

Review: Quiz 1 Concepts

Celestial sphere: The apparent sky. So distant that earthly distances are insignificant.

Frame of reference: the point of view. In astronomy, all frames of reference are moving. The stars and planets move in the horizon frame, the planets move in the frame defined by the stars, the pole of the stellar frame moves about a degree per century, etc.

Coordinates: The distances and directions we use for locations. Many frames of reference use two coordinates. e.g. latitude & longitude.

Angular measure: In astronomy our subjects are unreachable. We often measure that which we can see, angles. The apex is our eye, and the apparent separation is an angle. For a physical object the angular size depends on both physical size and distance. e.g. The apparent diameter of the moon is about 1/2 degree. The sun is about the same - much larger physically, and much farther, but similar apparent size. Sometimes there is no meaningful physical dimension, just an angular separation. Example: two unrelated stars have a measurable angular separation, but that doesn't translate to a physical separation or distance.

Angular speed: The rate of change in apparent position. Depends on speed, distance, and frame of reference. The sun moves 360 degrees/day toward west in the horizon frame, and 1 degree per day, toward east, in the star frame. The stars move 361 degrees per day (west) in the horizon frame.

Important circles:

There are four circles that divide the celestial sphere in half. We use them in our frames of reference.

Horizon: The horizontal circle. Divides the celestial sphere into up (visible), and down (hidden).

Meridian: The vertical circle that touches the poles. Divides east & west. Various kinds of days begin and end with the sun on the meridian.

Celestial equator: Divides north & south. It is always over the earth's equator. Is 90 degrees from each pole. Touches the horizon exactly E. & W.

Ecliptic: Projection of earth's orbit. It is the apparent path of the annual motion of the sun. It is nearly parallel to the paths of other planets. It is tilted 23 degrees to the equator.

Days:

Begin and end with an object crossing the meridian.

Sidereal day-any star will do as the object. Measures the rotation of earth.

Solar day-sun is the object. Both orbit and rotation are involved.

Months:

Moon is the object.

Synodic (ordinary) month: Begins and ends with conjunction (new moon).

Sidereal month: Begins and ends at a star. Measures lunar orbit period.

Planetary cycles:

Synodic: Begins and ends with conjunction. Includes retrograde motion—see below.

Sidereal: Begins and ends at a star. Measures planetary orbit period.

Sidereal year: Begins & ends with sun-star conjunction. Measures earth orbit period.

Tropical (ordinary) year: Begins & ends with the sun at **spring equinox**. Measures the seasons.

Directions:

Direct: The direction the celestial sphere appears to move. Generally it is west for visible stars, but not for stars near to and below the pole. ...Definition—
- Counterclockwise looking north (clockwise looking south)

Prograde: East along or near the ecliptic. Also, east in the orbital sense.

Retrograde: West along or near the ecliptic

Sidereal: pertaining to the stars. **Sidereal day:** Period for a star (not the sun) to go full circle starting from the meridian. (It is about 23 hr 56 min)

Solar: pertaining to the sun. The solar day is 24 hours.

Location:

Horizon system: Azimuth: Angle along the horizon E. of North. **Altitude:** Angle up from the horizon.

Earth: Longitude (angle E. or W. of Greenwich.) **Latitude:** angle N. or S. of earth equator. **Definition:** latitude = altitude of the pole.

Equatorial system: **Right ascension:** angle E of a reference point on the celestial sphere. Given in time units. (24 hours = 360 degrees). **Declination:** Angle N. of the celestial equator. (Southern declinations are negative.)

Sun-planet relationships:

Superior planets orbit outside the earth's orbit. **Inferior** planets (Mercury & Venus) orbit inside.

Elongation (of a planet): angle along the ecliptic from sun to planet.

Conjunction of two planets: Elongations are equal. One planet "in conjunction" means the planet is in conjunction with the sun, so its elongation = 0 degrees.

Opposition: Elongation = 180 degrees.

Greatest elongation: Only applies to inferior planets. It is about 47 degrees for Venus, 28 degrees for Mercury.

Lunar phase: A visible shape, caused entirely by the elongation of the moon.

Eclipse: Hiding of the sun or dimming of the moon, which can only happen at lunar conjunction or opposition.

Seasons: Caused by the changing declination of the sun.

Cardinal points: (N E S W) Intersections of the horizon with the meridian or equator.

Named star groups:

Constellation: defined star region. e.g. Ursa Major

Asterism: A recognized star pattern e.g. Big Dipper, within Ursa Major.

Zodiac: constellations along the ecliptic

Precession: Motion of the pole, which moves in a circle, 66.5 degrees from the ecliptic, period 26 thousand years. Preserves the 23 degree tilt of the axis.

