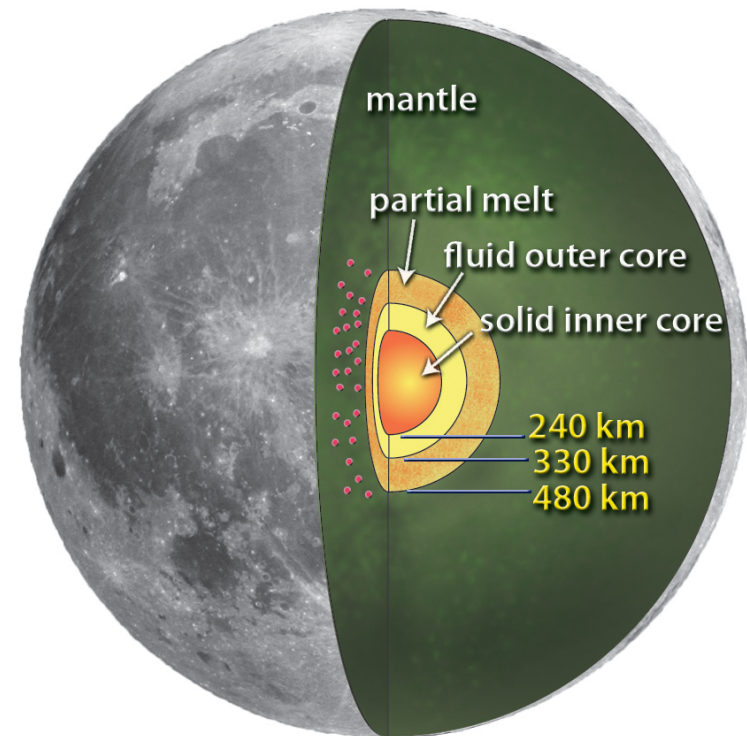


# What's Inside the Moon?

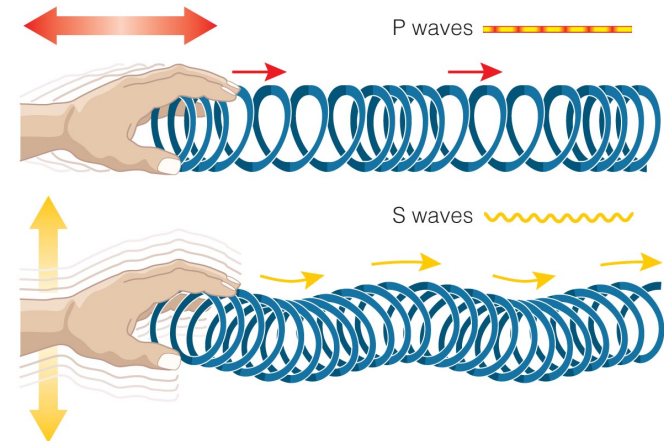
- Indirect measurements and models are typically used to constrain the structure and composition of planetary interiors
- The Moon was known to have a fairly small core, but scientists debated its precise size, composition, and whether it was solid or fluid
- Re-examination of seismometer data from the Apollo Moon landings has recently confirmed a model of the lunar interior that consists of a solid inner core, liquid outer core, and partially molten surrounding layer



*Schematic diagram of the interior structure of the Moon, recently determined using Apollo seismometer data from the 1970's. Red circles show the locations of "moonquake" events (probably caused by tidal interaction with Earth) measured at the surface.*

# Why Cores are Solid or Molten

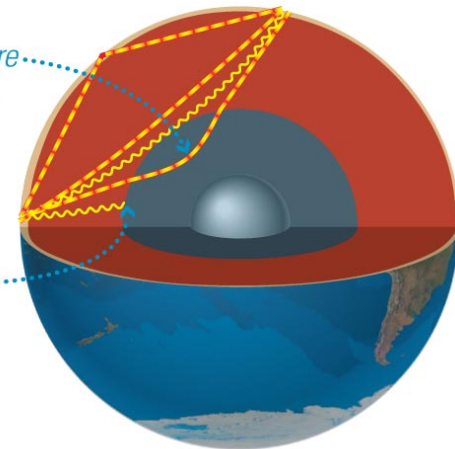
- New statistical and averaging methods allowed scientists to make the old Apollo seismometer measurements less 'noisy', revealing the Moon's interior structure
- Though much of its internal heat should have been lost by now because it is small, the Moon is still hot enough that it contains liquid and molten layers inside
- Temperature is highest at the center of the planet, but pressure there is high enough that the inner core is solid instead of liquid
- As the Moon loses its internal heat (via conduction and radiation) the size of the solid core will increase over time



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*The liquid outer core bends P waves . . .*

