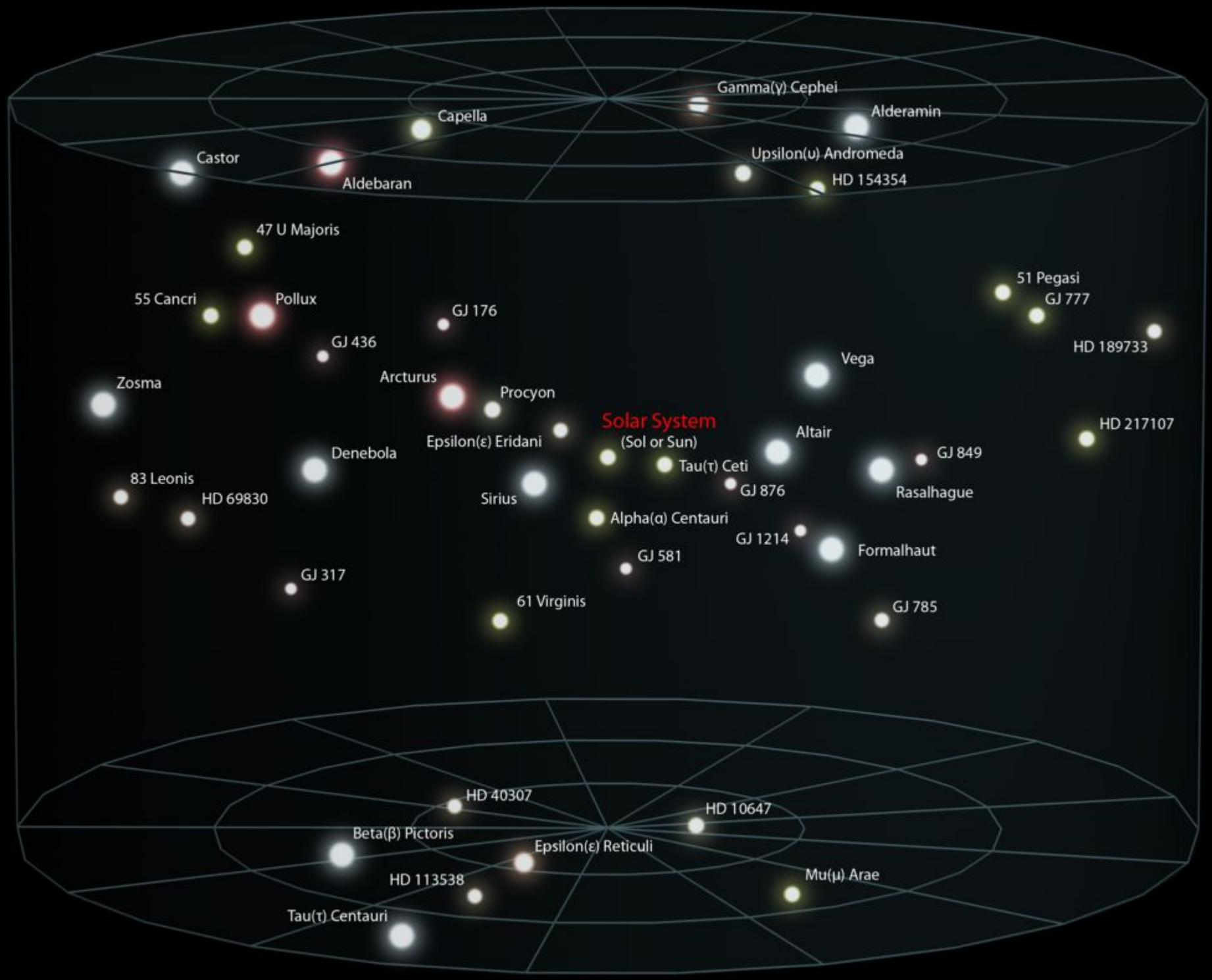
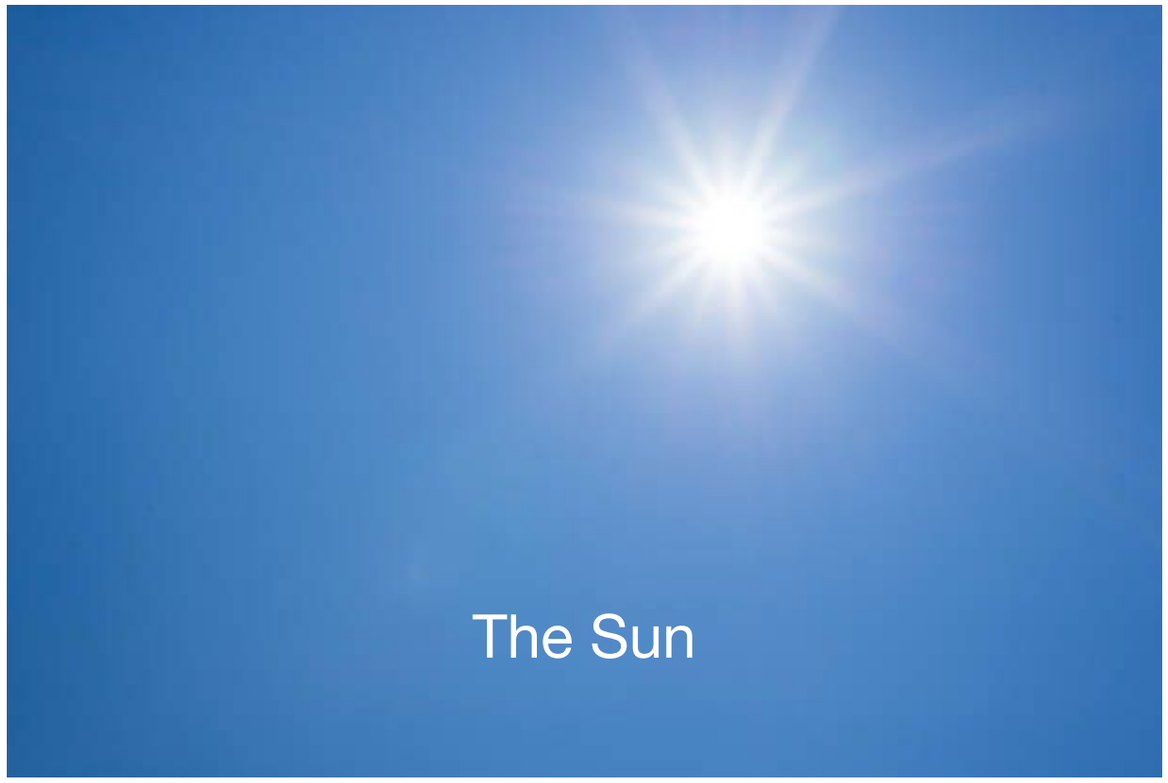
PHYS201 - Introductory Astronomy
A user's guide to the sky

