THE MOON'S RECESSION AND AGE

The history of modern naturalistic lunar origins theories traces back to George Darwin in the 1800s. These theories presume that the moon is extremely old. However, the moon is slowly receding from the earth, a phenomenon which establishes an upper limit for the moon's age of approximately one-third the conventional age of 4.6 billion years. This outcome has been a long-standing challenge to conventional chronology. Use of adjustable tidal parameters presumes conventional age rather than proving it, so is no support for a long chronology.

NATURALISTIC THEORIES PUT THE MOON'S ORIGIN CLOSE TO EARTH

According to Genesis 1:14-18, God spoke the moon into existence as a unique celestial body on Day Four of the Creation Week. Opposing the Genesis account are naturalistic theories of lunar origin: (1) the fission theory (the "spouse" theory), popularized first by George Darwin, son of Charles Darwin;[1] (2) the capture theory ("daughter" theory); (3) the accretion theory ("sister" theory); and (4) the impact theory. **The impact theory is now most favored because the other theories "have serious flaws."**[2]

The capture theory has been discredited because of the improbability of earth's capturing an approaching moon-size object. Rather than explaining the origin of the moon, this theory merely displaces the problem of lunar origin to an indeterminate point far from earth.

The accretion theory claims that the moon coalesced from debris remaining from the solar nebula in close orbit around earth. This theory, also called the "double planet theory," says that the earth and the moon formed in tandem from the solar nebula. If this theory were true, the earth and the moon should have similar structure and composition. As might be expected from the creation of the moon as a unique heavenly object, its composition does not match the earth's. Indeed, the accretion theory has been discredited because of the problem of "explaining why the abundance of iron in the Earth and the Moon is so different,"[3,4] and also because of the difficulty in explaining how debris can coalesce.

The fission theory claims that the moon coalesced from debris spinning off the allegedly molten earth eons ago. The impact theory says that a Mars-size asteroid once struck the earth, and the debris thrown upward by the impact eventually coalesced into the moon. **The fission and impact theories both require that the debris forming the moon began coalescing at or near earth's Roche limit.**

The Roche limit is the distance from a central body, such as a planet, inside of which orbiting debris cannot coalesce. The gravitational force of the central body on an orbiting particle is stronger on the particle's near side than on its far side. Inside Roche's limit, this differential gravitational force is greater than the particle's own self-gravitation, and particles break apart instead of joining.

An artificial satellite can exist within Roche's limit if non-gravitational cohesive forces hold the object together, but once torn apart into smaller pieces, the pieces cannot rejoin. Saturn's rings are evidently fragments of moons once orbiting Saturn. Forces due to collisions, or disruptive forces within the moons, tore the moons apart.

Before they fragmented, cohesive forces held the moons together, but once they disintegrated, they could not re-form. **Similarly, earth's moon could never form inside the Roche limit out of debris due to fission.** Even the impact theory leaves moon's origin "still unresolved," and it was adopted "not so much because of the merits of theory as because of the ... shortcomings of other theories."[5,6]

Lunar origin theories have a history of being accepted with fanfare, then being quietly dropped as unworkable. Indeed, Hartmann quipped, "The moon seems a highly unlikely object. Theoreticians have been led by frustration on more than one occasion to suggest facetiously that it does not exist."[7,8]

THE MOON'S MAXIMUM AGE IS LESS THAN 4.6 BILLION YEARS

The moon was never at Roche's limit, but was positioned or "set" in the firmament (Genesis 1:17) at approximately its present distance from earth. The moon is very slowly receding from the earth. Below we compute the time that would be required hypothetically for the moon to recede from Roche's limit to its present position. The recession rate dr/dt of the moon is

$$\frac{dr}{dt} = \frac{k}{r^6} \qquad (1)$$

where r is the semimajor axis of the moon's orbit about the earth, t is time, and k is a proportionality constant.[9,10] When t = 0, r = r_0.

To compute the moon's recession time to its present orbit, we first integrate equation (1). Over the time interval 0 to t, the moon's distance from the earth increases from Roche's limit r_0 to its present orbit at distance r. Integrating t and r over these intervals gives

$$t = \frac{1}{7k}\,(r^7 - r_0^7) \qquad (2)$$

in which t is the maximum age of the earth-moon system. The present value of r is 3.844×10^8 m. For an object orbiting a planet, Roche's limit r_0 is

$$r_0 = 2.4554\, R \left[\frac{\rho_p}{\rho_m}\right] \qquad (3)$$

where R is the radius of the central body (the earth in this case); ρ_p is the density of the central body; and ρ_m is the density of the orbiting body, in this case the moon.[11] With R = 6.3781×10^6 m for the earth; ρ_p = 5515 kg/m^3; and ρ_m = 3340 kg/m^3,

we find that $r_0 = 1.84 \times 10^7$ m. This is less than 5% of the moon's current orbital radius.

