such as Miller (2009). In demonstrating this alignment, Kvanvig (2007) provides a good analogy of Craig's (1998) continuing process by pointing out that a good watchmaker is unlikely to be continuously involved with that which he creates but only intermittently so. He must act to wind, to replace worn batteries, oil gears, or replace springs—all of which reflect intermittent continuing action on the part of the creator, rather than continuous action. That which man creates for a scientific purpose of data collection is no different. It is acted upon intermittently but not continuously—unless design intent requires such continuous action. Either way, said decision to act in either manner is always catalyzed via the application of tools—knowledge and theory—at the discretion of their creator.

Conclusion

In the end, all scientific tools with intent to generate explanation and understanding via data, as per the CP, require the creator (man) to "breathe life" into them, act upon them, apply them, initialize them, or prime them so that they may accomplish the utility they were designed for. The looming question is this: How would ET, as an enduring, long-term, nonentity, mechanistic creator of man, be able to initiate action upon that which it has created—man "the tool"—so as to allow the tool (man) to reciprocally generate data facilitating explanation and understanding of his creator (ET)? In short, if man must "act" upon that which he creates *before* that which he creates can generate data toward explanation/understanding of its surrounding world, then man himself—as something that has been created—must be acted upon before he himself can generate data toward explanation/understanding. CT falls back on concepts such as divine inspiration of the Bible as a divinely-given tool that acts upon man "the tool" to generate such explanation. ET has no such entity to provide such inspiration. Thus, one can readily see how the Bible—as a tool of knowledge created by God—inspires man to generate explanation of himself and where he came from. Understanding how ET as a *nonentity* acts upon man to allow such explanation and understanding of man's origin to occur is far more obscure at best, while simultaneously failing to follow the CP.

From the CT perspective, the CP is an earthly-manifested, parsimonious, fundamental, and directional progression whereby God's creational sequence unfolds for those whom He has created in His own image. As philosopher Xavier Zubiri states, "Gods creational paradigm—if you will—is just the order of reason" (Zubiri, 2009, p. 185). Both CT and ET as theoretical tools are held to the CP, an observable law, and they may not circumvent it. To argue against the CP is to argue contrary to scientific methodology and the systematic process by which it unfolds. To accept the CP is to acknowledge the CP as a fundamentally required *creationism* concept, *not* an evolutionary one.

Ultimately, of greatest interest is that ET proselytizers must use the CP to create, revise, and progress their theories, and they must use the CP to make and apply their full-range of scientific tools. They use these tools, whose utility under ET is to validate ET, while at the same time attempting to demonstrate that God's creational paradigm, the very root paradigm of their own tool creation and use, is false!

References

Aristotle. 350 BC. *Posterior Analytics*. Translated by G.R.G. Mure. http://classics.mit.edu/Aristotle/posterior.2.ii.html (accessed February 27, 2014).

Barnes, R.M., and R.A. Church. 2013. Proponents of creationism but not proponents of evolution frame the origins debate in terms of proof. *Science & Education* 22:577–603.

Carus, P. 1893. *The Philosophy of the Tool*. Open Court Publishing Co., Chicago, IL.

Cook, S.D., and J.S. Brown. 1999. Bridging epistemologies: the generative dance between organizational knowledge and organizational knowing. *Organization Science*, 10(4): 381–400.

Craig, W.L. 1998. Creation and conservation once more. *Religious Studies* 34:177–188.

Darwin, C. 1859. *On the Origin of Species by Means of Natural Selection*. John Murray, London, UK.

Falcon, A. 2014. Aristotle on causality. In Zalta, Edward N. (editor), *The Stanford Encyclopedia of Philosophy*. http://plato.stanford.edu/entries/aristotle-causality/ (accessed March 3, 2014).

Fromkin, V., S. Krashen, S. Curtiss, D. Rigler, and M. Rigler. 1974. The development of language in Genie: a case of language acquisition beyond the "critical period." *Brain and Language* 1(1): 81–107.

Hacker, W. 2003. Action regulation theory: a practical tool for the design of modern work processes? *European Journal of Work and Organizational Psychology* 12(2): 105–130.

Harris, T. 2002. How luminol works. http://science.howstuffworks.com/luminol.htm (accessed February 28, 2014).

Kvanvig, J. 2007. Creation and conservation. In Zalta, Edward N. (editor), *Stanford Encyclopedia of Philosophy*. http://plato.stanford.edu/entries/creation-conservation/ (accessed February 2, 2014).

Miller, T.D. 2009. On the distinction between creation and conservation: a partial defence of continuous creation. *Religious Studies* 45(4): 471–485.

Taylor, R. 1963. Causation. *The Monist* 47(2): 287–313.

Wilson, T., and J.W. Hastings. 1998. Bioluminescence. *Annual Review of Cell and Developmental Biology* 14(1): 197–230.

Woolnough, A.P., P.B. West, and G.R. Saunders. 2004. Institutional knowledge as a tool for pest animal management. *Ecological Management & Restoration* 5(3): 226–228.

Zubiri, X. 2009. *The Fundamental Problems of Western Metaphysics*. University Press of America, Lanham, MD.

Minutes of the 2015 Creation Research Society Board of Directors Meeting

The fifty-second annual meeting of the Creation Research Society (CRS) Board of Directors was held 4–6 June 2015 at the Hampton Inn in Prescott, Arizona, and at the CRS Van Andel Creation Research Center (VACRC) in Chino Valley, Arizona.

President Don DeYoung called the first session of the general board meeting to order at 19:00 on Thursday, 4 June 2015. The following board members were present: Rob Carter, Gene Chaffin, Don DeYoung, Danny Faulkner, Robert Hill, Russ Humphreys, Jean Lightner, Gary Locklair, Michael Oard, Ron Samec, and Glen Wolfrom. John Reed joined the meeting via Skype. VACRC director Kevin Anderson and professional staff member Diane Anderson were also present. Don overviewed the logistics of our meeting. The first part of the general board meeting would be Thursday evening. Friday would be dedicated to committee meetings. The second half of the general board meeting would be on Saturday.

President DeYoung outlined the busy weekend's agenda, which would include a conversation with our attorney, a visit with a local creation organization, and a star party. He reviewed the duties of board members and shared some thoughts about creation and the current state of society. Don shared ideas from Os Guinness on how to react to a changing culture, including engagement, discernment, and courage. He encouraged us not to withdraw from society or to compromise the Word, since the creation message is greater than current trends. These are interesting days and times. Don asked each board member to provide a brief update on his or her life and work. On behalf of the board, Don presented John Reed with a certificate for 15 years of dedicated service to the society.

Recording secretary Gary Locklair asked for corrections or additions to the 2014 meeting minutes as published in the Spring 2015 CRSQ (Vol. 52, No. 1). The minutes stood approved as printed. Gary reported the results of the 2015 board elections. Jerry Bergman received enough member signatures to be placed on the ballot. With 194 ballots received, the following were elected to a three-year term: Jerry Bergman, Gene Chaffin, Jean Lightner, John Reed, and Glen Wolfrom. The board now stands at 13 members. A list of future candidates suggested by the membership was presented.

Financial secretary and treasurer Danny Faulkner reported that our income should be $215,000 for this fiscal year. Danny reported that we used $30,000 of our endowment for expenses. Danny indicated that the Society needs to increase revenue in order to support Kevin Anderson as a full-time director and researcher. Danny provided instructions regarding the budget for Friday committee meetings. He also cautioned that we might be faced with non-budgeted expenditures relating to our incorporation status.

Danny Faulkner reviewed the most recent CRS conference in 2014 held at AIG, which consisted of 3 parallel sessions with 42 presenters. The 2015 conference has seen a record number of submissions (50 so far) for 42 presentation time slots. We are thankful for the participation of ICR and AIG scientists in the CRS conference. The 2015 conference has 100 registrations so far. The CRS conference is "hitting its stride."

A summary of the lab committee meeting, which was held earlier in the day, was presented. The lab facilities received new paint, and several unused items were disposed of. A fund-raising letter was sent out in March. Expenditures of the iDino project have reached $45,000. The committee moved that Kevin Anderson begin negotiation with Jay Seegert to determine how he might be used as a speaker for CRS. The motion was approved with one abstention.

Rob Carter shared an article related to experiential thinking in creation, providing a textual analysis. Rob encouraged all of us to ensure we carefully analyze the data. We should study carefully and write dispassionately and encourage each other to be the best scientists we can be.

Next year's board meeting will be held in Birmingham, Alabama, on June 2, 3, and 4, 2016. John Reed will be our host.

The board discussed suggestions for future board members.

The first session of the full board meeting adjourned at 20:50.

Friday, 5 June 2015, was devoted to committee meetings. The constitution, finance, Internet, membership, periodicals, publication, and research committees all met and conducted business. (The lab committee had met previously on Thursday afternoon.) In addition to the board members present on Thursday, Jerry Bergman was present for the Friday committee meetings.

A discussion with the CRS attorney, Mr. Don Zavala, occurred early Friday afternoon with all board members participating. A number of topics were discussed, and Mr. Zavala, who supports the mission of the CRS, offered a number of suggestions on how to sharpen our Society documents. Mr. Zavala prepared several draft documents and shared them with the board. Mr. Zavala shared an issue with our incorporation and also how it had been resolved (we are still a 501(c)3 with a Michigan incorporation). The board expressed its thanks for former board member Ted Aufdemberge, who helped with the Michigan incorporation. Mr. Zavala stressed that we need to have, and keep, documentation on a number of items. Some of the documentation required includes the following: (1) a document retention policy (the board will need to adopt and provide the policy to Diane for implementation), (2) a whistleblower policy to ensure there is no retaliation against the party who brought forth a complaint, and (3) a conflict of interest policy. An annual disclosure statement must be signed by board members indicating we are not taking money from the CRS for our personal benefit. Mr. Zavala indicated that our bylaws should be updated. He also suggested that we should consider merging our constitution and bylaws into a single document. Mr. Zavala will send his draft bylaws to the board for review. The board will review the draft and propose changes as stipulated in the current bylaws.

During Friday meetings, these individuals chaired the standing committees of the CRS: Don DeYoung, the lab committee; Gary Locklair, the Internet committee; Gene Chaffin, the periodicals committee; Mike Oard, the publication committee; Glen Wolfrom, the membership committee; Gary Locklair, the constitution committee; Gene Chaffin, the research committee; and Danny Faulkner the finance committee.

A reception with the local creation group, AZOSA, was held Friday evening. The sky cleared up to allow for a star party featuring some great views of several planets.

The second part of the general board meeting was called to order at 08:30 on 6 June 2015 by President DeYoung. The following board members were present: Jerry Bergman, Rob Carter, Gene Chaffin, Don DeYoung, Danny Faulkner, Robert Hill, Russ Humphreys, Jean Lightner, Gary Locklair, Michael Oard, Ron Samec, and Glen Wolfrom. VACRC director Kevin Anderson and professional staff member Diane Anderson were also present.

Bob Hill led a devotion based on Exodus 12. The Passover was a significant event for the Israelites. It was a defining event in their history and provided meaning for their lives. In a similar way, the CRS needs to answer its personal origin questions.

Don DeYoung encouraged all CRS members to share our story. Each member should develop an "elevator pitch" for CRS. From the Society Facebook page: "The CRS is the oldest international professional organization dedicated to scientific research regarding the creation model of origins."

The loss of Wayne Frair, who served on the board for 31 years and also served as CRS president, was noted with sadness. The losses this past year of Kevin's mother and Bob's father were also noted.

Internet committee chairman Gary Locklair reported on matters relating to the CRS website, CRSnet, and the CRS Facebook page. The fine work of volunteer webmaster Fred Williams was noted. The CRS online presence continued its steady growth. A number of issues were identified that need to be addressed on our website, most notably

a better search engine that allows all the online publications to be searched. Rob suggested the use of a content management system (CMS) and will discuss this possibility with a consultant. The committee discussed possibilities for additional assistance with our web page. John Meyer, the CRSnet moderator, joined the committee to share some items of concern. The committee reviewed the rules pertaining to CRSnet discussions. The committee encouraged members to create short "research notes" that can be shared on our Facebook page. Board members agreed that the Internet is the key to sharing and promoting our vital message.

Gene Chaffin, periodicals committee chairman, shared problems with the late publication of recent Quarterlies (CRSQ). He shared plans for proposed special symposium issues, while associate editors reported on their areas. Material for publication should be sent to general editor Danny Faulkner, who was thanked for his work. *Creation Matters* (CM) editor Glen Wolfrom stated that the format was changed to allow CM to be flat with a stapled binding. There was discussion to provide the special CRSQ issue on iDino in the CRS bookstore.

Publication committee chairman Mike Oard reported book sales were down, possibly due to the lack of a catalog. Even with only $24,000 in sales, book sales are profitable for the Society. It was noted that eBooks have not sold as well as anticipated. The committee will investigate "print on demand" as another option.

Glen Wolfrom, membership committee chairman, shared that there has been a small decrease in voting and sustaining members. The Society currently has 639 voting members. He reported on the successful launch of the student Future Leaders program. Future Leaders receive a free membership, which is supported by other members. Rob will draft a letter that can be used to promote the Future Leaders program to colleges, and he will create a fund-raising letter for the program. The Society currently has 48 student members, the highest number over the past 10 years.

Kevin Anderson demonstrated a 6-minute promo video for the iDino project, "Dinosaurs in Dispute." We are seeking funding this year for a 50–60-minute video detailing the iDino project and results.

Research committee chairman Gene Chaffin reviewed last year's research projects, including work by Ron Samec and Mike Oard. While several new research projects are in the works, no new research was approved at this meeting. Gene shared information about new legal documentation for our researchers.

