



Lecture Outlines

## Chapter 8

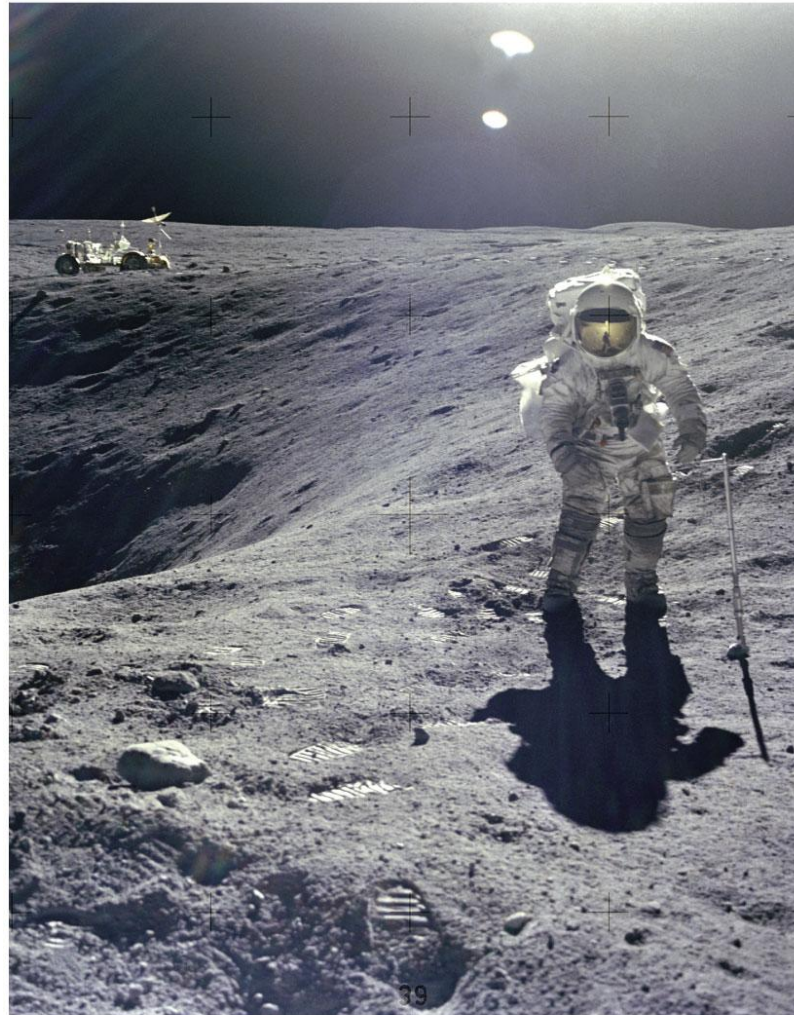
***Astronomy Today***

***7th Edition***

Chaisson/McMillan

# Chapter 8

## The Moon and Mercury



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# Units of Chapter 8

**8.1 Orbital Properties**

**8.2 Physical Properties**

**8.3 Surface Features on the Moon and Mercury**

**8.4 Rotation Rates**

**Lunar Exploration**

**Why Air Sticks Around**

**8.5 Lunar Cratering and Surface Composition**

# Units of Chapter 8 (cont.)

**8.6 The Surface of Mercury**

**8.7 Interiors**

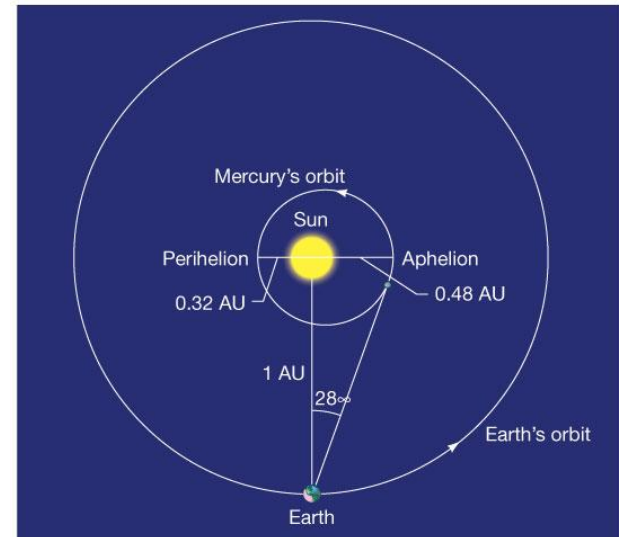
**8.8 The Origin of the Moon**

**8.9 Evolutionary History of the Moon and  
Mercury**

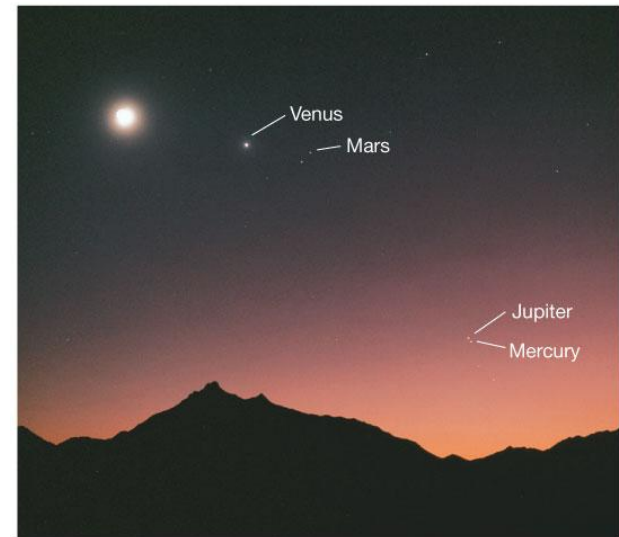
# 8.1 Orbital Properties

**Distance between Earth and Moon has been measured to accuracy of a few centimeters using lasers**

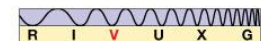
**Viewed from Earth, Mercury is never far from the Sun**



(a)



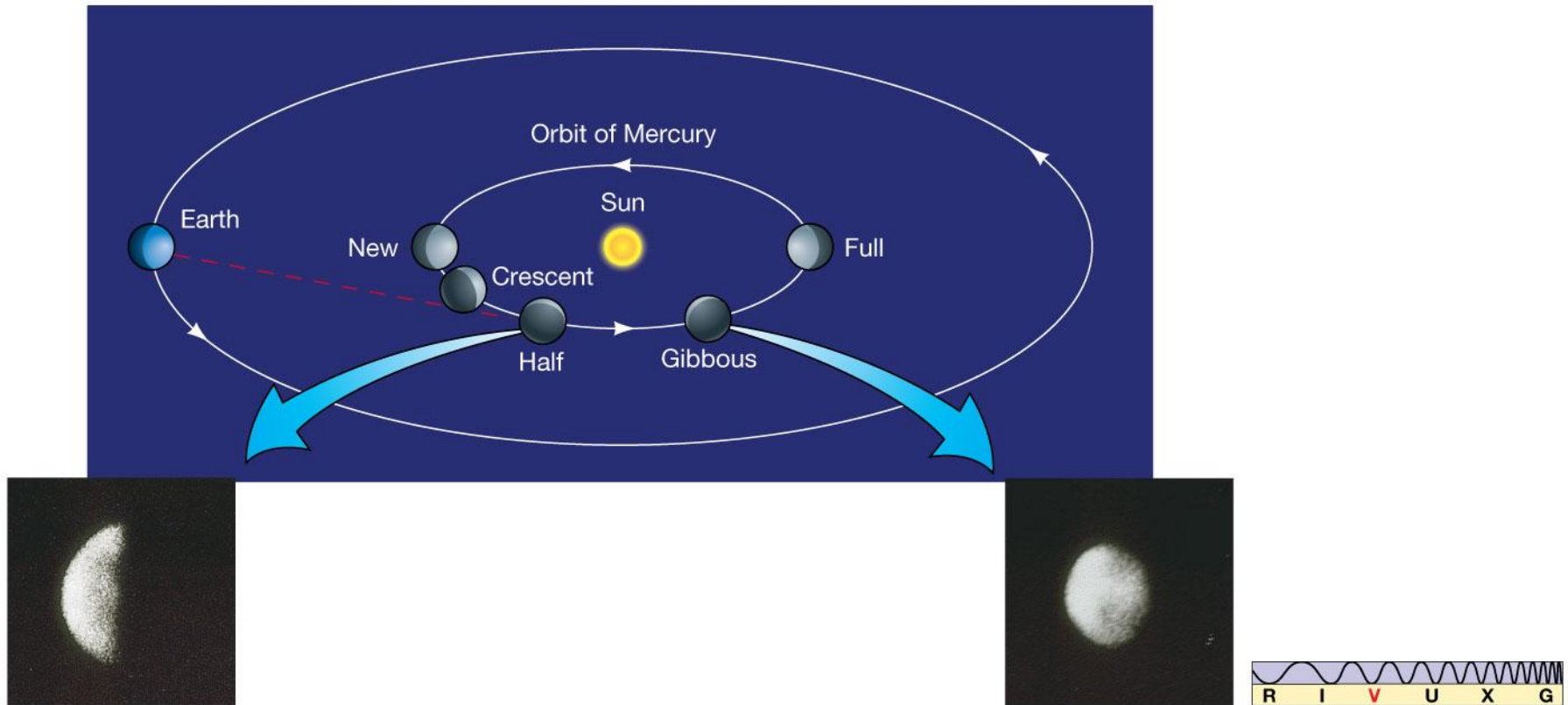
(b)





