Sun-Scorched Mercury
Chapter Eleven

Mercury

The Moon

ASTR 111 – 003 **Fall 2006**
Lecture 10 Nov. 06, 2006

Introduction To Modern Astronomy I

Introducing Astronomy
(chap. 1-6)

Planets and Moons
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Ch7: Comparative Planetology I
Ch8: Comparative Planetology II
Ch9: The Living Earth
Ch10: Our Barren Moon

Ch11: Sun-Scorched Mercury

Ch12: Cloud-covered Venus
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Ch15: Satellites of Jup. & Saturn
Ch16: Outer World
Ch17: Vagabonds of Solar System

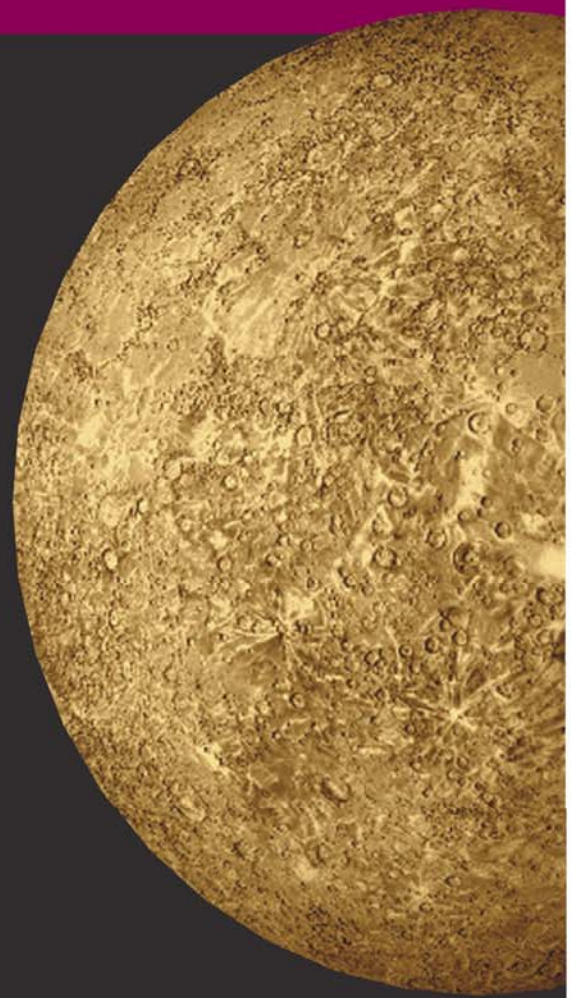
Guiding Questions

1. What makes Mercury such a difficult planet to see?
2. What is unique about Mercury’s rotation?
3. How do the surface features on Mercury differ from those on the Moon?
4. Is Mercury’s internal structure more like that of the Earth or the Moon?

