entirely neutralize any possible disadvantage of an inverted retina. Although Dawkins does not mention it, branches of the small retinal blood vessels are also lacking in this same place.

Dawkins writes that the state of affairs which he describes as being present in the vertebrate eye would offend any tidy-minded engineer. It probably would if his description was in accordance with the facts, but such is not the case. Any tidy-minded engineer, if aware of all the surpassing advantages of visual acuity and astonishing efficiency of the vertebrate eye, would be quite happy with the anatomical and physiological framework of its inverted retina and quite in agreement with the structural principles involved.

It is to be hoped that before propagating this unfortunate and ill-founded idea further, evolutionists will take the time to thoroughly acquaint themselves with the detailed anatomy and physiology of the vertebrate retina and subsequently eliminate this particular item from their list of supposed examples of poor and deficient design.

References

Dawkins, Richard. 1986. The blind watchmaker. W. W. Norton and Co. New York.

Diamond, Jared. 1985. Voyage of the overloaded ark. *Discover.* 6(6):82-92

Hamilton, H. S. 1985. The retina of the eye—an evolutionary road block. *Creation Research Society Quarterly* 22:59-64.

Thwaites, William M. 1983. An answer to Dr. Geisler—from the perspective of biology. *Creation/Evolution,* Issue XIII:13-20.

_____. 1984. Design: can we see the hand of evolution in the things it has wrought? Proceedings of the 63rd Annual Meeting of the Pacific Division, American Association for the Advancement of Science, Volume I, Part 3. p. 210.

Contributed by H. S. Hamilton

THE EFFECT OF NON-UNIFORM DENSITY ON SOLAR CONTRACTION ENERGY

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Abstract

The potential energy of a spherical body with non-uniform density is developed. Data for solar shrinkage is analyzed using the derived relationships for a hypothetical radial density variation. The effect of non-uniform density on the energy generated by solar contraction is presented.

Introduction

There has always been a significant interest in the mechanism by which the sun produces energy. Since the publication of the solar diameter measurements of Eddy and Boornazian (1979), this interest has increased and has been the subject of much debate within the evolution/creation controversy. During a recent debate with the author, an evolutionist challenged that the potential energy of the sun could not be computed, that the relationship for potential energy given by Akridge (1980) was incorrect, that the non-uniform density of the sun made such small variations in solar diameter trivial and furthermore, that the data were either wrong or only indicative of a temporary fluctuation. It is this challenge that the present paper attempts to address—with the exception of the last point, as the author is in no position to make any judgment as to the correctness of the data.

Potential Energy of A Spherical Body

The potential energy of a spherical body with respect to itself is equal to the negative of the work required to pick it apart bit-by-bit and remove each to infinity. This energy may be expressed in differential form by Equation 1.

$$dE = -\int_r^\infty dF\, dz \tag{1}$$

The differential force may be expressed by Equation 2.

$$dF = -g\left(\frac{r}{z}\right)^2 dm \tag{2}$$

Combining Equations 1 and 2 yields Equation 3.

$$dE = gr^2 dm \int_r^\infty \frac{dz}{z^2} \tag{3}$$

Equation 3 can be readily integrated to yield Equation 4.

$$dE = grdm \tag{4}$$

The differential mass can be expressed as

$$dm = 4\pi\rho r^2 dr \tag{5}$$

The local gravity is given by the following:

$$g = \frac{Gm}{r^2} \tag{6}$$

Equations 5 and 6 can be combined to yield Equation 7.

$$g = \frac{4\pi G}{r^2}\int_0^r \rho r^2 dr \tag{7}$$

Substituting Equations 5 and 7 into Equation 4 and integrating yields

$$E = -16\pi^2 G \int_0^R \left[\int_0^r \rho r^2 dr\right]\rho r dr \tag{8}$$

The Case Of Uniform Density

If the density were uniform, some $\bar{\rho}$, then Equation 8 could be readily integrated.

$$\bar{E} = -16\pi^2 G\bar{\rho}^2 \int_0^R \left[\int_0^r r^2 dr\right] r dr \tag{9}$$

$$\bar{E} = -\frac{16\pi^2 G\bar{\rho}^2 R^5}{15} \tag{10}$$

Substituting the definition of average density

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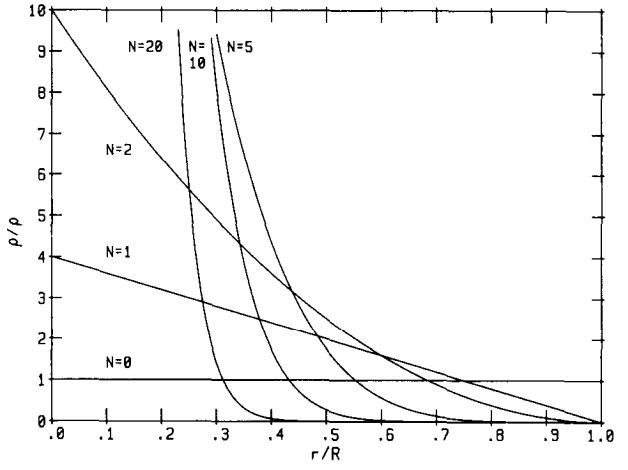

Figure 1. Radial Variation in Density for Various Values of n.

$$\bar{\rho} = \frac{3M}{4\pi R^3} \tag{11}$$

yields the following relationship for potential energy.

$$\bar{E} = -\frac{3M^2G}{5R} \tag{12}$$

Equation 12 differs from that of Akridge (1980) only by a factor of 0.6.