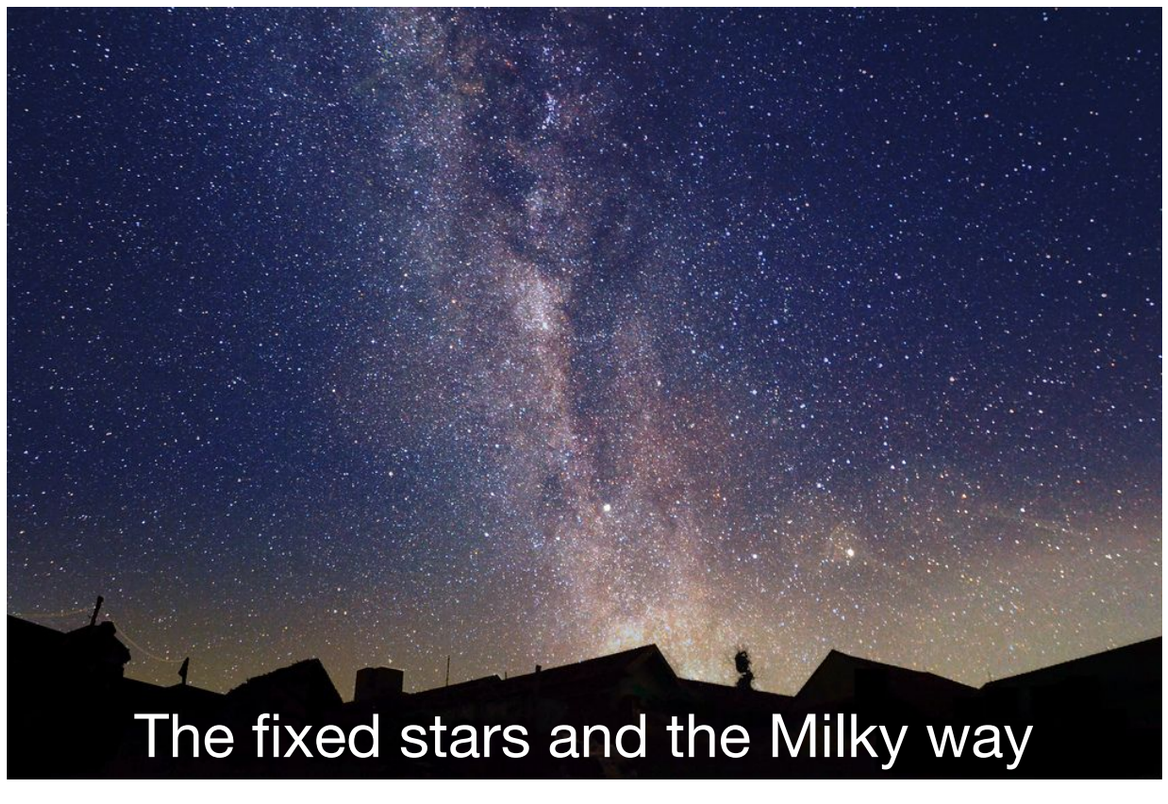
How many stars can you count at night?