# 8.1 Orbital Properties

**Phases of Mercury can be seen best when Mercury is at its maximum elongation**



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## 8.2 Physical Properties

	<b>Moon</b>	<b>Mercury</b>	<b>Earth</b>
<b>Radius</b>	<b>1738 km</b>	<b>2440 km</b>	<b>6380 km</b>
<b>Mass</b>	<b><math>7.3 \times 10^{22}</math> kg</b>	<b><math>3.3 \times 10^{23}</math> kg</b>	<b><math>6.0 \times 10^{24}</math> kg</b>
<b>Density</b>	<b>3300 kg/m<sup>3</sup></b>	<b>5400 kg/m<sup>3</sup></b>	<b>5500 kg/m<sup>3</sup></b>
<b>Escape Speed</b>	<b>2.4 km/s</b>	<b>4.2 km/s</b>	<b>11.2 km/s</b>

# 8.3 Surface Features on the Moon and Mercury

**Moon has large dark flat areas, due to lava flow, called maria (early observers thought they were oceans)**

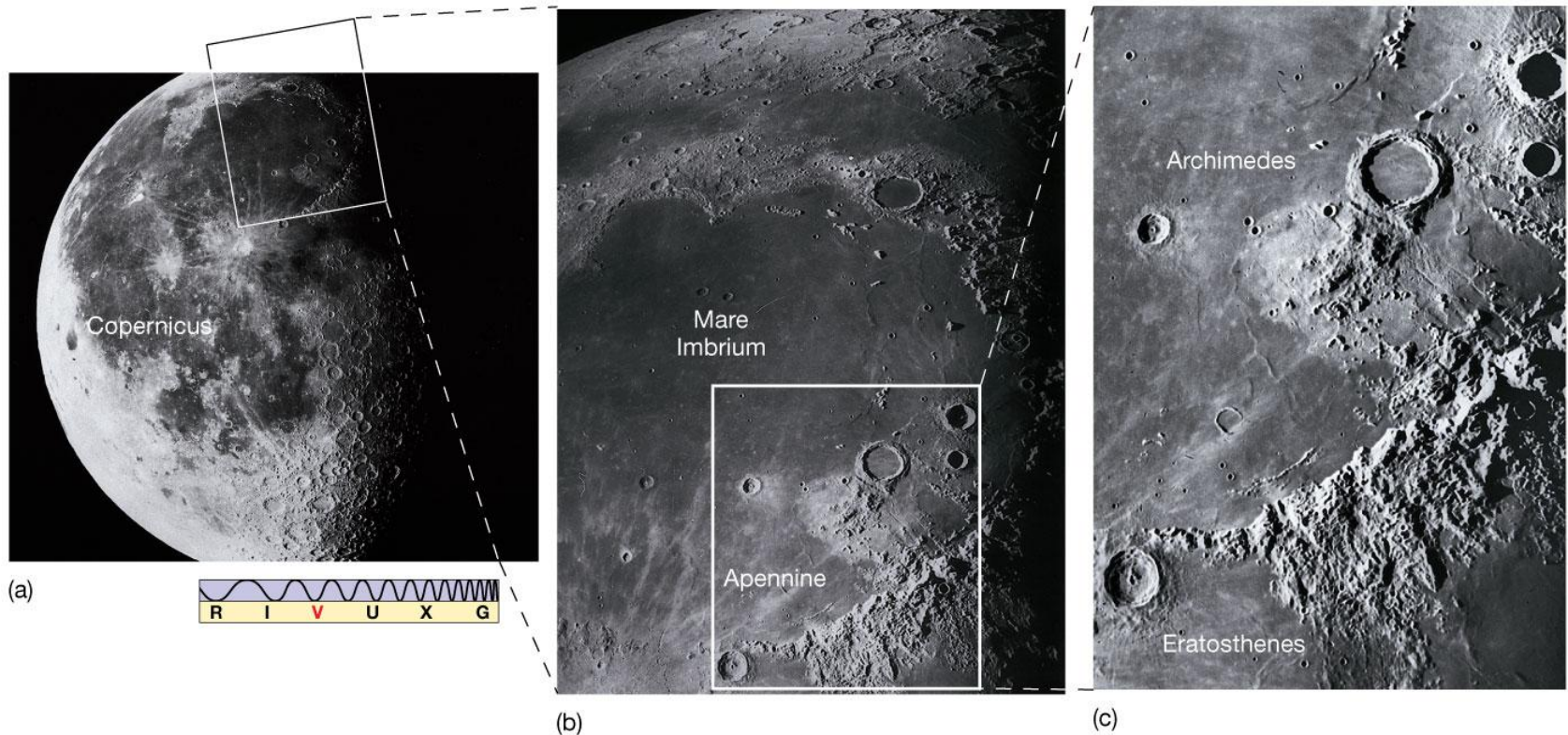


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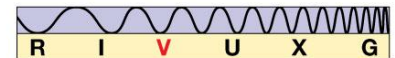
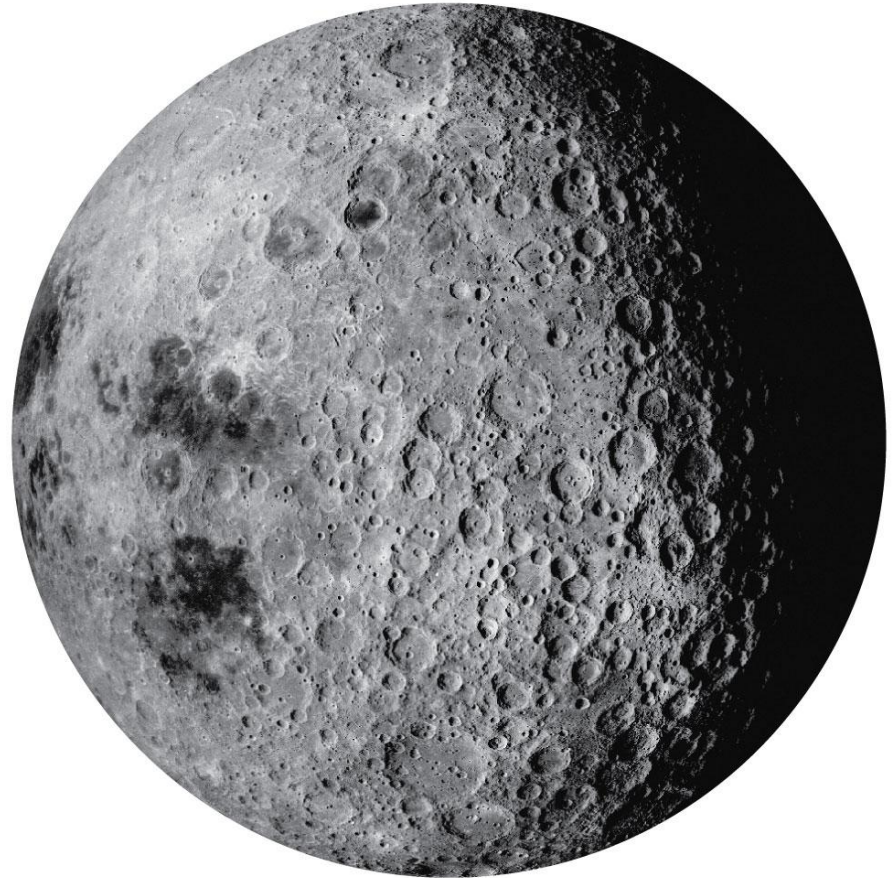
# 8.3 Surface Features on the Moon and Mercury