Mercury Data

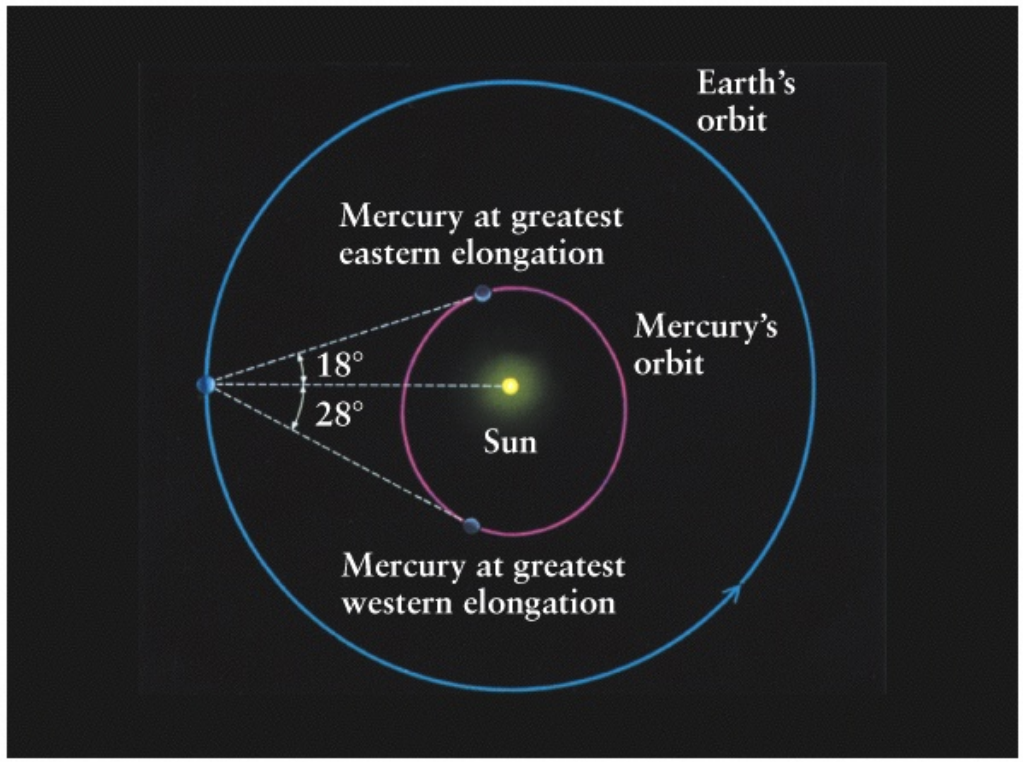
table 11-1 | Mercury Data

Average distance from Sun:	0.387 AU = 5.79×10^7 km
Maximum distance from Sun:	0.467 AU = 6.98×10^7 km
Minimum distance from Sun:	0.307 AU = 4.60×10^7 km
Eccentricity of orbit:	0.206
Average orbital speed:	47.9 km/s
Orbital period:	87.969 days
Rotation period:	58.646 days
Inclination of equator to orbit:	0.5°
Inclination of orbit to ecliptic:	7° 00′ 16″
Diameter (equatorial):	4880 km = 0.383 Earth diameter
Mass:	3.302×10^{23} kg = 0.0553 Earth mass
Average density:	5430 kg/m^3
Escape speed:	4.3 km/s
Surface gravity (Earth = 1):	0.38
Albedo:	0.12
Average surface temperatures:	Day: 350°C = 662°F = 623 K
	Night: −170°C = −274°F = 103 K
Atmosphere:	Essentially none



Observation of Mercury

- At its greatest eastern and western elongation, Mercury is never more than 28° from the sun
- It can be seen for only brief periods (< 2 hours) just
  - after sunset: evening star, at eastern elongation
  - before sunrise: morning star, at western elongation