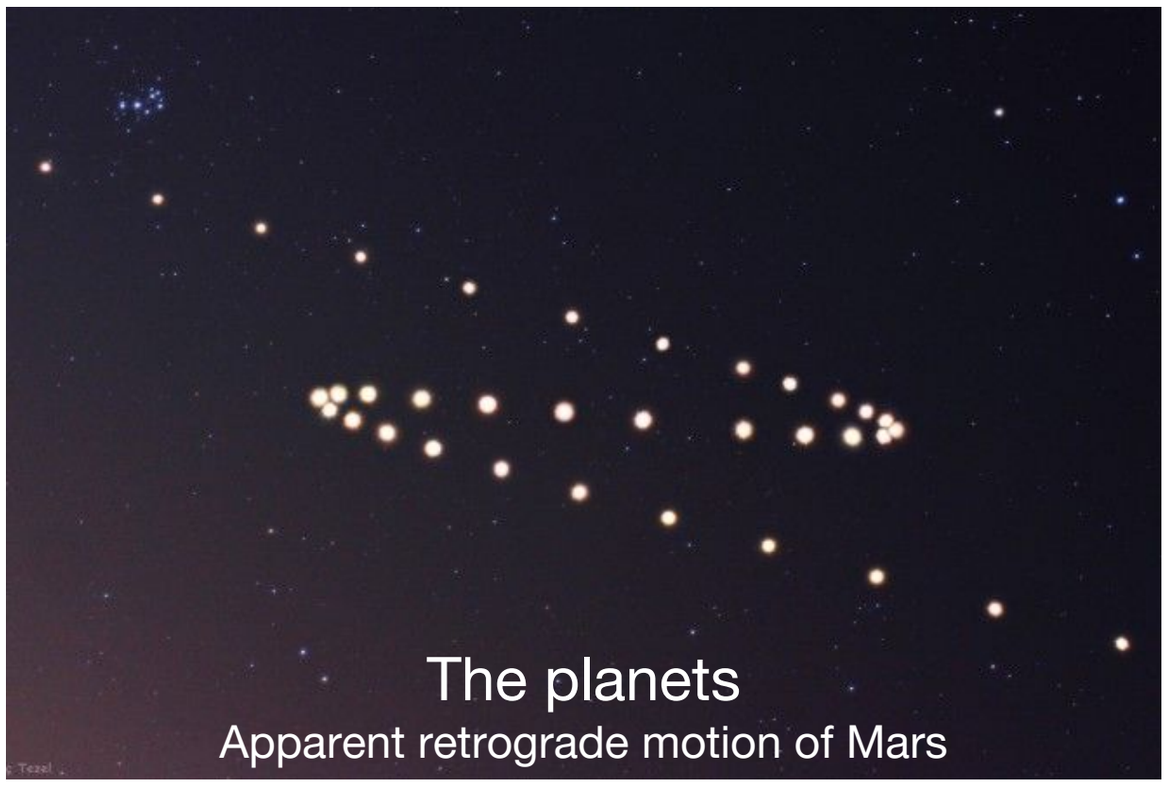
Solar Interstellar Neighborhood



What can we see in the sky?