Gary Locklair, constitution committee chairman, reported on several issues related to the bylaws and ideas for long-range planning. The proposals from our attorney related to the constitution, bylaws, and supplemental documentation were reviewed. Four forms presented by Don Zavala should be part of our corporation. These include the document retention policy, the whistleblower policy, the conflict of interest policy, and the annual disclosure statement. A proposed new bylaw dealing with removal of a board member (Article II, Section 5) and a modification to Article III, Section 3 on election of board members (changing petition from 25 members to 5% of the voting membership) were discussed.

Treasurer Danny Faulkner presented information about fiscal year 2014–2015. Danny provided estimates of $244,800 for net income versus $240,000 of estimated expenses for the fiscal year. Our actual expenses will be slightly more

than the approved expense budget of $234,000 for fiscal year 2014–2015.

Financial secretary Danny Faulkner reported on the Society's financial holdings. He stated the current value of CRS investments (endowments) decreased $11,000 during the past year. Danny also noted former board member Ted Aufdemberge's comment that we need to repay our endowments since we have borrowed against them ($20,000 this past year).

Treasurer Faulkner led the discussion regarding the 2015–2016 budget. The following committee budget requests were approved: VACRC (lab)–$165,500; Executive / Treasurer–$14,000; Membership–$4,150; Publication–$15,000; Periodicals–$38,000; Research–$10,000; Internet–$1000; Constitution–$5,000; Finance–$0.

An expense budget of $252,650 was approved for fiscal 2015–2016. This budget represents an $18,000 increase over last year's expense budget. A motion was approved to authorize Diane to withdraw up to $20,000 without executive committee permission to cover Society expenses.

The board submitted the names of Don DeYoung, Russ Humphreys, Gary Locklair, and Ron Samec as candidates for the 2016 board of directors election. The board discussed several other candidates to be submitted for consideration next year.

Election of board officers was held. Don DeYoung was elected president (Don is the longest serving president in Society history), Gene Chaffin was elected vice-president, and Gary Locklair was elected recording secretary. The following were elected for the first year of a three-year term: Glen Wolfrom as membership secre-
tary, Bob Hill as financial secretary, and Danny Faulkner as treasurer. Glen indicated that the position description for the membership secretary will be changing as some activities will be carried out by the CRS professional staff in Chino Valley.

The meeting was adjourned at 12:15.

Respectfully submitted,
Gary Locklair
CRS Recording Secretary

Letters to the Editor

The policy of the editorial staff of CRSQ *is to allow letters to the editor to express a variety of views. As such, the content of all letters is solely the opinion of the author, and does not necessarily reflect the opinion of the* CRSQ *editorial staff or the Creation Research Society.*

No Imaginary Uniformitarian Thrusts

I am writing to clarify a few things that were only partially discussed or incompletely explained in the recent *Creation Research Society Quarterly* article by Oard and Klevberg (2015) entitled "Imaginary Uniformitarian Thrusts."

First, I would like to compliment the lead author on his admittance that at least major thrust faults are real and are caused by gravity sliding and not by pushing or compression. I agree with this explanation but take it a step farther as discussed below. While working in the oil and gas industry, I had the opportunity to observe many examples of thrusting or overthrusting. I found that virtually all thrust faults are real. Creation scientists in the past were correct to criticize secular explanations for overthrusts (Whitcomb and Morris, 1961; Lammerts, 1966, 1972; Burdick, 1969, 1974, 1977). However, most of this criticism began before secular geologists understood the extent, general workings, and unique geometries of overthrusting and prior to the drilling and gathering of seismic data across thrusted terrains. Since the late 1970s, the scientific community has established these faults as real features. Yet, even today, the mechanical difficulties of moving large, extensive sheets of rock have been poorly explained in the secular literature without invoking special, if not impossible, conditions.

Second, Oard and Klevberg stated, "Only field exploration can answer the question of which [thrust faults] are real and which are not." This is not entirely true. Most thrust faults are now visualized with aforementioned seismic reflection data and by direct observation of oil well drilling logs. Thrust faults are routinely imaged with seismic reflection data. Repetition of sedimentary layers is clearly visible in the study of the logs that pass through thrust faults. Contrary to what Oard and Klevberg implied, very few, if any, fossils are involved in these observations. Instead, they are directly observed in the reflection data and/or are observed as distinctive well log characteristics for each rock layer.

Third, Oard and Klevberg listed four options for explaining thrusts in western Montana: "(1) older layers were slowly pushed east at a steep angle over younger rocks … (2) there are no thrusts at all; (3) the thrusts are real, but the mechanism is different from that proposed by uniformitarians; and (4) some of the thrusts are real, and some are not."

Let's review their options, starting with number 1. Secular explanations of overthrusts (Price, 1988), using slow movement and long-term maintenance of overpressured horizons over great distances, still cannot resolve the glaring mechanical paradox. Rock cannot be "pushed" either slowly or rapidly, as Oard and Klevberg noted. This is why they concluded that thrusts must move due to gravity, as it operates uniformly on the entire thrust sheet. However, the apparent "uphill" movement or steep angle of many thrusts is simply a geometric consequence of cutting upward toward the surface from the underlying detachment layer. Overthrusts usually have a layer-parallel basal detachment from which all subsequent thrusts originate. Many thrusts cut up the section from this detachment surface at a much steeper angle. Other "steep" overthrusts can be explained as a consequence of later folding and steepening by subsequent thrusts, as they generally get younger in the direction of transport or by simply ramping uphill as the thrusting ceased. And note, it is usually just the distal end of the thrusts that are steepened.

Their option 2 is the claim that there are no thrusts at all. As discussed above, this may have been a valid criticism in the 1960s, but today, after the gathering of a plethora of empirical data and the improved industry understanding of overthrusting, this option is no longer valid. Creation scientists must accept the empirical results of thousands of drill-hole penetrations and thousands of kilometers of seismic reflection data collected since the 1970s proving the existence of overthrust faults (Royse et al., 1975; Jones, 1982; Lamerson, 1982; Boyer and Elliott, 1982; Price, 1988; Coogan, 1992). If not, we risk sticking our heads in the sand and denying factual data. That is not good science.

Near this point in their paper Oard and Klevberg oddly stated, "That leaves options 2 and 4." What happened to their option 3? It is never again discussed in their paper. Option 3, that the mechanism for thrusting is different from that proposed by secular science, is in all likelihood, the correct answer (Clarey, 2013). Overthrusts require a layer-parallel basal detachment from which all subsequent thrusts originate. High fluid pressures, developed during dewatering, have the ability to create overpressured zones and "float" large thrust sheets downslope (Hubbert and Rubey, 1959; Guth et al., 1982; Clarey, 2012). This is why there is usually little deformation to the layers above and below. And it is the reason why there is little fault gouge associated with thrust faults, as Oard and Klevberg observed.

These conditions must have occurred late in the Flood, after most of the sediments were deposited but while they were still uncemented. Unlithified, freshly deposited sediments are essential to the development of overthrust faults in order to explain the tightly folded geometries that are observed in the toe areas (Clarey, 2013). Rapid deposition during the Flood, combined with compaction and dewatering of sediments, created numerous overpressured zones along impermeable boundaries. Then all that is needed is a slight tilt, sometimes as little as a few degrees, to get the near "weightless" thrust to slide (Clarey, 2012, 2013). Only a Flood model of overthrusting, involving rapid downhill movement of unlithified sediment, can provide both a cause and a mechanism for the development of large thrust sheets and the resulting tightly folded geometries observed in the toe areas.

Oard and Klevberg's option 4 is also not a good choice. Thrusts are real, or they are not. There is little evidence that some thrusts are imaginary, as claimed. Their conclusion that the thrusts in Mortimer Gulch are not real because the "dip of the layers is so uniform" is not scientifically valid. Thrusts commonly develop and follow bedding planes, so they would not always be expected to change the dip orientations (Royse et al., 1975; Jones, 1982; Lamerson, 1982; Boyer and Elliott, 1982; Price, 1988; Coogan, 1992).

Oard and Klevberg also stated, "Since most strata are dated by their fossil content, we suggest that Mudge's [1972a, 1972b] minor thrusts resulted from out-of-order fossils" and boldly claimed the mapped thrusts are merely "mental" thrusts. They further concluded that Mudge "was just filling in the geological column. For instance, strata above the middle Jurassic Ellis Group would by default be identified as the Morrison Formation, since it is the formation that succeeds the Ellis Group on the geological column over the Montana high plains."

The Morrison Formation is one of the most easily recognized and extensive units across the American West. It is distinctive in color, sedimentary structures, and lithology. Only rarely are fossils used in the field to identify this formation. It is most commonly identified on its unique set of observable, lithologic characteristics. Fossils found in it may be used to confirm it but are usually secondary in its identification. A good field geologist can identify all the rocks in a particular area by the combination of mineralogy, color, lithology, and sedimentary structures in each of the rock layers. I am sure Mudge was a competent field geologist and was not merely "filling in the geological column" as claimed. Like all geologists, Mudge (1972a, 1972b) may have made some mistakes and added too many thrusts in a particular area (or not enough) due to poor exposures and a lack of closely spaced outcrops.

Oard and Klevberg's conclusions that many of the mapped minor thrusts are "imaginary" or "mental" because they show little deformation and change in dip above and below the fault surface reflects a lack of understanding of thrust faults, as noted above. And their conclusion that all strata are dated solely by their fossil content is also made invalid by knowing common field identification procedures, again, as described in the preceding paragraph.

Authors who are critical of the geologic column should no longer use the denial of overthrusts as part of their argument. Empirical data have demonstrated they are real (Matthews, 2011). Instead, creation scientists should embrace the existence of overthrust faults as an opportunity (Clarey, 2013). Only a Flood model can explain their formation. The secular explanation fails to offer a valid movement mechanism and fails to explain tight fold development in the leading edge or toe of many thrusts. Overthrusts are unique features that could have occurred only within a Flood context.

Regards,
Timothy L. Clarey
Dallas, Texas
tclarey@icr.org

References

Boyer, S.E., and D. Elliott. 1982. Thrust systems. *American Association of Petroleum Geologists Bulletin* 66:1196–1230.

Burdick, C.L. 1969. The Empire Mountains—a thrust fault? *Creation Research Society Quarterly* 6:49–54.

Burdick, C.L. 1974. Additional notes concerning the Lewis thrust-fault. *Creation Research Society Quarterly* 11:56–60.

Burdick, C.L. 1977. Heart Mountain revisited. *Creation Research Society Quarterly* 13:207–210.

Clarey, T.L. 2012. South Fork fault as a gravity slide: its break-away, timing, and emplacement, northwestern Wyoming, U.S.A. *Rocky Mountain Geology* 47(1): 55–79.

Clarey, T.L. 2013. South Fork and heart Mountain faults: examples of catastrophic gravity-driven "overthrusts," northwest Wyoming, USA. In Horstemeyer, M. (editor), *Proceedings of the Seventh International Conference on Creationism* [CD-ROM]. Creation Science Fellowship, Pittsburgh, PA.

Coogan, J.C. 1992. Structural evolution of piggyback basins in the Wyoming-Idaho-Utah thrust belt. In Link, P.K., M.A. Kuntz, and L.B. Platt (editors), *Regional Geology of Eastern Idaho and Western Wyoming,* Geological Society of America Memoir 179, pp. 55–81. Geological Society of America, Boulder, CO.

Guth, P.L., K.V. Hodges, and J.H. Willemin. 1982. Limitations on the role of pore pressure in gravity gliding. *Geological Society of America Bulletin* 93(7): 606–612.

Hubbert, M.K., and W.W. Rubey. 1959. Role of fluid pressure in mechanics of overthrust faulting. I. Mechanics of fluid-filled porous solids and its application to overthrust faulting. *Geological Society of America Bulletin* 70:115–166.

Jones, P.B. 1982. Oil and gas beneath east-dipping underthrust faults in the Alberta Foothills. In R.B. Powers (editor), *Geologic Studies of the Cordilleran Thrust Belt, Volume 1*, pp. 61–74. Rocky Mountain Association of Geologists, Denver, CO.

Lamerson, P.R. 1982. The Fossil Basin and its relationship to the Absaroka thrust system, Wyoming and Utah. In R.B. Powers (editor), *Geologic Studies of the Cordilleran Thrust Belt, Volume 1*, pp. 279–340. Rocky Mountain Association of Geologists, Denver, CO.

Lammerts, W.E. 1966. Overthrust faults of Glacier National Park. *Creation Research Society Quarterly*, 3:61–62.

Lammerts, W.E. 1972. The Glarus overthrust. *Creation Research Society Quarterly* 8:251–255.

Matthews, J.D. 2011. The stratigraphic geological column—a dead end. *Journal of Creation* 25(1): 98–103.

Mudge, M.R. 1972a. Pre-Quaternary rocks in Sun River Canyon area, northwestern Montana. *U.S. Geological Survey Professional Paper* 663-*A*. U.S. Government Printing Office, Washington, DC.

Mudge, M.R. 1972b. Structural geology of the Sun River Canyon and adjacent areas, northwestern Montana. *U.S. Geological Survey Professional Paper* 663-*B*. U.S. Government Printing Office, Washington, DC.

Oard, M.J., and P. Klevberg. 2015. Imaginary uniformitarian thrusts. Creation Research Society Quarterly 52:34–43.

Price. R.A. 1988. The mechanical paradox of large overthrusts. *Geological Society of America Bulletin* 100:1898–1908.

Royse, F. Jr., M.A. Warner, and D.L. Reese. 1975. Thrust belt structural geometry and related stratigraphic problems, Wyoming-Idaho-Northern Utah. *Rocky Mountain Association of Geologists 1975 Symposium:* 41–54.

Whitcomb, J.C., H.M. Morris. 1961. *The Genesis Flood: The Biblical Record and Its Scientific Implications*. Presbyterian and Reformed Publishing, Phillipsburg, NJ.