**Moon also has many craters (from meteorite impacts)**



# 8.3 Surface Features on the Moon and Mercury

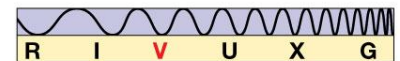
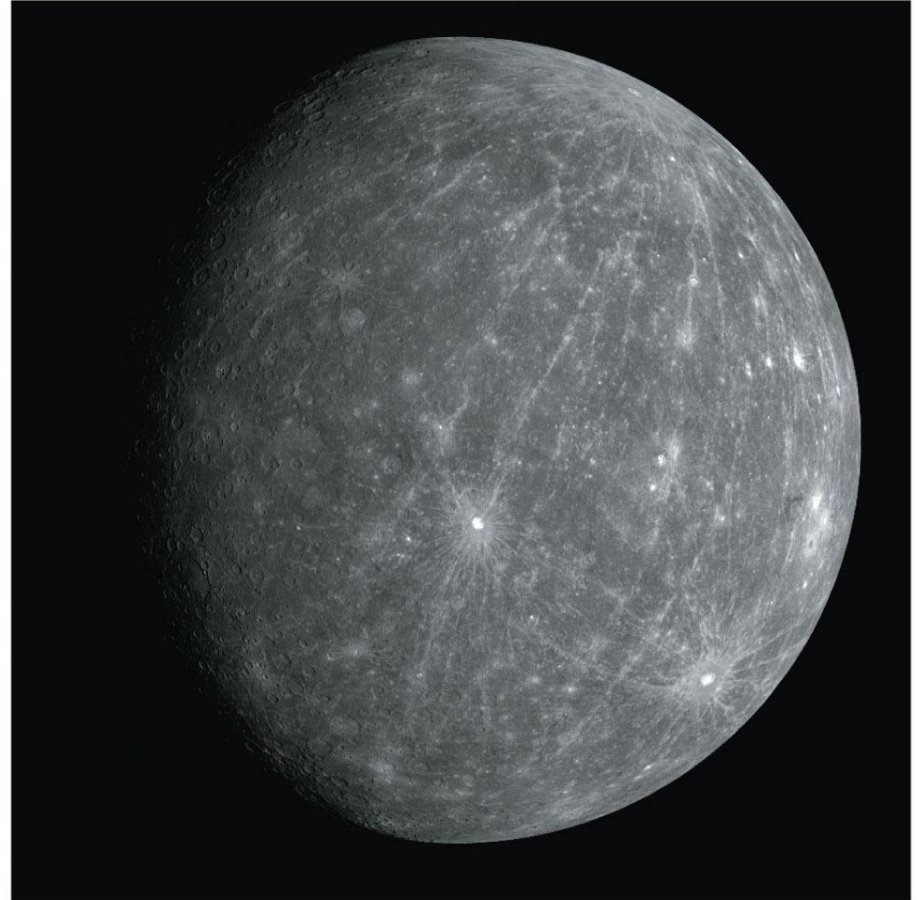
**Far side of Moon  
has some craters  
but no maria**



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# 8.3 Surface Features on the Moon and Mercury

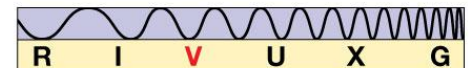
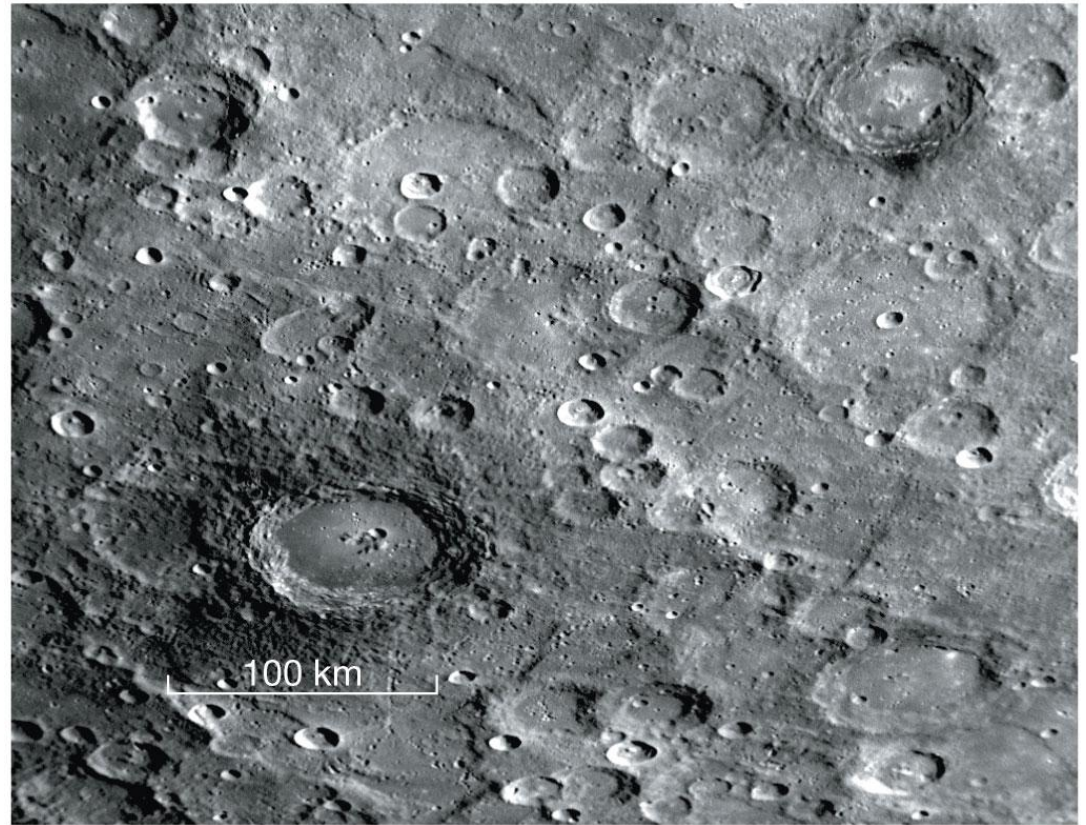
**Mercury cannot be imaged well from Earth; best pictures are from *Messenger***