Non-Uniform Density

The density of the sun is no doubt a function of the radius. The exact relationship is, of course, unknown. However, it is a safe assumption that the density is less at the outside than at the center. One possible simple functional relationship for the density would be the following.

$$\rho = \rho_c\left(1 - \frac{r}{R}\right)^n \tag{13}$$

If n = 0, then the density is constant; and if n = 1 the density varies linearly with the radius. Because the total mass of the sun is known (Borowitz and Beiser, 1971; Weast, 1973), the density at the center, ρ_c, is a function of n.

$$\frac{4\pi\bar{\rho}R^3}{3} = 4\pi\rho_c\int_0^R\left(1 - \frac{r}{R}\right)^n r^2 dr \tag{14}$$

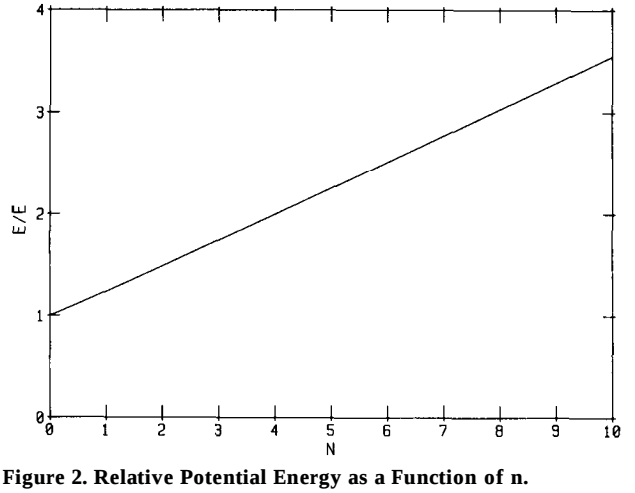

Figure 2. Relative Potential Energy as a Function of n.

Integrating the above expression twice by parts and re-arranging yields:

$$\rho_c = \bar{\rho}\frac{(n+1)(n+2)(n+3)}{6} \tag{15}$$

Equation 13 is illustrated for several values of n in Figure 1.

Substituting Equation 13 into 8 and dividing by Equation 10 yields the ratio of the potential energy associated with non-uniform density to that of uniform density.

$$E/\bar{E} = 15\left[\frac{(n+1)(n+2)(n+3)}{6}\right]^2\int_0^R\left[\int_0^r\left(1 - \frac{r}{R}\right)^n\left(\frac{r}{R}\right)^2\frac{dr}{R}\right]\left(1 - \frac{r}{R}\right)^n\left(\frac{r}{R}\right)\frac{dr}{R} \tag{16}$$

Integrating the above expression by parts and re-arranging yields:

$$E/\bar{E} = \frac{5(5n^5 + 53n^4 + 217n^3 + 427n^2 + 402n + 144)}{24(4n^4 + 28n^3 + 71n^2 + 77n + 30)} \tag{17}$$

Equation 17 yields a value greater than one for any positive, real value of n. In other words, the potential energy is greater (negative) for non-uniform density than it is for uniform density. In fact, $E/\bar{E}$, increases with n as illustrated in Figure 2. Thus, the challenge that non-uniform density makes changes in the solar diameter irrelevant is false.

The Rate Of Energy Generation Due To Contraction

In order to determine the rate of energy generated as a result of solar contraction, it is necessary to take the derivative of Equation 8 with respect to time. In order to do this, it is assumed that the density can be represented by Equation 13, the mass remains essentially constant, and that n remains constant. The resulting relationship is (accounting for the sign reversal for energy released / energy stored)

$$\frac{dE}{dt} = -\left(\frac{3M^2G}{5R^2}\right)\frac{5(5n^5 + 53n^4 + 217n^3 + 427n^2 + 402n + 144)}{24(4n^4 + 28n^3 + 71n^2 + 77n + 30)}\frac{dR}{dt} \tag{18}$$

which is illustrated in Figure 3. Also shown in Figure 3 is the data of Eddy and Boornazian (1979) and the actual power output (Weast, 1973). It can be seen from Figure 3 that the contraction rate as determined by Eddy and Boornazian is about two orders of magnitude greater than the rate necessary to account for the energy produced by the sun.

Given the density function, Equation 13, in order for a contraction to yield no energy release, n would have to simultaneously decrease. This means that the ratio of the density at the center to the average density would have to decrease also (see Equation 15). However, if the sun is contracting it is unlikely that the relative density at the center would be decreasing at a sufficient rate to account for two orders of magnitude in energy.