Response to "No Imaginary Uniformitarian Thrusts"

I heartily agree with Dr. Clarey's statement, "Yet, even today, the mechanical difficulties of moving large, extensive sheets of rock have been poorly explained in the secular literature without invoking special, if not impossible, conditions." As I remember a physicist putting it years ago (wish I could remember who he was), "Shoving rocks over each other without deforming them is like trying to push a rug across the floor without wrinkling it."

Geophysical methods are field methods. But seismic profiling, like all geophysical methods, is only as good as the borehole control. One must be careful with cyclic sedimentation—are these truly *repeated* sections or only similar sections? And as for fossils, that is a major criterion for many of the conclusions in our study area; geophysical methods were not used. We address his comments on the four options for interpretation we introduced in our paper:

We are fully familiar with geometric consequences of the thrusting process. So was Mudge. I can model some of these if he likes. There is nothing new here.

Clarey makes the same mistake as previous writers but in the opposite sense. It is premature to claim the thrusts are real without seeing them. Each locale must be investigated for itself. We should not accept the prevailing opinion, even if every other locale in the world fits the common wisdom. One could easily miss some very important feature that way, regardless of whether one is looking at tectonics or lithology or any other aspect of the local geology.

This would not be considered by secularists, but we should consider it. We are glad that Clarey does. Overpressuring must be a very transient phenomenon, so the time frame must be brief—as one would expect during the Deluge.

This is not simply based on accordance of dip, though the alleged thrusts do generally cut across bedding at a low angle. What this is based on is lack of evidence of movement where it is inferred in *some* cases, and also evidence of movement (measurable offsets, small amounts of gouge) in some areas to the west where thrusts are *not* indicated by Mudge et al. We suspect that stratigraphic prejudice may have played a role in this. This is not an isolated incident. All researchers should pay close attention to physical details like these and not just swallow the hook along with the bait.

I urge Clarey not to fall into the ditch opposite the one in which those he criticizes from earlier years landed. Some of these thrusts show evidence of movement—possibly less than some have posited but still evidence of movement. Others show no evidence of deformation. There are also zones of folding that could have accommodated considerable differential movement, and there are apparently considerable amounts of intrabed brittle strain, which Mudge also observed.

Mudge's competence I do not question. I have examined much of what he studied, and I have confidence in his measurements. I do not have confidence in his paradigm. Much uniformitarian natural history has been read into his stratigraphic interpretation. For example, after two decades of working in the Kootenai Formation, I was baffled as to why he classified some of these strata as Kootenai—except that was the empty pigeonhole in the column. And if the Morrison is so readily recognized on *lithologic* grounds, why on earth is so much classified as Morrison around here that does not look anything like the type locality or places closer to it? We have everything from coal to pure limestone called Morrison around central Montana, and if it is not to fill a preconceived pigeonhole, pray tell, what is it? Clarey does himself a disservice to take all this at face value without looking into it for himself. I would love to have him join me in the field.

Peter Klevberg with Michael Oard

A Young and Old Earth
A Creation Theory of Genesis 1:1–19

Understanding when the universe was created, including the creation of planet Earth, helps solve many difficult problems, such as the size and age of the universe, light transmission, radiometric dating, and the possible times and causes which produced the solar system's characteristics. The following synopsis helps develop that understanding.

In the Beginning

Genesis 1:1–2a states, "In the beginning God created the heavens and the earth. Now the earth was…" The words, "the earth was" reveal the Earth had been created, i.e., it had been created "in the beginning." (Earth's time of creation is recorded nowhere else but only in verse 1.) Verse 1 states, *the heavens* were also created *in the beginning*. Thus, verse 1 declares the Earth and the heavens were created before the first day. All subsequent creations and developments, therefore, occurred in six days with an earth that had been created.

Contradictions exist, however; e.g., the translations of Genesis 1:14–17 delay the heavens' creation until the fourth day. But using acceptable and appropriate verbs, a translation of these verses removes these contradictions. However, other issues exist. But first, an analysis of the Genesis language.

Asah, Natan

Depending on the context, the verb asah is translated in the NIV into about 275 verbs, including the verb, "made." The usual translation of *asah* in verse 16 states the sun, moon, and stars were made on the fourth day. However, *asah* is equivalent to the comprehensive English verb "do." Literally, verse 16 states, "God did the two great lights." Now the following verbs, all from the NIV, are used in translating *asah: assigned, appointed, instituted, established, ordained, committed, used, applied,* and *put into practice.* These potential verbs, applied in verse 16, convey the meaning that the sun, moon, and stars were then simply assigned, committed, used, ordained, appointed, or put into practice for their tasks.

In verse 17 the verb *natan* is usually translated "set" or "placed." Basically *natan* means "give." Literally, verse 17 states, "God gave them (the heavenly bodies)." Now *natan* is translated in the NIV by many verbs including *appointed, assigned, committed, designated, established,* and *dedicated.*

None of these generative verbs, and other verbs translating *asah* and *natan*, require the doctrine that the sun, moon, and stars began their existence—were *made* or *placed*—on the fourth day. Furthermore, the following developments and probable conditions support the revelation of verses 1–2a, the cosmos' preexistence.

Days One, Two, and Three

Verse 1 reveals the heavens had been created and therefore light existed. But verse 2 states the Earth had a dark surface and was covered with water. The probability is very high that, with heat, water vapor supplied a thick cloud cover from earth-cloud-earth circulation, and that cloud cover produced an albedo, which prevented visible light from penetrating to the Earth's surface. (Job 38:9 reveals the primeval Earth had a shielding cloud cover: "I made the clouds its garment and wrapped it in thick darkness." This relationship clearly indicates the darkness of verse 2 was produced and enclosed by the cloud cover.)

God said, "Let there be light." This command made light shine on the Earth's surface—probably by separating the cloud cover. The *Day* and *Night* declaration demarcated the first day, which also indicates the Earth's rotation rate of 360 degrees in 24 hours with light coming from one direction.

On the second day, God made an expanse over the Earth, creating the atmospheric environment needed by all forms of life.

On the third day, God elevated above the original waters a portion of the Earth for dry-land life. The plant life created provided the sustaining environment for all life.

The Fourth Day

Verse 1 reveals the heavens existence but does not reveal its structure and functions. But on the fourth day its constituents and purposes were given. Because the heavens had been created, these revelations can be expressed as follows.

Verses 14 and 15 should be translated, "Then God said, Let the lights in the expanse of the sky separate the day from the night … and for signs and for seasons and for days and years, and let them be lights in the expanse of the heavens to give light on the earth."

Verse 16 could be translated, "And God used (or entrusted or commissioned or appointed or established or put into practice, etc.) the two great lights, the greater light to govern the day and the lesser light to govern the night—the stars also."

Verse 17 could be translated, "God appointed (or committed or designated or assigned or gave, etc.) them … to give light on the earth."

These revisions remove the contradictions of verse 1, establish the cosmos' preexistence, and enlighten the day-by-day developments of the Creation.

Light

The relationship of light energy (the electromagnet spectrum) and matter is expressed by the equation, $e = mc^2$: e = energy; m = mass; c^2 = speed of light squared. Because of mass-energy equivalence, light exists in matter intrinsically, as well as existing externally. Therefore, when God said, "Let there be light," God did not create light then; light existed. His command brought the visible light to the Earth's surface.

Problems Resolved and Remain

Biblical and physical evidence, e.g., the fossils buried in catastrophic stratigraphy, reveal life on earth has existed for only thousands of years. However, biblical and physical evidence also reveal the universe has probably existed for a long time. Therefore, the expression "young earth" denotes the period since life was created, while the expression "old earth" denotes the chronology of the cosmos. This Creation theory seeks to establish the reality of these chronologies.

This Creation theory has consequences: Some scientists try to explain the phenomena of radioactive decay, stellar distances, etc. as if they existed only since life began. Specifically, their theories are based on the heavens' supposed origin on the fourth day. As a result, their explanations of these phenomena are forced: e.g., theories of accelerated decay, light velocities, and time. Consequently, their theories are erroneous. These scientists need to reassess the biblical evidence. The universe may be very old.

New knowledge is needed concerning the Creation's chronology and cosmology. For example, a translation of Exodus 20:11 (and Exodus 31:17), which supports preexistence, could be, "For in six days the Lord ordained (or established or instituted, etc.) the heavens and the earth…"

An important element of this theory is the proposed solution to the darkness problem of verse 2; i.e., it advocates that the Earth was originally covered with a shielding shroud that produced darkness, which God then removed. More important than any aspect of this theory, however, is the revelation of Genesis 1:1–2a, which clearly declares the preexistence of the heavens and the Earth.

Conclusion

The Creation record is the foundation of good theology and sound science. Therefore, it is necessary that the misleading translations of Genesis 1 be corrected, that the forced Creation theories be abandoned, and that research be pursued relevant to the two chronologies.

David P. Nelson
Pittsburgh, PA
davidnwv@aol.com

Response to David Nelson's "A Young and Old Earth"

Mr. Nelson has been a member of the Creation Research Society for a long time. In his letter, he appears to be advocating for the gap theory or some variation of the gap theory: that there was vast time prior to the Creation Week consisting of six normal days. A careful reading of the Society's statement of belief reveals that it is consistent with the gap theory. This is because the Society's statement of belief was crafted more than a half century ago when the gap theory enjoyed considerable support among creationists. However, since that time, the popularity of the gap theory has waned considerably among creation scientists. In response to this, the Society's Board of Directors long ago established a policy of publishing articles that support a young earth, young universe creation model only. As an astronomer, I am well aware of the light travel time problem. However, to suggest that the astronomical world predated the earth by billions of years is to suggest that there were no creative acts on Day Four, setting it apart from the other five days of Creation. Furthermore, this does injustice to the text. For instance, Exodus 20:11 states that in six days the LORD made not only the heaven and earth, but the sea and all that is in them as well. If we were to read Exodus 20:11 to mean that God established or ordained these things, then the entire Creation Week amounts to establishing or ordaining. This renders the Creation account of Genesis 1 meaningless, allowing for billions of years throughout.

Danny R. Faulkner
Editor

A Critique of the 6000-Year Theory

A popular theory in the creationist community of scientists asserts the Creation occurred about 6000 years ago. The physical evidence, however, disproves the theory. This critique outlines some of the evidence.

The time since the six days of the Creation can be divided into three intervals: the first interval, Creation to the Flood; the second interval, the Flood to Abraham; the third interval, Abraham to the present. The historical record from Abraham to the present indicates he lived approximately 4000 years ago. The interval from Creation to the Flood is problematic: that interval would be approximately 1650 years—if its genealogy (Genesis 5) is chronologic and not telescopic.

This critique concerns the second interval. According to the 6000-year theory, which is based on the chronologic interpretation of Genesis 11, that interval was about 350 years. 350 years is much too short to include the many post-Flood physical events completed or nearly completed by Abraham's time. The following are brief descriptions of some of those events.

Glacial Epoch Maximum (GEM)—The Glacial Epoch developed after the Flood; the water for the ice came from the ocean via snow. At the GEM the ice volume was immense: with the 9% ice expansion and at an average thickness of one mile, the glaciers covered about 18 million square miles of land. To produce that ice, the post-Flood sea level dropped approximately 650 feet.

Coral—During the GEM coral grew in the warm costal shallows, e.g., at New Guinea and Barbados. As the glaciers melted and the sea level rose, the coral fossilized. (For a picture of the coral, see the cover of Science, 5-29-09.) The average of many measurements from today's sea level to the coral is about 450 feet, and estimates indicate at least 200 vertical feet of ocean water remain as ice on Greenland and Antarctica.

Caves—During the GEM limestone caves were formed at those ocean depths, caves with stalactites and stalagmites. (See the August 2010 National Geographic, page 34, for pictures of a deep, submerged cave formed during the Glacial Epoch.)

Drumlins—Accumulated debris reveal a history of glacial expansion and contraction. For example, drumlins are smooth, elongated, debris-filled hills. They were formed when a glacier contracted, exposing its abundant debris, and then the glacier advanced again to ride over that debris to form drumlins. (Wisconsin has hundreds of debris-covering drumlins. Their elongations reveal the directions of the glacier's movements.)

Two Creeks Buried Forest—(These phenomena also are evidence of glacial expansion and contraction.) The Michigan lobe moved southwest eroding a blue-gray bedrock creating a blue-gray till. The lobe contracted, enabling a forest to grow on that till. Then, the Green Bay lobe moved south, eroding reddish bedrock creating reddish till. That till buried the forest. (See Google for Two Creeks Buried Forest.)

Glacial Epoch Diastrophism—Continental glacial remains, together with the underlying strata, were deformed by mountain-building forces. These phenomena reveal that during the Glacial Epoch new mountains were formed.

Analyzing these events reveals how prolonged was the Flood-to-Abraham interval. These phenomena disprove the 6000-year theory, while proving the genealogy of Genesis 11 is telescopic.

The 6000-year theory is scientifically and socially detrimental. It misleads research and leads many to dismiss genuine Creation evidence. For sound apologetics this theory needs to be abandoned.

