COULD THERE BE LIFE ON OTHER PLANETS OF THE SOLAR SYSTEM?

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The author considers life as we are familiar with it on the earth. The conditions under which such life exists are discussed, and then compared with whatever conditions, that might be suitable for such life, are to be found on the other planets of the solar system.

Introduction

It has been conjectured that life could exist on any other heavenly body, so constructed as to be able to exist in that particular environment. The inception of this thought, though in many circles it is rather widely held, is probably due to the French astronomer Camille Flammarion, who goes to great length on this matter in his *Popular Astronomy*. There is an out of print translation of this by Gore which may be found frequently in second-hand book stores.

Since such speculation has become rather common, the reader should understand that this article involves only life as we know it. Life, in any other form, is no more than a metaphysical speculation, incapable of proof.

What the real essence of life, in a scientific sense, is we do not know, and for that matter we might say with Dubois Reymond, *ignorabimus,* that is, we shall never know, in a scientific sense, i.e., in terms of physical or chemical law.

Certain Life Requirements

All living organisms are made up of a combination of various types of cells. There are single-celled organisms (protozoa) and multi-celled organisms. Single-celled organisms multiply by cell fission and in some cases sexual union, while in the more highly organized multi-celled organisms the reproductive functions are kept separate.

Life as we know it involves assimilation of oxygen by the animals, the *fauna.* In their metabolism the combustion product of carbon and oxygen, carbon dioxide, is released. In turn, with the plants in the light, the overall exchange is the reverse, carbon dioxide being absorbed and oxygen released. Here we can see a balance of natural events. However, the believer will see in this a marvelous provision by the all-wise God.

Consider now the conditions under which animals, including man, can exist. The factors of prime importance are pressure, temperature, and humidity. The latter becomes extremely important because life as we know it is impossible without water. Thus the chemical composition of the human body is predominantly water, the remainder consisting of a variety of chemical compounds that were around the year 1920 worth perhaps $.75 (which today has probably risen to $3.00, plus tax). Life as we are familiar with it cannot exist in the absence of water.

The atmospheric pressure limitations are from about 8 p/in^2 to 15 p/in^2. The larger value obtains at sea level. The smaller value is found in high mountainous regions, such as the South American Andes, where mules instead of horses must be used, since horses cannot live, or at least cannot work, in a very rarified atmosphere.

From the standpoint of human comfort the range of temperatures is extremely limited. Some people are quite comfortable at 60°F, while others require an "incubation" temperature of 80°F and perhaps 85°F. At any rate, *comfortable* limits of temperatures are from 60°F to 85°F. Temperatures of the outdoors go beyond these limits. In Arctic or Antarctic regions we may find -80°F, while the highest recorded, in the Sahara Desert, is close to +160°F (in the shade). For any appreciable length of time such temperatures are of course intolerable.

Relative humidity is the percentage of water vapor in the air as compared to the percentage the same volume of air *could* hold at a given temperature. For most people 40% relative humidity is about right.

Much higher than this (though many tropical plants require it—Orchids ca. 75-85%), results in discomfort, especially in a high temperature. Here the automatic refrigeration of the human body is hampered, i.e., you cannot perspire. Perspiration involves evaporation of water, which will in turn lower the body temperature. On the other hand, too low a relative humidity with a high temperature promotes excessive perspiration, tending to reduce the water content of the body and causing fatigue.

These points are stated to emphasize how important the balance of water is. If water is completely absent we need not talk about life as we know it. Depending on the individual, especially if a large amount of adipose tissue exists, the person can probably go without food for a month or more; but he cannot live without water for much in excess of three days.

General Features of Planet Orbits

Let us consider next the basic life factors on each of these planets as compared to the limits previously given for the earth.

The eccentricity of the orbit of Mercury is such that the ratio variation of its distance from

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Table I
Physical Data of the Solar System[1]

Object	Distance from sun in astronomical units[2]	Period of Revolution (d = days, y = years)	Time of Rotation (d = days, h = hours, m = minutes)	Diameter miles
Mercury	.3871 (av.)	88^d	59^d	2900
Venus	.7233	225^d	243^d	7600
Earth	1.0000	365^d[3]	$23^h\ 56^m$[4]	7913
Mars	1.5237	687^d	$24^h\ 37^m$	4200
Jupiter	5.2028	11.86^y	9h 50^m	86800
Saturn	9.5388	29.46^y	$10^h\ 02^m$	71500
Uranus	19.182	84.01^y	$10^h\ 45^m$	29400
Neptune	30.0577	164.79^y	$15^h\ 48^m$	28000
Moon	———	27^d	27^d	2160
Sun	———	———	24.7^d	864000

(Note: Figure 1 provides a scale drawing of planet size in relation to the sun.)