# 8.3 Surface Features on the Moon and Mercury

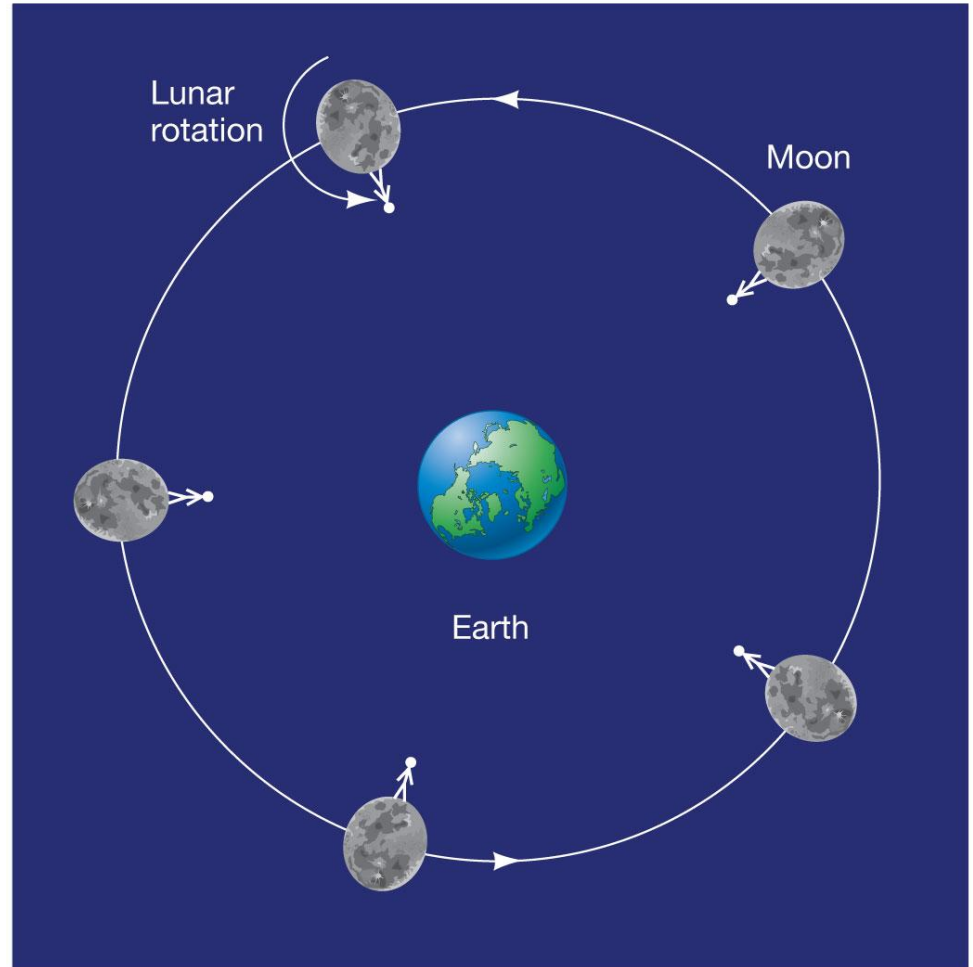
**Cratering on Mercury is similar to that on Moon**



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# 8.4 Rotation Rates

**Moon is tidally locked to Earth—its rotation rate is the same as the time it takes to make one revolution, so the same side of the Moon always faces Earth**



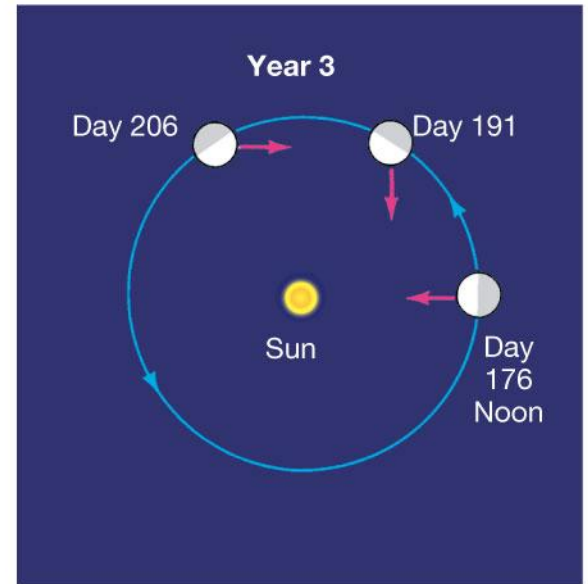
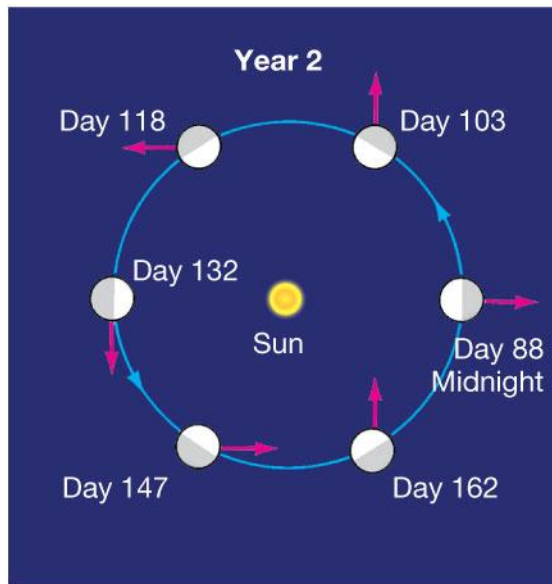
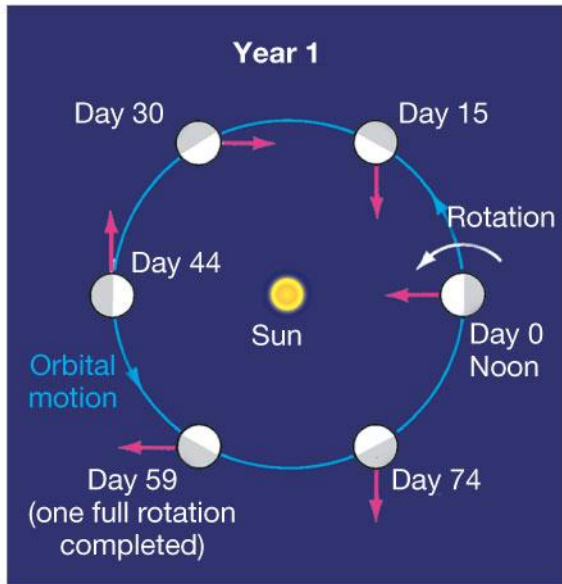
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## 8.4 Rotation Rates

**Mercury was long thought to be tidally locked to the Sun; measurements in 1965 showed this to be false.**

**Rather, Mercury's day and year are in a 3:2 resonance; Mercury rotates three times while going around the Sun twice.**



# Discovery 8-1: Lunar Exploration

**Soviets had first contact with Moon:**

- **First spacecraft to fly past Moon: January 1959**
- **First spacecraft to (crash) land on Moon: September 1959**
- **First pictures of far side of Moon: October 1959**

**The United States is (so far) the only country to send people to the Moon:**

- **First person on Moon: July 1969**
- **Last person on Moon: December 1972**

# More Precisely 8-1: Why Air Sticks Around

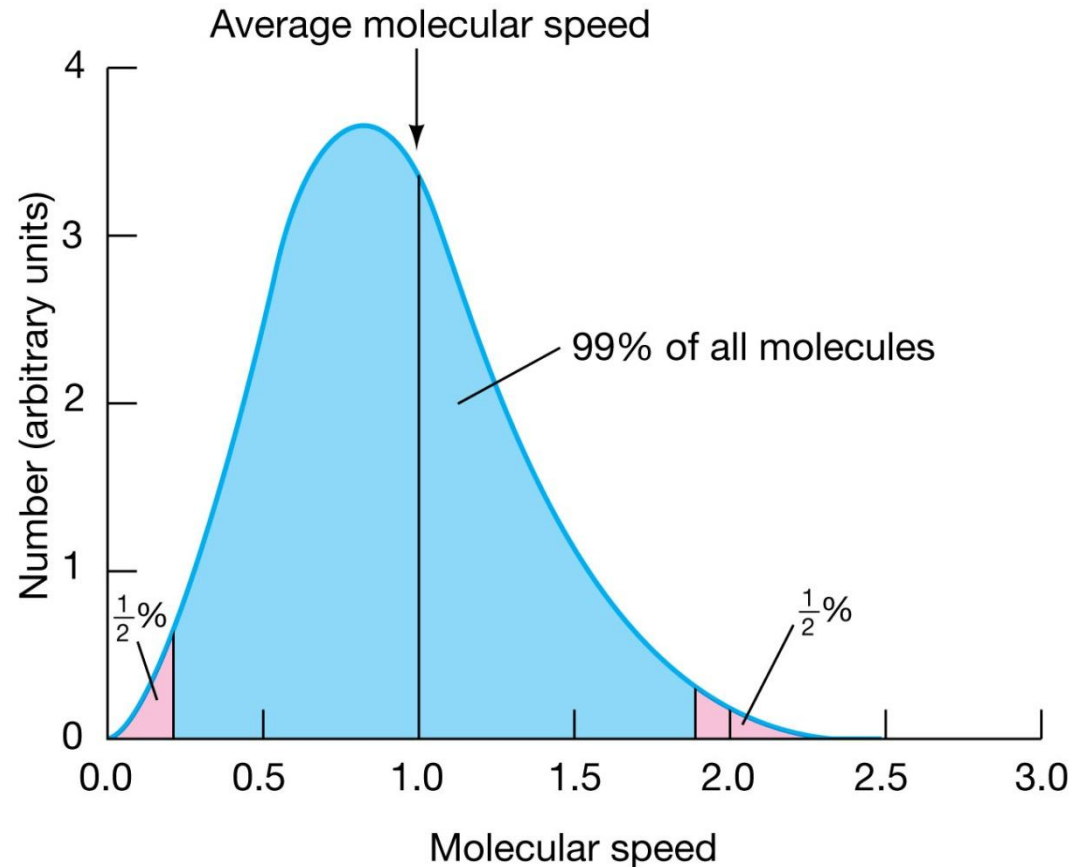
**Air molecules have high speeds due to thermal motion. If the average molecular speed is well below the escape velocity, few molecules will escape.**