From equation (1), the proportionality constant k is the product of the sixth power of the distance r, and the current recession rate. The present value of the recession rate is 4.4 ± 0.6 cm/yr, or $(4.4 \pm 0.6) \times 10^{-2}$ m/yr.[12] Thus $k = 1.42 \times 10^{50}$ m^7/yr. With this value for k, the right hand side of equation 1 is the present recession rate dr/dt, when r = the moon's current orbital radius.

From equation (2), the time for the moon to recede from r_0 to r is 1.3 billion years. Without introducing tidal parameters, **this is the moon's highest allowable evolutionary age,** similar to DeYoung's estimate.[13] Though long relative to biblical chronology, it is a serious challenge to the belief that the moon is 4.6 billion years old.[14] As Baldwin noted: "Jeffreys' early studies of the effects of tidal friction [the cause of lunar recession] yielded a rough age of the Moon of 4 billion years. ... Recently, however, Munk and MacDonald have interpreted the observations to indicate that tidal friction is a more important force than had been realized and that it would have taken not more than 1.78 billion years for tidal friction to drive the Moon outward to its present distance from any possible minimum distance. This period of time is so short, compared with the age of the earth, that serious doubts have been cast upon most proposed origins and histories of the moon."[15]

EFFORTS TO SAVE CONVENTIONAL LUNAR CHRONOLOGY HAVE FAILED

One response to the chronological challenge of recession has been the impact theory, in which lunar material originates within Roche's limit but is quickly ejected beyond it. The impact theory in turn is grounded in an older concept, the "resonance theory," which claims that the moon was never actually at Roche's limit. According to this theory, the moon is currently receding, but was once approaching the earth as part of a series of alternating recession/approach events as old as the moon's conventional age.[16,17] The resonance theory, however, presumes conventional age rather than proving it, so is no support for evolutionary chronology.

Another response has been to minimize the lunar recession rate. The current recession rate is 3.8 cm/yr according to NASA,[18] which is the *lower* end of the range of lunar recession rates discussed above, yet Fix cites a value of only 3 cm/yr.[19] A third response is to employ adjustable tidal parameters to stretch recession chronology into harmony with the conventional solar system lifetime.[20,21]

Naturalistic lunar origin theories assume the moon to have been once close to the earth. But if the moon's distance r had ever been much smaller than presently, equation (1) shows that the recession rate dr/dt "must have been much larger in earlier times."[22] George Darwin stated, "Thus, although the action [rate of lunar recession] may be insensibly slow now, it must have gone on with much greater rapidity when the moon was nearer to us."[9] Using equations 2 and 3 above, together with the conventional age of 4.6 billion years for the earth-moon system, we can compute how far the moon should have receded from Roche's limit over that time. Using $r_0 = 1.84 \times 10^7$ m, $k = 1.42 \times 10^{50}$ m^7/yr, and $t = 4.6 \times 10^9$ yr, we find that $r = 4.7 \times 10^8$ m. **This is 20% higher than the actual distance of the moon from the earth.**

Conclusions. Over the approximately 6000 years since the creation of the universe, the lunar recession rate has been essentially constant at the present value. It is a mistake to assume the present value over the entire evolutionary time frame, however, because over this much longer time frame, the lunar recession rate would not have been constant. Lunar recession rates would have been much higher in the distant past than now, meaning that **the moon would have moved from its origin at the Roche limit to its present position in "only" 1.3 billion years.** This is the moon's upper-limit age and shows that conventional chronology cannot be incorrect.[23]

If the moon were really 4.6 billion years old, the moon would have receded to a distance from earth some 20% beyond its present position. There is a widespread belief that the impact theory of lunar origin has neutralized these dilemmas for conventional chronology. That is not true. Lunar scientist Irwin Shapiro used to joke that "the best explanation [of these conundrums] was observational error - the Moon does not exist." The situation has not fundamentally changed, for lunar scientist Jack Lissauer recalled this anecdote as continuing to apply in a post-impact theory paper.[6]

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