Science Space
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# 4 Theories About How the Moon Formed

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The moon's origins are shrouded in mystery, but we've developed plenty of theories over the centuries. 阿爾特斯 /Wikimedia Commons

## Space

The moon may have made life as we know it possible here on Earth, but it's also full of mysteries. We don't even know its exact origins.

Wondering about the moon is a pastime that has been enjoyed by scientists, philosophers and artists throughout history. Galileo was the first scientist to point out that the moon has a landscape similar to Earth's.

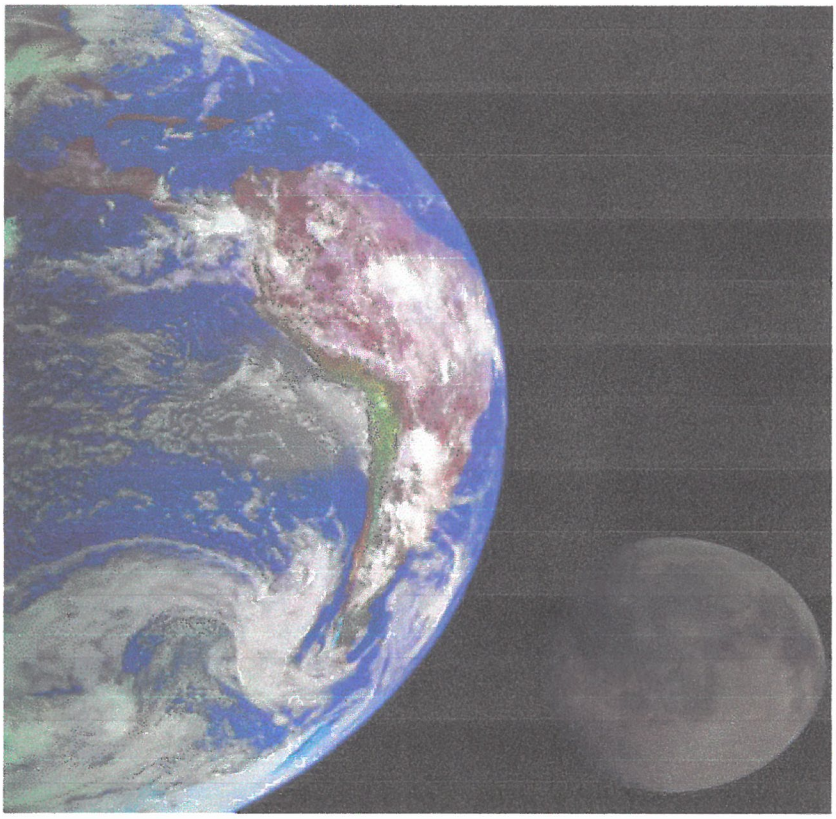
Over time, other scientists have posited a variety of theories about what the moon is and where it came from. From mostly debunked hypotheses to the current prevailing theory, scientists have debated several scenarios, each of which might explain our moon, but none of which are without flaws.

# 1. Fission Theory

*The fission theory suggests that, at one point, the Earth was spinning so fast that part of it spun off to form the moon. Festa/Shutterstock*

In the 1800s, George Darwin, the son of Charles Darwin, suggested that the moon looked so similar to the Earth because at one point in Earth's history, Earth might have been spinning so fast that part of our planet spun off into space but was kept tethered by Earth's gravity. Fission theorists posit that the Pacific Ocean might be the site where the would-be moon material came off of Earth. However, after moon rocks were analyzed and introduced to the equation, they largely debunked this theory because the moon rock compositions differed from those in the Pacific Ocean. In short, the Pacific Ocean is too young to be the source of the moon.

