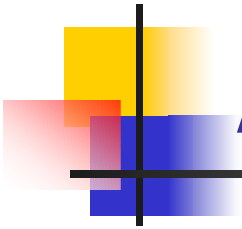
Clockwork in the Heavans (Part II)

Jan. 14, 2004

The Cowboy Astronomer (Planetarium)

1) Review
2) The Moon Revolves Around the Earth
3) Eclipses
4) Summary



Announcements

- The first extra credit question is available on Blackboard
  - Due: Friday Jan. 16 at 5pm
  - Follow the instructions to receive credit!
- Optional homework questions are now available on Blackboard
  - Answers will be posted after some time
- Shortly you will be assigned a PRS number (1-150)
  - check Blackboard
  - know your number before Wednesday's class

Review

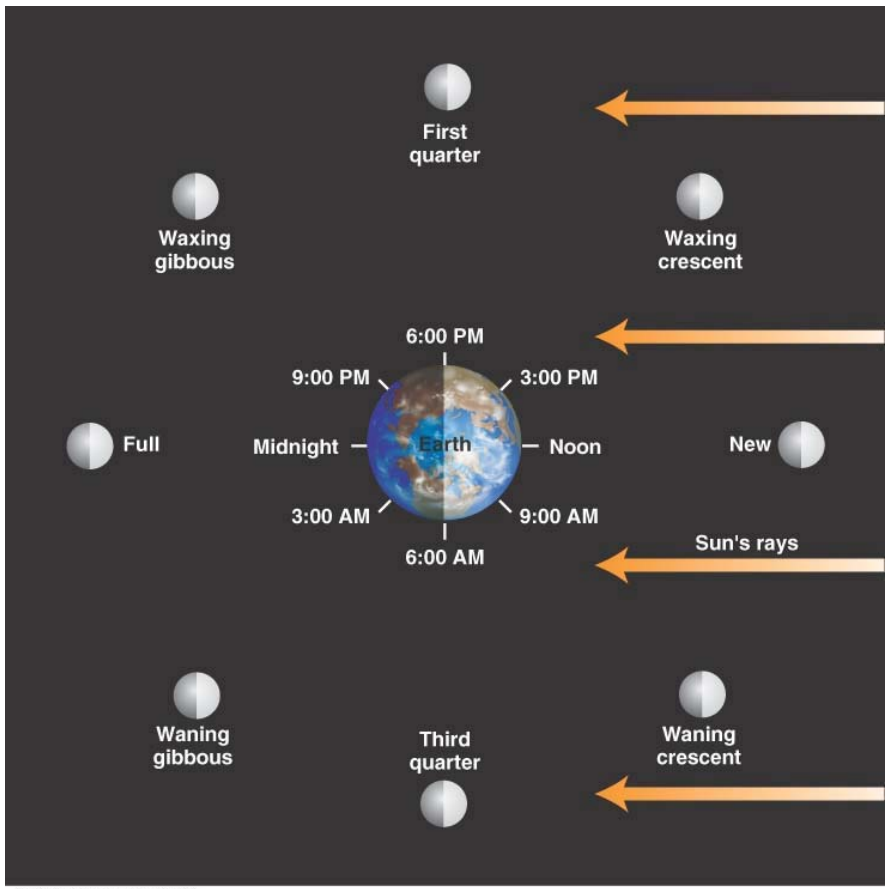
- There is lots of motion in the Universe
- The Earth spins around its axis once per day
  - north & south celestial poles, horizon
- The Earth revolves around the Sun once per year
- The Earth is tilted 23.5° on its axis
- Seasons are caused by the Earth's tilt and revolving around the Sun

Length of the Year

- It takes the Earth 365.242199 days to go from one vernal equinox to the next
  - NOT an integer number
  - But the extra is close to $\frac{1}{4}$ = 0.25
- So every 4 years (leap year) we add an extra day to the calendar (Feb. 29)
  - But this is too much (we've added 0.25!)
- So every 100 years (on the century) we don't add the extra day (no leap year)
- But this isn't right either, so every 4th 100 years, we do include the leap year
- This is why 2000 was a leap year