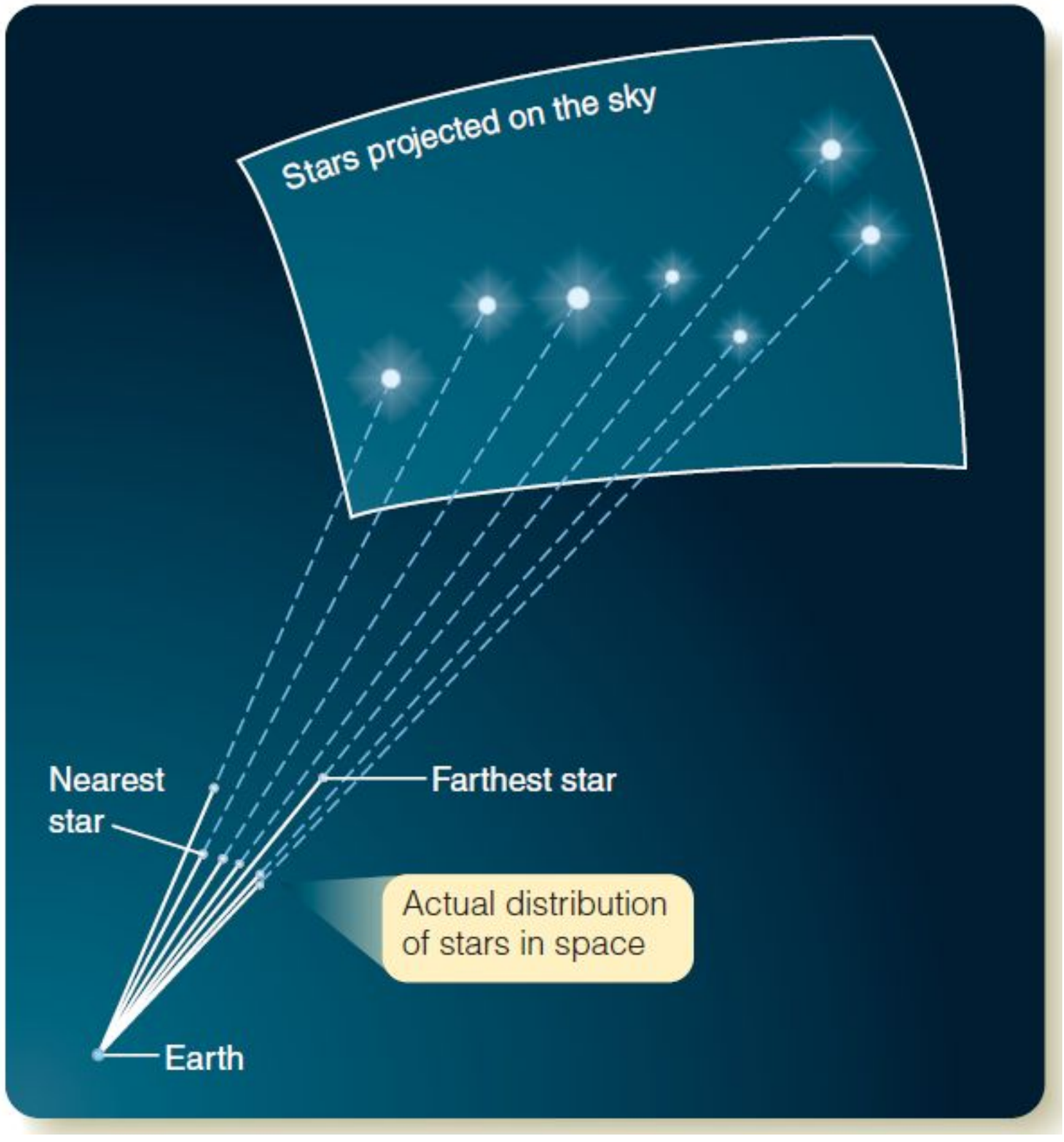


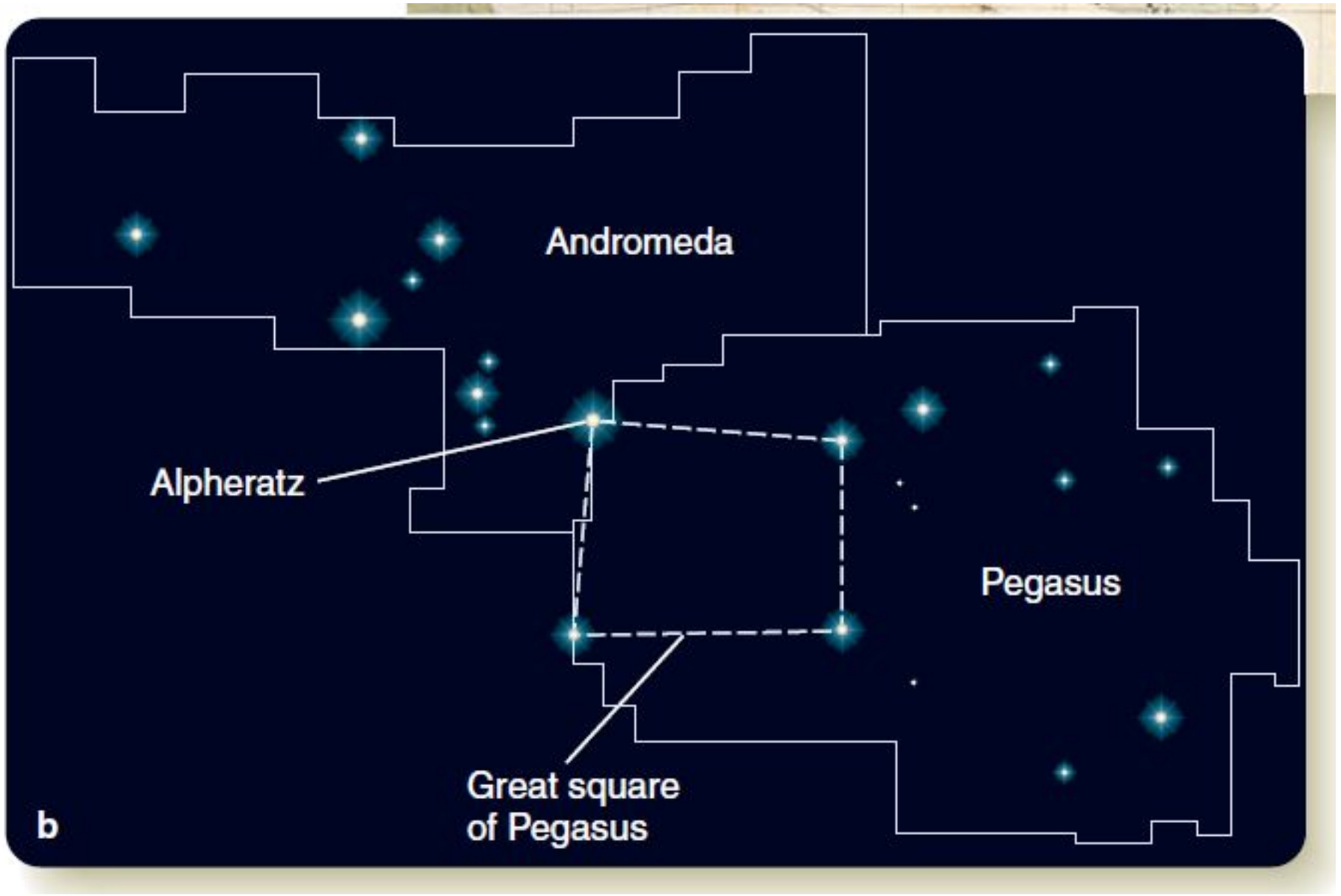




The fixed stars

Constellations



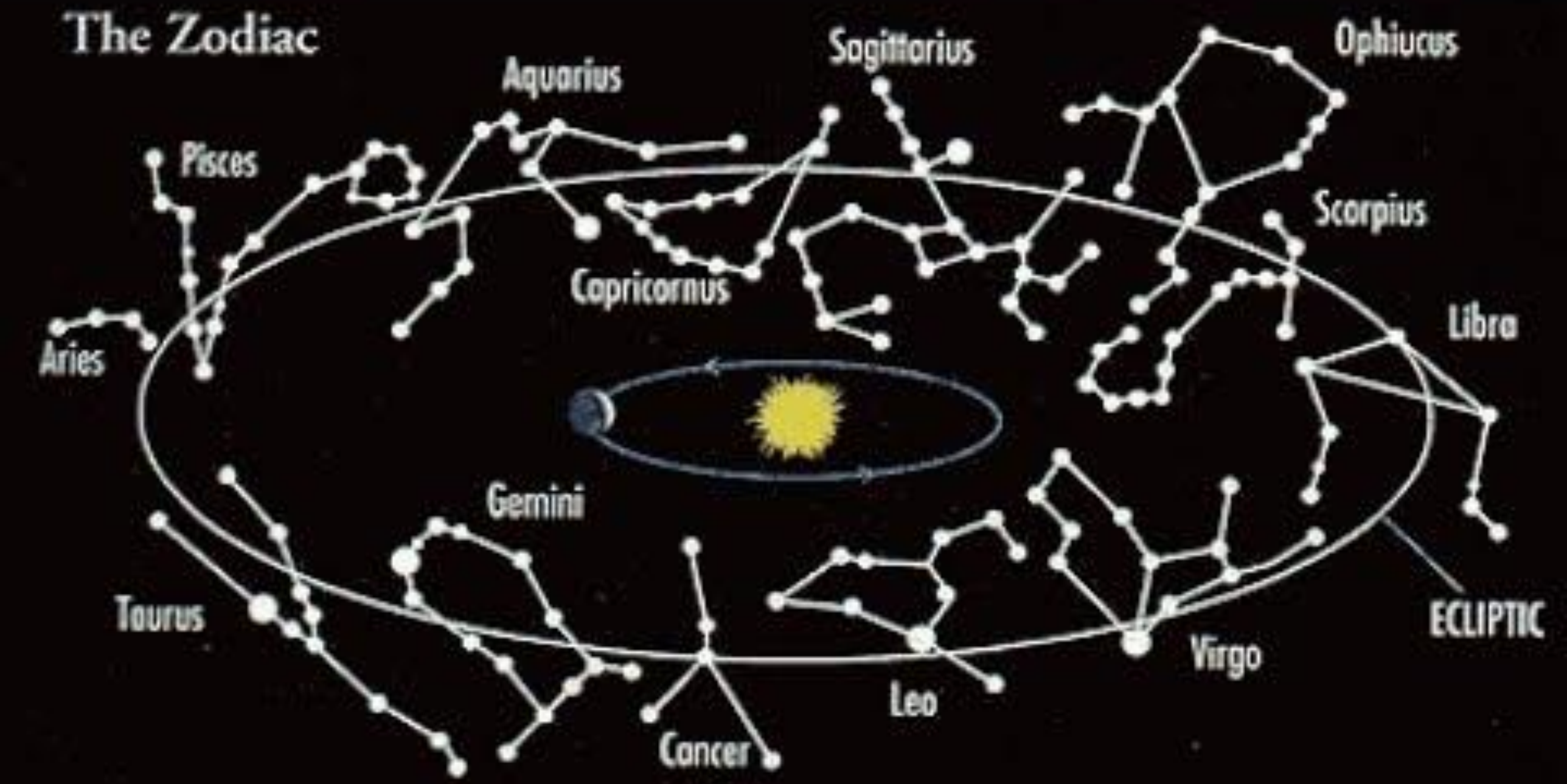


- Boundaries were not exact until recently.

- In 1928, the International Astronomical Union established 88 official constellations with clearly defined boundaries that cover the whole sky.

- There are also asterisms, small groups of stars in a Constellation.

Lyra
Vega
M92
M13
M57
M56
Corona Borealis
Canes Venatici
M63
M94
Coma Berenices
M64
M53
M85
M99
M58
M49
M61
Hercules
Serpens
Arcturus
Sagitta
Altair
M5
M14
M12
M10
Ophiuchus
M11
Scutum
Serpens
M16
M107
Virgo
Oct
Spica
M104
Sagittarius
M25
M23
M9
M21
M8
Jan
Dec
Libra
Nov
Corvus
M19
Antares
M68
M62
M83
M55
M54
M69
M6
Scorpius
Lupus
Corona Australis
Centaurus


The Zodiac
Aquarius
Sagittarius
Ophiucus
Pisces
Scorpius
Capricornus
Libra
Aries
Gemini
Taurus
ECLIPTIC
Virgo
Leo
Cancer

Names of Stars

- Ancient astronomers gave individual names of the brightest stars.