*. . . but stops S waves.*

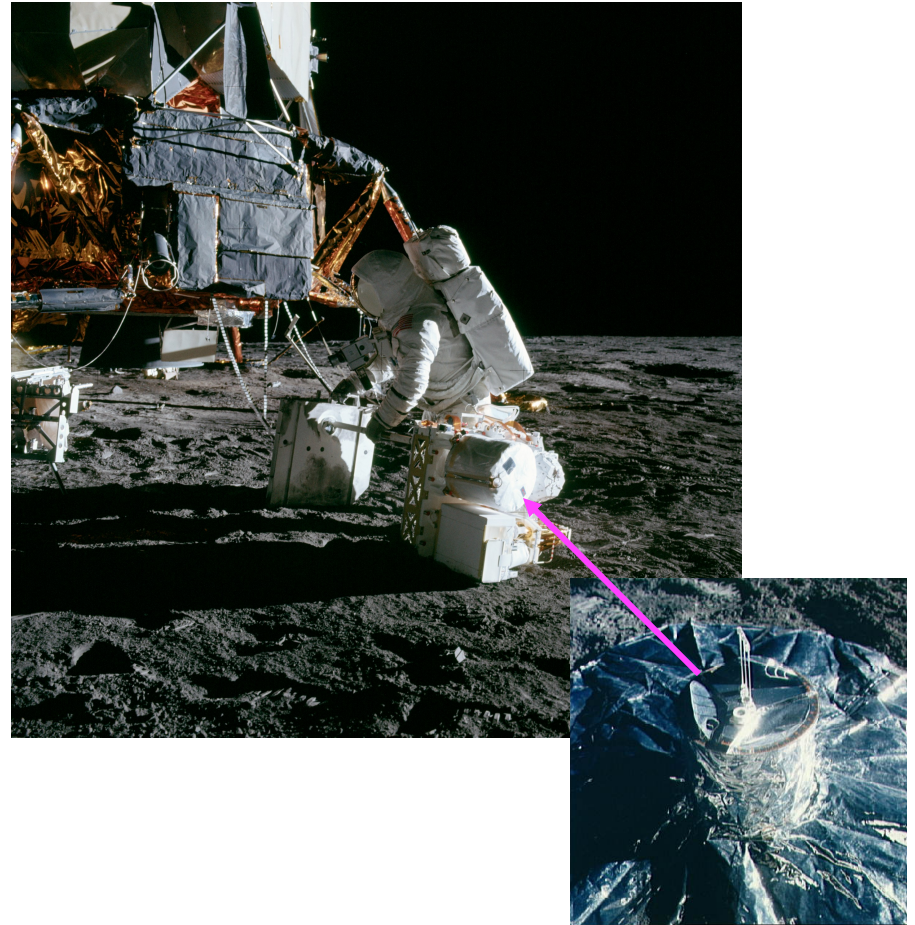


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*Two types of wave propagate through planet interiors, causing vibrations at the surface that can be measured by seismometers. The two waves behave differently in rock and liquid, allowing us to remotely probe a planet's interior structure.*

# The Big Picture

- The Moon is believed to have formed from a mixture of Earth's outer layers and a Mars-sized body that struck the Earth ~4.5 billion years ago. The terrestrial material was less dense than Earth's deeper interior. The lunar core is small relative to those of other terrestrial planets because the Moon formed with fewer dense elements.
- Important advances in scientific research are not always the result of new measurements. Sometimes old data can prove valuable when looked at in new ways.



*Seismometers (below right) placed by Apollo astronauts (above) during 4 missions allowed us to probe the lunar core nearly 40 years later.*

# For More Information...

## Press

- NASA - 10/29/10 - “NASA Research Team Reveals Moon Has Earth-Like Core”  
[http://www.nasa.gov/topics/moonmars/features/lunar\\_core.html](http://www.nasa.gov/topics/moonmars/features/lunar_core.html)
- Arizona State University - 01/07/11 - “The Hunt for the Lunar Core”  
[http://asunews.asu.edu/20110106\\_lunarcore](http://asunews.asu.edu/20110106_lunarcore)

## Images

- Slide 1 image courtesy NASA / MSFC / R. Weber  
[http://www.nasa.gov/topics/moonmars/features/lunar\\_core.html](http://www.nasa.gov/topics/moonmars/features/lunar_core.html)
- Slide 2 image from “The Cosmic Perspective”, by Bennett et al., Addison Wesley, Inc.
- Slide 3 images courtesy NASA  
[http://upload.wikimedia.org/wikipedia/commons/9/95/ALSEP\\_AS12-46-6792.jpg](http://upload.wikimedia.org/wikipedia/commons/9/95/ALSEP_AS12-46-6792.jpg)  
[http://en.wikipedia.org/wiki/File:ALSEP\\_AS14-67-9362.jpg](http://en.wikipedia.org/wiki/File:ALSEP_AS14-67-9362.jpg)

## Source Articles (on-campus login may be required to access journals)

- Weber et al., ‘Seismic Detection of the Lunar Core’, *Science*, 331, doi:10.1126/science.1199375, 2011.  
<http://www.sciencemag.org/content/331/6015/309>

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[dpsdisc@aas.org](mailto:dpsdisc@aas.org) - <http://dps.aas.org/education/dpsdisc/> - Released 15 April, 2011

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