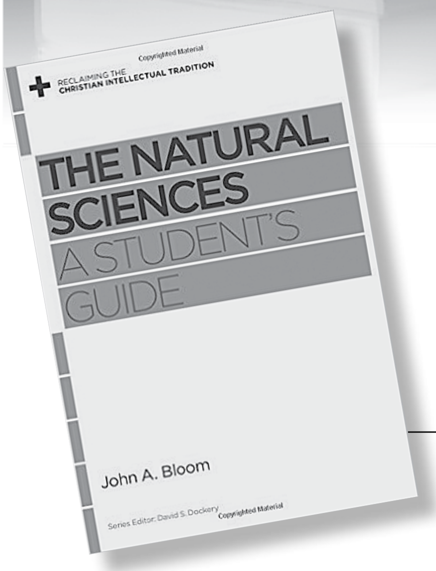
David P. Nelson
Pittsburgh, PA
davidnwv@aol.com

Response to David Nelson's Critique of the 6000-Year Theory

The approximately 6,000-year age of creation comes from biblical genealogies. Mr. Nelson, a long-term member of the Creation Research Society, appears to agree that those genealogies are reliable enough to indicate that Abraham lived nearly 4,000 years ago, but he expresses doubt about earlier dates. The basis for his doubt is not textual, but rather stems from perceived difficulties of physical evidence. However, this conclusion depends upon one's framework of interpretation of the physical evidence. For instance, an ice age does not necessarily take many thousands of years as generally assumed. The expected conditions of warm ocean water and relatively cool air immediately after the Flood would have produced tremendous snowfall unmatched since. Society board member Michael Oard has modeled the ice age extensively. His sea-level drop is more like 300-400 feet, and his model can accommodate a 350-year time span. Most corals today appear to be near stasis, with little or no growth, but studies have shown that with the right conditions, corals can grow very rapidly. The immediate post-Flood conditions likely facilitated rapid coral growth. Similarly, caves and drumlins can form rapidly. Forests can grow in a few decades, so rapid burial of a forest in between episodes of glacial advance in a rapid and chaotic glacial model is not a problem. Finally, I do not understand Mr. Nelson's comment about mountain-building forces deforming glacial remains. Most mountain building had finished by the ice age in both the uniformitarian and recent-creation models. If anything, mountains were deformed by glaciers.

Danny R. Faulkner
Editor

Media Reviews



The Natural Sciences: A Student's Guide (Reclaiming the Christian Intellectual Tradition)

by John A. Bloom

Crossway Books, Wheaton, IL, 2015, 134 pages, $11.99

This short book is part of an academic series on the major Christian intellectual traditions. The balanced, well-documented study includes a short overview of the people and events that gave rise to modern naturalistic science and its perspective.

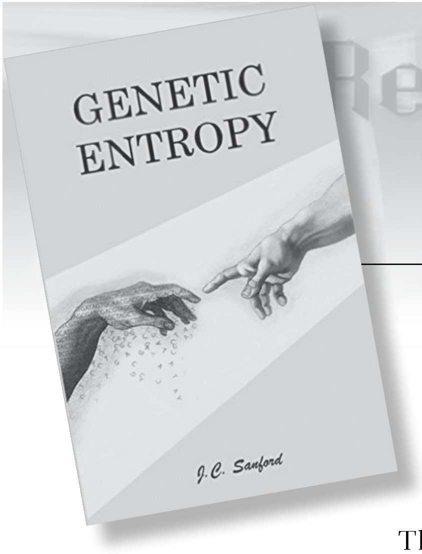
Professor Bloom has two earned PhDs, including one from Cornell University in physics, and thus is well qualified to write such a book. The volume reviewed here covers the natural sciences, including the creation-evolution issue, from a Christian tradition. Bloom documents the fact that science was once the handmaiden to theology and also that Christianity was a critical factor in many major historical science advancements. This is illustrated in the life and work of Isaac Newton, along with that of Johannes Kepler, Robert Boyle, and many other leading pioneer scientists.

Bloom documents the rift caused by the so-called Enlightenment and the many reasons why the methodological naturalism philosophy that dominates science today is "the wrong road" to social and scientific progress (p. 53). Bloom says the dominance of methodological naturalism is counterproductive because, first, it limits explanations of natural events to materialistic naturalism. Second and more importantly, Bloom argues that this set of blinders actively suppresses the research and publication of ideas that attempt to explain certain natural events by appealing to explanations outside of the naturalism box, such as explaining the origin of information in DNA by intelligence.

As Bloom notes, the methodological naturalism view is the "philosophical position of the atheist" and is often used to suppress theist philosophical positions (p. 54). Methodological naturalism is not a neutral position, as many scientists often claim, but is hostile toward research that does not conform, or have the potential to conform, to this narrow worldview. Bloom argues that the "way back home" is to think "outside of the box of naturalism" (p. 87).

He also documents the fact that every science theory "includes a philosophical perspective," and secular humanists use methodological naturalism as a means to suppress Christianity and the Christian worldview, including both creationism, however defined, and intelligent design (p. 88). The sections in the book on the contribution of Darwinism to the problem of evil, an often-ignored aspect of the Darwinian worldview, are excellent.

Jerry Bergman
Jerrybergman30@yahoo.com



Genetic Entropy, 4th edition

by John C. Sanford

FMS Publications, 2014, 270 pages, $25.00

This book was first published in 2005 by John Sanford, a well-known geneticist from Cornell University. He has done extensive studies in the field of plant genetics leading to over 100 publications and a number of patents in the area of plant genetic engineering. The *CRSQ* review of the first edition by Wayne Friar highlighted the main point of the book: It "convincingly clarifies that (evolution) could not happen" (Frair, 2007). In the fourth edition, this premise has been underscored by the inclusion of a number of current studies that augment the original premise (including an additional chapter devoted to examining these studies), substantially increasing the impact of this book.

John Sanford focuses on the primary axiom of evolution, which states that random mutation of the genetic code plus natural selection acting on those mutations are responsible for the maintenance of the genomes of living organisms (and ultimately for their increasing in complexity as well). Multiple lines of evidence are presented from the work of Sanford and others that strongly supports his conclusion that the primary axiom "is clearly false and must be rejected" (p. 115). These evidences instead support the concept that the human genome is deteriorating rapidly and that "the extinction of the human genome appears to be just as certain and deterministic as the death of organisms" (p. 89). What is the cause of this deterioration? Sanford points to random mutations in the genome, accumulating at an alarming rate in the population (very conservative estimates of 100 per person (pp. 44–45). Earlier scientists dismissed most of these as being located in nonessential "junk" DNA, but recent evidence shows that the percentage of nonfunctional, nonexpressed DNA is very small, meaning that these mutations are likely to have a negative overall impact. The worse news is this: The large majority of these mutations are nearly neutral in their impact (with significantly damaging mutations being rare, and beneficial mutations even rarer) and due to the sheer number of them, the process of natural selection is not adequate to eliminate them from the population. This work claims that the human species is headed for a "mutational meltdown" in the not-so-distant future (p. 45).

It is interesting to note that the focus of this book is on current genetic trends and their future implications. No substantial extrapolation of these principles is made to suggest a point where this genetic deterioration might have begun, although the author does look at decreasing life spans in the Bible to show that the deterioration is apparently not a new phenomenon (pp. 158–160). He also presents convincing arguments that if the primary axiom is unable to halt the deterioration of the genome, it certainly could not achieve the opposite of creating new, functional information ex nihilo (pp. 109–110). Not surprisingly, not everyone agrees with Sanford's conclusions. Those stating that his assertions are unfounded have been less than magnanimous in their responses (Letters to Creationists, 2013).

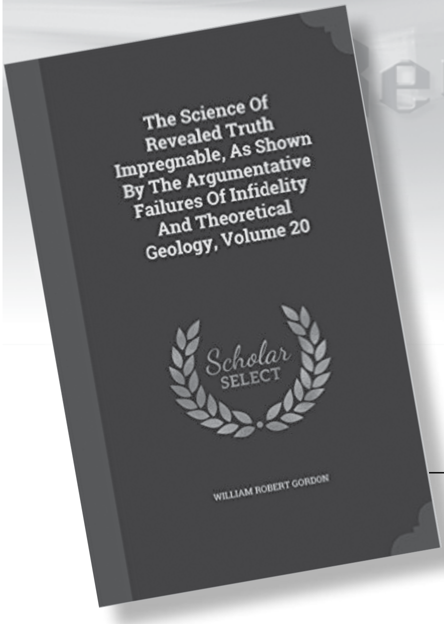
While a background in biology and genetics helps in an understanding of the complexities of the data discussed by Sanford, he presents the general concepts at a level accessible to a lay reader as well. He addresses several issues at a more technical level in detailed appendices. He also presents his case in an objective manner, without significant disparaging of those who might have a different opinion, although he occasionally suggests that attempts to explain away some of these observations amount to "conceptual sleight of hand, not to resolve a problem, but to hide it" (p. 117). Sanford also acknowledges that there might be other explanations that could cast a different light on what we currently know, such as the suggestion that a yet-undiscovered "rescue" mechanism to remove mutations might exist or have existed in the past. The book has an extensive literature citation section referencing many scientists, as well as a glossary to help the non-geneticist, and an index. The conclusions drawn in this work by Sanford are dire indeed; but they are tempered by a short personal postlude in which he explains the hope he has through the Lord Jesus Christ.

Rick Roberts
rick.roberts@grace.edu

References

Friar, W., 2007, Book Review, *CRSQ* 44:55

Letters to Creationists. 2013. https://letterstocreationists.wordpress.com/gen_entropy/ (accessed March 18, 2015).



The Science of Revealed Truth Impregnable as Shown by the Failures of Infidelity and Theoretical Geology

by William Robert Gordon

Board of Publication of the Reformed Church in America (RCA), New York, 1878. Reprinted by Nabu Press, Charleston, SC, 2012, 316 pages, $31.75

William Gordon, was a first-rate nineteenth-century academic theologian who demonstrated that old-earth geological theory (OEGT) was incompatible with the philology (or hermeneutics) of the Bible, as well as observed geological facts. The book is a published summary of the 1877 Vedder Lectures delivered to the students of Rutgers College and their theological seminary in New Brunswick, New Jersey.

The Reformed Church in America (RCA) still has a graduate school called New Brunswick Theological Seminary. It is located on a tiny island surrounded by Rutgers, which became the State University of New Jersey in 1956. As a 1987 Rutgers alumnus, I joined a number of Christian faculty members who met regularly for prayer at the seminary in 1994. Originally named Queens College and one of the nine colonial colleges, Rutgers was founded in 1766 by the RCA, like the other early eastern colleges begun by church denominations. Rutgers College severed its RCA ties in 1906 to qualify for funds from the Carnegie Foundation (Sloan, 1994, p. 20). Similar to Princeton and Harvard, the original Christian affiliation of Rutgers survives only in divinity schools or seminaries, now separated from their respective universities.

Gordon points out (p. 7) that though some Christian geologists compromised with OEGT in order to take away unbelievers' objections to the Bible, this had a contrary effect: the contempt of skeptics who rejoiced in the concessions made.

Gordon wrote, "The facts of geology are all true, but the speculations formed to account for them are not" (p. 285). He encouraged the study of geology for the purpose of building a theory consistent with the Bible (p. 271). He concluded that the medical-doctor-turned-geologist Martyn Paine's work (1872) was "well done." Paine was a leader in medical research and education and on the 1841 founding faculty of the Medical College, University of the City of New York. He authored a number of textbooks. For a skeptical review of Paine, see Stiling (1999). Paine's book was published five years before Gordon's lectures.

Gordon challenged the claim of *theoretical* geology "that the Mosaic record is untrue" (p. 175). He pointed out that it could not be determined from the strata themselves "whether the world was formed 6,000 years ago or 60,000 years" (p. 185). Gordon believed the creation occurred about 4,000 B.C. (pp. 73, 192).

The consequence of OEGT is that the Bible, deprived of its foundational facts, falls as the accredited vehicle for God's revelation to man. Christian geologists, trying to harmonize revelation with geological theory, strengthened the hands of infidelity and weakened the faith of a multitude of Christians. Gordon "met young men so damaged by [OEGT] arguments, against which they could not reply, that they avowed disbelief of the Bible on account of them" (p. 214). Gordon quotes from David King's (Glasgow) 1851 book on geology: "In my intercourse with young men of good education, I have found more of them disquieted in their minds, if not unsettled in their religious principles, by the results of geological investigation, than by any other difficulties attending revealed truth" (pp. 193–194).

On pages 203–210 Gordon answers Christian OEGT proponent John Dawson. Dawson thought that the Greek word *aiōn* in Hebrews 1:2 and Ephesians 3:11 (plural) referred to the creative days as long ages. Gordon answered that there was no more authority for translating the Hebrew word *yom* ("day" in Genesis 1) by *aiōn* (age) than for supplanting it by *olam*, the usual Hebrew word for a long duration. Dawson's assumption "deserved the bitter sarcasm of Huxley ... all such efforts play into the hands of the enemies of Revealed Truth." He further wrote, "Philology requires us to understand a word ("day") in its literal sense when first used, not figurative" (p. 286). Gordon makes a very strong argument that the word (*yom*) used in the fourth commandment has the literary genre of a legal document (Exod. 20:11), where a figurative use is forbidden.

Hugh Miller attempted an OEGT

compromise by claiming that the seventh day of Creation was still continuing, in order to avoid the difficulty that the first six were long ages though the seventh was just 24 hours (pp. 214–218). However, Gordon observed, on the seventh day "God rested" (past tense), not "God rests," and "God was refreshed," not He "is being refreshed," so the seventh day activities are not ongoing. Miller (1857) promoted OEGT in England and the U.S.

Gordon considered yielding the biblical point of a six-day Creation "to be an abandonment of the doctrine of divine inspiration" (p. 287). Teaching that the Flood was only local is "a sin against God and a crime against man, because it is adapted to destroy all confidence in revelation" (p. 288). The historical Flood, he wrote, was "taken everywhere in Scripture to be literally true. ... if these facts are *fictitiously* presented in the Scriptures, then their *inspiration* at least must be given up." He pointed out that if OEGT is true, "we must let Moses go as an uninspired historian, whose alleged physical history cannot be accredited; since it is demonstrably impossible to reconcile his cosmogony with the prevailing theory without destroying the science of philology, and the very basis upon which a verbal revelation from God to man is at all possible" (p. 234).