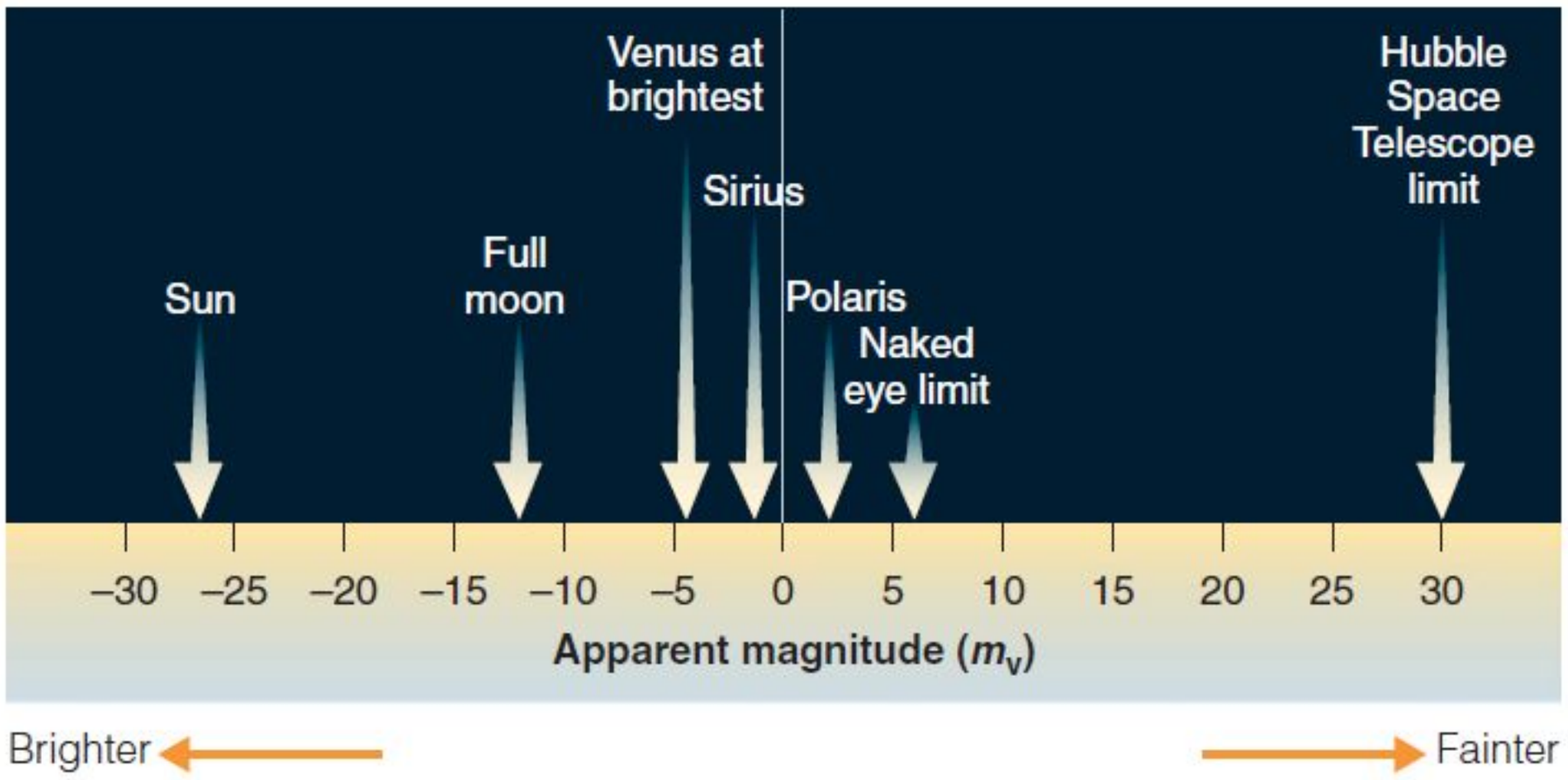
- Most constellations names come from greek.

- Most star names are Arabic, though much altered (e.g., Betelgeuse is from *yad al jawza*.)

- The brightest stars in any constellation are named with a greek letter in order of brightness followed by the name of the constellation (e.g. Alpha Centauri, Epsilon Eridani, Tau Ceti, etc.).

Brightness of stars

- Astronomers describe brightness of stars using the **magnitude scale**.
- First appears in writing of Claudius Ptolemy around the year of 140 attributed to Hipparchus (190-120 BC).
- Ancient astronomers estimated by eye and used 6 classes (brightest ≈ 1st magnitude, faintest ≈ 6th magnitude).
- Modern astronomy uses precise instruments. Apparent visual magnitude m_v.



Magnitude and Flux

- Human eye is subjective. It is better to measure brightness with flux, F.

- The flux measures the amount of energy from the light of a star that hits a square meter in one second.

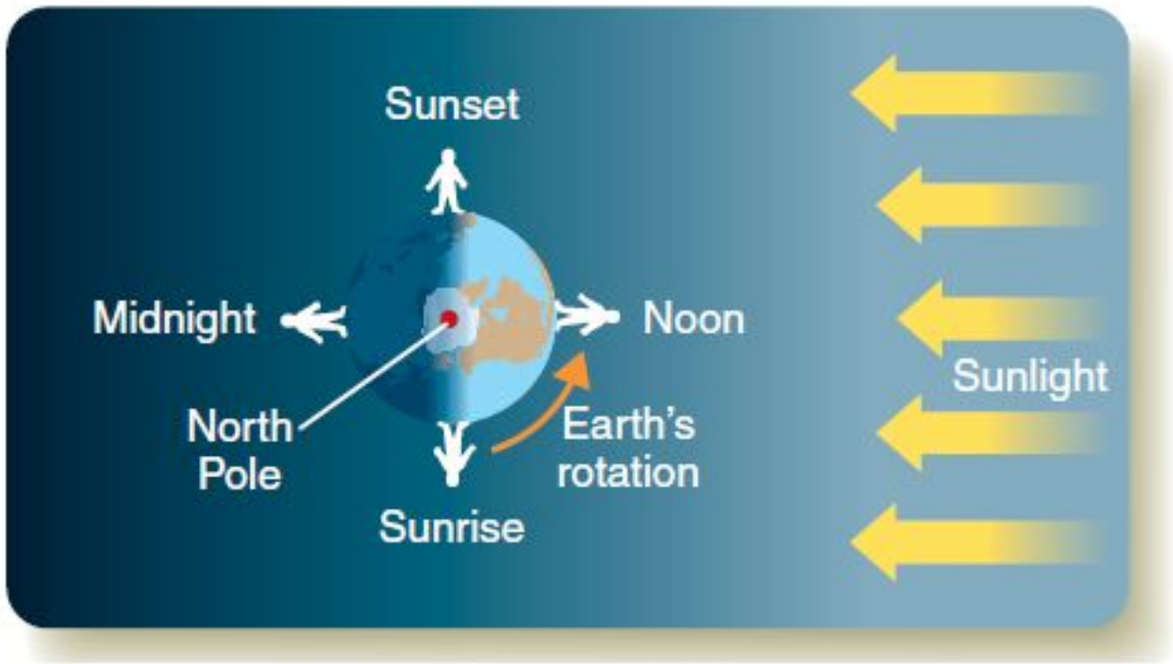
Modern magnitude scale is defined such that two stars that differ by 5 magnitudes have a ratio of flux of 100. This, two star that differ by one magnitude, have fluxes differing by 2.512.