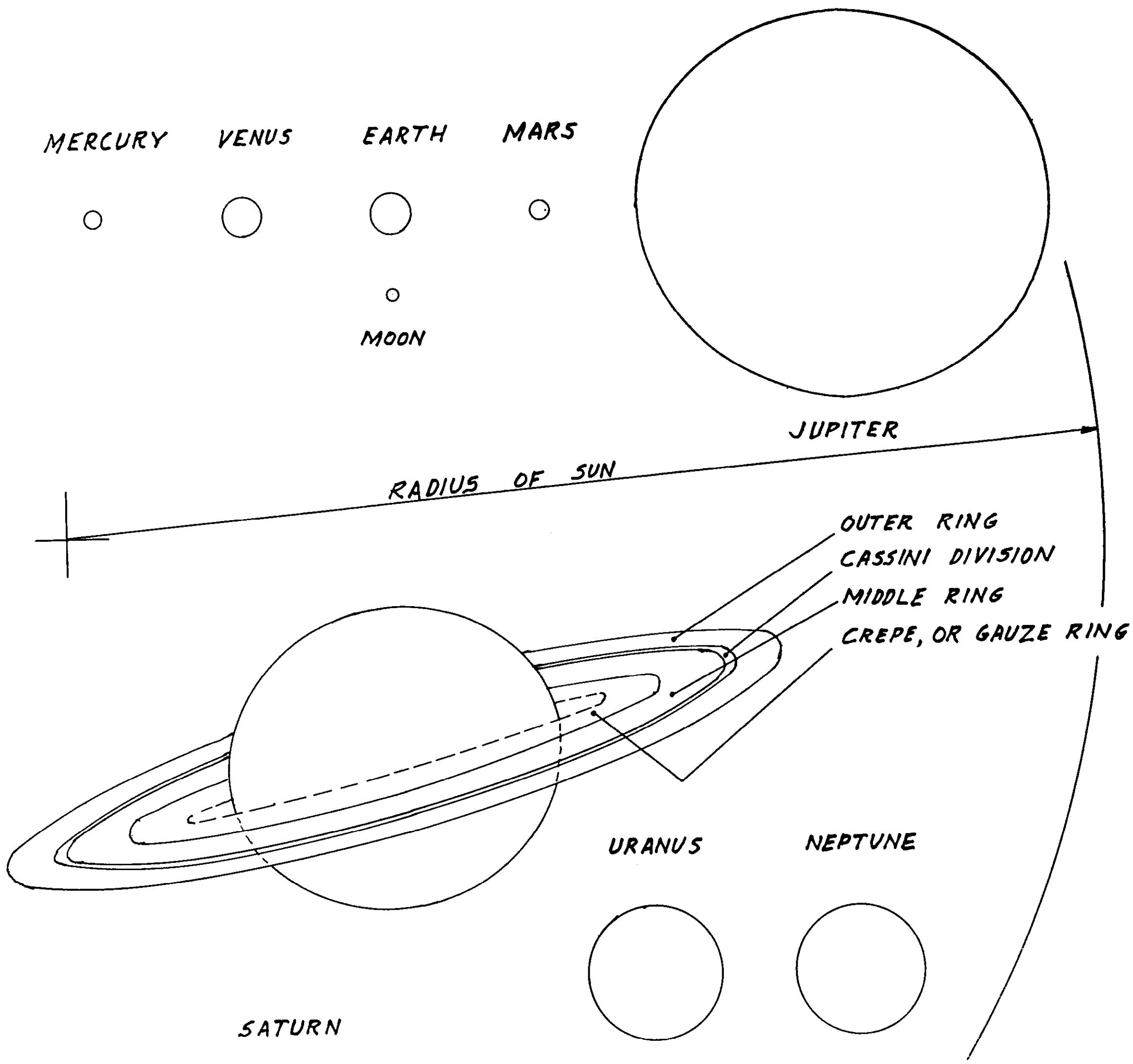

Figure 1. Scale drawing of planet size in relation to the Sun. Scale is .5 inch for earth's diameter.

the sun is 3:2. This would make the light and heat variation in the ratio $3^2:2^2 = 2.25:1$, which would clearly result in a most uncomfortable change for light and heat received from the sun.