Gordon sagely observes that OEGT Christians who adopt the skeptic Charles Lyell's assumption of slow and gradual geological processes as a starting axiom will find it impossible to go against his conclusion. Gordon believed that past rates of geological activity were greater than at present, especially "if the Noachian Flood be admitted" (p. 224). This is identical to the argument of his earlier contemporary David Lord (Goertzen, 2002). Gordon also mentions plastic deformation of unbroken strata (p. 226), polystrate fossils (p. 246), and living fossils, as well as fossils found in the wrong strata (p. 259), as geologic facts against OEGT. He thought the thickest coal deposits were from Noah's Flood "sweeping the entire flora of the antediluvian world into vast basins" (p. 277), a theory that the scriptural geologist Martyn Paine advanced (cited by Stiling, 1999, p. 184).

Paine (1872) observed that the conflict would be fought in the disciplines of the sciences and those trained in them. However, seminary alumni are well aware of the uphill challenge to reclaim the straightforward hermeneutics that Professor Gordon made clear. During a more recent evangelical conference, theologian Ted Cabal (2001) acknowledged that no credible biblical interpretation for an old earth has been developed. Nevertheless, OEGT is believed because it is thought that those interpretations of science must be correct.

Gordon's hermeneutical arguments are still sound, as is his point on initial assumptions. His writings are yet another refutation of Ronald Numbers's flawed history, adopted uncritically by Noll, that flood geology sprang from George Price (cf. Goertzen, 2010). If Gordon could return to Rutgers today, he would consider his 1877 concerns amply justified. Multiple campus buildings are named in honor of atheist activists, while Christian groups are banned.

John Goertzen
bluejay@birdlover.com

References

Cabal, Ted. 2001. *Evangelicalism and Young Earth Creationism: Necessary Bedfellows?* Paper read at the Evangelical Theological Society, Colorado Springs, CO.

Goertzen, John. 2010. Review of *Evolution, Science, and Scripture: Selected Writings of B. B. Warfield*, edited by Mark Noll and David Livingstone. *Creation Research Society Quarterly* 47:30–32.

Goertzen, John. 2002. Review of *Geognosy or the Facts and Principles of Geology Against Theories*, by David Lord. *Creation Research Society Quarterly* 39:13–14.

Miller, H. 1857. *The Testimony of the Rocks, or, Geology in its Bearings on the Two Theologies, Natural and Revealed*. T. Constable & Co., Edinburgh, Scotland; Gould & Lincoln, Boston, MA.

Paine M. 1872. *Physiology of the Soul and Instinct, as distinguished from materialism: with supplementary demonstrations of the divine communication of the narratives of creation and the flood*. Harper & Brothers, New York, NY.

Sloan, D. 1994. *Faith and Knowledge: Mainline Protestantism and American Higher Education*. Westminster John Knox Press, Louisville, KY.

Stiling, R. 1999. Scriptural geology in America. In Livingstone, D., D. Hart, and M. Noll (editors), *Evangelicals and Science in Historical Perspective*, pp. 177–192. Oxford U. Press, New York, NY.

Opening Up Job

by Ian S. McNaughton

Day One Publications, Leominster, England, 2014, 176 pages, $14.00

Author McNaughton pastors churches in the Fellowship of Independent Evangelical Churches (FIEC), England. He holds a Th.M. degree from Westminster Seminary, Glenside, PA. This popular-level book takes a conservative look at the book of Job. This includes recognizing Job as a literal Old Testament patriarch living near the time of Abraham and interpreting behemoth (Job 40) and leviathan (Job 41) as dinosaur-era creatures that survived the global Flood.

The Book of Job is credited for its science content, including cosmology (Job 9, 26, 38), the hydrologic cycle (Job 26, 28, 37), geology (Job 38), and astronomy (Job 9, 38). Several purposes for the book of Job are given (pp. 23–24): To show there is no necessary link between individual sin and personal suffering; to reveal the sovereign character of God in terms of justice, wisdom, and grace; to show the reality of Satan and his limited power; to comfort the people of God in times of need; and to encourage trust in God in all circumstances. I especially like the additional purpose: our preparation for the inevitable "treadmill of pain" when it comes along (p. 53).

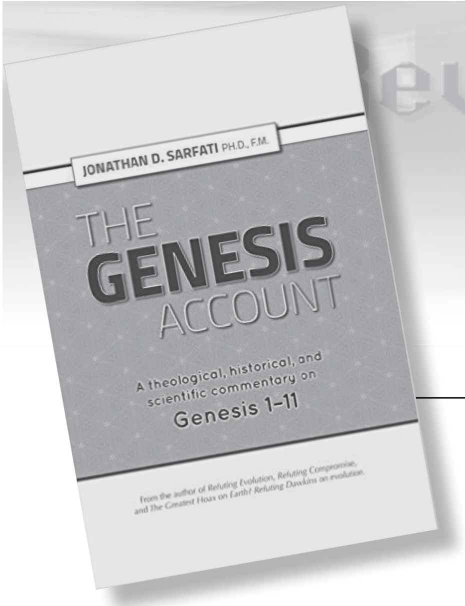
As a "theology of suffering," four distinct reasons are given for pain (p. 59): (1) the curse of Genesis, which touches all the physical creation, including disease and death; (2) Satan himself, who was allowed to bring grief to Job; (3) personal sinfulness such as poor choices in life; and (4) God's way of sanctifying His people for their own eternal good. As has been stated often, "Trouble brings out the best or the worst in people" (p. 70).

The author freely quotes the writings of Charles Spurgeon and Matthew Henry. Other resources are listed; however, there is no mention of the classic commentaries on Job by Delitzsch and Easton (1950); Driver and Briggs (1921); Ellicot (1905); Jamieson, Fausset, and Brown (1921); Gaebelein (1988); Walvoord and Zuck (1985), and others. Collateral reading from these writings is required in conservative seminary studies on the life of Job.

The book assumes consistent young-earth biblical creation. McNaughton concludes, "Job had no thoughts of evolution [or] millions of years of suffering and bloodshed before Adam … because he trusted the revelation given to him by God" (pp. 32–33). Although Job had no scripture available in this early period, there were surely clear oral traditions concerning "the creation (Job 26:7), the Flood (Job 22:16), and what happened at Sodom and Gomorrah (Job 22:20)" (p. 108).

At the conclusion of the book of Job, God speaks to Job in a theophany about creation (Job 38–41). The three "miserable comforters" of Job (Eliphaz, Bildad, and Zophar) make peace with God (Job 42:7–9). The position before God of Job's fourth friend Elihu is less certain (p. 119). After the episode of intense suffering, Job lives an additional 140 years of service to God. The entire book of Job, and this particular commentary, is an encouragement for believers. Helpful questions are given at the end of the book chapters. Endnotes are provided. There is no index.

Don DeYoung
DBDeYoung@Grace.edu



The Genesis Account: A Theological, Historical, and Scientific Commentary on Genesis 1–11

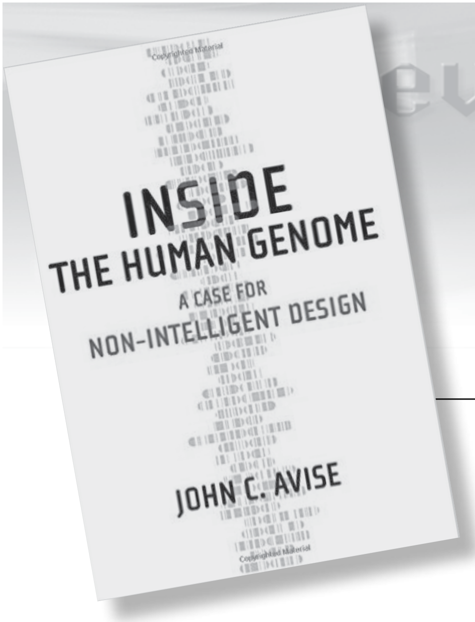
by Jonathan Sarfati

Creation Book Publishers, Powder Springs, GA, 2015, 786 pages, $35.00

This book is a large, scholarly commentary on Genesis 1–11 from a messianic Jew, who knows the original Hebrew, plus other languages, as well as the science related to origins from all fields. It is packed with information, but technical terms are mostly explained in the text or footnotes. The importance of a new commentary on Genesis 1–11 is that these chapters especially have been attacked by secular intellectuals, and as a result some in the church have been intimidated to compromise Scripture with Enlightenment ideas. The author provides abundant evidence that those compromises are big mistakes and cannot be supported by the Bible.

Although creation scientists will agree with the vast majority of the commentary, not everyone will agree with everything Sarfati writes, which is to be expected. But even those areas of disagreement are food for thought. The first part deals with introductory material such as the author of Genesis; the type of literature, which is historical narrative; and an overview of the theology. About 30% of the book is a commentary on Genesis 1 and 2, probably because there is more controversy and varied opinion here than in any other chapters in Genesis 1–11. One area of sure controversy, which the author does not sidestep, is the account of the sons of God and the daughters of man, who produced the Nephilim. Sarfati provides a good case that the sons of God were fallen angels. He also spends major time on the Flood, since it is one of the most attacked parts of Scripture. He finishes with details of what we know about the Table of Nations and the location of the spreading of people groups after the Tower of Babel incident. Scholars and layman both will benefit from this book.

Michael Oard
mikeoard@bridgeband.com



Inside the Human Genome: A Case for Non-Intelligent Design

by John Avise

Oxford University Press, New York, 2010, 222 pages, $20.00

Author Avise, professor of evolutionary biology at the University of California, Irvine, selects the human genome as the cornerstone of his argument against intelligent design. The book is an excellent, readable review of the complex design of the human genome.

Ironically, the author argues that the enormous complexity is one reason that the human genome is *not* designed. This is a problem because the more complex something is, the more likely it is that something will go wrong; thus natural selection will select against it. The author argues that if the genome is designed, it should be far simpler, and thus less likely that things could go wrong. For example, the Krebs cycle, which every biochemistry student is familiar with, is only one example of the 2,766 documented metabolites and 3,311 metabolic and transport reactions known in human cells, and many more exist that no doubt await discovery.

To illustrate his premise, Avise lists a few of the thousands of diseases that result from genetic errors (pp. 62–63) and from mitochondrial mutations (pp. 100–103). He also includes diseases caused by deletions, duplications, and inversions or translocations (pp. 110–112), all of which change the original design.

Another Avise argument is that, as far as we know, all genes in all eukaryotes contain *introns*, which are gene sequences that are spliced out by a complex machine called a spliceosome before the gene transcript is used as a template to produce a protein segment. In the total of protein specifying genes, 97% of the known protein-coding gene base pairs consist of introns. The diseases caused by splicing errors in the introns when the mRNA transcript genes are processed include amyotrophic lateral sclerosis (ALS), commonly called Lou Gehrig's disease, and many others (pp. 76–77).

Avise lists the various evolutionary theories postulated to explain the origin of introns and the spliceosome, all of which he admits are problematic. As genetic research has progressed, we now realize that these introns are not junk, as once believed, but rather serve a wide variety of functions, including genetic regulation and the advantage of a single gene called an isoform, which is able to produce many different proteins. A specific intron, or set of introns, may or may not be spliced out, allowing one gene transcript to potentially produce hundreds of different kinds of proteins.

As Avise notes, 75% of the protein-coding genes express alternatively spliced variants. Avise argues that rather than producing different proteins by intron splicing, which requires the complex splicing system, instead of the actual 21,000 genes, four or five times this many genes would be much simpler and less prone to mistakes. Nor would this approach, he argues, require a spliceosome. This suggested option is naïve and ignores the whole regulation and economy advantage of the existing system. Some of the arguments Avise uses to support his thesis have already been proven wrong, such as the claim that less than 1% of the 6 billion bases (T, A, G, C) code for amino acids (p. 135) and the claim that over half of all genetic bases are functionless junk, a view that the ENCODE project and other research has now largely laid to rest.

Another problem with his theory, as Avise admits, is that cellular machinery goes "to great lengths to screen and repair DNA mutational damages. Inside the cells of various organisms are legions of enzymes and multiple biochemical pathways that carry out the following" (p. 66) classes of molecular repair:

1. Photoreactivation repair, acting on nucleic acid pyrimidine dimmers that often arise in skin as a result of exposure to ultraviolet light from the sun.
2. Nucleotide excision repairs base dimmers by excising them and splicing new base pairs into the area of damage.
3. Recombinational repair on DNA by using strand exchanges from nonmutated daughter chromosomes.
4. Base-excision repair, which identifies and then excises, individual aberrant bases.

5. Mismatch repair, which recognizes and then replaces improperly matched bases with the correct base.
6. Inducible repair, which screens for bases that were incorrectly chemically modified by, for example, methylation.
7. SOS repair, which renovates single-strand gaps or the presence of DNA degradation products.

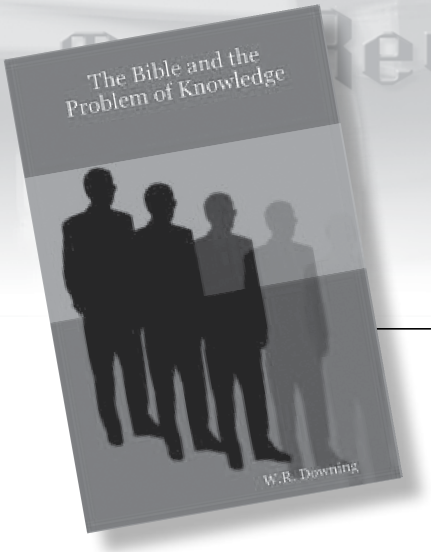
Avise concludes, "Like quality-control inspectors in a factory assembly line, these cellular mechanisms are diligent, but not infallible" (p. 66). He then adds, "The fact that cells employ such extensive and conscientious workforces is itself testimony to the conclusion that mutations create genuine biological defects that are not merely some negative prejudice in the eye of the human beholder" (pp. 66–67). The evolutionary explanation for these repair systems "is that genomes have evolved the capacity to screen and correct mutational errors, but the mechanisms do not always perform perfectly" (p. 67). This is true, but the repair success rate is extremely high. Over an estimated 99.99% of all repairs are made successfully. Avise concludes that the alternative explanation "is that an intelligent designer has fabricated post-hoc molecular systems, which themselves are imperfect, to partially compensate for molecular flaws inherent in his original biological blueprints" (p. 67).