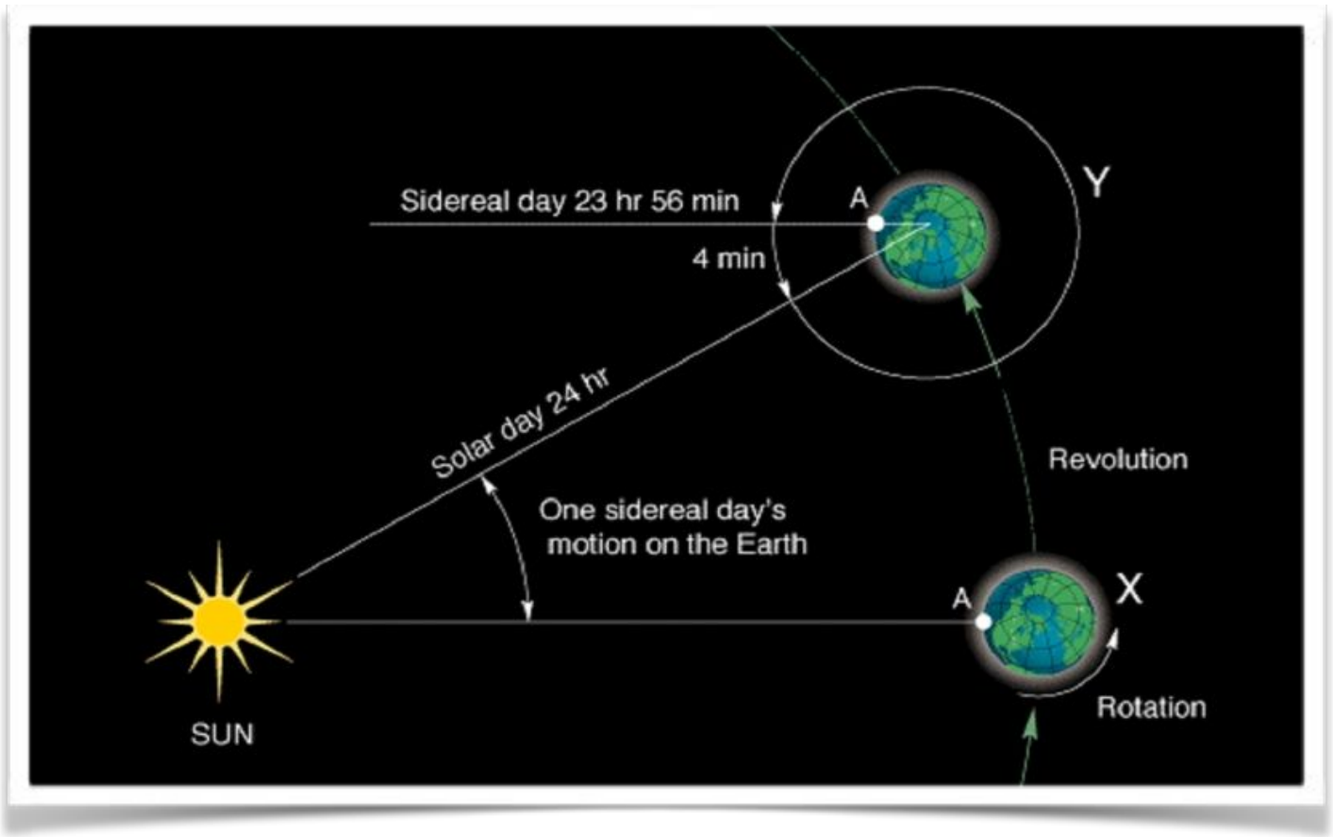
$$\frac{F_{\mathrm{A}}}{F_{\mathrm{B}}} = (2.512)^{(m_{\mathrm{B}} - m_{\mathrm{A}})} \qquad m_{\mathrm{B}} - m_{\mathrm{A}} = 2.512 \log\left(\frac{F_{\mathrm{A}}}{F_{\mathrm{B}}}\right)$$