**Escape becomes more probable:**

- **For lighter molecules (higher speed for same kinetic energy)**
- **At higher temperatures**
- **For smaller planets (escape speed is less)**

# More Precisely 8-1: Why Air Sticks Around

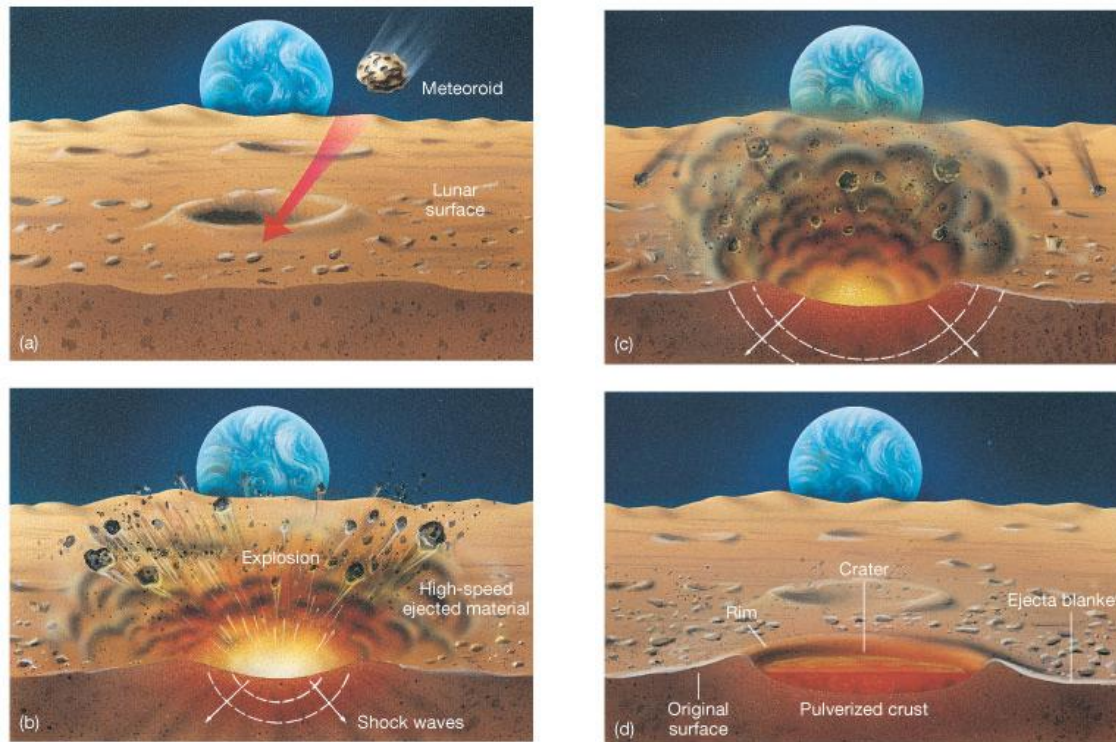
**Molecules in a gas have a range of speeds; the fastest (and those that are headed in the right direction) will escape**



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# 8.5 Lunar Cratering and Surface Composition

**Meteoroid strikes Moon, ejecting material; explosion ejects more material, leaving crater**



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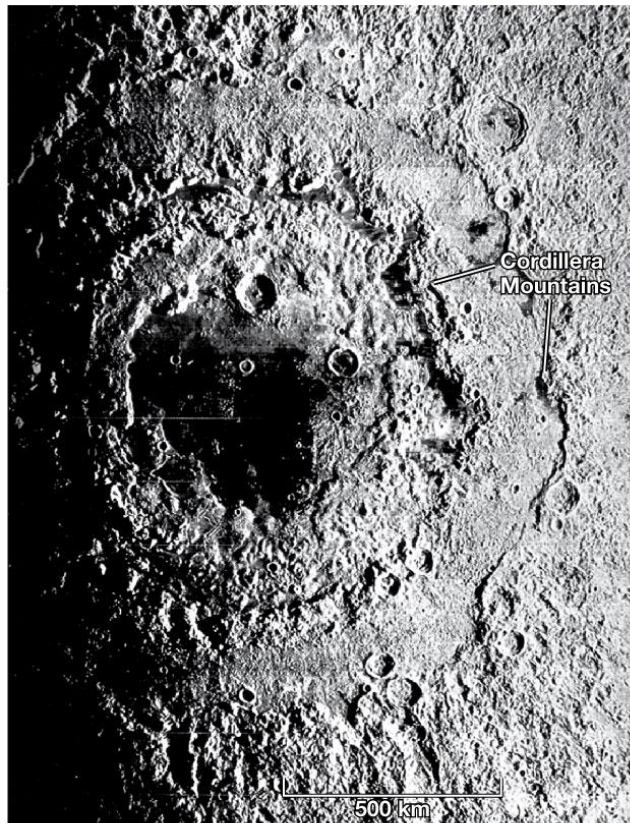


# 8.5 Lunar Cratering and Surface Composition

- **Craters are typically about 10 times as wide as the meteoroid creating them, and twice as deep**
- **Rock is pulverized to a much greater depth**
- **Most lunar craters date to at least 3.9 billion years ago; much less bombardment since then**

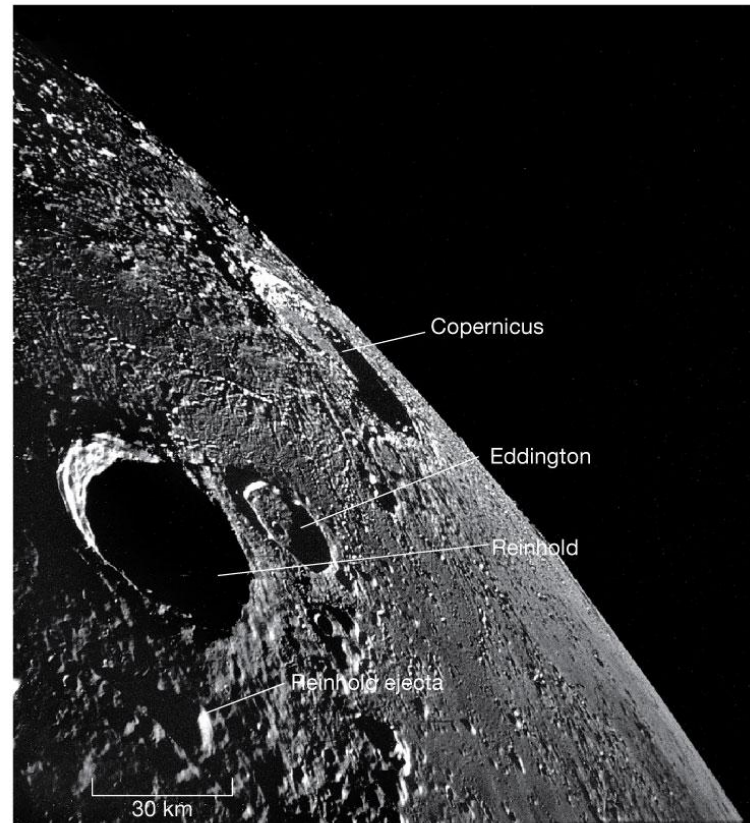
# 8.5 Lunar Cratering and Surface Composition

Craters come in all sizes, from the very large...