Of course, the cause of mutations is not flaws in the original design, as Avise claims, but damage to DNA caused by radiation, mutagenic chemicals, and free radical damage. The major problem with Avise's thesis is that the original blueprint is not the problem, but the DNA mutational events per day number in the multimillions and would be lethal for life without this complex repair system. Few, if any, humans, or even vertebrates, would survive to be able to reproduce, and the extinction of all species would be rapid. Avise writes that intelligent design supporter Michael Behe promulgated the notion of irreducible complexity at the biochemical level in his objection to natural evolutionary causation, stating that "biochemistry offers a Lilliputian challenge to Darwin." However, in the recent empirical light of rampant genomic defects and biochemical breakdowns, it might be said with even greater force that the findings of molecular biology offer a gargantuan challenge to intelligent design (p. 140).

The fact is, as Avise himself acknowledges, every disorder that he blames on poor design actually "results from a deleterious mutation in one or another of the thousands of structural and regulatory genes that populate our genomes. In many cases, the mutant locus (or loci) for each genetic disorder now can be specified precisely, as can its laboratory diagnosis and its operational consequences for a patient's tissues and organs" (p. 141).

This supports the intelligent design view he attempts to refute, not evolution. Nonetheless, Avise concludes, "Evolution is a sloppy tinkering process, constrained by happenstance and historical precedence and guided with respect to adaptations by a mindless directive agent (natural selection)" (p. 141). In fact, life is anything but this, and the evolution process he describes would hardly be sufficient to create life, let alone sustain it for any significant amount of time. The information presented in detail by Avise cannot be explained by the accumulation of mutations, nor does Avise even attempt to do so. Rather it supports the deterioration of the genome, as predicted by the Fall or Curse. A major argument Avise uses against intelligent design is the existence of evil, especially genetic disease caused by mutations. This theological argument would not seem to belong in a book on genetics but rather one on philosophy or theology and thus is not covered here except to note this concern is also explained biblically by the Fall or Curse on mankind.

Jerry Bergman
Jerrybergman30@yahoo.com



The Bible and the Problem of Knowledge

by W. R. Downing

PIRS Press, Morgan Hill, CA, 2006, 148 pages, $11.95

W. R. Downing serves as a pastor as well as director and president of the Pacific Institute for Religious Studies. He is also the author of numerous books and papers. As anyone who has done a thorough study of apologetics will acknowledge, the subject of epistemology is unavoidable in such an endeavor. Pastor Downing takes on this weighty topic as it relates to apologetics in a scholarly yet accessible way.

I appreciated his repeated appeal to Genesis history in making his case for the default epistemological condition of fallen man. He asks, "What would the implications be if the Genesis account of the fall of man were only myth, legend, or religious symbolism?" (p. 39). Upon noting some insights in the book (that a universe rather than a "multiverse" implies God [pp. 32, 40]; that 2 Peter 3:1–10 alludes to the rise of uniformitarianism [p. 98]), I was reminded of how I was first introduced to them by the late Henry Morris (2002, pp. 28, 114). That does not mean, however, that Downing would endorse Morris's apologetic methodology.

Creationists will appreciate Downing's argument that "unbelievers unconsciously … assume the laws of God's ordered universe, without which no scientific research could take place or scientific conclusions could be reached. Indeed, the unbeliever could not function at all without assuming (unconsciously and inconsistently) the realities of Divine creation and order" (p. 119, footnote 228). "Secular Humanism has necessarily built upon this traditional Christian base (built on the borrowed capital of Christian principles)" (p. 19, footnote 26). This is another insight previously pointed out by Morris (2002, p. 22) and reiterated often in creationist literature.

In this short book, Downing brings to the layman an integral yet often neglected component of apologetics. Frankly, a lack of epistemological groundwork and consequent underdevelopment of a consistent apologetic methodology has been a major setback for biblical creationists. I am convinced that the early days of the modern creation movement neglected some important theological considerations in an effort to convince unbelievers of the doctrine of creation. Fortunately, the movement in general has matured since then; our presuppositions have moved more to the foreground, and our approach seems to be less fragmented. Still, Creation Science Fellowship Chairman Robert Walsh's assessment that, "the underlying methodology of most creationists today can be shown to be fundamentally flawed" (Walsh, 2008, p. viii) remains, in my opinion, an accurate one.

While Downing's small book may only serve as an introduction to epistemology, the author explains why an understanding of this subject is crucial for a biblical approach to apologetics. I think it is safe to assume that many Christians—myself included—were enthusiastic about "scientific creationism" as a major weapon to be used in defending the faith, not realizing that we were lacking the necessary methodology to properly employ this newly acquired storehouse of "evidence".

Too often apologists in general (and biblical creationists in particular) have been guilty of either promoting physical evidence in a vacuum, or admitting to certain presuppositions but still lacking consistency in how physical evidence should be presented within the context of a biblical view of post-Fall man. Without attempting to address the many issues related to the various apologetic approaches (which Downing reduces to only two), I would simply challenge my fellow creationists to consider whether our apologetic method has been the one employed by Jesus and the apostles in the New Testament (Robbins, 1996), and whether such a method takes a comprehensive theology of the Fall into consideration. The irony is that while the biblical creationist has made every effort to defend the *historicity* of the Genesis record, he has unwittingly denied the *theological ramifications* of the Fall if he fails to consider the effect it had on Adam's progeny, particularly with regard to the intellect. Put another way, the historicity of the Fall event has been consistently affirmed by creationists, but the same cannot be said for the theology of the Fall. We must remember that when we proclaim biblical truth, we are not interacting with a "very good" (Genesis 1:31) Adam today (who incidentally still could not depend solely on general revelation) but with his fallen, finite, fallible, and epistemologically futile descendants.

Apologetics is not separate and distinct from the rest of theology. Therefore, an approach that does not interact with other key doctrines will tend to be faulty, unbiblical, ineffective, or at the very least, inconsistent. Downing assesses the various theories of knowledge and philosophical systems, showing that they all fail the test of logic and consistency. He then reduces the many nuanced apologetic systems simply to presuppositionalism and evidentialism. This means that readers acquainted with the multiple apologetic systems and associated objections will not have all their questions answered here. But the author makes this simplification, not because he is unfamiliar with the variety of opinions within those apologetic camps (the extensive bibliography and his other writings testifies to that fact), but because his emphasis is on the crucial issue of the "epistemological futility" of the natural man versus the "revelational epistemology" of the regenerated man.

Pastor Downing brings the unavoidable apologetic component of epistemology to us in a way that is easily understandable with more technical points, original language text, and detailed references set in 245 footnotes. The book is loaded with Scripture and would greatly benefit biblical creationists willing to reconsider the way in which evidence is utilized in light of a comprehensive theological system.

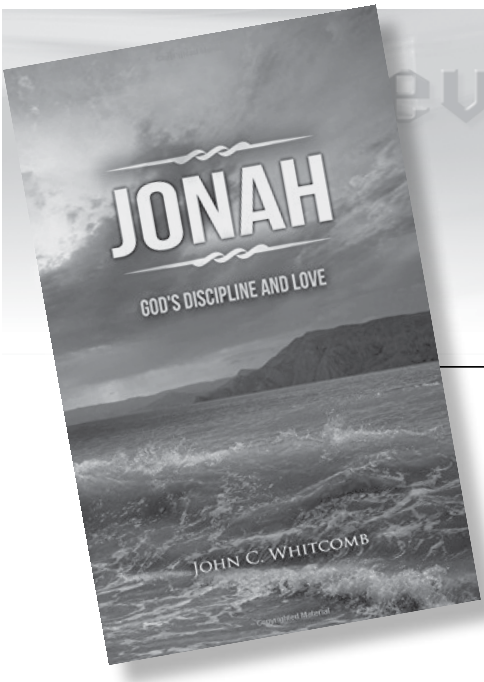
Nick Sabato
n.sabato@yahoo.com

References

Morris, H.M. 2002. *The Biblical Basis for Modern Science*. Master Books, Green Forest, AR.

Robbins, J.W. 1996. The apologetics of Jesus and Paul. *The Trinity Review*, May/June, 1–11.

Walsh, R.E. 2008. Preface. In Snelling, A.A. (editor), *Proceedings of the Sixth International Conference on Creationism*, p. viii. Creation Science Fellowship and Institute for Creation Research, Pittsburgh, PA and Dallas, TX.



Jonah: God's Discipline and Love

by John C. Whitcomb

Whitcomb Ministries, Indianapolis, 2015, 143 pages, $8.00

This clear commentary follows from Whitcomb's decades-long study and teaching of Old Testament books. A 6-hour DVD series on the book of Jonah is also available (Whitcombministries.org). This work begins with an overview of Near East history, including the division of the kingdom of the Hebrews into the north (Israel) and the south (Judah). Jonah lived in the midst of this period of national separation.

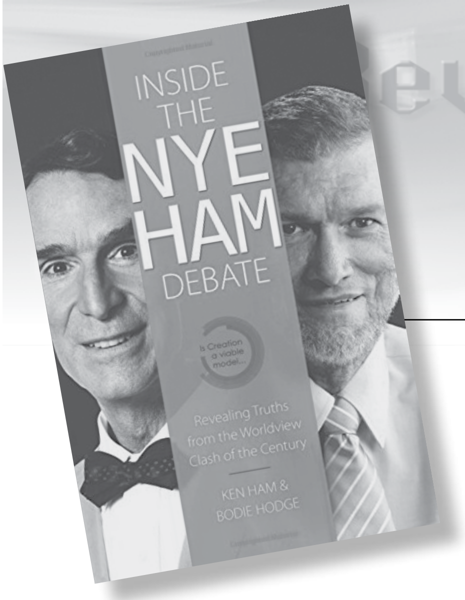
In Whitcomb's colorful description, Jonah is described as "the worst missionary in all of human history" because he fled in the opposite direction from God's direct call (p. 5). At the same time Jonah also is one of the world's greatest missionaries for preaching God's truth at risk of reputation and life (p. 5). The "great fish" that swallowed Jonah is "God's magnificent, organic submarine" (p. 58). Whitcomb does not dwell on the debate of whether a literal fish could naturally swallow a person whole (p. 72). He concludes that far more significant and miraculous is the prayer of Jonah: "Then Jonah prayed to the Lord his God from the fish's belly" (Jonah 2:1).

This book makes many side references to Noah's time, seven centuries before Jonah. It is estimated that at least one billion people were on earth at the time of the Flood (p. 95). Whitcomb also suggests that at that time "everybody in the world had heard the warning and had laughed it to scorn" (p. 103). But perhaps some repented and believed before they died, similar to the conversion of the thief on the cross (p. 103).

The book of Jonah is summarized with ten miracles: The storm, the casting of lots, the sudden calming of the sea, the great fish, the three-day trip inside the fish, the vomiting of Jonah on the shore, the growing vine, the worm, the scorching wind, and, greatest of all, the miraculous submission of Jonah to God's will (p. 131). Dr. Whitcomb also reminds us that Jonah himself wrote the book as his way of saying, "I did this. I sinned. I am guilty. God wins, and I lose" (p. 131).

The book of Jonah and this brief commentary are both encouraging to read. A scripture index is provided.

Don B. DeYoung
DBDeYoung@Grace.edu



Inside the Nye Ham Debate

by Ken Ham
and Bodie Hodge

Master Books, Green Forest, AR, 2014, 393 pages, $16.99

Bodie Hodge claims authorship of this book; however, since he works with Ken Ham at Answers in Genesis, this book also reflects Ken Ham's viewpoint. Hodge has an M.S. degree in mechanical engineering, the same discipline in which Mr. Nye received his college degree. Bill Nye is best known as "the science guy" because of his television series by that name.

The book is well organized with a table of contents, two forwards, an introduction, five parts of the debate format, and four appendixes. The introduction describes how the February 2014 debate was organized, the topic that was agreed upon, the basic debate facts, and the debaters' positions. The official topic was, "Is creation a viable model of origins in today's modern scientific era?"

Both debaters claimed their worldview best explained the origin of our universe. Ken Ham presented his worldview in his opening statement and was consistent thereafter, building on it throughout the debate. In this worldview, creation is the basis of all true observational science. Bill Nye opened the debate by claiming that there are two stories for the origins of the universe, that of Ham and that of mainstream science. What Nye neglected to point out was that evolution, as promoted by mainstream science, is based only on historical science and has nothing to do with operational science. Historical science is based on mankind's interpretation and extrapolation of observed data in the present. Operational science is the pursuit of truth found in the observed data and its use in the future.

In part two of the debate, Ken Ham described scientific disciplines in use today that were founded by creationists in the past. Original concepts for their disciplines were based on the logic and intelligence God provided when he created man in his image. Ken Ham then made these predictions from Genesis: Life could only be produced by intelligence; kinds propagated after their kind; there was a global flood; mankind is one race; people were dispersed due to their language differences from the Tower of Babel; the universe is found to be young by the majority of dating methods.

Bill Nye proposed that it would take more than 4000 years since the global Flood to form the fossils in the rock layers, to form the layers in the ice cores, to form the tree rings in bristlecone pines, and to provide the time required for radioactive isotope dating. Nye went into more detail with fossil skulls, claiming that there is evidence of kinds that exist between gorillas and humans. Bill Nye posed two questions for Ken Ham. First, how did animals get to Australia if there was a global flood, and, second, how did a novice like Noah build a ship large enough to protect his family and all the animal kinds? Nye also claimed that big-bang cosmology is fact and that it proves long ages for the universe.

