INTRODUCTION TO CELESTIAL MOTIONS

(Duration: 1.5 - 2 hrs)

Summary of Presentation

REVIEW

NORTH CIRCUMPOLAR SKY

- alt-azimuth coordinate system
- coordinate system referenced to horizon
- used quite naturally for pointing out objects in the sky

CONSTELLATIONS

AUTUMN SKY

- Equatorial coordinate system
  - fixed with respect to the background stars for a given epoch (precession affects)
  - tilted by colatitude wrt horizon (angle of rising & setting of celestial objects)
  - can determine how long a celestial body is visible in the sky

Abstract Spherical Coordinate Systems

- fundamental reference great circle provides a zero
  - small circles - give angular distance above or below fundamental reference circle
    - vanish at poles
  - great circles - give angular distance around fundamental reference circle
    - meet at poles
    - establish arbitrary zero

CONSTELLATIONS

MOTION OF THE SUN

- daily motion of sun
- annual motion of the sun along the ecliptic
  - projection of earth’s orbit on the sky
  - daily angular rate ~1°/day

Ecliptic Coordinate system

- natural coordinate system to use for solar system bodies
- ecliptic provides fundamental reference circle
  - small circles of ecliptic latitude
  - great circles of ecliptic longitude
- inclination to equatorial system by earth’s axial tilt 23 1/2°
- Equinoxes & Solstices
  - declinations of the sun
  - Seasons
  - sidereal time
  - earlier rising & setting of stars wrt sun with changing seasons
MOTION OF THE MOON

- visible surface of the moon > 50%
  - rotation & revolution rates
- librations
  - elliptical orbit about the earth
  - moon’s axial tilt
- phases
  - waxing - western side of moon
    - can see all waxing phases at sunset
  - waning - eastern side of moon
    - can see all waning phases at sunrise
  - crescent, quarters & gibbous
- geometry of the phases
  - angle between sun, earth & moon
    - crescent < 90°
    - quarter = 90°
    - gibbous > 90°
- telling time by the moon
  - where is the sun?
- sidereal month - true period of revolution of moon about the earth
- synodic period - period of phases ~30 days
- inclination of moon’s orbit
  - ascending & descending nodes
- eclipses

ASPECTS OF THE PLANETS

- inferior planets - orbits interior to the earth’s
  - elongations
    - morning & evening stars
    - maximum eastern/western elongation
      - Venus ~45°
      - Mercury ~30°
  - inferior/superior conjunction
  - prograde & retrograde motions
- superior planets - orbits exterior to the earth’s
  - superior conjunction
  - opposition
  - quadratures

INTRODUCTION TO STELLARIUM: ADVANCED USAGE

- Show Planetary Aspects
- Centre on Object
- Toggle Off Atmosphere (use A)
- Toggle Off Ground (use G)
- Track (use shift T & T)
APPENDIX:

Celestial Sphere Diagrams

<table>
<thead>
<tr>
<th>Coordinate System Name</th>
<th>Fundamental Reference Circle</th>
<th>Zero Point</th>
<th>Great Circles (around, through pole)</th>
<th>Small Circles (parallel, above and below equator)</th>
<th>Poles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alt-Azimuth</td>
<td>Horizon</td>
<td>North</td>
<td>Azimuth N-E-S-W-N 0-360°</td>
<td>Altitude ±90°</td>
<td>Zenith &amp; Nadir</td>
</tr>
<tr>
<td>Equatorial</td>
<td>Celestial Equator</td>
<td>Vernal Equinox</td>
<td>Right Ascension (RA, α) W to E 0-24h</td>
<td>Declination (Dec, δ) ±90°</td>
<td>North &amp; South Celestial Poles (NCP &amp; SCP)</td>
</tr>
<tr>
<td>Ecliptic</td>
<td>Ecliptic</td>
<td>Vernal Equinox</td>
<td>Ecliptic Longitude W to E 0-360°</td>
<td>Ecliptic Latitude ±90°</td>
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</tr>
</tbody>
</table>

Above: celestial sphere diagrams in the equatorial (left) and ecliptic (right) coordinate systems. Both diagrams are for sunrise on the day of the Vernal Equinox (March 21 or 22 of a given year).