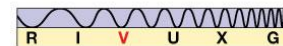


(a)

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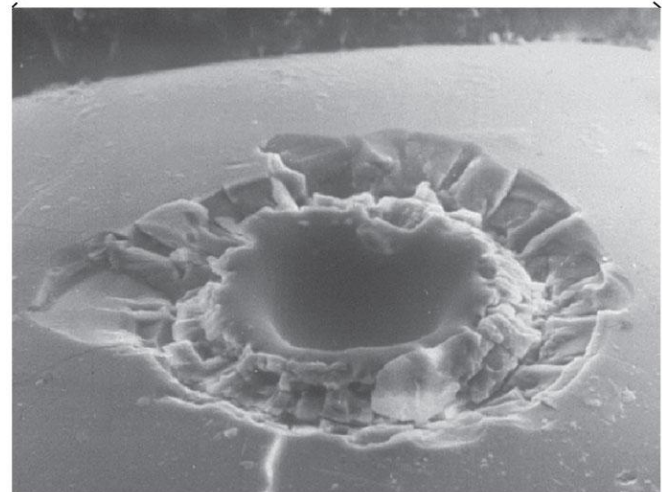
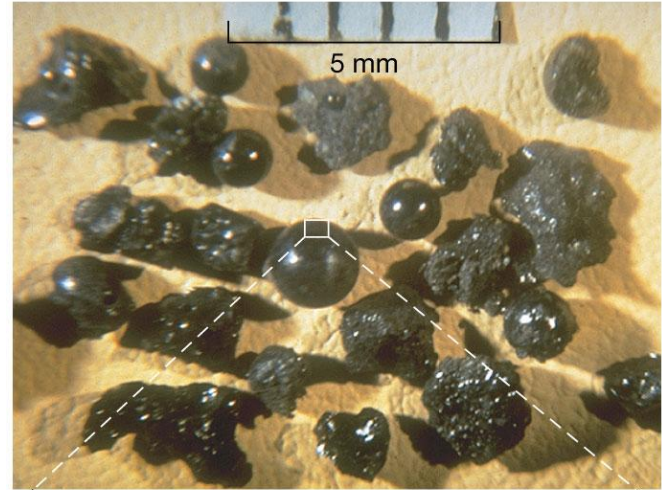


(b)



# 8.5 Lunar Cratering and Surface Composition

...to the very small

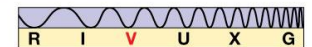


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# 8.5 Lunar Cratering and Surface Composition

**Regolith: Thick layer of dust left by meteorite impacts**

**Moon is still being bombarded, especially by very small “micrometeoroids”; softens features**



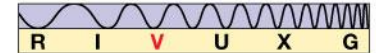


# 8.5 Lunar Cratering and Surface Composition

**Meteorites also hit Earth; this crater is in Arizona**



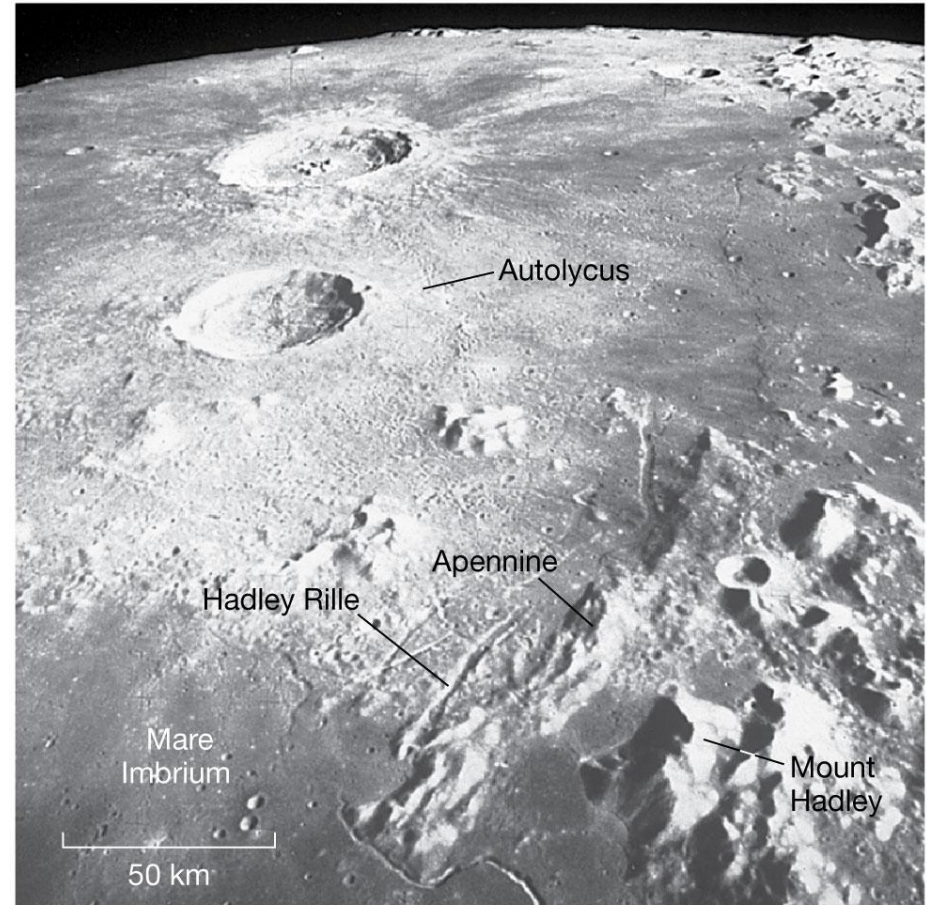
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# 8.5 Lunar Cratering and Surface Composition

**More than 3 billion years ago, the moon was volcanically active; the rille here was formed then**

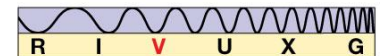
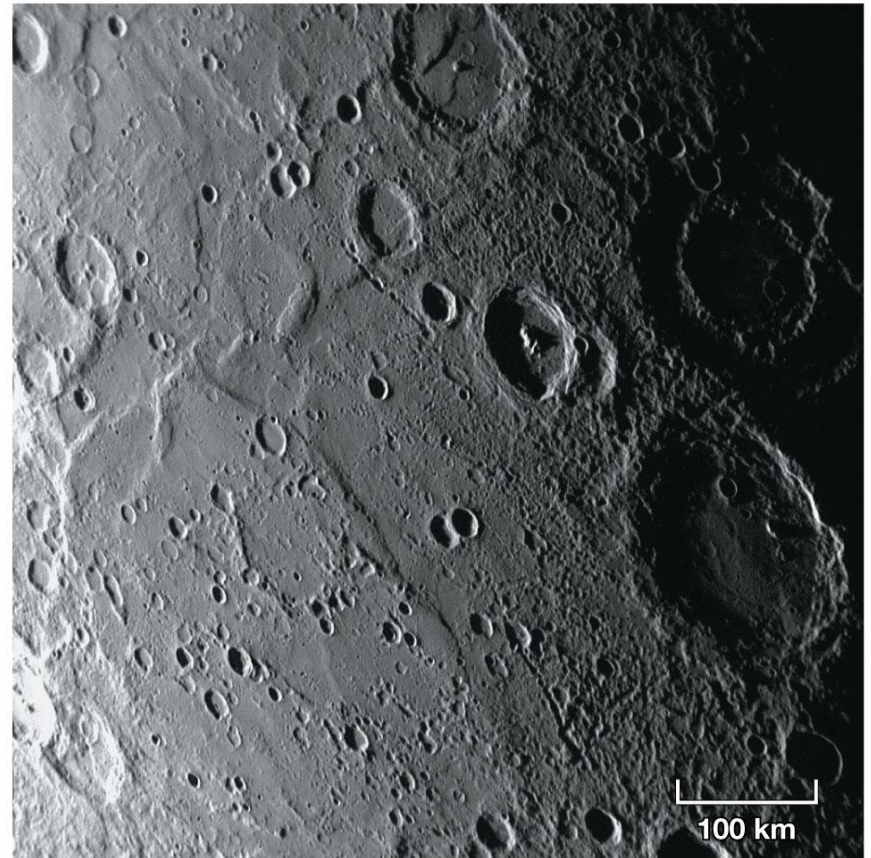