Shady definitions:

Umbra: the part of a shadow where the sun can't reach.

Penumbra: the fuzzy border of a shadow, where the sun is partly blocked.

Planets:

Planet: Classically "Wanderer" Planets move through the zodiac, prograde and retrograde, in predictable patterns.

Classical planets: Sun, Moon, Mercury, Venus, Mars, Jupiter, Saturn.

(Compare with the modern Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and maybe Pluto.)

Day names: allowing Tiw (an Anglo-Saxon god of war) to replace Mars, Anglo-Saxon Woden for Roman Mercury (Both carried off the dead.), Norse Thor for Roman Jupiter (Both were big, scary gods), Norse Freya for the Roman Venus: Sun day, Moon day, Tiw's day, Woden's day, Thor's day, Freya day, Saturn day.

The Sun and Seasons:

Obliquity of the ecliptic: The scientific name of the angle between the equator and the ecliptic---the path of the sun. It is 23.5 degrees.

Equinox: The sun crosses the equator twice each year. Both the dates and the intersections are called equinoxes. Since two great circles always cut one another in two, several things have to be true. a. The equator of course cuts the horizon into north and south, so the intersections mark E. and W. exactly. The sun rises due east and sets due west on the equinox dates. b. The horizon cuts the ecliptic into equal parts, so when the sun is on the ecliptic it is up for exactly 12 hours.

Solar declinations & solstices: The 23.5 degrees shows up as the extremes of declination of the sun. It is 23.5 degrees north of the equator at summer solstice, June 21, & 23.5 degrees south of the equator on winter solstice, Dec 21.

Christmas cheer: When the winter sun was returning to the north, the ancient world had pagan ceremonies all over Europe -- Saturnalia, Yule, & other feasts -- a few days after Dec. 21. Christianity didn't celebrate the sun as a god, but they did decide to celebrate Christmas at the same time - an inspired political move. Later, a fundamentalist group, the puritans, hated the pagan aspects of Christmas-Yule logs, mistletoe, singing, feasting, and drinking, so they banned Christmas while in power in England-an uninspired political move. Their approval ratings went way down, and the Puritans only held power for about 20 years.

Solar declination and seasons: (Examples)

Buffalo seasons: The equator is 47 degree above the Buffalo southern horizon. The altitude of the sun is: winter solstice 23.5 degrees; equinox 47 degrees; summer solstice 70.5 degrees. In summer a square meter of sunlight warms just over a square meter of ground. In winter it is spread over nearly 3 square meters of ground, giving much less heat. The arc from the winter solstice rising to setting points is 8 hrs, 12 hrs at equinox (everywhere), and 16 hrs at summer solstice.

Tropical seasons: At Havana, about 20 degrees N, altitude ranges from about 42 degrees at noon at winter solstice (like spring here) to nearly overhead in summer. Day length ranges from 11 to 13 hours.

Near arctic seasons: (Anchorage) Winter solstice - Day is 4.5 hrs long. So what? The sun is only 5 degrees above the horizon at noon. Summer solstice - day length 19.5 hours, but sun only rises to 50 degrees at noon.

Lunar language: The changing elongation of the moon results in a moth of phases, a synodic month. A synod is a meeting, as I learned long ago in church history. The "meetings" that begin and end the month are conjunctions of moon and sun. We don't see the moon then, at new moon. The language of phases includes:

Shape: crescent, gibbous, full

Elongation angle: new, 1st, full & 3rd quarter moons have elongations 0, 1/4 1/2 3/4 circle.

Change: waxing moon-increasing elongation-becoming full; waning is opposite.

Conversation starters and pickup lines: *

"The obliquity of the ecliptic is 23.5 degrees. That it why we have seasons."

"Synodic cycles begin and end with conjunctions with the sun."

"A sidereal period uses the stars as a frame of reference. They measure orbits and rotations".

"Synodic cycles use the sun as a reference frame. Our orbit is involved with what we see."

"Angular' size and speed just mean 'apparent'".

"Actually, the Pleiades is an asterism, not a constellation".

"Most things depend on the frame of reference. The few that don't are laws of physics."

The precession of the poles was discovered by Hipparchus, but not the pattern."

The daily motion of the sun is neither prograde nor retrograde. It is direct."

The tropical year is 20 minutes longer than the orbital (sidereal) year."

"No two orbits are exactly in the same plane, that's why conjunctions don't always cause eclipses."

"I've decided to figure out what celestial phenomena depend on our location."

"Proper motion has the stars as the frame of reference. It is tricky, because even nearby stars have a tiny proper motion of their own."

"I like small numbers, so I use big units. The light-year is my favorite."

"I hold with the heliocentric theory. How about yourself?"

***Before trying any of these lines, I took the precaution of marrying the lady.**