Physics 155: Lecture 2

Announcements

Finish going over equatorial coordinate system. Lab 1 will help make these familiar by "dialing in" and identifying stars of known coordinates or finding coord's of named stars. Analogies of declination and right ascension are latitude and longitude on earth, except that longitude is zeroed to England. One more item of interest on celestial sphere is the inclined path of the sun among the stars called the ecliptic, which crosses the equator in the spring at the point called the Vernal Equinox (the origin of right ascension), and again in the fall.

There are 4 "cardinal points" we should know and will be using all semester, with the dates the sun is located there and its coordinates at that time.

<table>
<thead>
<tr>
<th>Date</th>
<th>Name</th>
<th>Right Ascension</th>
<th>Declination</th>
</tr>
</thead>
<tbody>
<tr>
<td>March 21</td>
<td>Vernal Equinox</td>
<td>0 hours</td>
<td>0 degrees</td>
</tr>
<tr>
<td>June 21</td>
<td>Summer Solstice</td>
<td>6</td>
<td>23.5</td>
</tr>
<tr>
<td>Sept. 21</td>
<td>Autumnal Equinox</td>
<td>12</td>
<td>0</td>
</tr>
<tr>
<td>Dec. 21</td>
<td>Winter Solstice</td>
<td>18</td>
<td>-23.5</td>
</tr>
</tbody>
</table>

Setting the star globe:

1. Altitude of NCP equals observer's latitude. Proof. Consequences: at north pole on earth stars move parallel to horizon and none rise and set. The sun is above horizon for half the year (midnight sun) and invisible 6 months.

   at equator the sky rolls like a barrel, with NCP on N horizon and SCP on S horizon. All stars rise and set and are visible some time of year. Sun always transits + 23.5 of zenith. No circumpolar stars.

   at Storrs the NCP is 42 degrees above north so we have 3 classes of stars:
   - circumpolar north, always visible, located within angle = observer's latitude of NCP, never set
   - circumpolar south, never visible, located within angle = observer's latitude of SCP, never rise

   rising and setting stars seen some time during the year when the sun is out of the way

Example: can we see the star Canopus here at Storrs, lat=42°N, where for this star R.A. = 6h 23m, Decl= -53°? (Probably not since you've never heard of Canopus and its Decl. seems really far south...)

Ans. Ignore R.A. since if you can see it, it will rise sometime.
This star lies at an angle of $90 - 53 = 37^\circ$ to SCP, but in Storrs the SCP is depressed $-42^\circ$, hence Canopus never rises.

Aside: note that on the star globe the constellations are "backwards" since we are looking from the "outside" and should in fact have our heads inside the globe to see them correctly.

2. To set the R.A. correctly on the globe we have 3 methods:
   a) put a known star on the meridian at a known time, then
      advance (or reverse) globe the correct number of hours for
      whatever time is requested, moving the globe 1 hour circle
      (equals 15°) for each hour of time.
   b) same as a) but use the sun, which moves along the ecliptic
      -- its noon position is marked for the first and middle
      of each month. E.g. putting the Sept.1 sun position on the
      meridian sets the globe for noon, Sept.1.

Note Storrs is east of center of EST time zone (Philadelphia) so
horizon events happen earlier here by 11 minutes (sunrise,
transit, sunset, etc.).

c) use Sidereal Time (if you have a Sidereal Clock).

Sidereal Time has 3 equivalent definitions and can be thought of
as a giant celestial clock, keeping track of where the Vernal
Equinox is located relative to the meridian.

   S.T. = hour angle of the Vernal Equinox
   = time since the V.E. transited
   = R.A. of whatever is then transiting

Another example of the use of Sidereal Time:
What is the Sidereal Time at noon, Sept. 21?
Ans. What transits at noon (the sun), and what is the R.A. of
the sun on Sept. 21 (12 hours)? hence ans. is 12 hours.

We now have the basis of simple celestial navigation:
1) your latitude can be found by the altitude of NCP (or other
   known star plus a calculation, e.g. a star on the equator
   will transit at an angle equal to your co-latitude).
2) your longitude may be found by timing a known horizon event
   such as sunrise, and consulting a table for e.g. the center
   of your time zone. For example in Storrs, the sun rises 11
   minutes before the table for EST says it rises in Phila.
   Therefore you know Storrs is located east of Phila by 11/60
   of 15° or at longitude 72° (where Phila. is at 75° W).