# 8.6 The Surface of Mercury

**Mercury is less heavily cratered than the Moon**

**Some distinctive features:**

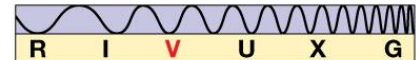
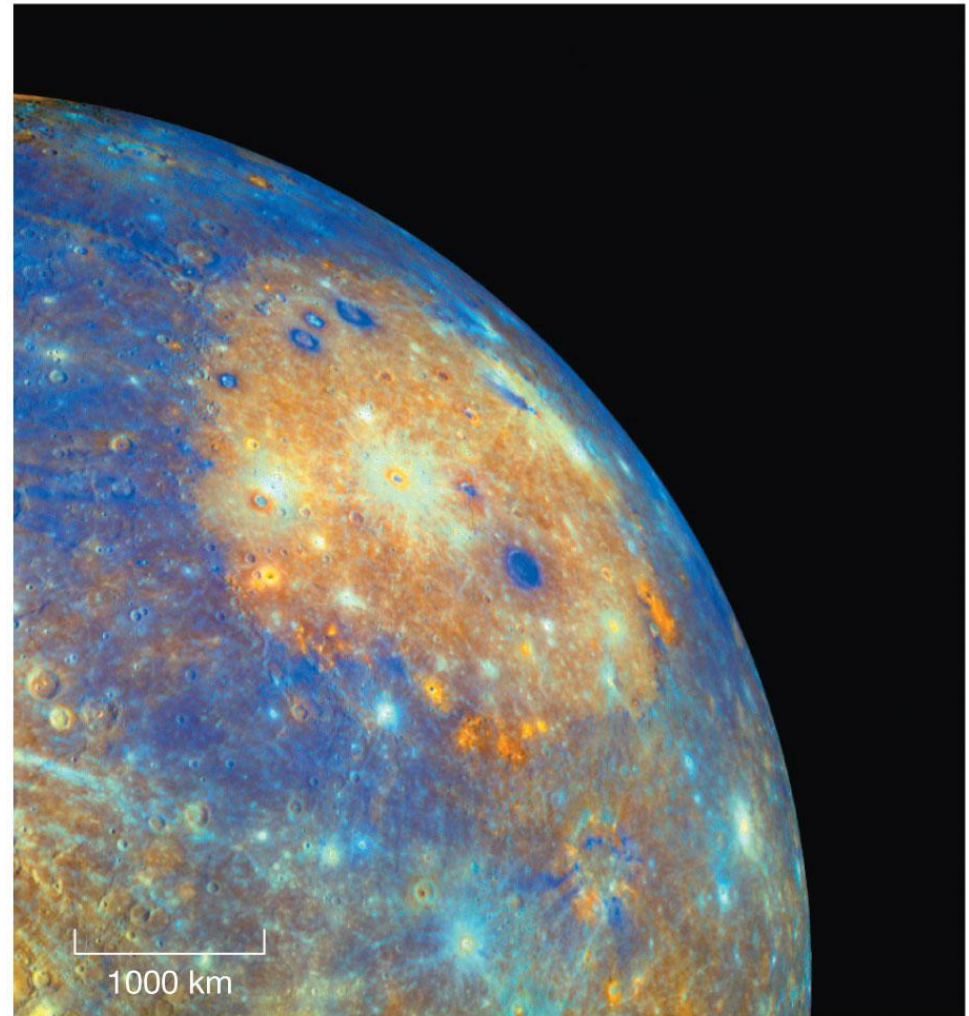
**Scarp (cliff), several hundred kilometers long and up to 3 km high**



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# 8.6 The Surface of Mercury

**Caloris Basin,  
very large impact  
feature on  
opposite side of  
planet**

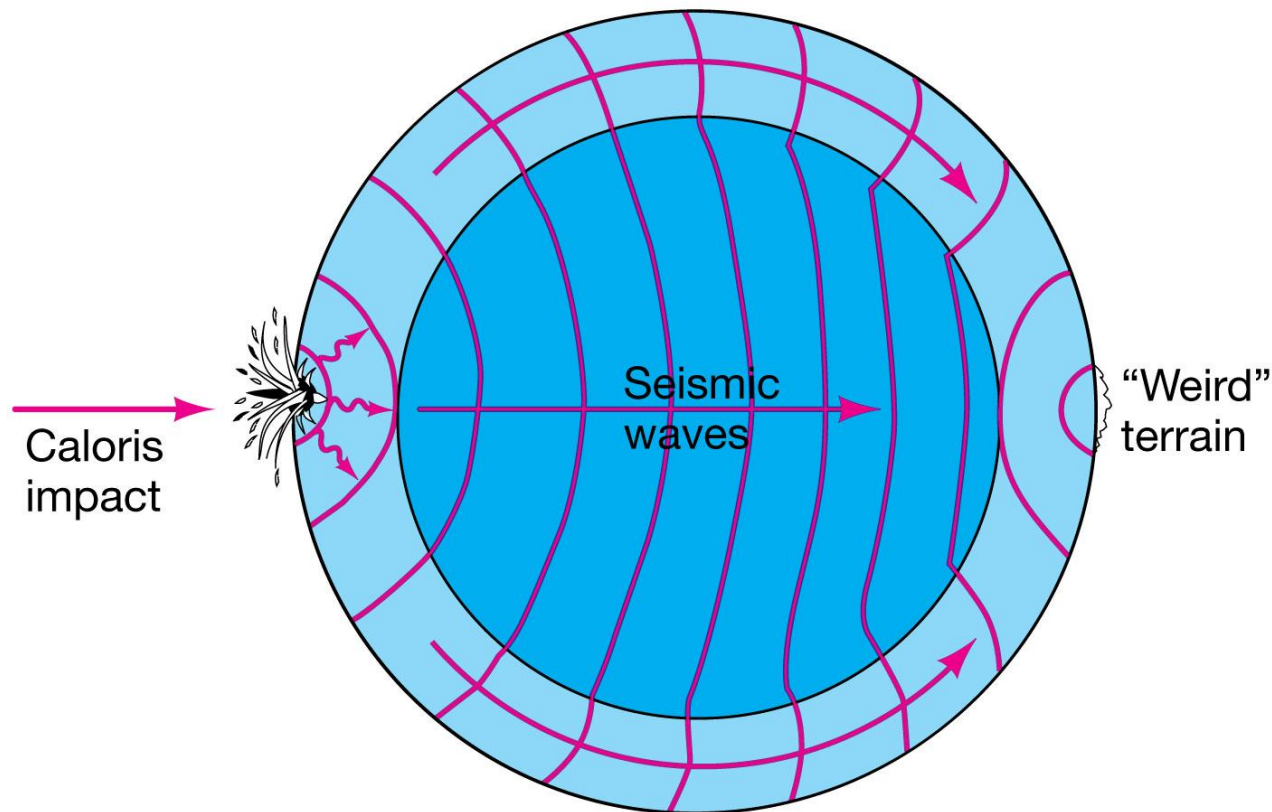


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# 8.6 The Surface of Mercury