The orbit of Venus is almost circular (e = .007.)

The distance of the earth from the sun varies by 3,000,000 miles. The closest approach is during the Northern hemisphere's winter. However, this variation of distance because of the eccentricity of the earth's orbit has no sensible effect on the seasons, the percentage variation being only 3,000,000 / 93,000,000 = .032 = 3.2%—very small.

The eccentricity of the orbit of Mars is again fairly large. It is .093. A simple geometric calculation will show that the ratio of distance variation is 1.2:1, making light and heat received from the sun $1.2^2:1^2 = 1.44:1$. This is much greater than for the earth and would result in perceptible seasonal variations, even though the inclination of Mars' axis of rotation is 24°, almost the same as the earth's.

In passing we note that the orbit of Neptune is also almost a circle, the eccentricity being only .009.

Pluto has been omitted from Table I. It need not be given serious consideration because the low temperature is probably close to zero on the absolute scale. Many observers look upon Pluto as a rather erratic asteroid of large size. The orbit of Pluto is highly eccentric (e = .249), and the inclination of the plane of the orbit with respect to that of the earth takes it out of the classical 16° width of the Zodiac.

More Physical Characteristics of Planets

MERCURY. For many years, astronomers thought the surface of Mercury was very mountainous. It may not be unlike the surface terrain of the moon, or as recently noted in the case of Mars.[5] There is no evidence of water vapor or oxygen. Water could not exist in the liquid state because of the undoubtedly high temperature, which need only be 200°F for an atmospheric pressure of 1 p/in^2.[6]

VENUS. The probe of some years ago substantiated fairly well the view of astronomers that Venus has an atmosphere with a large percentage of carbon dioxide (CO_2), and in addition, that it is heavily dust-laden. Again, the average temperature must be much higher than that of the earth's. There is some scant indication of oxygen.[7]

MARS. Recent photographs,[8] showing Mars pitted with craters just like the moon, ought to be almost conclusive in settling the question of whether it is habitable by life as we know it. Besides, the density of the atmosphere is far below that of the earth's. The planet is actually too small, concerning mass, to hold an atmosphere indefinitely.[9] The much vaunted canals appear to be, in the light of photographs taken (photographs which show craters but not canals), some optical phenomenon not as yet explainable. (There are many things twixt heaven and earth that are not dreamed of in our philosophy as per Shakespeare, and this is one of them.)

The so-called polar snow caps have long ago been shown to be solid carbon dioxide (CO_2—"dry ice"). And even if the existence of the canals were admitted, they would be visible only because of the imagined vegetation growing on their banks.

JUPITER. According to the latest model[10] the atmosphere consists of hydrogen, contaminated with ammonia (NH_3) and methane (CH_4). Positively no chance for "life as we know it" on Jupiter, because of an additional fact that the average temperature is -100°F. If "life as we do not know it" could be imagined, involving a metabolism for which methane and ammonia are necessities, we have absolutely no scientific evidence. Thus, this would remain a philosophic postulate, for which a test cannot even be imagined—and it is certain that such a view cannot be considered axiomatic.

SATURN. The situation is the same as for Jupiter. Also, there is no evidence of water or oxygen and the average temperature is no doubt lower than on Jupiter.

We need hardly consider Uranus or Neptune. The temperatures there must be even considerably less than that of Saturn. Water could not exist there in the liquid state—which rules out the existence of life as we know it.

This much is now certain, without necessarily going even further, that the earth is the only planet on which liquid water is to be found, and this is absolutely necessary for the sustenance of *life as we are familiar with it.*

Light and Heat Received by Planets

Many other interesting facts can be brought to light. First attention will be given to the apparent diameter of the sun as seen from the various planets, which can be used to discuss the relative amount of light and heat received by these planets.

Table II
Apparent Diameter of Sun[11]

Planet	Apparent diameter, as seen from earth = 1	Apparent diameter in angular units
Mercury	2.58 (av.)	1° 28'
Venus	1.48	47'
Earth	1.00	32' (av.)
Mars	.656 (av.)	21'
Jupiter	.194	6' 12"
Saturn	.105	3' 24"
Uranus	.052	1' 40"
Neptune	.033 (av.)	1' 03"

In connection with Table II, it will be interesting to note the apparent stellar magnitude. These are given in Table III, together with the proportion of heat and light received from the sun by each of the other planets, using = 1 for that received by the earth.

