

Resonances

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Two recent solar eclipses observable over wide areas of the North American continent, plus last year's well observed event in North Africa, have prompted Michael Mendillo and Richard Hart, of the astronomy department at Boston University, to examine the total-eclipse situation in some detail. Here is a (somewhat abbreviated) account of their paper on "Total Solar Eclipses, Extraterrestrial Life, and the Existence of God":

Almost without exception, the authors of astronomy textbooks express a feeling of wonderment that a total solar eclipse can occur. Some say it with amazement, some drily, some gratefully; the similarity in the apparent sizes of the Sun and Moon is "one of the most surprising coincidences of nature," "... a peculiar quirk of fortune," or "... an extraordinary and very fortunate occurrence."

Because the History of Science has taught us not to harbor as even a most secret and innermost thought the notion that our place in the Universe is something special, we decided to put these emotional reactions to a mathematical test—that is, we tested the "remarkableness" of the solar-eclipse phenomenon. As we see it, the "remarkableness" of our Earth-Moon system is not merely that total solar eclipses occur, but rather the fact that the eclipses are *exactly* total.

The process of computing the percentage of the solar disk that is eclipsed by a moon moving about a planet is a simple geometrical problem involving the radius of the Sun (R_s), the distance to the Sun from the planet (D_s), the radius of the planet's moon (R_m) and the distance from the planet to the moon (D_m). Because the planets and their moons move in elliptical orbits, there are clearly two extreme cases for each satellite/planet pair: maximum obscuration occurs with a planet at aphelion and its satellite at pericenter, minimum obscuration for a planet at perihelion and its satellite at apocenter. At such configurations, the eclipse ratio E_r can be obtained by the following simple expression

$$E_r = \left[\frac{R_m/D_m}{R_s/D_s} \right]^2$$

where $E_r < 1$ means a partial eclipse,



$E_r > 1$ is a total eclipse and $E_r = 1$ is an *exactly* total eclipse.

We have calculated E_r for the 32 planetary satellites of the solar system, obtaining in each case maximum and minimum eclipse ratios at the surface of the appropriate planet. Values of E_r range all the way from 1151.82 for the Triton/Neptune maximum, to 1.0×10^{-7} for VIII/Jupiter. Only for Moon/Earth ($0.82 \leq E_r \leq 1.09$) does the ratio span unity; so only from Earth is it possible to view an *exactly* total solar eclipse. For the other planets there are 14 cases of partial (annular) eclipses and 17 cases of massively total eclipses. Only Mars has no total eclipses, whereas from Jupiter, Saturn

and Neptune, there are both partial and total eclipses; at Uranus's position, all eclipses are total.

We interpret these results as follows: In light of the new realization of the significance of the *exactly* total solar eclipse, we suggest that the statements in the textbooks concerning the "remarkableness" of the phenomenon be strengthened to a fully fledged proof. The fact that from only our planet is it possible to study the chromosphere and corona during totality is too important an opportunity to be called coincidence. Thus, we suggest the following:

Theorem An exactly total solar eclipse is a unique phenomenon in the solar system.

Lemma There are observers on Earth to witness the remarkable event of an exactly total solar eclipse.

Conclusion A planet/moon system will have exactly total solar eclipses only if there is someone there to observe them. As only Earth meets this requirement, there is no extraterrestrial life in the solar system.

Corollary In a system composed of nine planets and 32 moons, for only Earth with its single moon to have exactly total solar eclipses is too remarkable an occurrence to be due entirely to chance.

Therefore, there is a God.

Mysteries of Pluto

We probe the riddles of this barren sphere
That haunts the outer limits; whether star
Condensed to atoms, shunned with deadly fear,
Or satellite of Neptune strayed afar;

We ask if this mute prowler of the night
Was found by sheerest accident, a chance
That only offers to our puzzled sight
Still further questions, nothing to advance

Our cosmic view; yet some today believe
This errant boulder may in future dock
In Neptune's orbit, bearing home to cleave
With Triton as before, a jagged rock

Of cosmic mystery, a sometime guest
That will come back to Neptune's regal nest.

Wade Wellman of Milwaukee, Wisconsin, sent us this poem with the comment that the suggestion referred to at the end is due to Harold Urey.

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