# 2. Capture Theory



*According to the capture theory, the moon traveled about the solar system before getting stuck in Earth's gravitational pull. NASA/JPL/Wikimedia Commons*

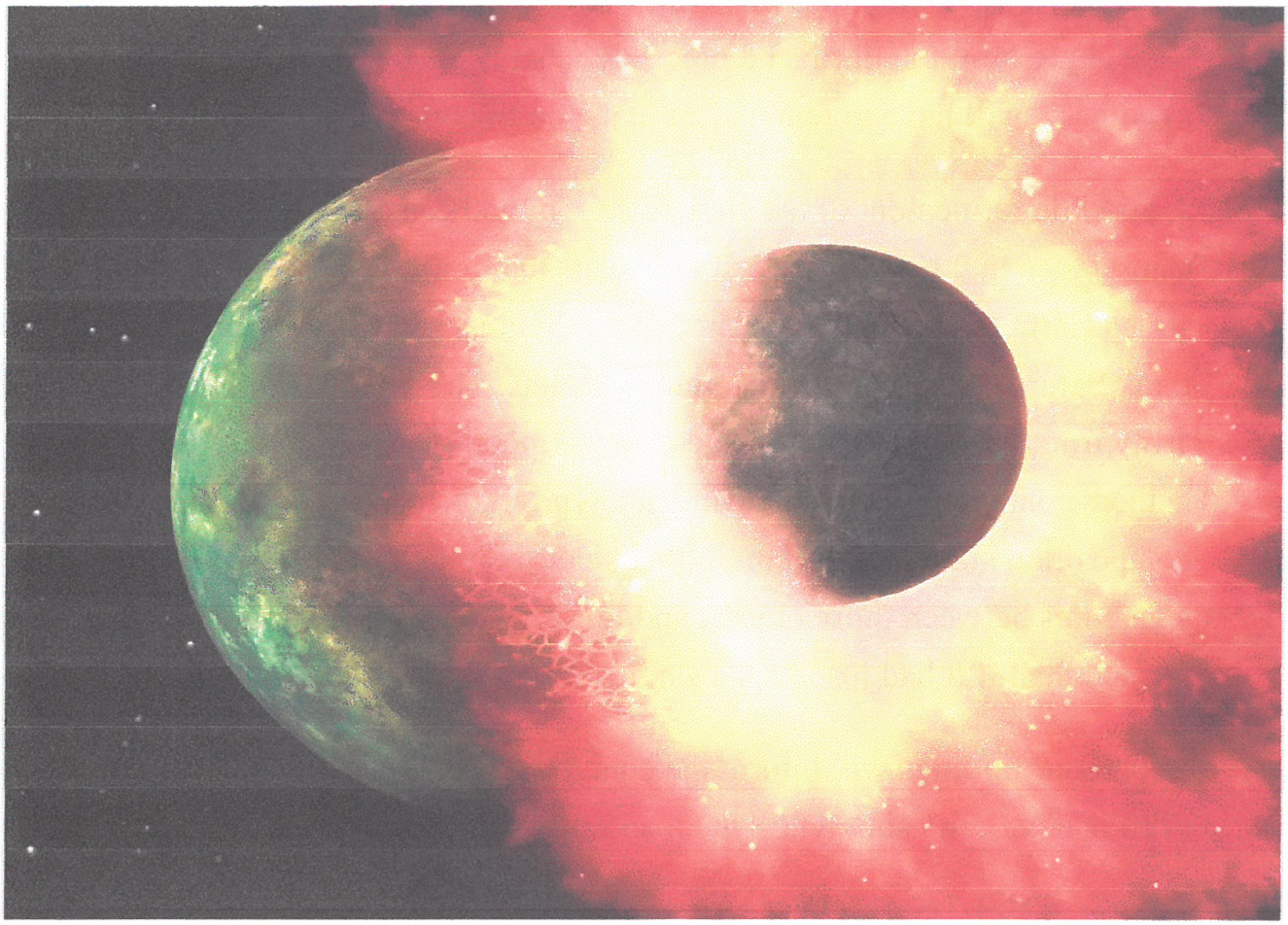
The capture theory suggests that the moon originated elsewhere in the Milky Way, completely independent of Earth. Then, while traveling past Earth, the moon got trapped in our planet's gravity. The holes in this theory range from suggestions that the moon would have eventually broken free from Earth's gravity because Earth's gravity would have been massively altered by catching the moon. Also, chemical components of both the Earth and the moon suggest they formed at around the same time.