Table III
Apparent Stellar Magnitude of Sun and Light Received[12]

Planet	Light received Earth = 1	Stellar Magnitude
Mercury	6.73 (av.)	-28.9
Venus	1.92	-27.5
Earth	1.00	-26.8
Mars	.43	-25.9
Jupiter	.037	-23.2
Saturn	.011	-21.9
Uranus	.0027	-20.4
Neptune	.0011	-19.4

In a purely general way, with the assumption that all the planets have an atmosphere of the same light-absorbing power as the earths, heat received may be taken as equivalent to light received.

While studying Table III, it is interesting to remember that perhaps the least stellar magnitude by the light of which average print may be read is that of the full moon, which is -12.6. Thus, even at the distance of Neptune, 2,700,000,000 miles from the sun, the sun is still 6.8 magnitudes brighter than the full moon, thus giving 525 as much light to Neptune as the full moon does to the earth! The sun's apparent diameter, as seen from Neptune, about one minute of arc (the average resolution of the human eye), would still be too bright to look at for any length of time without a shade screen.

Illustration of Stellar Magnitude

This effect may be illustrated by observing a very bright star, for example Alpha Canis majoris (Sirius), through a fairly large aperture. Suppose we have a telescope of 24-inch aperture. The minimum magnitude it can reach is given by the familiar formula,

$$M_g = 5 \log A + 9.2$$

where A = aperture in inches. The constant 9.2 is for the average eye. For less sensitive eyes it may be as low as 8.5, and for eyes especially sensitive to very small points of light it may be as high as 10.0. (In any individual case it must be determined by experiment. The author uses 9.6.)

Thus the lowest magnitude visible with 24-inch aperture is 16.1. Now, the average eye can see stars of the sixth magnitude. Therefore the increase is 16.1 - 6 = 10.1 magnitude. The magnitude of Sirius is -1.4. Therefore, the magnitude for Sirius, when seen in a 24-inch, becomes -1.4 - 10.1 = -11.5, i.e., very close to the magnitude of the full moon. This is intolerable to the eye, and an observer will experience a black spot "dancing" before the eye for some time.

Thus the light of the sun, as seen from Neptune, is still extremely intense—more than is needed for reading. From this point of view there is enough solar light at any of the planets for human comfort, which is about the only redeeming feature when we consider the possibility of the existence of human life on the planets.

Temperature, Physical Forces Considered

As far as temperatures are concerned, it is impossible to make any kind of accurate calculation. Perhaps the best that can be said is that the temperatures of the inferior planets, Mercury and Venus, are far too high as compared to that of the earth. If any water vapor were present, it could only exist in the superheated state. Likewise, temperatures of the planets outside of the earth's orbit are far too low. In all cases water would exist only in the solid state. But water in the liquid state is necessary for life as we know it!

The average temperature of the earth is +60°F. That of Mars is -40° (F or C).[13] By spectroscopic methods, the calculation is -200° F for Jupiter, ammonia mainly solid, methane and hydrogen still gaseous. For Saturn it is -240°F. For Uranus and Neptune we can only conjecture, except with the certainty that it must be lower than that of Saturn. For the planets Mercury and Venus it must be extremely high: +800°F and +500°F for Mercury and Venus respectively might seem a fair approximation. It should be noted that +800°F is high enough to vaporize lead, which has a melting point of about 700°F.

Also questions of physical forces must be considered. The human body, as an example, is fearfully and wonderfully designed. The same applies to the vertebrate animals. The skeleton in all cases is designed to withstand all common stresses. The forces that produce these stresses depend on the value of gravity (g), which on the earth, and, curiously, almost the same on Uranus, is 32.173, or, for practical purposes 32.2 f/s^2. Table IV contains data that will help illustrate this matter.

One can hardly refrain from considering some of these aspects in a humorous vein. Consider the weight-conscious lady, tipping the scales at 250 pounds on the earth. On the moon her weight would have been reduced to 40.5 pounds, and without dieting! However, were she to live on Jupiter, she would tip the scales at 663 pounds, nearly one-third of a ton.