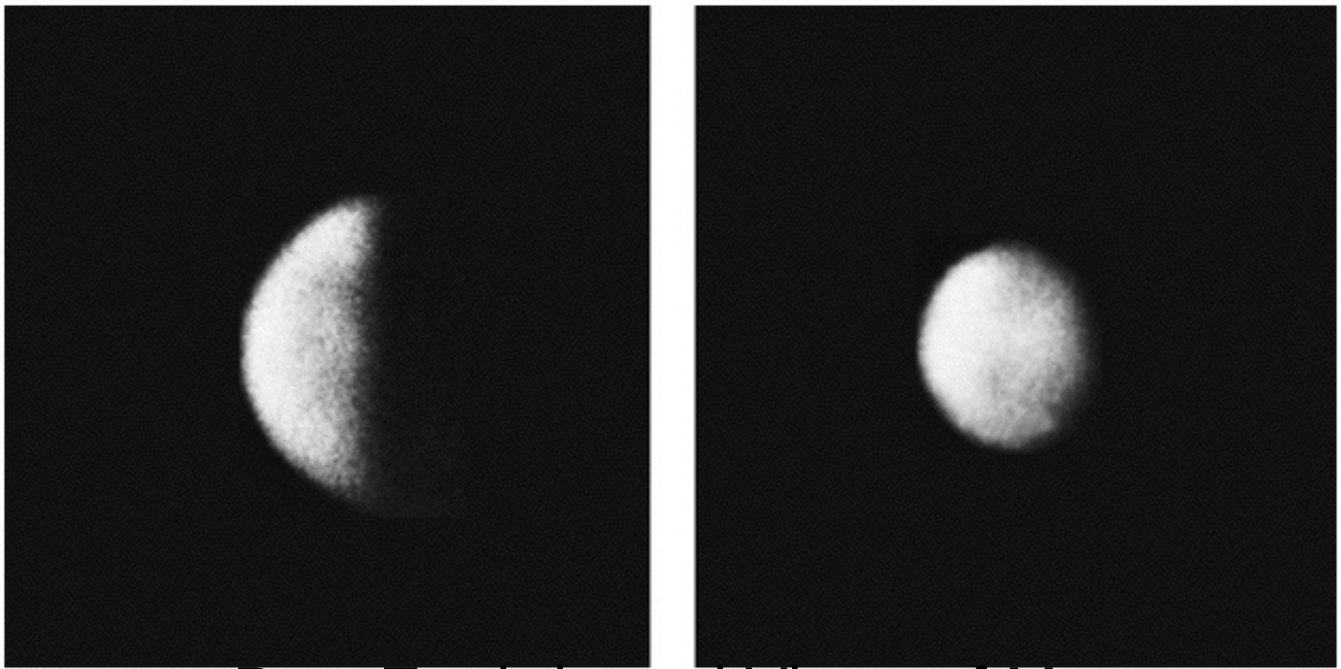


Observation of Mercury

•Difficulties observing Mercury

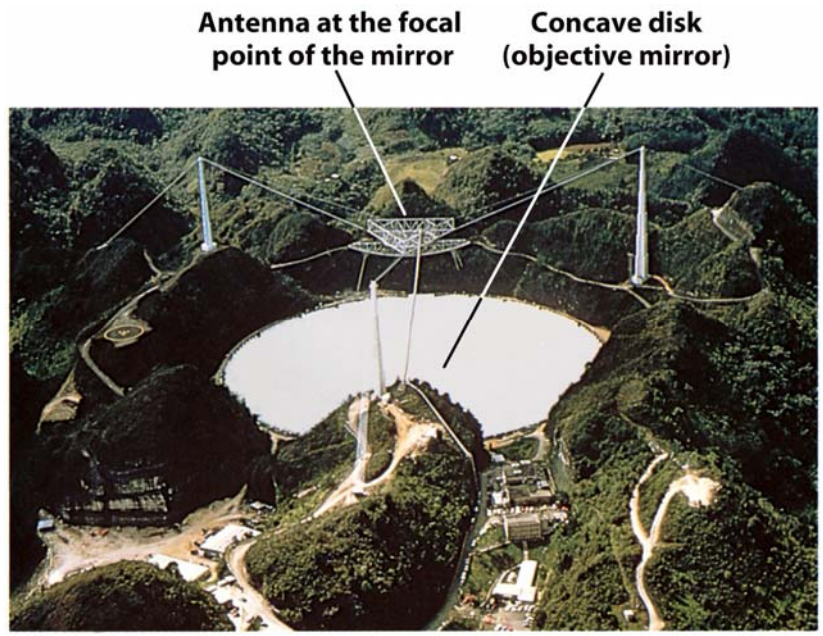
- Because the approximation to the Sun
- Because of atmospheric distortion over the horizon

• Lacking of observations, astronomers incorrectly decided that Mercury always kept the same face towards the sun in synchronous orbit