# 3. Co-Accretion Theory

*This composite image shows the Earth, the moon and a black hole. The co-accretion theory posits that both the Earth and the moon formed together while orbiting a black hole. janez volmajer/Shutterstock*

Also known as the condensation theory, this hypothesis offers that the moon and the Earth formed together while orbiting a black hole. However, this theory neglects an explanation of why the moon orbits the Earth, nor does it explain the difference in densities between the moon and Earth.

# 4. Giant Impact Hypothesis



An artist's illustration of two celestial objects colliding in a way that some scientists think the moon came to be. NASA/JPL-Caltech

The reigning theory is that a Mars-sized object impacted with a very young, still-forming Earth about 4.5 billion years ago. The planetary object that impacted Earth has been dubbed "Theia" by scientists because in Greek mythology, Theia was the mother of the moon goddess Selene. When Theia hit Earth, a portion of the planet came off and eventually hardened into the moon. This theory does a better job than others of explaining the similarities in chemical compositions of the Earth and the moon, however it doesn't explain why the moon and the Earth are chemically identical. Scientists have suggested that, among other alternatives, Theia could have been made of ice, or that Theia could have melted into Earth, leaving no separate

trace of its own on the Earth or the moon; or Theia could have shared a close chemical composition to Earth. Until we can determine how large Theia was, at what angle it hit the Earth and precisely what it was made of, the giant impact hypothesis will have to remain just that — a hypothesis.

A possible refinement of the giant impact hypothesis was published in Nature Geoscience in 2017. The new study posits that multiple moon- to Mars-sized objects struck Earth, and the debris from these collisions formed disks around the Earth — think Saturn — before forming into moonlets. These moonlets eventually drifted away from Earth and merged to create the moon we know today. The study's authors contend that this multi-impact hypothesis helps to explain the chemical composition similarities. If multiple objects collided with Earth, the chemical signatures between those objects and Earth would even out more as the moon formed than if it had just been a single impact event.

New lunar findings will inform the continued discussion of the origins of the moon. (Too bad we can't simply ask the man in the moon how he got there.)

## How Old Is the Moon?

*Determining the age of the moon has proven to be a complicated endeavor. SAENRIT KLINLUMDAUN/Shutterstock*

The age of the moon is the subject of some debate within the scientific community. Some scientists think that the moon formed roughly 100 million years after our solar system formed,

while others favor a date somewhere between 150 and 200 million years after the solar system's birth. These dates would put the moon between 4.47 billion and 4.35 billion years old.

A new study published in Science Advances claims to put the controversy over the moon's age to rest. A team of researchers think they have accurately dated the moon at 4.51 billion years old.

The researchers used moon rocks taken from the lunar surface during the Apollo 14 mission in 1971 for their study. Most moon rocks astronauts have brought back to Earth are composites of rocks fused together during meteor strikes, and that makes dating them tricky as the different pieces of the rocks will reflect different ages. To get around this, the researchers turned to zicorn, a very durable mineral found in both the Earth's crust and in moon rocks.

"Zircons are nature's best clocks,"said co-author Kevin McKeegan, a UCLA professor of geochemistry and cosmochemistry. "They are the best mineral in preserving geological history and revealing where they originated."

McKeegan and lead author Mélanie Barboni focused on the tiny zicorn crystals that contained small amounts of radioactive elements, particularly uranium and lutetium. They isolated when these two elements has decayed to calculate how long the zicorn had formed and used that to provide what they contend is an accurate age for the moon.

This isn't to say that the zicorn-dating approaching is without its own controversy. Speaking to The Verge about the findings, Richard Carlson, the director for the department of terrestrial magnetism at Carnegie Institution for Science, he praised the work but cited concerns about the zicorn approach. Namely, Carlson questions the assumption that the decayed ratios for the uranium and lutetium would be the same in the early days of the solar system as they would be today.

"It's just a very complicated problem they are addressing here, which is why we still don't have a clear answer to such an obvious question as the age of the Moon," Carlson said.