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The Origin of the Moon and the Origin of Humanity: An Analogy

The Earth – Moon System

1. The Tides

   Earth's ocean levels rise and fall, replenishing nutrients

   Tidal distortion of Earth's shape causes the Moon to spiral away from the Earth, now at 4 cm per year.

2. Stability of Earth's Spin Axis

   Large angular momentum of Moon keeps the Earth's spin axis at 23° tilt, producing modest seasonal effects

Paradigm Shift in Science

Prior to 1960's scientists favored theories based on gradual, continuous processes:
e.g. The Cosmological Steady-State Theory

- Discovery of Cosmic Microwave Background Radiation: The Cosmological Big Bang

- Discovery of Earth's Magnetic Field Reversals: Plate Tectonics

Early Ideas on the Moon's Origin

Co-accretion Model

The Earth and Moon formed simultaneously from same region of the protoplanetary disk

Early Ideas on the Moon's Origin

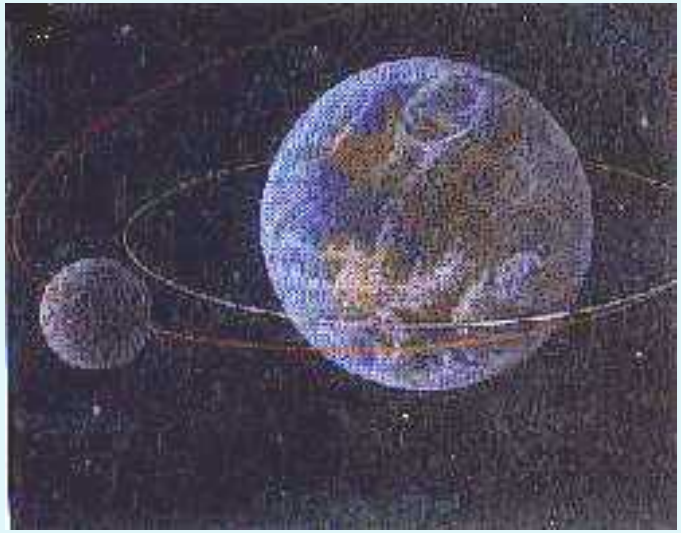
Fission Model

The Moon fissions out of a rapidly spinning proto-Earth (George Darwin, 1879)

Early Ideas on the Moon's Origin

Capture Model

The Moon forms in a different region of the solar system, wanders close to Earth, and is captured. (Thomas Jefferson Jackson See, 1909)

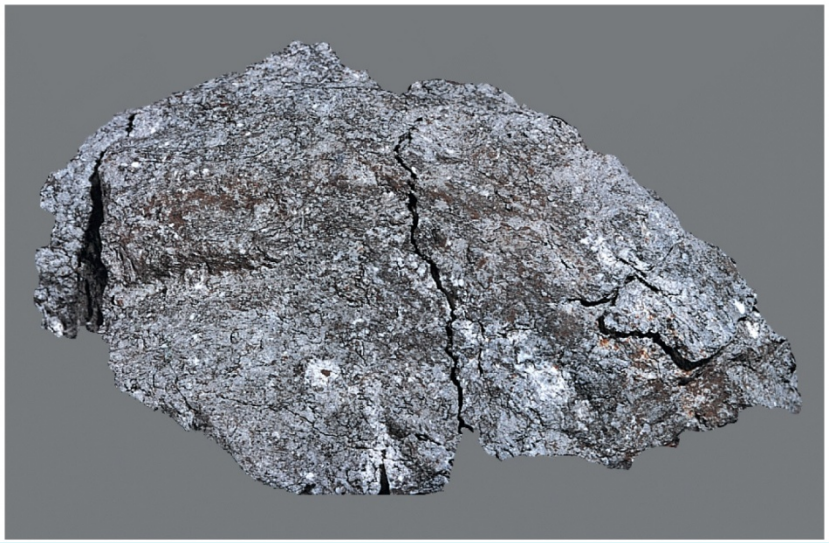


Model Expectations

- "Terrestrial" Models (Co-accretion & Fission) predicted strong similarities between Earth and Moon rocks
- "Extraterrestrial" Model (Capture) predicted distinctive differences (based on analyses of meteorite samples)