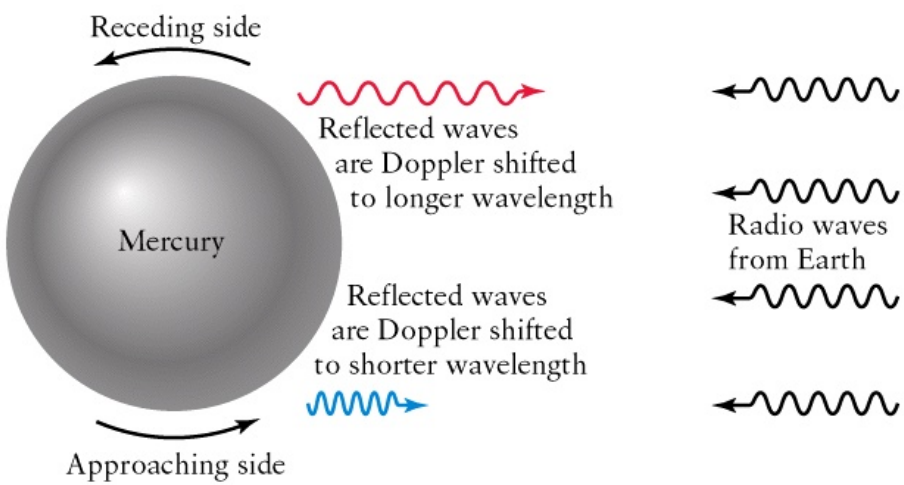


Best Earth-based Views of Mercury

Mercury rotation

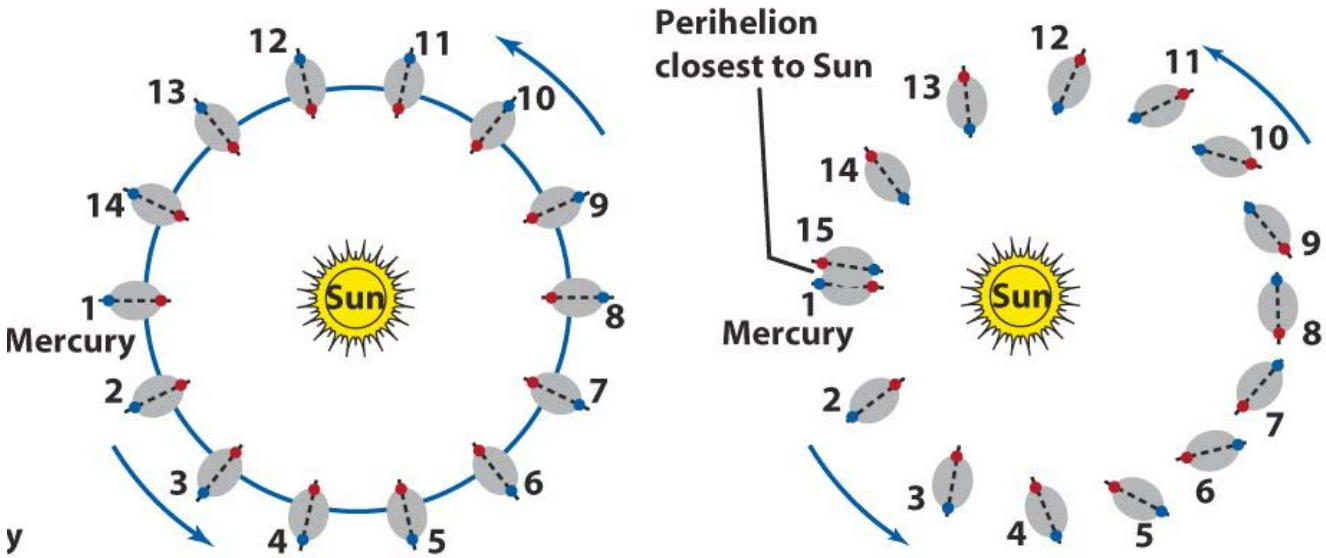


- Radio telescope radar measurement gave evidence of a non-synchronous orbit
- The rotation period of 58.6 days is exactly 2/3 of the orbital period of Mercury (87.9 day).
- There is 3-2 spin-orbit coupling
- This is in contrast to the synchronous rotation, or 1-to-1 spin-orbit coupling, e.g, Moon,



Mercury rotation

- Its very **eccentric orbit**, coupled with strong tidal effects and Mercury's slightly elongated shape, cause this strange 3-to-2 orbit
- A synodic day on Mercury would be 88 earth day



(b) If Mercury were in a circular orbit, its long axis would always point toward the Sun: Mercury would be in synchronous rotation (1-to-1 spin-orbit coupling).

