Lockhart Planetarium Session No. 3

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

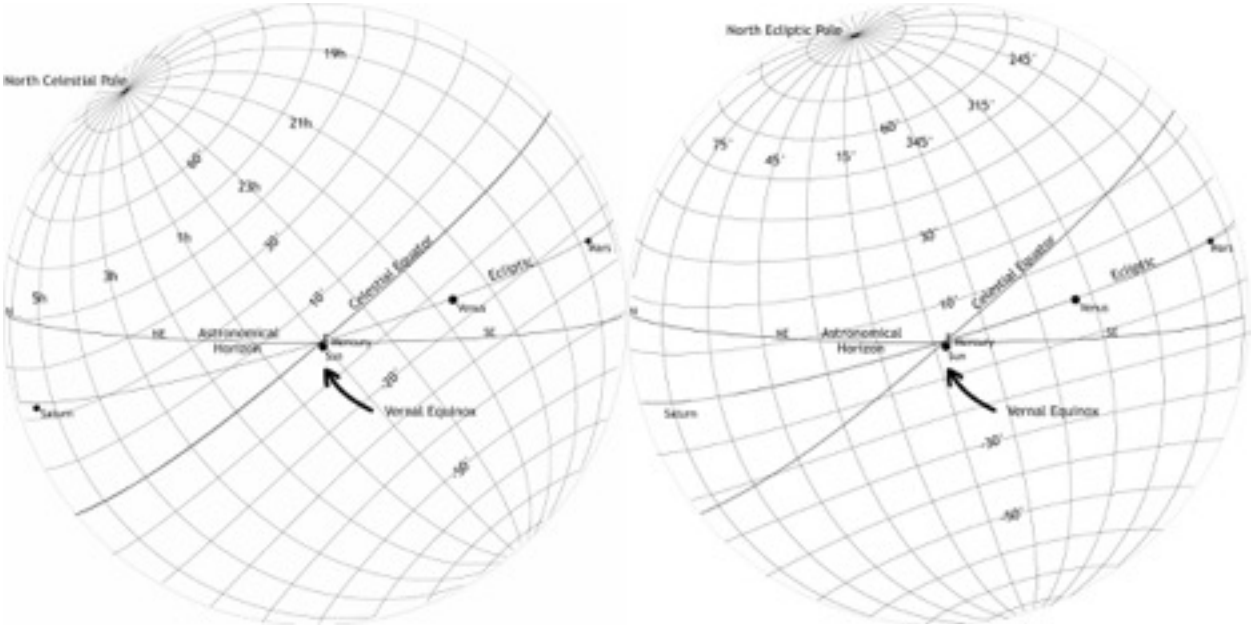
Introduction to Stellarium: Advanced Usage

- 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

Equatorial Coordinate System **Ecliptic Coordinate System**



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

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).