Appearance of Sky, Sleep Considered

We can, of course, also think about the appearance of the sky as seen from the different planets,

Table IV
Surface Gravity of Planets and Related Matters[13]

Planet	g	g Earth = 1	Spring Scale weight, Earth = 250 pounds (p)	Distance (in feet) jumped vertically with same effort as three feet on earth
Mercury	12.05	.375	93.5	8.0
Venus	28.3	.96	220	3.4
Earth	32.2	1.00	250	3.0
Mars	12.6	.53	98	7.7
Jupiter	85.2	2.65	663	1.0
Saturn	37.7	1.17	293	2.5
Uranus	34.1	1.06	265	2.8
Neptune	44.1	1.37	343	2.2
Moon	5.2	.162	40.5	18.5
Sun	894	27.8	6950 = 3½ tons, nearly.	1.25 inch

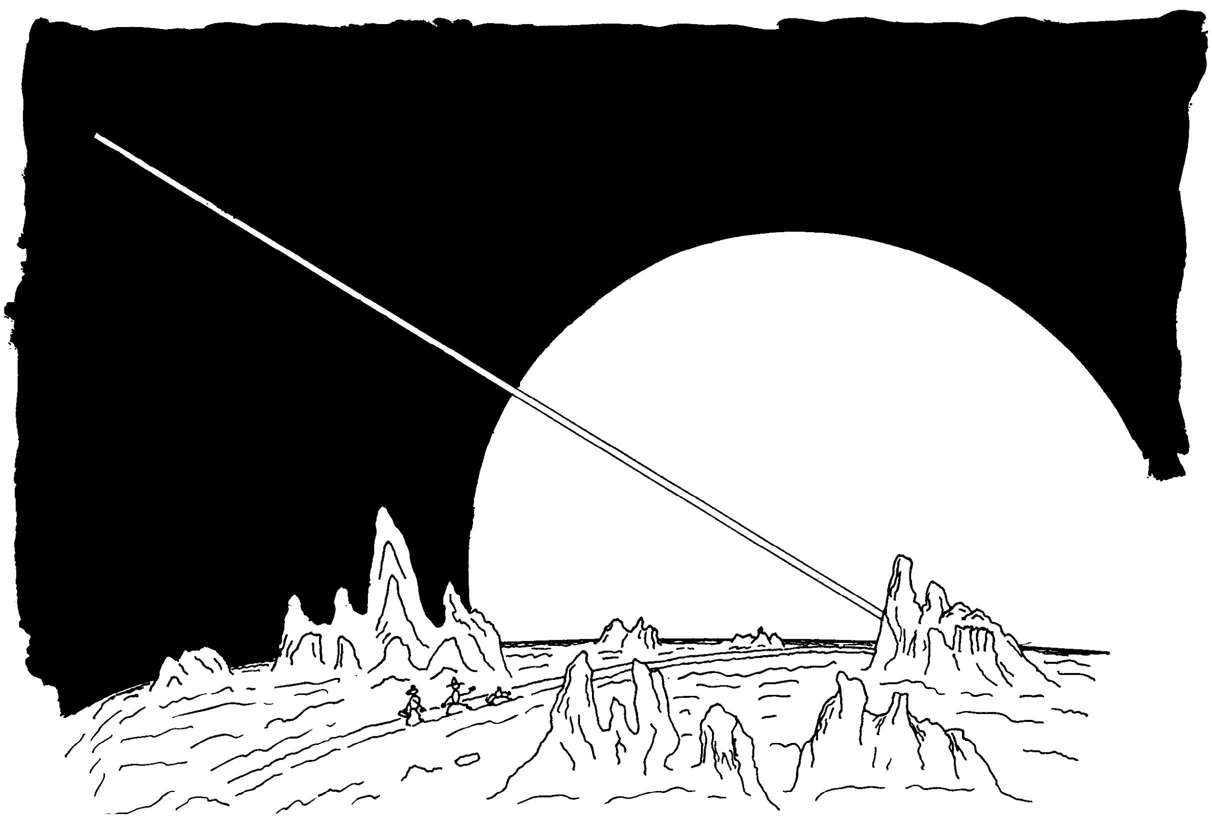

Figure 2. Saturn, as seen from the innermost satellite, Mimas, 115,000 miles from the planet.

were we to live there. We might as well forget about Jupiter. The satellites of Jupiter would be interesting to contemplate, but the intensity of the light that Jupiter casts would blot out such things as clusters and faint nebulae. For the remainder of the planets the celestial spectacle would in no wise be altered. Even the diameter of the orbit of Neptune (5,400,000,000 miles) will not, as far as the naked eye is concerned, alter the constellations; however, it would be desirable to live there because, with this enormous base line, we could obtain much more accurate values of stellar parallaxes.