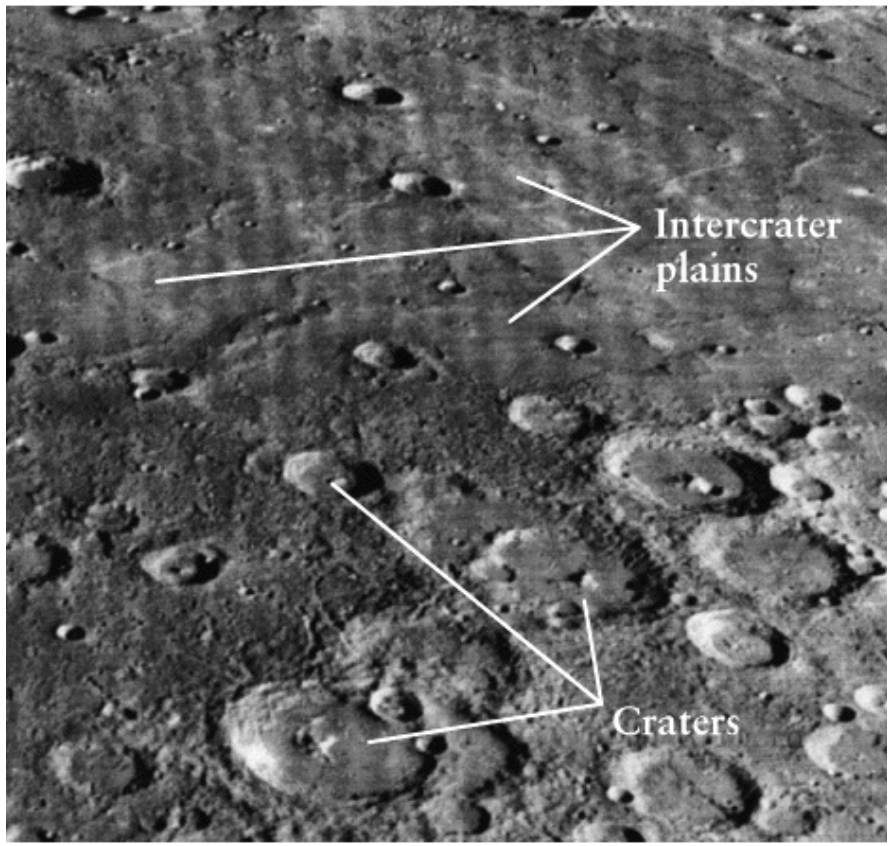
(c) In fact Mercury is in an elliptical orbit, and its long axis only points toward the Sun at perihelion: Mercury spins on its axis 1½ times during each complete orbit (3-to-2 spin-orbit coupling).

Mercury's Surface

- Most information about Mercury's surface is from Mariner-10 fly-by mission in 1974/1975.
- Heavily cratered surface, like the Moon
- Less dense cratering than moon

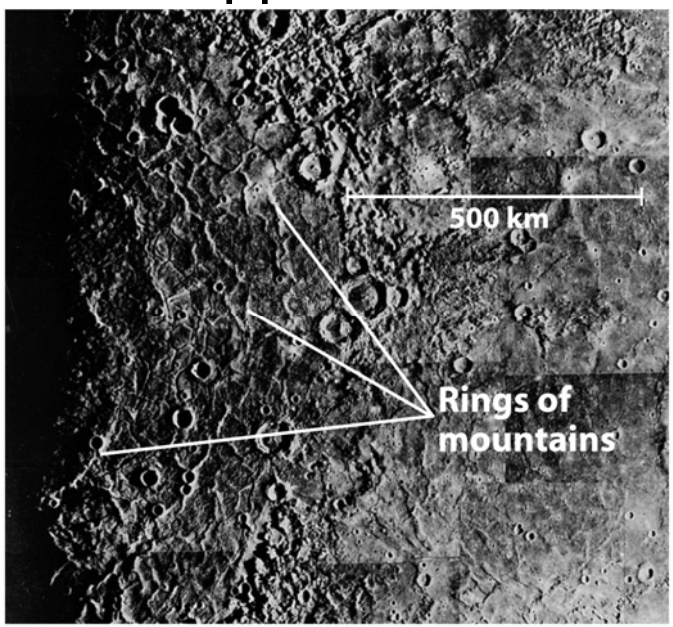
- No evidence of tectonics; due to small size and fast cooling

