

Astro 210
Lecture 19
October 8, 2010

Announcements

- Remember me?
- HW 5 due
- HW 6 available, due in class next Friday
- Night Observing continues next week

Last time: The Moon

Q: from Earth we only see one side of the Moon—why?

Q: on the Moon, how often does the Sun rise?

iClicker Poll: Earthrise from the Moon

As seen from the Moon, how often does the Earth rise?

- A** every 1 Moon spin period
- B** every 1 Earth year (Earth-Moon system orbit around Sun)
- C** none of the above

The Moon

Global Properties

$$M = 7.3 \times 10^{22} \text{ kg}$$

$$R = 1738 \text{ km} \sim 1/4 R_{\text{earth}}$$

$$d_{\text{EM}} = 3.8 \times 10^5 \text{ km} \sim 60R_E$$

diagram: Earth-Moon to scale

$$\rho_{\text{avg}} \sim 3000 \text{ kg m}^{-3}$$

→ not big metallic core

$$g_{\text{moon}} = GM/R^2 = 1.6 \text{ m/s}^2 \simeq 1/6 g_{\text{earth}}$$

The Moon: Surface Features

★ **highlands**: lighter in color, heavily cratered

www: Apollo 17 in highlands (mountains made by impacts)

★ **maria** – “seas” (singular: mare): dark plains

www: Mare Imbrium large scale

www: maria/highlands comparison

smooth: fewer craters, made of volcanic rock Q: *how do we know?*

formed by lava flows

★ craters

cover surface

occur in all sizes, > 20km to microscopic

↳ www: Mare Oriental

www: maria--overlapping craters

Right After the One Small Step

(Garbled) the surface is fine and powdery. I can kick it up loosely with my toe. It does adhere in fine layers, like powdered charcoal, to the sole and sides of my boots. I only go in a small fraction of an inch, maybe an eighth of an inch, but I can see the footprints of my boots and the treads in the fine, sandy particles.

Niel A. Armstrong

July 20 1969

Mare Tranquillitatis—Sea of Tranquility

★ “soil” **regolith** = “rock blanket”

www: footprint

www: Real Audio Armstrong--start at 3:35

dust, rock fragments

accumulated debris from many impacts

★ other tips for tourists:

- no atmosphere → no UV, X-ray protection

- slow rotation → long “days”

huge day/night temp diff: 370K vs 125 K

Q: why?

iClicker Poll: Lunar Cratering Patterns

highlands: lighter in color, heavily cratered
maria smooth: significantly fewer craters

Why this difference?

- A** highlands are younger surface than maria
- B** maria are younger surface than highlands
- C** highlands and maria same age,
but maria are “lucky” regions not hit by impacts

Lunar Cratering and Solar System Impact History

highlands: lighter in color, heavily cratered

maria smooth: fewer craters

Why the difference?

- ★ impactor bombardment random but same over all Moon
large regions cannot “hide”
- ★ cratering differences immediately show maria younger!
- ★ combine with lunar rock composition (maria basaltic)
 - maria formed by lava flows due to large impacts
 - younger surface → fewer craters

Implications

- violent impacts common in the past
- fewer impacts after maria formed → bombardment has slowed
- can use cratering counts to deduce impact history
 - ⇒ huge bombardment rate initially

The Moon: Origin

Earth & Moon similar in composition of crust, different in core

- Fission model (“sparated at birth”) :
moon spun out from rapidly rotating earth

- Binary (“Sister”) model
earth and moon formed together as binary system

- Capture model
“vagabond” moon gravitationally captured by earth

- giant impact model
Moon created in collision of Mars-sized object with early Earth

o

Q: pros, cons of each?

- Fission model (“sparated at birth”) :
unlikely: ang mom problem—Earth wouldn’t rotate fast enough
- Binary (“Sister”) model
unlikely: where do differences come from?
- Capture model
unlikely: where do similarities come from?
- giant impact model
“least unlikely”—accounts for both differences and similarities
→ eary solar system a violent place!

Moon Wrapup

www: image comparison

Q: *compare/contrast?*

Venus

Properties

M, R, ρ_{avg} Earth-like, “sister planet”
→ probably very Earth-like initially
now: hellish!

atmosphere: thick

mostly CO_2 ; clouds of concentrated sulfuric acid
surface pressure $P_0 = 90\text{atm} = 90\times$ Earth

surface $T = 750\text{K} = 380\text{ C} = 800\text{ F}$; melts lead!

www: Venera 9 & 10 comparison

www: Venera 13 image

↳ landers lasted for $\sim 1 - 2$ hr, then got cooked
found: flat rocks, basaltic soil → volcanic activity

other evidence for “geo”logical activity on Venus:

www: Guinevere plains---stretching forces from mantle

www: Venus craters

crater counts similar to Earth—a few 100 Myr old

but no plates! Has to be resurfaced some other way, perhaps active volcanism?

www: radar map: volcano lava flows?

Note: $T_{\text{surface}} \gg T(a_{\text{Venus}}) \approx 230 \text{ K}$ from our master equation

→ i.e., much hotter than expected equilibrium avg

Q: Why so hot?