Today's Class: Mercury

- Reading on Venus for next class – Section 9.5 in Cosmic Perspective.
- Homework #5 due on Monday.

1

Last Class

- Overview of Solar System
- Tour through the Solar System – Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Nepture, dwarf planets.
- How do robotic spacecraft work?
  - Flybys
  - Orbiters
  - Landers
  - Sample Return

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Class Exercise

How are Mars and Earth *similar* and *different*? What is the impact for planning human missions to Mars?

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Today's Class

- Mercury
  - Interiors of Terrestrial Planets.
    - Heating
    - Cooling
  - What geological processes shaped Mercury?
  - NASA's Messenger mission to Mercury.

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Overview of Mercury

- Made of metal and rock; large iron core
- Desolate, cratered; long, tall, steep cliffs
- Very hot, very cold: 425°C (day), –170°C (night)

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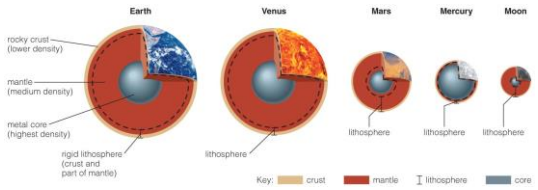
Terrestrial Planet Interiors



- Applying what we know about Earth's interior to other planets tells us what their interiors are probably like.

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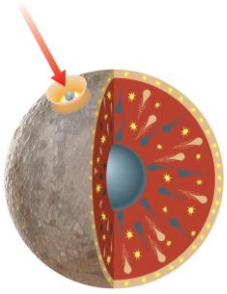
Heating of Planetary Interiors



- Accretion and differentiation when planets were young
- Radioactive decay is most important heat source today.

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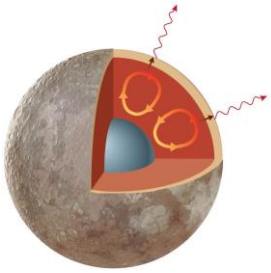
Cooling of Planetary Interiors



- **Convection** transports heat as hot material rises and cool material falls.
- **Conduction** transfers heat from hot material to cool material.
- **Radiation** sends energy into space.

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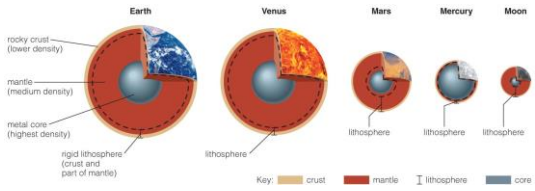
Role of Size



- Smaller worlds cool off faster and harden earlier.
- The Moon and Mercury are now geologically "dead."

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Surface Area–to–Volume Ratio

- Heat content depends on volume.
- Loss of heat through radiation depends on surface area.
- Rate of cooling depends on surface area divided by volume:

$$\text{Surface area–to–volume ratio} = \frac{4\pi r^2}{\frac{4}{3}\pi r^3} = \frac{3}{r}$$

- Larger objects have a smaller ratio and cool more slowly.

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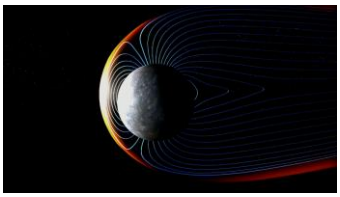
Class Exercise

Why do you think Mercury has a planet-wide magnetic field but the Moon does not?



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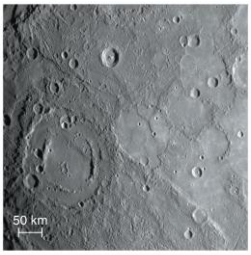
What geological processes shaped Mercury?



a A close-up view of Mercury's surface, showing impact craters and smooth regions where lava apparently covered up craters.

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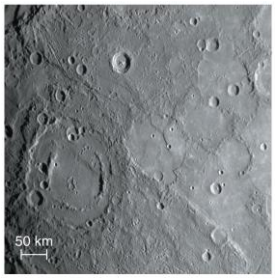
Cratering of Mercury



- Mercury has a mixture of heavily cratered and smooth regions like the Moon.
- Smooth regions are likely ancient lava flows.

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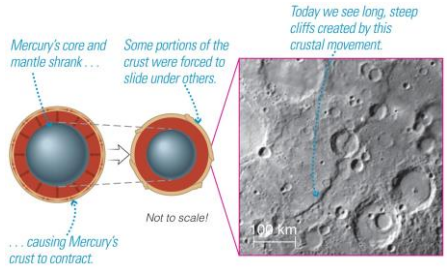
Tectonics on Mercury



- Tectonics = large-scale properties that affect the crust.
- Long cliffs indicate that Mercury shrank early in its history.

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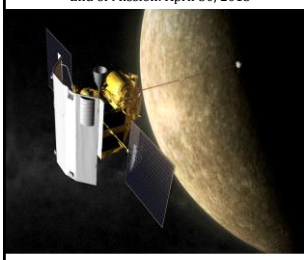
NASA's Messenger Mission

Orbit Insertion: March 18, 2011
End of Mission: April 30, 2015



It's hard to get to Mercury!

Science Questions

1. Why is Mercury so dense?
2. What is the geologic history?
3. What is the nature of Mercury's magnetic field?
4. What is the structure of the core?
5. What volatiles are important at Mercury?

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Mercury Atmospheric and Surface Composition Spectrometer (MASCS)

- Developed at LASP, University of Colorado
- Using a UV spectrometer and an IR spectrograph, MASCS measures the abundance of atmospheric gases and identifies surface minerals

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Mercury vs. the Moon

- Mercury and the Moon have very similar surfaces. They both show ancient lava flows and lots of cratering. The both lack any significant atmosphere and therefore have very little erosion.
- Mercury has a much higher density and has a molten core. This leads to a magnetic field on Mercury that is about 1% the strength of Earth's.

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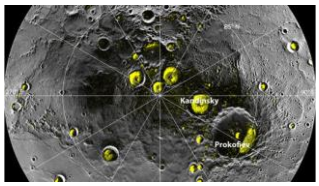
Notable Discoveries

- Found water on the planet closest to the Sun!
- Volcanic activity in Mercury's past.



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What did we learn today?

- Mercury
  - Interiors of Terrestrial Planets.
    - Heating
    - Cooling
  - What geological processes shaped Mercury?
  - NASA's Messenger mission to Mercury.