Of greatest interest would be Saturn, the rings showing as a huge arc in intermediate latitudes. But the aspect of Saturn, seen from the innermost satellite, Mimas, 115,000 miles from the planet, would be stupendous. Such a view is represented in Figure 2. Yet another interesting feature could be investigated. The amount of sleep needed on the earth, by the average individual, is about six hours minimum, or one-fourth of the earths rotation at the most. Translating this for the other planets, using the rotation periods given in Table I, and referring this to earth time, the length of sleep on the other planets is as given in Table V.

Table V
Sleep in Terms of Earth Time

Planet	Time	Time of Rotation
Mercury	14.75 days	59^d
Venus	61 days	243^d
Earth	6 hours	1^d
Mars	6.05 hours	$24^h\ 37^m$
Jupiter	2.46 hours	$9^h\ 50^m$
Saturn	2.5 hours	$10^h\ 02^m$
Uranus	2.66 hours	$10^h\ 45^m$
Neptune	3.95 hours	$15^h\ 48^m$
Moon	6.75 days	27^d
Sun	6.2 days	24.7^d

Conclusions

1. It is apparent that no life as we know it can exist on any of the other planets, the basic shortcoming being the absence of liquid water, without the consideration of other factors as shown in the various Tables.

2. We know of no other elements necessary for any other imagined kind of metabolism, which rules out all speculations concerning beings particularly adapted to their environment.

3. Scripture is silent on the question. We prefer to consider Psalm 115:16 as conclusive. In other words, the Word of God says so—not human sophistry. This is a close parallel to the question of evolution vs. creation. Why is creation an axiomatic truth? Because evolution cannot be substantiated scientifically? No. Because Gods Word says so, Gen. 1:1. The scientific refutation is there. But it is only a gratuitous, on the part of God, confirmation of the *sola Scriptura.*

4. Let us picture life on Jupiter. Let us consider the actual time of a classroom lecture as = one hour. Let us consider also the actual length of a sermon as 20 min.

On Jupiter each classroom lecture would then be 11.1 min. and the sermon will be $3^m\ 42^s$.

Let us now go to Venus. The classroom lecture will be 2.55 hours and the sermon will be 49.2 minutes.

Let us now translate a sermon, say, into the tape recorder and adjust speeds. On Jupiter it will have a "chipmunk" effect, while on Venus it will be "Molto Lento Commodo."

5. Obviously the Lord knew what he was doing when he placed us on the earth and constructed us accordingly.

References

[1]A similar table, with perhaps minor modifications, will be found in any standard textbook of astronomy.

[2]An astronomical unit = distance of earth from the sun, about 93,000,000 miles.

[3]The precise figure is 365.2422 solar days.

[4]This is the length of the sidereal day.

[5]Mars pictures from Mariner #6 & #7. 1969. *Sky and Telescope*, October, Vol. 38 (4), p. 212-221.

[6]See Steam Tables. Keenan. Joseph H. and Frederick G. Keyes. 1936. Properties of steam. John Wiley and Son.

[7]Baker and Frederick. Introduction to astronomy. Seventh Edition.

[8]See *Sky and Telescope*, October, 1969. Vol. 38, No. 4.

[9]See Baker and Frederick. *Op. cit.*

[10]Baker and Frederick, *Ibid.*

[11]Geometric calculations by the author based on similar triangles.

[12]By agreement (definition), a star of the first magnitude is 100 times as bright as a star of the sixth magnitude. From this it follows that the ratio of brightness between two successive magnitudes is the fifth root of 100 = 2.512. Now, let A be the magnitude of one star, and B that of another, the relation between their light is given by

$$\log \text{“A”} - \log \text{“B”} = .4(\text{“B”} - \text{“A”})$$

where $.4 = \log_{10}2.512$. Since "A" and "B" are measures of brightness (in any convenient unit) apparent magnitudes are readily computed. All logs are to the base 10. (Note: log "A" - log "B" would ordinarily indicate that the right hand member should be "A" - "B". But remember that the magnitude scale is numerically an inverse scale, hence "B" - "A" is used. This derivation was independently worked out by the author.)

[13]Surface gravity ("g") varies directly as the mass and inversely as the square of the radius. That is $g = m/r^2$.