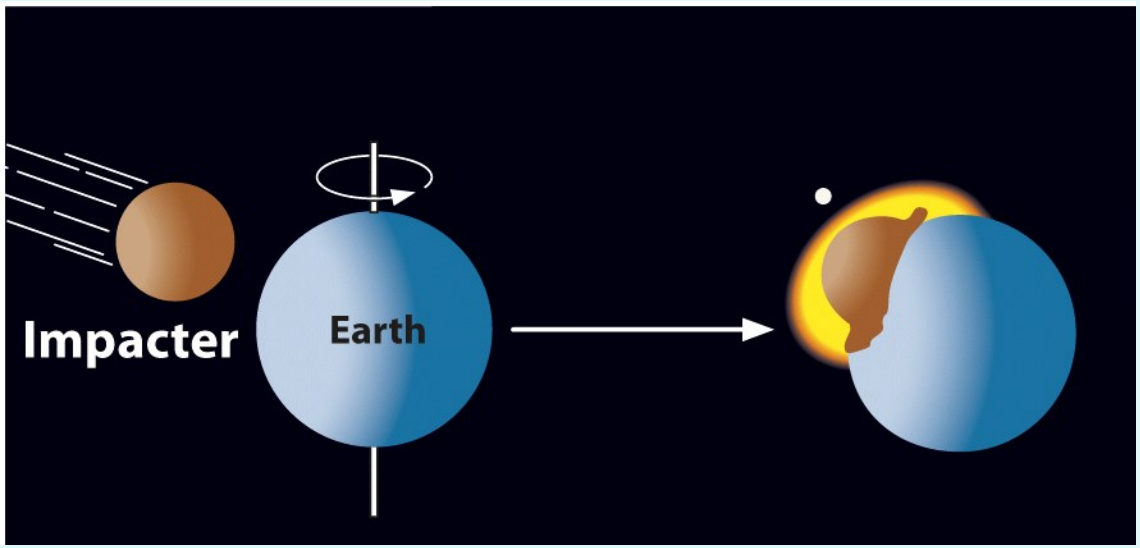
Apollo Missions to Moon: 1969-1972

- Astronauts return with 382 kg of lunar rocks and soil. Surprise Discovery – Strong similarities and Distinct differences between lunar rocks and Earth rocks:
  - Identical Ratios of Oxygen Isotopes
  - Lunar Rocks are extremely "parched": nearly devoid of water and volatiles



Shift in Lunar Origin Models

- The Origin of the Moon must involve both "Terrestrial" and "Extraterrestrial" elements
- Rare Large Impact Model?



History of Impacts

The Collision – Ejection Model

- William Hartmann and Donald Davis of the Planetary Science Institute proposed impact theory, based on calculations of expected planetesimal sizes in early solar system. (Hartmann, W. K. and Davis, D. R. 1975 Icarus, 24, 505.)

(Painting by William K. Hartmann.
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The Collision – Ejection Model

- A Mars-sized planetesimal collided with a proto-Earth, causing mantle debris to be thrown into orbit, coalescing into the Moon.