**“Weird terrain” is thought to result from focusing of seismic waves**

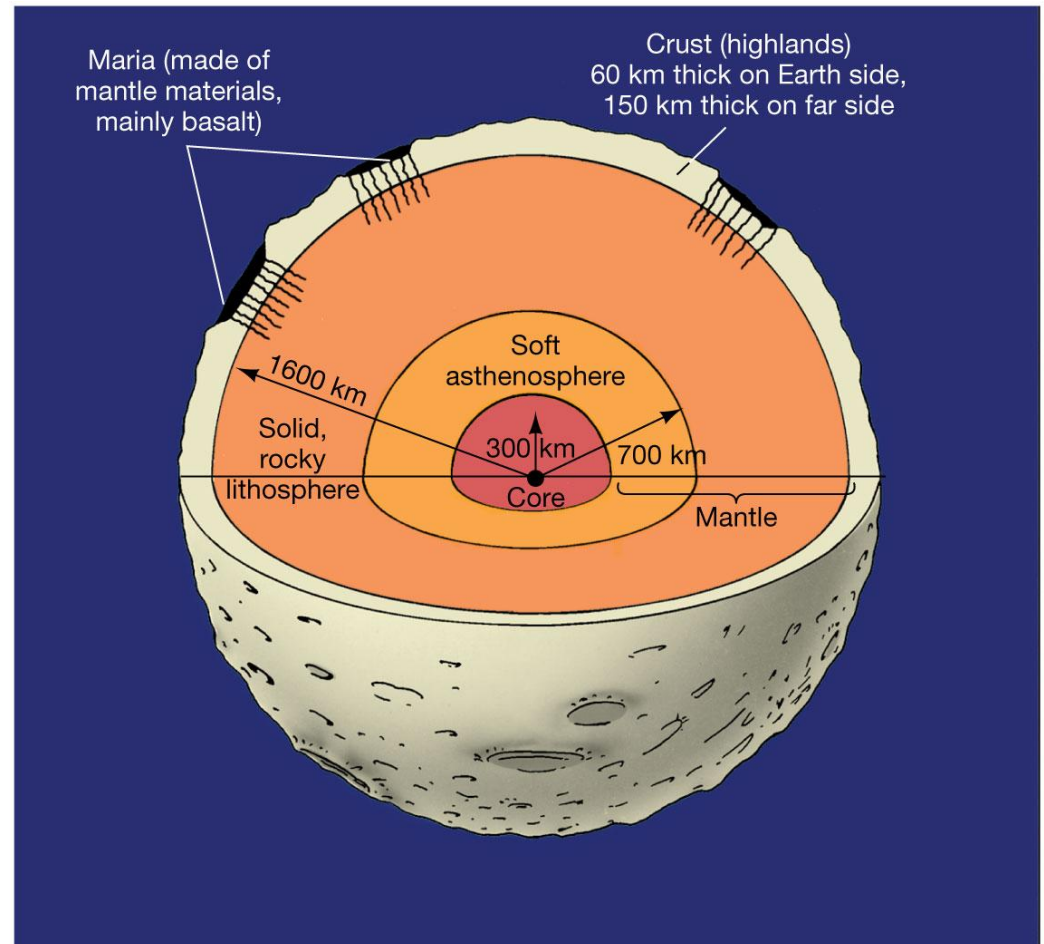


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# 8.7 Interiors

**Moon's density is relatively low, and it has no magnetic field—cannot have sizable iron/nickel core**

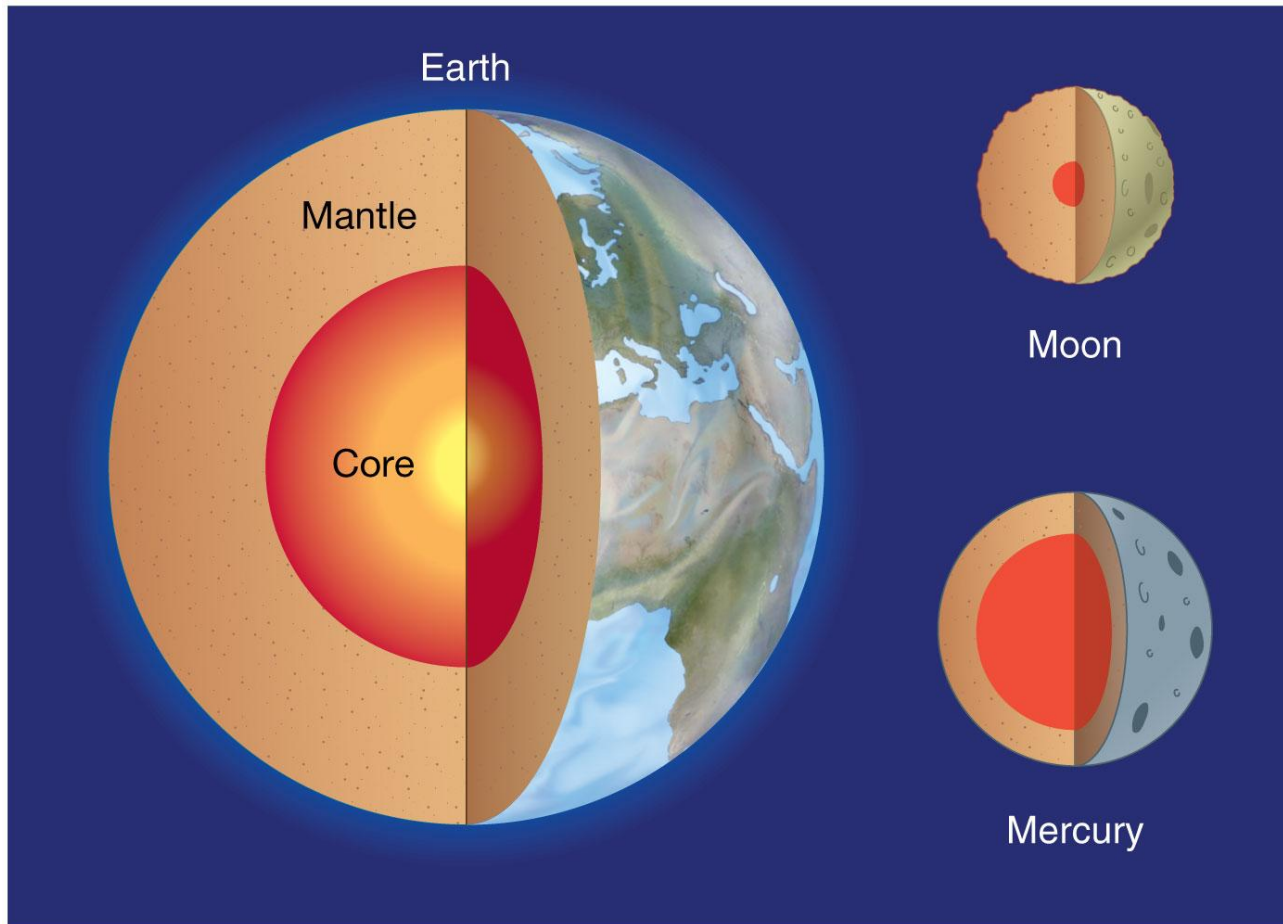
**Crust is much thicker than Earth's**





# 8.7 Interiors

**Mercury is much denser than the Moon and has a weak magnetic field—not well understood!**

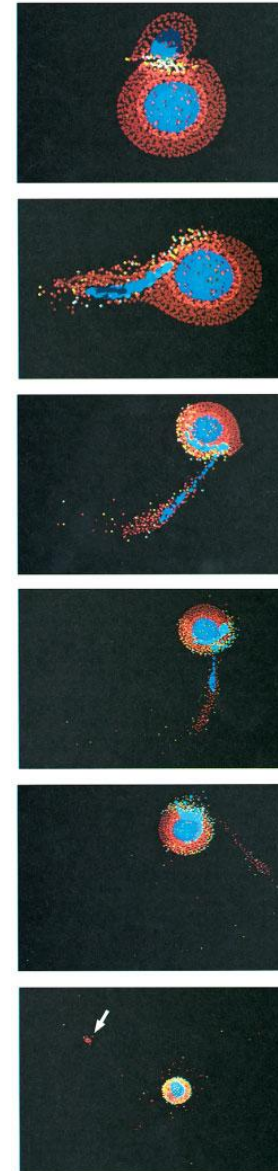


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# 8.8 The Origin of the Moon

**Current theory of Moon's origin: Glancing impact of Mars-sized body on the still-liquid Earth caused enough material, mostly from the mantle, to be ejected to form the Moon**

**Computer model**



# 8.9 Evolutionary History of the Moon and Mercury

<b>Time before present</b>	<b>Event</b>
<b>4.6 billion yr</b>	<b>Formation of Moon; heavy bombardment liquefies surface</b>
<b>3.9 billion yr</b>	<b>Bombardment much less intense; lunar volcanism fills maria</b>
<b>3.2 billion yr</b>	<b>Volcanic activity ceases</b>

# 8.9 Evolutionary History of the Moon and Mercury

**Mercury much less well understood**

- **Formed about 4.6 billion years ago**
- **Melted due to bombardment, cooled slowly**
- **Shrank, crumpling crust**

# Summary of Chapter 8

- **Main surface features on Moon: maria, highlands**
- **Both heavily cratered**
- **Both have no atmosphere, and large day–night temperature excursions**
- **Tidal interactions responsible for synchronicity of Moon's orbit, and resonance of Mercury's**



# Summary of Chapter 8 (cont.)

- **Moon's surface has both rocky and dusty material**
- **Evidence for volcanic activity**
- **Mercury has no maria but does have extensive intercrater plains and scarps**