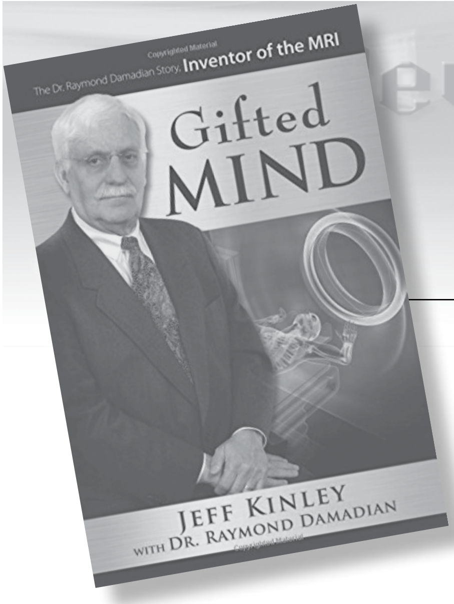
In the rebuttals, Ken Ham again emphasized the difference between operational and historical science. He pointed out that the theory of evolution that Bill Nye endorses is made of four different disciplines—astronomy, geology, chemistry, and biology—and the ages they predict are based on historical conjecture instead of proven facts. There is no one combined theory of origins by evolution. Any evidence found today can be used by either a creationist or evolutionist, but their conclusions will be completely opposed to each other. Nye's rebuttals were weak since he used evidence and arguments that have been shown to be frauds or improvised to make his stories plausible. His main point, that the Bible has been composed by mankind over the centuries and that it is not God's Word, shows that his position is based on a belief and not science.

The debate transcript (Appendix A) shows clearly that Ham provided much more information to support his position than Nye. In my opinion Ham earned an A grade for his effort. The book's description of the days of creation is rather short. I have a thorough, personal interpretation of the Creation Week (Dobberpuhl, 2011).

Del Dobberpuhl
dobberpuhl@crsvarc.com

Reference

Dobberpuhl, D., 2011, *The First Four Days*. Winepress Publishing, Enumclaw, WA.



Gifted Mind: The Dr. Raymond Damadian Story, Inventor of the MRI

by Jeff Kinley and Raymond Damadian

New Leaf Publishing Corp, Green Forest, AR, 2015, 240 pages, $18.00

This history of the invention of magnetic resonance imaging (MRI) is the most detailed account published of the life of its inventor, Raymond Damadian. The book was written by Jeff Kinley, based on extensive interviews with Damadian. Kinley's book is an indispensable, updated reference on the history of the development of MRI. The only other book, *A Machine Called Indomitable: The Remarkable Story of a Scientist's Inspiration, Invention, And Medical Breakthrough* by New York Times reporter Sonny Kleinfield, is now 30 years old. MRI, now a ten-billion-dollar industry, is by far one of the most important medical technologies developed in the last century.

Somewhat similar to x-ray, MRI uses magnetic fields and radio waves to form images of the body to portray the anatomy and the physiological processes of the body in both health and disease. The technique is widely used in hospitals for medical diagnosis, staging of disease, and follow-up without exposure of the body to ionizing radiation. The system is noninvasive and non-ionizing yet produces remarkably detailed images and has saved thousands of lives. Since its invention millions of scans have been done on over 25,000 scanners now estimated in use worldwide.

Much detail is provided about Damadian's background to help the reader gain an appreciation of both his achievements and the struggle he was forced to endure to achieve his breakthrough. Briefly, while studying violin at the world famous Juilliard School of Music, Damadian triumphed over nearly 100,000 other applicants and was awarded a Ford Foundation Scholarship at age fifteen that enabled him to attend the University of Wisconsin to complete a mathematics degree. He then completed his M.D. at the Albert Einstein College of Medicine and later did graduate work in biophysics at Harvard University. His interest, however, was not in clinical practice but in scientific research. Damadian became a professor at SUNY Downstate Medical Center, where he remained until he founded his own company to manufacture MRI scanners.

The pressure faced by students and faculty alike to accept Darwinism was detailed by Damadian, who states, "Constantly exposed to scientific naturalism (and evolution), I became virally infected with such thinking, eventually reaching the conclusion that there was no God, and thus no longer any practical need for Him in my life. I have since observed that this experience is repeated by tens of thousands of churched young people today after a few semesters at college or graduate school. Looking back, it's now easy to see how I was dissuaded away from faith to embrace the 'rock solid conclusions' of science. This pressure to cast off all vestiges of faith was greatest in my life when I became a faculty member at Downstate" (p. 36).

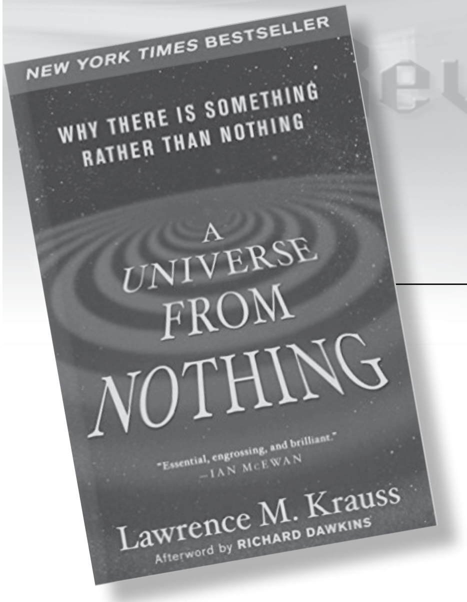
Damadian adds that even during medical school the "strong atheistic currents of the scientific community caused [him] to drift far from the shore of God's reality and truth" (p. 36). Kinley documents the persecution that Damadian experienced as a result of his rejection of Darwinism, a topic he spends some time on in the book, especially as related to the denial of the Nobel Prize for his achievements.

Damadian's deeply held Christian beliefs, especially his conclusions on biological origins, are also detailed in this book. Specifically, his reasons for rejecting Darwinism are detailed in chapter 9. As an active creationist, he serves on the boards of several creation organizations, including the *Institute for Creation Research* and the *Answers in Genesis Creation Museum*.

MRI technology has a special meaning for me because I completed a Ph.D. thesis under University of Pittsburgh professor John A. Short titled, "A History and Evaluation of Noninvasive Medical Diagnostic Treatment and Research Techniques." I also completed graduate work at the Medical College of Ohio specifically on MRI.

The book includes an index and is copiously illustrated with numerous historic pictures, including copies of the documents that established Damadian as the inventor of MRI. Much technical information is given on how MRI works, written in a layman's friendly terminology. Once I started reading this book, I could not put it down.

Jerry Bergman
Jerrybergman30@yahoo.com



A Universe from Nothing

by Lawrence M. Krauss

Atria Paperback, New York, 2012, 202 pages, $16.00

Lawrence M. Krauss was awarded a Ph.D. in physics from the Massachusetts Institute of Technology in 1982. He is an internationally known theoretical physicist and the author of nine popular books on topics ranging from the physics of *Star Trek* to cosmology. Since 2008 he has served on the physics department faculty of Arizona State University. He serves as ASU's Director of the Origins Project, a university initiative he helped originate.

The book is well organized with a table of contents, two prefaces, eleven chapters, an epilogue, a short afterword by Richard Dawkins, and an index. In the first preface, Krauss attempts to clarify the subtitle "*Why There Is Something Rather Than Nothing*." He claims that the real question is how formlessness led to form and that modern science provides a possible roadmap. In other words, he believes that there was formless and unorganized "stuff" that formed itself into the universe that now exists. So *nothing* actually means some unknown and possibly unknowable stuff. He spends most of the book trying to convince the reader this is the case.

In the second preface, he makes it clear that he does not believe that the results of the creation event, the known universe, required a creator. Rather the results are due to the potential residing in the unknown stuff itself. In my opinion he neglects the fact that without outside intelligence and design a natural process has no potential to create itself. For example, the most sophisticated computer cannot bootstrap itself but requires an external intelligent programmer. He does not address the question of where in nature that required intelligence existed.

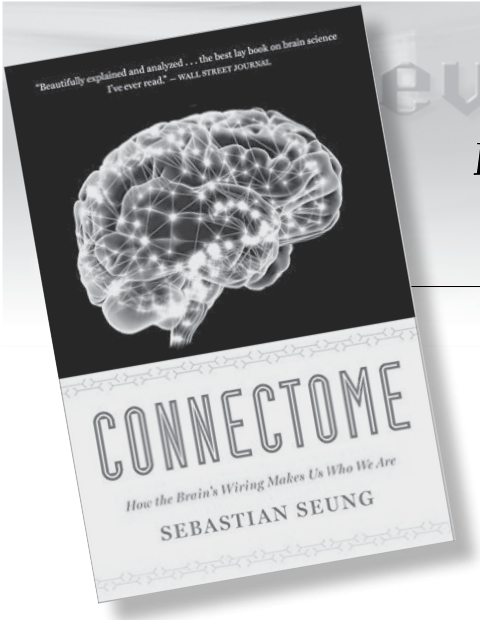
Throughout the book Krauss appeals to hypothetical instead of real known entities. In the first chapter, he attempts to apply Einstein's theory of general relativity to the beginning of the universe in a big-bang scenario. The hypothetical entities appealed to are an inflation field that initially expanded the universe along with dark energy, which continues to expand it. The expansions have resulted in an infinite universe without center or edge to fit with that theory. The big bang theory proposes that the universe came into existence 13.7 billion years ago through a quantum fluctuation in the "stuff." Krauss does not define this quantum fluctuation or give any details. Scientists up to now have only defined one real quantum, and that is a quantum of electromagnetic radiation called the photon.

Chapter 2 switches to addressing the possible scenarios for the future of the universe. There is an appeal to hypothetical dark matter particles and dark energy as part of all these scenarios. Dark matter is the answer to why the matter in the universe held together for the billions of years in the past and will be for many eons to come. Dark energy is the energy required to keep the universe expanding at an accelerated rate for the foreseeable future. Chapter 3 discusses the hypothetical origin of the cosmic microwave background radiation as a scattering surface formed by ionized atoms of mainly hydrogen and helium. According to the big bang theory, the universe expanded and cooled for 300,000 years with the space containing high temperature plasma before it formed into enough neutral atoms to become transparent to all wavelengths of electromagnetic radiation.

Author Krauss uses the remaining chapters to fill in his story of evolution from atoms to mankind. It is interesting that he uses pair production as the example of nothing being unstable and producing something. Quantum mechanics physicists traditionally explain pair production of a positron and an electron as requiring both an atomic nucleus and a photon to exist. So this process does not address something from nothing, unless atoms and photons themselves are nothing. It is proposed that a quantum fluctuation in gravity produced the matter and radiation of the original universe in a similar manner.

In my opinion, the afterword by Richard Dawkins does not add any substance to the arguments presented in this book. It is mainly an example of how evolutionary scientists of various disciplines support each other in spreading their worldview.

Del Dobberpuhl
dobberpuhl@crsvarc.com



Connectome: How the Brain's Wiring Makes Us Who We Are

by Sebastian Seung

Mifflin Harcourt, Boston, 2013, 384 pages, $27.00

Sebastian Seung is professor of computational neuroscience and physics at the Massachusetts Institute of Technology. He received his Ph.D. in theoretical physics from Harvard. His pioneering neuroscience research has been published in numerous leading scientific journals. Seung's MIT laboratory is currently developing new technologies for mapping the billions of connections between the brain's neurons, which, as a set, is called the *connectome*. Forming connections between neurons is the major method used by the brain to learn new ideas, new concepts, and everything else. The lab is also investigating the hypothesis that humans are unique compared to all other life, including primates, because we are wired very differently then all other life forms. A major factor that distinguishes us from apes is our larger and far more complex connectome (p. 276).

The end goal is to map the total connectome, the totality of the collection of our brain's neuronal connections, meaning specifically how it is wired together to produce all that our brains achieve. Learning about this circuitry could help us to cure or treat diseases, such as Alzheimer's, autism, and schizophrenia. As Seung documents, mapping the connections of the over 100 billion neurons in the human brain is an enormously daunting project. Scientists are still far from being able to achieve this task, but some progress, although still very limited, is now being made.

In the first chapter, Seung reviews both the structure and role of the brain's neurons. He then discusses his own research in some detail. His end goal is to attempt to delineate the connectome and its interconnectivity system and determine how the collection of our brain's neuronal connections can be mapped. To achieve this, he focuses on using functional magnetic resonance imaging (fMRI) as a major tool. This neuroimaging procedure uses MRI technology to measure brain activity by detecting blood flow changes. This technique relies on the fact that all neuronal activation usually results in increased cerebral blood flow. When an area of the brain is used, blood flow to that region increases, thus one can determine what part of the brain is used when, for example, a subject reads a book or looks at a picture. This is still a very crude way to detect brain activity and is also somewhat limited in mapping the brain's wiring, but researchers must begin somewhere in achieving the goal of understanding how that brain functions to do what it does.

Seung attempts to detail how memories are impressed and stored in the brain. The problem of understanding the human brain's complexity is currently still beyond overwhelming. Consequently, "many neuroscientists have chosen to study animals with drastically fewer neurons than humans" (p. xi). For this reason, researchers commonly use the roundworm, *C. elegans*, which actually "lacks what we'd call a brain. Its neurons are scattered throughout its body rather than centralized in a single organ. Together they form a nervous system containing a mere 300 neurons. That sounds manageable. … Every neuron in this worm has been given a unique name and has a characteristic location and shape. Worms are like precision machines" (p. xi).

