**Lecture 11: Precession**

* 1. Generalities
     1. We have heretofore described RA/Dec as a “fixed” system
     2. and described it as tied to the Earth’s longitude and latitude
     3. **to remind you: the Declination corresponds to Latitude**
     4. Declination of a star is equal to the latitude at which it transits through Zenith
     5. RA corresponds to Longitude
     6. **RA equal to Longitude on Vernal Equinox (Mar 21) at Noon UT (Greenwich time)**
     7. **So on vernal equinox RA/Dec of Sun is 0h+00deg**
     8. However.
     9. The earth’s axis of rotation is not fixed: it wobbles!
     10. VIDEO
  2. **Why does the earth’s axis wobble?**
     1. Because the earth has a very slight (1%) bulge along equator
     2. Both Moon and Sun (2/3 Moon 1/3 Sun) tug on the bulge a little
     3. Trying to align the bulge with the ecliptic
     4. But the Earth is spinning, so that doesn’t happen
     5. Instead, the Earth precesses
     6. For physicists: tidal forces exert a torque, which causes the precesion
     7. Very similar to orbits, where objects are accelerated to ground but always “miss”
  3. Wobble is around the Ecliptic axis
     1. Because it is caused mostly by Sun and moon
     2. The Earth’s motion is around the ecliptic axis
     3. Period of this wobble is 26000 years
     4. **How does this affect the solstices and equinoxes?**
     5. Means that the relationship between where Earth is and solstice/equinoxes change
  4. Precession effect on calendar year
     1. We define the months according to the seasons
     2. which are related to the equinoxes
     3. So the “year” as we know it is NOT exactly the time it takes Earth to go around once
     4. it is the time between equinoxes
     5. This is the “calendar year” or the “tropical year”
     6. slightly different than orbital year!!
     7. again, similar to difference between sidereal day and solar day, but a smaller effect
     8. **How would I calculate how much difference it makes to the year?**
     9. About 20 minutes difference per year
  5. RA/Dec precession
     1. However, you'll notice I took the RA/Dec labels off!
     2. We still continue to define the RA/Dec positions according to Earth
     3. That means the RA/Dec positions of stars must be changing!
     4. This is a fairly slow effect, hardly noticeable to a casual observer
     5. Important for astronomers!
     6. To understand this, consider a set of objects at around 18h
     7. In 2000, they transit at midnight on June 20, summer solstice
     8. In detail we call this the RA (2000)
     9. But as Earth precesses that changes
     10. Change something like 0.5 deg since 1975, when Edmund atlas was made
     11. So not incredibly small
     12. In later times, say 21328, we will keep RA/Dec defined according to the Earth so RA (21328) will line up with the equinoxes the way RA (2000) does in 2000
     13. But the locations of the stars in Space won't have changed.
  6. Precession effect on Polaris
     1. Another way of viewing this is situating ourselves on the NP
     2. In 2000, Polaris to zenith, but this changes
  7. Nutation
     1. Basically an extra little wobble on top of precession
  8. Precession effect on astrological signs
     1. Because the calendar year is not exactly the orbital year, where the Sun is relative to the constellations on any given calendar day changes
     2. So your astrological sign is not indicating what constellation the Sun was in on the day you were born.
     3. It indicates what that would have been ~ 2000 years ago.
     4. Not that you should pay attention to your astrological sign anyway.
  9. **How did Hipparcos discover precession??**
     1. Noticed slide of Moon’s eclipses
     2. careful observations + comparison with previous charts
     3. e.g. look at 1377 vs 2010
     4. The location of Moon during a total lunar eclipse says where Sun is (180 deg away from Moon).
     5. If you can relate that to a nearby solstice or equinox, and compare lunar eclipses widely separated in time, you can see that the location of the sun at an equinox (say) must have changed over years.
     6. Hipparcos did this over a baseline of 100-200 years, using old written observations. That's impressive.