Rotating celestial sphere

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For brevity, we write celestial sphere (without capitalization) to distinguish it from the Celestial Sphere (with capitalization), as a known astronomical concept. We shall however add the adjective "rotating" whenever the rotation of the celestial sphere needs to be emphasized.

The Celestial Sphere is an "imaginary" sphere, concentric with the Earth, upon which the Stars are centrally "projected".

The rotating celestial sphere is a portable (small) model of the Celestial Sphere. The Stars as observed on the (large) Celestial Sphere are further projected to stars on the (small) rotating celestial sphere, where the center of projection coincides with the center of the (portable) rotating celestial sphere. The rotating celestial sphere does not only locate the Stars (including the Sun), via determining their projections as the corresponding stars (including the sun), whenever and wherever (on Earth) you are, but also determines your observed (ever changing) Horizon.

Description

The celestial sphere is a transparent "perfect" sphere, (exactly) half-filled with "water".[1] The (directed) axis about which it rotates passes from its north to south pole. For brevity, we refer to this axis as "the axis". Do keep in mind that the direction of the axis is actually opposite to the direction of the Earth' (spinning) axis. However, the axis of the celestial sphere is aligned in antiparallel to the axis of the Earth, so, in particular, the north pole of the celestial sphere points towards the North Pole of the Celestial Sphere. Then as the celestial sphere rotates uniformly completing a full revolution in a sidereal day (that is, in a 1461/1465 fraction of a solar day) a projection of any particular Star to a star remains fixed on the celestial sphere. Two fixed (with respect to the celestial sphere) great circles are the equator, which plane is orthogonal to the axis, and the ecliptic, which plane is orthogonal to the straight line passing through the south and north pole of the ecliptic (being projections of the South and North Pole of the Ecliptic). Unlike the other stars, which are fixed on the celestial sphere, the sun moves (uniformly) on the ecliptic completing a full revolution in 1461/4 solar days. Here, the direction of the sun's rotation axis agrees with (Earth') orbital axis. A third great circle on the rotating celestial sphere, to which we might refer as the horizon, is determined by the water level. It corresponds to the ever changing observable Horizon of Celestial Sphere.

[1] Takayuki Ohira (creator and president of Ohira Tech) suggests replacing water with glycerol, which refractive index is quite close to that for borosilicate glass (pyrex).

Assumptions

1. The Stars are fixed with respect to an "absolute" reference frame, which we shall refer to as "the absolute space". All Stars except the Sun are infinitely far with respect to dimensions of Earth' orbit (around the Sun). Respectively, the stars (except the sun) are fixed on the celestial sphere.

2. The (Earth's) orbital plane is fixed in the absolute space. Respectively, the ecliptic is fixed on the celestial sphere.

3. The Earth's angular velocity (pseudo) vector is fixed. In particular, the precession of Earth's axis about the North Pole of the Ecliptic (leading to a discrepancy between the tropical and sidereal year) is ignored. The length of the year is assumed to be 1461/4 solar days = 1465/4 sidereal days.

4. The eccentricity of Earth's orbit is assumed to be vanishingly small. Respectively, the length of every season coincides with the quarter length of the year. We must confess however that an eccentricity as small as 0.017 has nevertheless a noticeable impact on the discrepancy of the lengths of the four seasons. The impact of the eccentricity on the lengths of the seasons might be taken into account via an elementary formula.

Alignment of the axis in general and special cases

As earlier said, the axis (of the celestial sphere) is aligned in antiparallel to Earth's (spinning) axis, so the axis would also antiparallel the axis of a telescope pointing towards the North Pole of Celestial Sphere, the upper most point of the celestial sphere must possess a latitude matching the geographical Latitude of your location (on Earth). Further note that the latitude on the celestial sphere is not altered by elevations of your geographical Latitude. Therefore, aligning the axis of the celestial sphere does not necessarily require a telescope. The celestial sphere might be rotated so as its upper most point possesses a latitude matching the (geographical) Latitude of your location. The alignment is done if your location happened to coincide with either the South or the North Pole. Otherwise, in the general case, you have to further rotate the celestial sphere, while maintaining its upper most point in its position, until the north pole is directed Northwards. Thus knowing your Latitude and the North direction suffice.

Key observations

Throughout the year the sun is confined to move between two extremal latitudes: the southern and the northern tropic, We might refer to the sun reaching its extremal latitude as solstice to signify the astronomical concept Solstice. Passing the equator signifies an Equinox. If we add to the assumptions stipulated above that the Sun is infinitely far and its angular diameter is negligibly small, rather than half a degree, then generally the length of the night (strictly) at the moment of Equinox is (exactly) 12 hours (that is, half the length of a solar day). The adverb "generally" cannot be omitted since the length of the night is zero at one of Poles and 24 hours at the other. In other words, the Equinox signifies the onset of a polar day at one Pole and the (simultaneous) onset of a polar night at the other.

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