- No evidence of atmosphere; due to small mass and low escape velocity

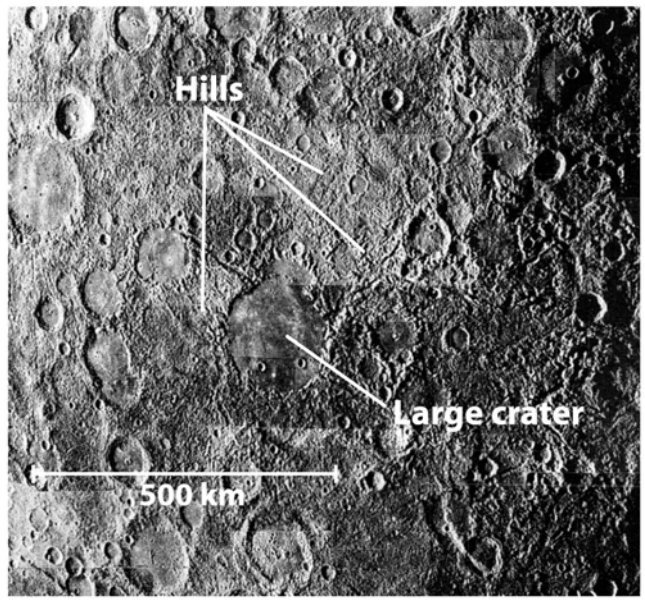


Mercury's Surface

- The Caloris Basin, 1300-km in diameter, caused by impact
  - Forming several concentric chains of mountains
  - Forming many 5-km wide hills on the side of Mercury opposite the Caloris Basin; Seismic waves from the Caloris impact passed through Mercury and focused on the opposite side.