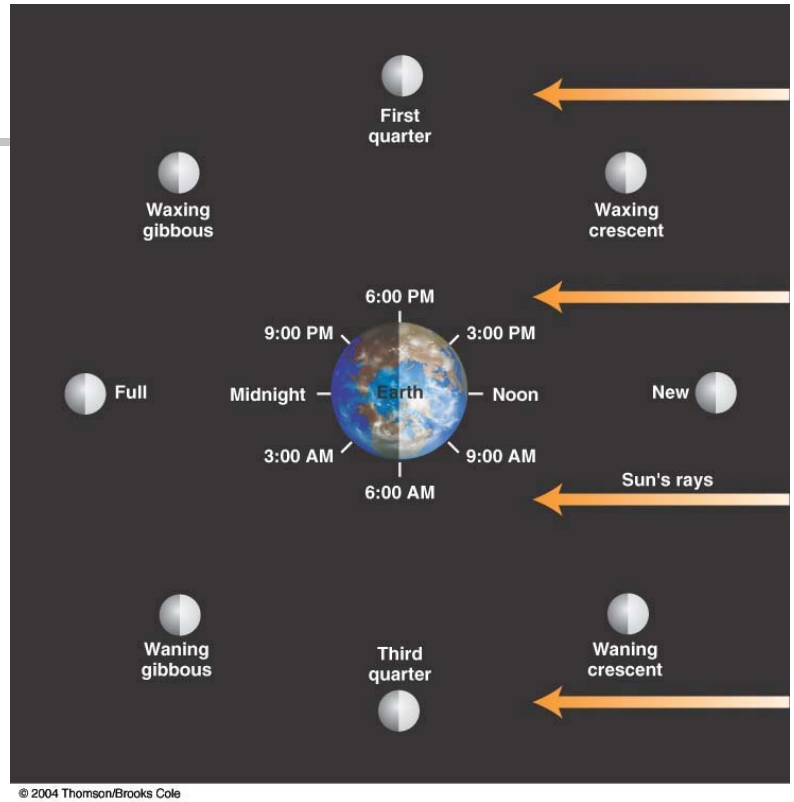
Moon Revolves Around the Earth

- **The Moon revolves around the Earth every 29½ days**



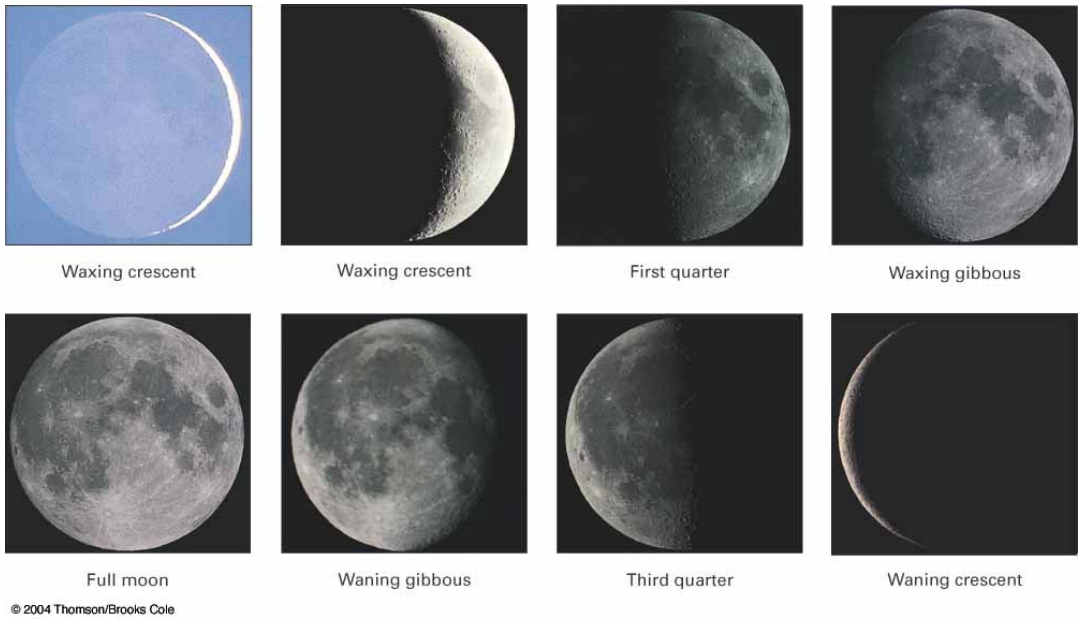
- Moon rises later and later as the month goes on
  - 50 minutes later each day
- The relative position of the Earth, Moon and Sun determine the phase of the Moon