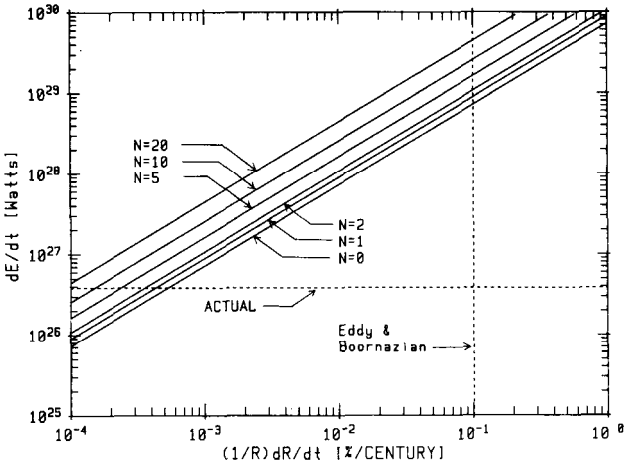

Figure 3. Comparison of Actual and Theoretical Solar Power Output.

Conclusions

It has been demonstrated that the potential energy of the sun can be computed given the functional relationship for the density. Also, the relationship of Akridge is correct within a factor of approximately two. Most importantly, it has been demonstrated that small variations in solar radius—even one-hundredth that of Eddy and Boornazian—are significant even in the case of non-uniform density. This does not prove that fusion does not occur within the sun; but it has been demonstrated that the solar contraction is more than sufficient to account for the energy generated by the sun.

Nomenclature

E	potential energy
$\bar{E}$	potential energy associated with uniform density
F	force
g	local gravitational acceleration
G	gravitational constant
m	mass of body between the center and r
M	total mass of body
n	exponent in density function
r	local radial distance from center of body
R	outside radius of body
t	time
z	arbitrary radial distance from center (outside body)
ρ	local density
$\bar{\rho}$	average density
ρ_c	density at center of body

References

Akridge, R. 1980. The Sun is shrinking. Impact Series No. 82. Institute for Creation Research, San Diego.

Borowitz, S. and A. Beiser. 1971. Essentials of physics, second edition. Addison-Wesley, Reading, MA. pp. 164-72.

Eddy, J. A. and A. A. Boornazian. 1979. Analyses of historical data suggest Sun is shrinking. (Reported by G. E. Lubkin). *Physics Today*. 32(9):17-9.

Weast, R. C. (Editor). 1973. CRC Handbook of chemistry and physics (54th Edition). CRC Press. Cleveland. pp. F160-7.

BOOK REVIEWS

The Genesis Connection by John Wiester, 1983. Thomas Nelson Publishers, Nashville, TN. 254 pages, index, glossary. $14.95.

Reviewed by George F. Howe*

Having been recently converted to Christianity, John Wiester began a search for truth in the interrelationships of science and the Bible. He studied current paleontological textbooks and interviewed Preston Cloud. After further discussions with Fred Bush about the meaning of the Genesis texts, Wiester formulated and presented his own origins views in this book, *The Genesis Connection* — hereafter referred to as TGC.

In TGC the young-earth creation catastrophist view of origins has been studiously ignored. One looks in vain to find any mention of key creationist names like Lammerts, Morris, or Gish. Organizations like Creation Research Society are likewise unmentioned. These omissions in a book about origins by a Bible-believer are serious flaws.

In TGC author Wiester expresses belief in deity and asserts that: "We owe our existence either to the creative acts of God or to random chance." p. 13. The author is committed to evangelical Christianity. His inscription on the fly leaf of the reviewer's copy reads: "May God continue to smile on you in Christ, II Tim. 2:15." He manifests a deep regard for the Bible which he evidently believes to be inerrant because he is concerned to show that each element in his origins model fits with what he believes to be the correct interpretation of scripture and "science."

While this is all commendable, "science" to John Wiester includes the authenticity of such non-scientific constructs as the "Big Bang," supposed transitional fossil series and vast theoretical "ages" of geology which he has canonized as follows: "I have chosen to use the time frame accepted by modern science throughout this presentation" p. 14. Wiester espouses much macroevolution because he assumes that the critical origins issue is not creation versus evolution but that: "The real question, the truly vital issue, is Creator versus no-creator" p. 13—also see p. 154. He thus obliterates any real distinction between rapid creation by miracles and some undefined type of God-directed evolution to which he apparently attributes most of the fossil record of animals.

Just how much creation the author relegates to macroevolution is obvious on page 156:

> "In my judgment, Scripture does not therefore preclude the transformation by God of a fish into an amphibian. The fact that the *eusthenopteron* lobe-finned fish appears to have been preadapted to life on land indicates a long-term cohesive plan . . . It is uncertain whether God created amphibians from fish, reptiles from amphibians, or mammals from reptiles. But He may have chosen this route to accomplish His miracle . . ."

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