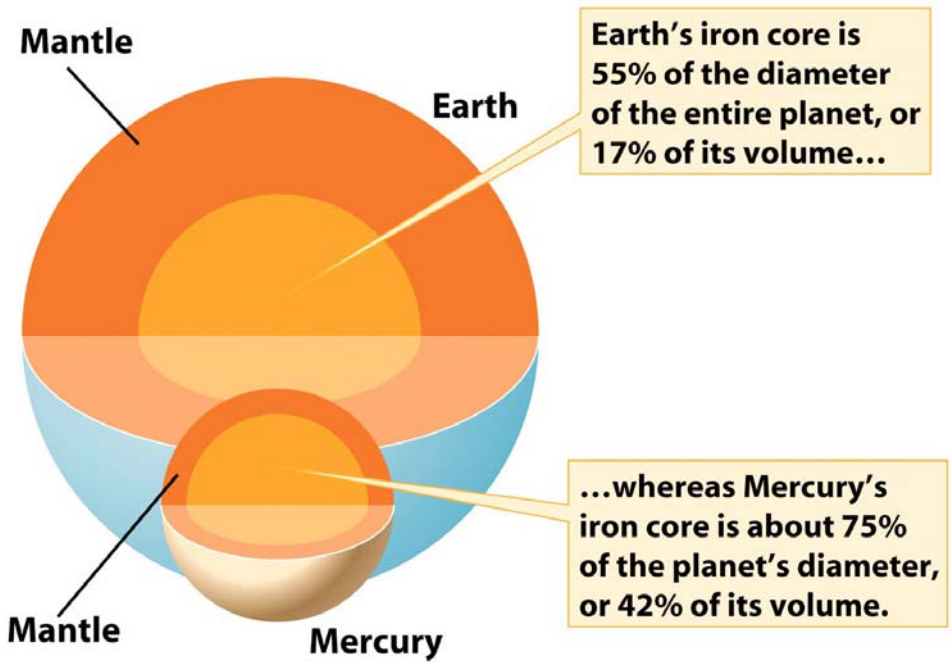
The Caloris Basin



Opposite side of the Basin

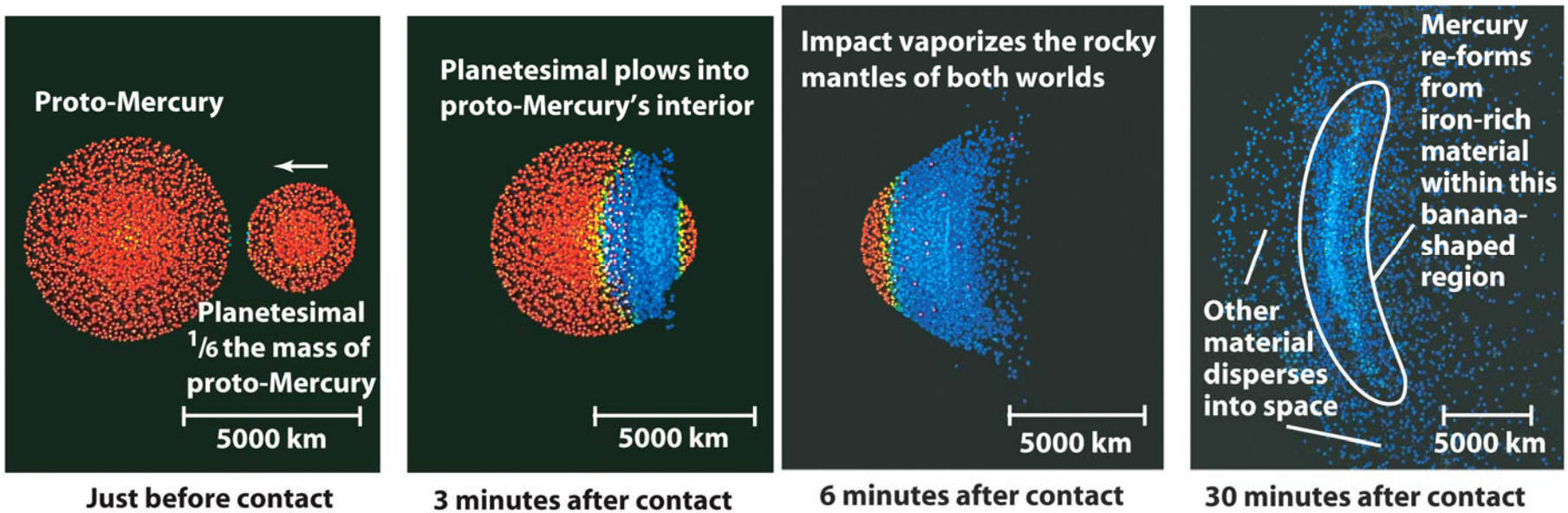
Mercury's Internal Structure

- Mercury's density is similar to that of Earth
- Mercury also has crust, mantle and core
- Mercury's core is relatively large
  - The core is 75% of its diameter
  - The earth's core is 55% of its diameter
  - the moon's core is 20% of its diameter



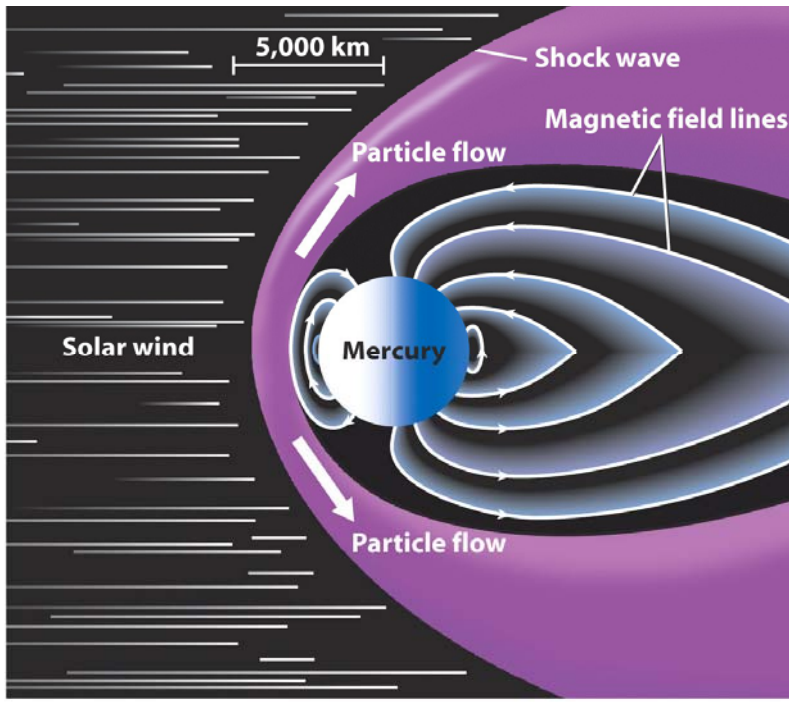
Mercury's Internal Structure

- To account for Mercury's large core and high iron content, one theory proposes that a collision with a planet-sized object stripped Mercury of most of rocky mantle.



Mercury's Internal Structure

- Mercury has a weak global magnetic field, about 1% as strong as the Earth
- Unsolved problem of Mercury magnetic field
  - What is the internal heat to keep the core partially molten?
  - Why can the slow rotation account for the magnetic dynamo?



Final Notes on Chap. 10

- There are 4 sections in total, all studied