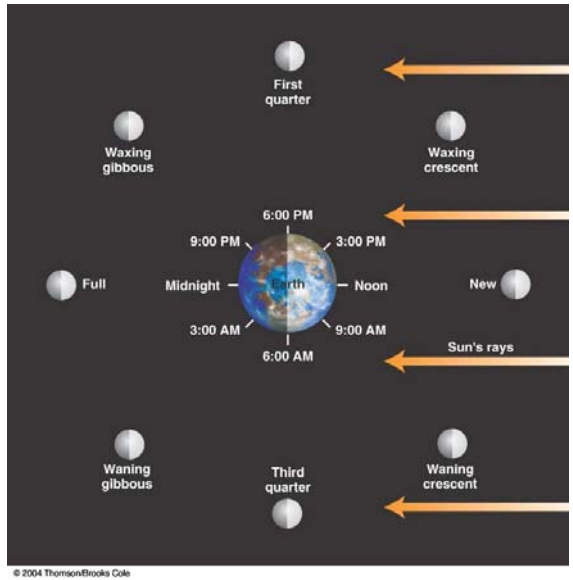
Lunar Phases



- Sunlight illuminates half of the Moon
  - it's a ball and the Sun is shining on it from one direction
- This causes the "phases" of the Moon
  - Waxing Moon – increasing from day to day
  - Waning Moon – decreasing from day to day

Lunar Phases (cont)





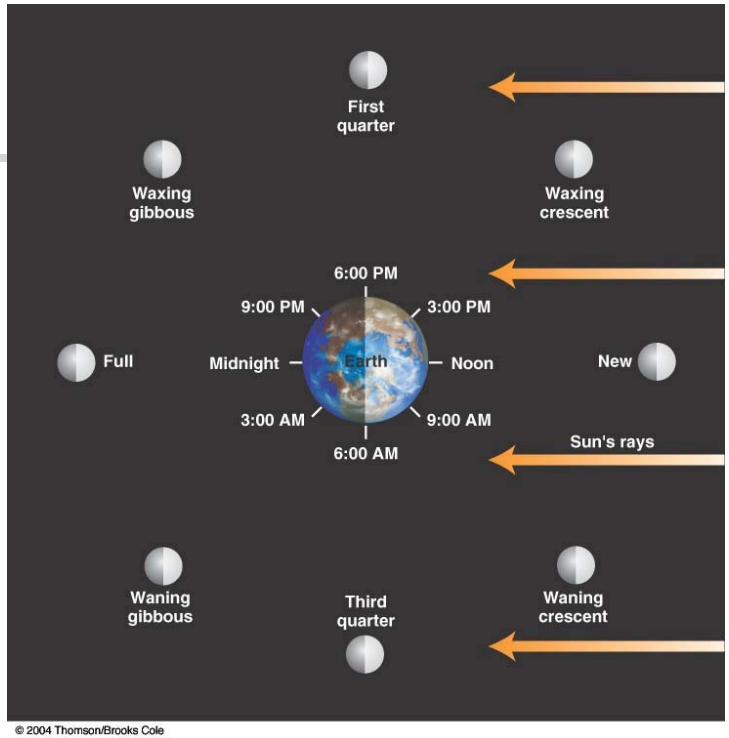
- New Moon
  - The Moon is on the same part of the sky as the Sun and rises and sets with the Sun
- Full Moon
  - The Moon is in the opposite side of the sky as the Sun and rises when the Sun sets and sets when the Sun rises

Moonrise/Moonset

The time the Moon rises and sets is correlated to its phase

Phase of the Moon	Rise	Zenith	Set
New Moon	6 am	Noon	6 pm
Waxing Half Moon	Noon	6 pm	Midnight
Full Moon	6 pm	Midnight	6 am
Waning Half Moon	Midnight	6 am	Noon
New Moon	6 am	Noon	6 pm