Supporting Factors of Model

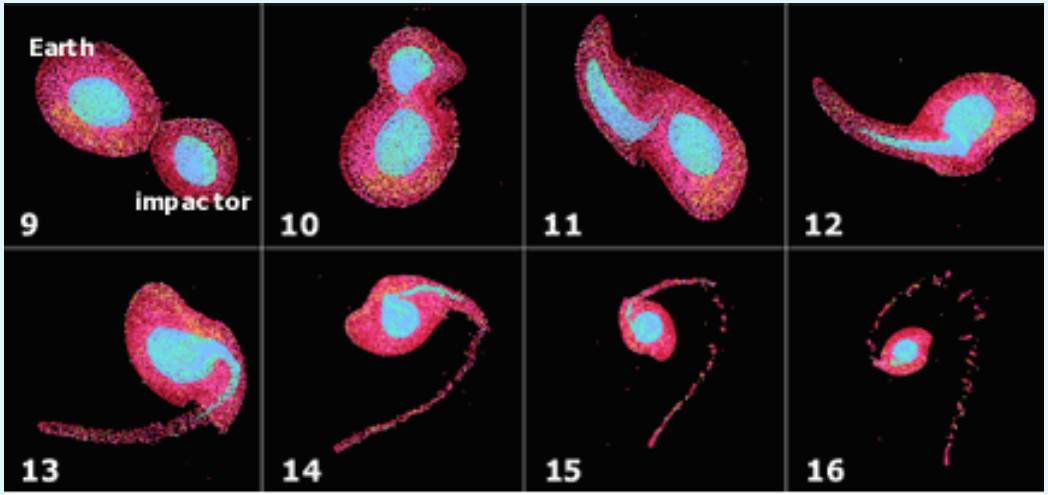
- Low Density of Moon (3.3 g/ml) compared to Earth (5.5 g/ml) indicates low iron content, as expected from an impact involving the Earth's mantle.
- Parched condition of Moon expected from a high temperature origin, removing water and volatiles, consistent with impact.
- Identical Oxygen Isotope Ratios between lunar and terrestrial rock, consistent with highly mixed matter such as an impact event would produce.
- Earth spin axis tilt (23°), the Moon's orbital inclination (5°) and its large angular momentum consistent with impact scenario.

Challenges of Model

- How can an impact eject matter into orbit? (Debris expected to be absorbed by Earth or achieve escape velocity)
- How does the ejected matter, having a large spread in trajectories, accrete into one Moon? (As opposed to several moonlets?)

Computer Simulations

- Computer simulations suggest a Mars-sized impactor at a glancing angle can result in sufficient portions of mantle material from both impactor and the Earth to stay in orbit to form the Moon. (Cameron, A.G.W. and Ward, W. 1976 Lunar Science VII, p 120.)



(Courtesy of A. G. W. Cameron, Harvard College Observatory.)

Moon Formation

- The resulting debris would take only 10 years or less to coalesce into the Moon, orbiting just beyond the Roche Limit (2.4 Earth Radii), with the Earth day only 5 hours long!

(Painting by William K. Hartmann.
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Paradigm Shift

- The Collision-Ejection Theory of the Moon's Origin represents a paradigm shift in thinking. Rather than either a "terrestrial" or an "extraterrestrial" model, scientists now accept a scenario involving both.
- Analogously, models of human origins are typically promoted either as a "naturalistic" scenario or as a "supernatural" event. The former focuses on the process by which humans arose, whereas the latter focuses on the involvement of a Creator God.
- Must we think of our origin as an either-or scenario?

Human Origins

- Science – Evidence of Hominid Fossils and comparative DNA studies strongly suggest common ancestry

- Scripture - Recent Scholarly examinations of Genesis I emphasize function and purpose in creation, not physical origins (e.g. John H. Walton, The Lost World of Genesis One, IVP 2009, C. John Collins, Genesis 1-4, a Linguistic, Literary, and Theological Commentary, P&R 2006).

Conclusion

- The Origin of the Moon appears to be best explained by the Collision-Ejection Theory, involving both terrestrial and extraterrestrial contributions.
- This paradigm shift occurred only when hard evidence in the form of lunar rock samples gave clues to its origin.
- Likewise, our ideas of human origins have tended be promoted as either naturalistic or supernatural.
- Evidence may once again lead us to the conclusion that both a natural process and a supernatural input is involved.

References

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