Progress in mapping the 300 neurons in the *C. elegans* roundworm and ongoing development in imaging technology, such as the automated ultra-microtome to obtain extremely thin tissue samples, has been critical in understanding the structure and function of the diverse neuron types and how their complex interactive network operates.

One important area of research is the brain's plasticity, meaning its ability to rewire after a brain injury, such as caused by a stroke or disease. Significant plasticity is well known in children, but research has indicated some plasticity also exists in adults. In spite of some promising reports, Seung concludes that, due to "our crude experimental techniques, only drastic kinds of rewiring have been detectable" (p. 128). The best method of plasticity detection is still behavioral evaluations, such as having the subject perform some specific task and, from his brain alterations that result, make some assumptions about brain plasticity.

A major contribution of the book, besides detailing the author's own research, is a fairly complete review and discussion of the literature in this growing field. Overall, this was a very engaging read about the research that has proven important in scientists' attempts to understand how the brain functions and, concurrently, to gain some insight into preventing, treating, and curing the many diseases that involve the brain. The main problem, Dr. Seung writes, is that researching something "as complex as the brain may seem almost futile. The brain's billions of neurons resemble trees of many species and come in many fantastic shapes. Only the most determined explorers can hope to capture a glimpse of this forest's interior, and even they see little, and see it poorly. It's no wonder that the brain remains an enigma. Humans are very "curious about brains that malfunction or excel, but even the humdrum [brain activity] lacks explanation. Every day we recall the past, perceive the present, and imagine the future. How do our brains accomplish these feats? It's safe to say that nobody really knows" (p. xi).

Some researchers question if humans will ever completely understand how the brain functions, and conclude that it may forever remain a black box, but we will never know if this is true unless we attempt this important task. The connectome project is one small step in this direction.

In chapter 15, Seung attempts to cover questions that have been with us as long as humans have existed, such as are we, to put it crudely, nothing more than a machine run by a computer made out of meat? Or do we have a soul, a personality existing apart from our physical body? In this chapter the author seems to be constrained by his worldview, unable to explore these issues with sufficient freedom to move beyond the Darwinian orthodoxy. This chapter is thought provoking and, in the end, concludes that we all have one life to live and one brain to do it with (p. 274). This conclusion is a common view in academia, which ignores the worldview that there is more to existence than this present physical life.

Jerry Bergman
Jerrybergman30@yahoo.com.

Seven Deadly Colours: The Genius of Nature's Palette and How It Eluded Darwin

by Andrew Parker

Simon and Schuster, Inc., London, UK, 2005, 286 pages, $34.95

How do bluebirds, morpho butterflies, green tree frogs, deep-sea fishes, and pygmy seahorses get their colors? These and other investigations lead to discussions of interference of light waves, rods and cones in the back of owl eyes, multi-reflector layers in butterfly and bird wings, and numerous thought-provoking subjects from creation. The author of this book has built his scientific career investigating these fields of biophysics. He organizes the book chapters by discussing the production of each color as examples from nature. The "seven deadly colors " title of the book is an allusion to the "seven deadly sins" often mentioned in sermons. Although it thoroughly discusses predator-prey interactions in the context of colors, the book does not major on why the colors might be considered "deadly" in the same sense that sins are harmful to Adam and his descendants. Instead, the chapters give reasons why the human eye is not perfect, refuting a statement of Darwin who wrote in *The Origin of Species* (Darwin, 1958, pp. 168-169):

> To suppose that the eye with all its inimitable contrivances for adjusting the focus to different distances, for admitting different amounts of light, and for the correction of spherical and chromatic aberration, could have been formed by natural selection, seems, I freely confess, absurd in the highest degree. … Reason tells me, that if numerous gradations from a simple and imperfect eye to one complex and perfect can be shown to exist, each grade being useful to its possessor, as is certainly the case; and if such variations could be useful to any animal under changing conditions of life, then the difficulty of believing that a perfect and complex eye could be formed by natural selection, though insuperable by our imagination, should not be considered as subversive of the theory.

Parker repeatedly returns to give reasons why the eye is not perfect. For instance, in chapter 1 he mentions that the human eye cannot see ultraviolet, although some animals can. On pages 156-157, he states that cone cells in the retina include blue cones whose sensitivity peaks at 520 nanometers wavelength (violet), green cones at 530 nanometers (green), and red cones at 565 nanometers (yellow). The green tree frog, as analyzed by a spectrometer, is actually a mixture of blue and yellow, not pure green. Hence the human eye is not perfect because it does not reveal this. On page 56 Parker states that due to the human inability to see ultraviolet, "the human eye is not perfect after all. On this account, Darwin had no cause to worry."

However, creationists believe that the eye was not designed to make Adam omniscient. The eye was completely sufficient for the purposes for which it was created. The size of the eyeball matches the range of focal lengths to which the lens can adjust, as the above quote of Darwin mentions. Parker, in spite of being given over 200 pages in which to do so, never explains how this and the other coincidences mentioned by Darwin could magically arise from natural selection.

Adam could not be given the ability to see everything possible because then man would be equal with God. Adam was created in the image of God, not to be a second God. Aside from God, nothing is self-caused. One might consider Colossians 1:16-17 and Exodus 33:20.

Subjects such as multi-reflector layers make this book useful for understanding what is called "structural color." The pigments present in some butterfly wings or hummingbird feathers cannot explain this. Instead, colors are due to constructive interference between light waves reflected from different scales (butterflies) or plume structure (birds). The origin of color from reflective layers, of course, means that there is no gene that leads directly to these colors.

Eugene Chaffin
ChaffinEF@aol.com

Reference

Darwin, Charles. 1958. *The Origin of Species.* Mentor Books, New York, NY.

Instructions to Authors

Submission

Electronic submissions of all manuscripts and graphics are preferred and should be sent to the editor of the *Creation Research Society Quarterly* in Word, WordPerfect, or Star-Office/Open Office (see the inside front cover for address). Printed copies also are accepted. If submitting a printed copy, an original plus two copies of each manuscript should be sent to the editor. The manuscript and copies will not be returned to authors unless a stamped, self-addressed envelope accompanies submission. If submitting a manuscript electronically, a printed copy is not necessary unless specifically requested by the *Quarterly* editor. Manuscripts containing more than 35 pages (double-spaced and including references, tables, and figure legends) are discouraged. An author who determines that the topic cannot be adequately covered within this number of pages is encouraged to submit separate papers that can be serialized.

All submitted manuscripts will be reviewed by two or more technical referees. However, each section editor of the *Quarterly* has final authority regarding the acceptance of a manuscript for publication. While some manuscripts may be accepted with little or no modification, typically editors will seek specific revisions of the manuscript before acceptance. Authors will then be asked to submit revisions based upon comments made by the referees. In these instances, authors are encouraged to submit a detailed letter explaining changes made in the revision, and, if necessary, give reasons for not incorporating specific changes suggested by the editor or reviewer. If an author believes the rejection of a manuscript was not justified, an appeal may be made to the *Quarterly* editor (details of appeal process at the Society's web site, www.creationresearch.org).

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2. Abstract page. This is page 1 of the manuscript, and should contain the article title at the top, followed by the abstract for the article. Abstracts should be between 100 and 250 words in length and present an overview of the material discussed in the article, including all major conclusions. Use of abbreviations and references in the abstract should be avoided. This page should also contain at least five key words appropriate for identifying this article via a computer search.

3. Introduction. The introduction should provide sufficient background information to allow the reader to understand the relevance and significance of the article for creation science.

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Lipman, E.A., B. Schuler, O. Bakajin, and W.A. Eaton. 2003. Single-molecule measurement of protein folding kinetics. *Science* 301:1233–1235.

Margulis, L. 1971a. The origin of plant and animal cells. *American Scientific* 59:230–235.

Margulis, L. 1971b. *Origin of Eukaryotic Cells*. Yale University Press, New Haven, CT.

Hitchcock, A.S. 1971. *Manual of Grasses of the United States*. Dover Publications, New York, NY.

Walker, T.B. 1994. A biblical geologic model. In Walsh, R.E. (editor), *Proceedings of the Third International Conference on Creationism* (technical symposium sessions), pp. 581–592. Creation Science Fellowship, Pittsburgh, PA.

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Creation Research Society

History—The Creation Research Society was organized in 1963, with Dr. Walter E. Lammerts as first president and editor of a quarterly publication. Initially started as an informal committee of 10 scientists, it has grown rapidly, evidently filling a need for an association devoted to research and publication in the field of scientific creation, with a current membership of over 600 voting members (graduate degrees in science) and about 1000 non-voting members. The *Creation Research Society Quarterly* is a peer-reviewed technical journal. It has been gradually enlarged and modified, and is currently recognized as one of the outstanding publications in the field. In 1996 the *CRSQ* was joined by the newsletter *Creation Matters* as a source of information of interest to creationists.

Activities—The Society is a research and publication society, and also engages in various meetings and promotional activities. There is no affiliation with any other scientific or religious organizations. Its members conduct research on problems related to its purposes, and a research fund and research center are maintained to assist in such projects. Contributions to the research fund for these purposes are tax deductible. As part of its vigorous research and field study programs, the Society operates The Van Andel Creation Research Center in Chino Valley, Arizona.

Membership—Voting membership is limited to scientists who have at least an earned graduate degree in a natural or applied science and subscribe to the Statement of Belief. Sustaining membership is available for those who do not meet the academic criterion for voting membership, but do subscribe to the Statement of Belief.

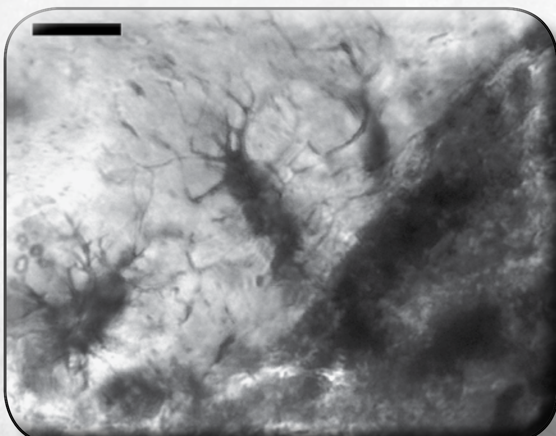
Statement of Belief—Members of the Creation Research Society, which include research scientists representing various fields of scientific inquiry, are committed to full belief in the biblical record of creation and early history, and thus to a concept of dynamic special creation (as opposed to evolution) both of the universe and the earth with its complexity of living forms. We propose to re-evaluate science from this viewpoint, and since 1964 have published a quarterly of research articles in this field. *All members of the Society subscribe to the following statement of belief:*

1. The Bible is the written Word of God, and because it is inspired throughout, all its assertions are historically and scientifically true in all the original autographs. To the student of nature this means that the account of origins in Genesis is a factual presentation of simple historical truths.
2. All basic types of living things, including humans, were made by direct creative acts of God during the Creation Week described in Genesis. Whatever biological changes have occurred since Creation Week have accomplished only changes within the original created kinds.
3. The Great Flood described in Genesis, commonly referred to as the Noachian Flood, was a historical event worldwide in its extent and effect.
4. We are an organization of Christian men and women of science who accept Jesus Christ as our Lord and Savior. The act of the special creation of Adam and Eve as one man and woman and their subsequent fall into sin is the basis for our belief in the necessity of a Savior for all people. Therefore, salvation can come only through accepting Jesus Christ as our Savior.

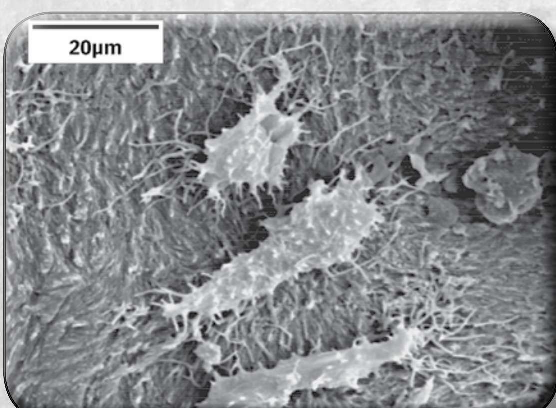
iDINO II

Investigation of Dinosaur Intact Natural Osteo-tissue

A fragment of the *Triceratops* brow horn. Fragments, such as this one, still contain tissue and cells.



Microscopic examination of tissue extracted from a *Triceratops* horn reveals bone cells still present.



Electron microscope picture of intact bone cells still in tissue extracted from a *Triceratops* horn.

How can pliable, stretchable tissue survive inside dinosaur fossils for over 65 million years?

How can this tissue still contain intact cells and even dinosaur proteins?

How can this fragile biological material survive for so long?

The answer to these questions directly challenges the current, evolutionary-biased, geologic timescale.

The Creation Research Society began its iDINO research initiative for the purpose of studying soft tissue in dinosaur fossils. The first phase of the project detected pliable, unfossilized tissue in a brow horn of a *Triceratops*. Within this tissue were intact osteocytes (bone cells). Some results from the iDINO project have been published in a technical microscopy journal and presented at an international microscopy conference. The Spring 2015 issue of the *Creation Research Society Quarterly* also features a special report of the iDINO project. Plus, to further spread the important information about soft tissue, the Society is developing a video (Echoes of the Jurassic).

The **second phase** of the project (iDINO II) will look more extensively at the process of tissue preservation. Evolutionists have offered various theories of how this tissue could survive for millions of years. iDINO II will methodically investigate these preservation claims, assessing their plausibility.

The iDINO results have already provided a strong challenge to the evolutionary worldview. More extensive and detailed examination may provide even stronger evidence that the age of dinosaur fossils is far less than 65 million years. To this end, the Society continues to seek those willing to fund this project with either one-time gifts or monthly donations.

For more information contact us at (928) 636-1153 or crsvarc@crsvarc.com.

Also visit http://tinyurl.com/nphm2c4 for project updates and details.