Moon Rotates



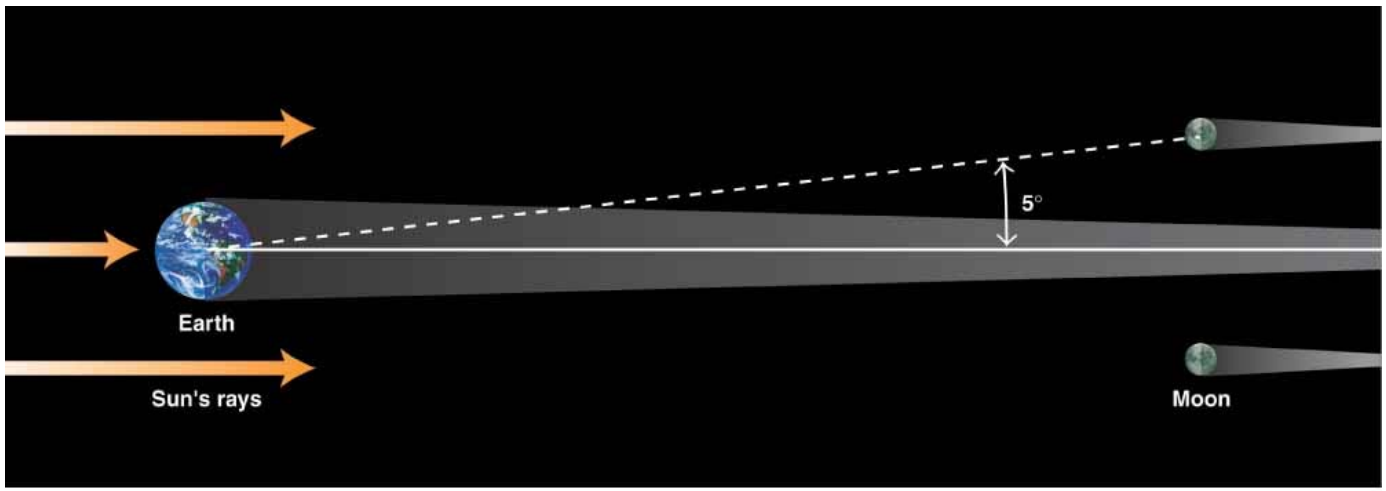
- The Moon spins with the same period that it revolves around the Earth (once every 29½ days)
- This means the same side of the Moon always faces the Earth
- A day on the Moon (sunrise to sunrise) is 29½ days long

"Dark Side" of the Moon

- The Moon doesn't have a "dark side"
  - Everywhere on the Moon, the Sun rises and sets once per month
- It has a side which faces away from us
  - During a New Moon, the far side is completely illuminated

