Astronomy 110
Lecture 4
Does the orientation of Earth’s axis change with time?

• Although the axis seems fixed on human time scales, it actually precesses over about 26,000 years.
  ⇒ Polaris won’t always be the North Star.
  ⇒ Positions of equinoxes shift around orbit; e.g., spring equinox, once in *Aries*, is now in *Pisces*!
The Moon

Far Side

Near Side
The Moon’s Orbit: Does it spin?
The Moon’s Orbit: Tilt of the Orbital Plane
The Moon’s Orbit: Precession of the Orbital Plane
Why Does the Moon Show Phases?

- Half the Moon is always illuminated by the Sun and half is always dark.
- As the Moon orbits the Earth we see the bright half from different perspectives.
Phases of the Moon: 29.5-day cycle

- new
- crescent waxing
  - Moon visible in afternoon/evening.
  - Gets “fuller” and rises later each day.
- first quarter waxing
- gibbous waxing
- full waxing
- gibbous waning
- last quarter waning
- crescent waning
  - Moon visible in late night/morning.
  - Gets “less” and sets later each day.
The Moon’s Phase is Related to When We See It
What Causes Eclipses?

Partly an Accident!

Partly simple geometry!

The Earth and Moon each cast shadows. When either passes through the other’s shadow, we have an eclipse.
When can Lunar eclipses occur?

- **Lunar eclipses** can occur only at *full moon*.
- Lunar eclipses can be *penumbral*, *partial*, or *total*.

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**Penumbral Lunar Eclipse**
Moon passes through penumbra.

**Partial Lunar Eclipse**
Part of the Moon passes through umbra.

**Total Lunar Eclipse**
Moon passes entirely through umbra.
When can Solar eclipses occur?

- **Solar eclipses** can occur only at *new moon*.
- Solar eclipses can be **partial**, **total**, or **annular**.
Why don’t we have an eclipse at every new moon and full moon?

Because the Moon’s orbit is tilted 5° to ecliptic plane therefore:

1. We must have a full moon (for a lunar eclipse) or a new moon (for a solar eclipse).
   and
2. The Moon must be at or near one of the two points in its orbit where it crosses the ecliptic plane (its nodes). …

So we have about two **eclipse seasons** each year when eclipses are possible.
Eclipse Seasons

The pond surface represents the ecliptic plane (the plane of Earth’s orbit around the Sun).
Predicting Eclipses

• Eclipses recur with the 18 yr, 11 1/3 day **saros cycle**, but type (e.g., partial, total) and location may vary.