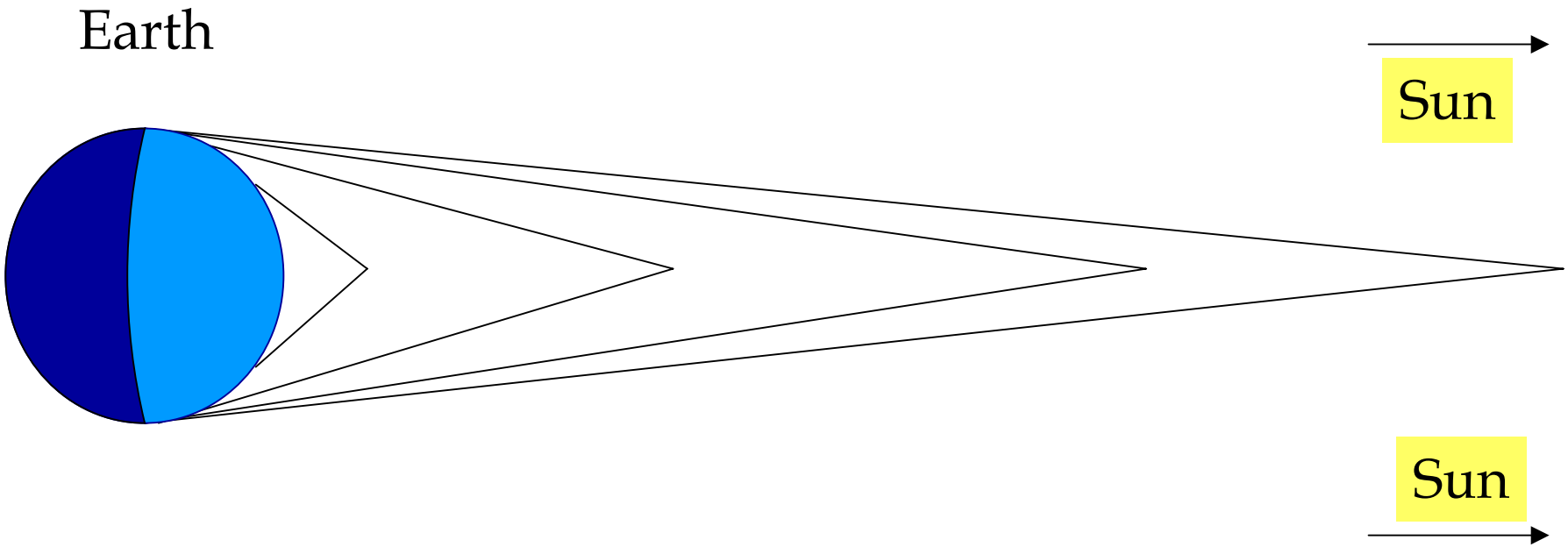
Eclipses

- Eclipses occur when the Sun, the Earth and the Moon all lie along a straight line
  - They must line up in all 3 dimensions + time
  - the Moon's orbit is tilted 5^{o} with respect to the ecliptic, so there are only two times a year when the paths overlap



Light Rays from Afar

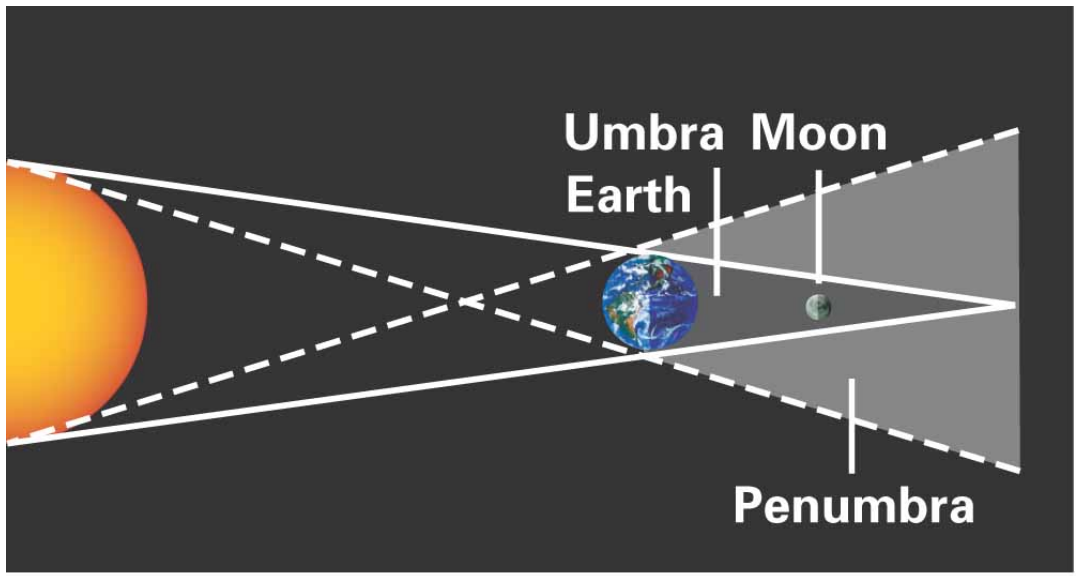
- The farther away a light source is, the more parallel the rays are
  - The Sun is so far away, the light rays hitting opposite sides of the Earth are almost parallel (about 10^{-6} degrees)
  - Stars are even farther away



Shadows

Informational only

- Umbra
  - dark cone of complete shadow
- Penumbra
  - lighter area of partial shadow



Lunar eclipse