The sky and celestial motion

Rotation: day and night

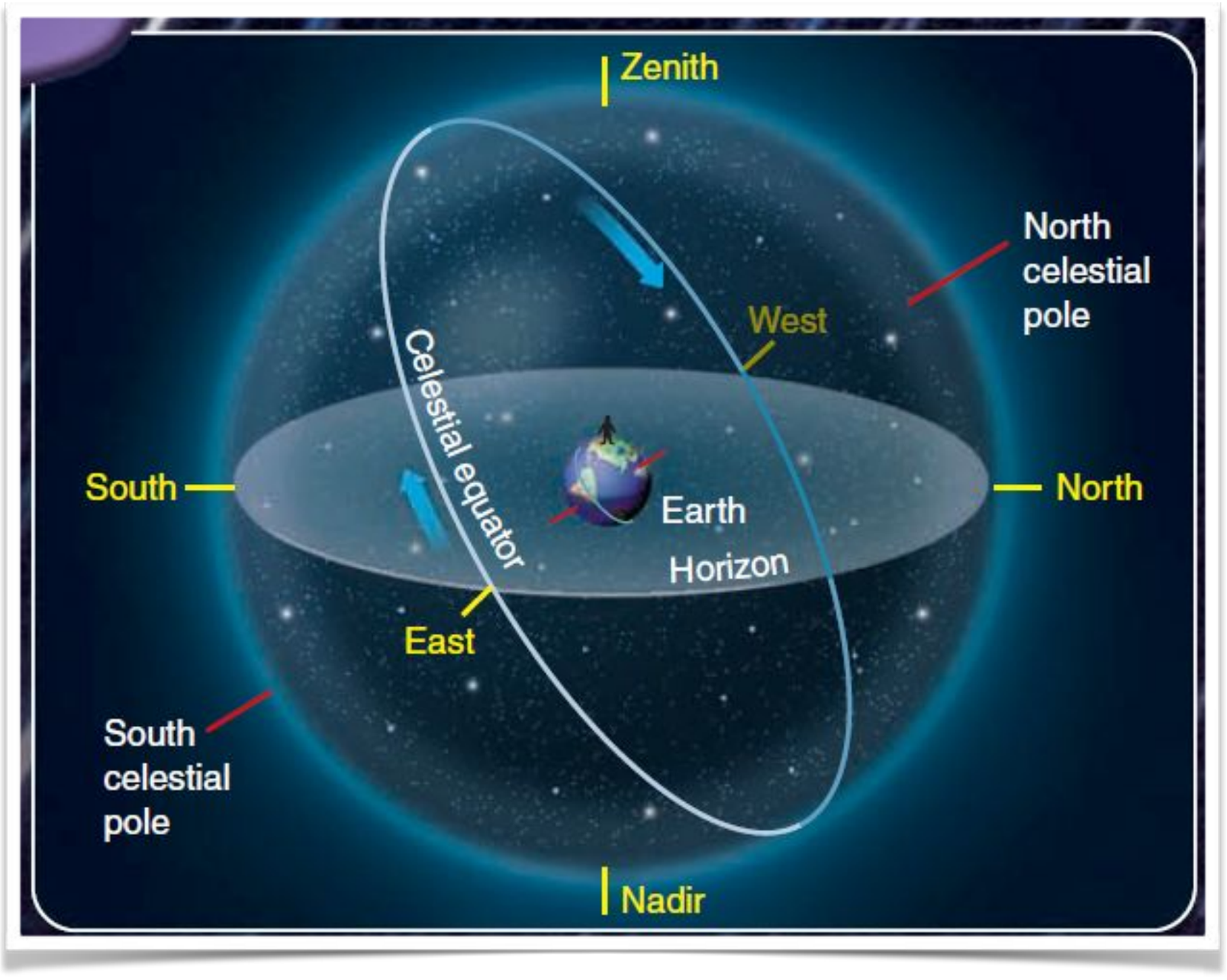
Rotation is the turning of a body on its axis.



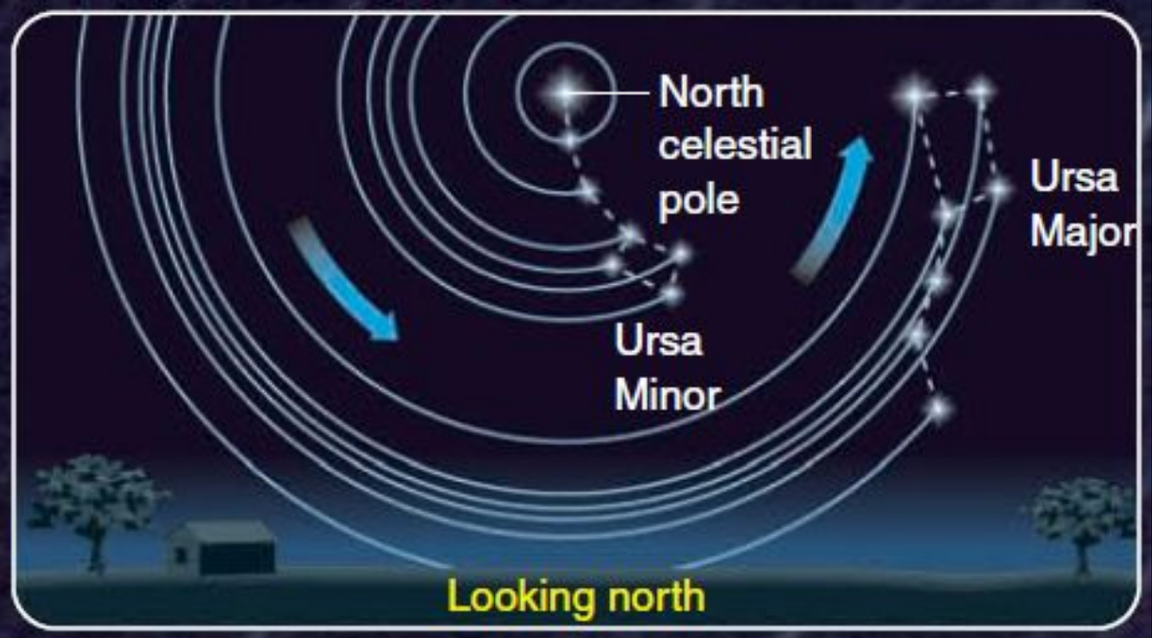


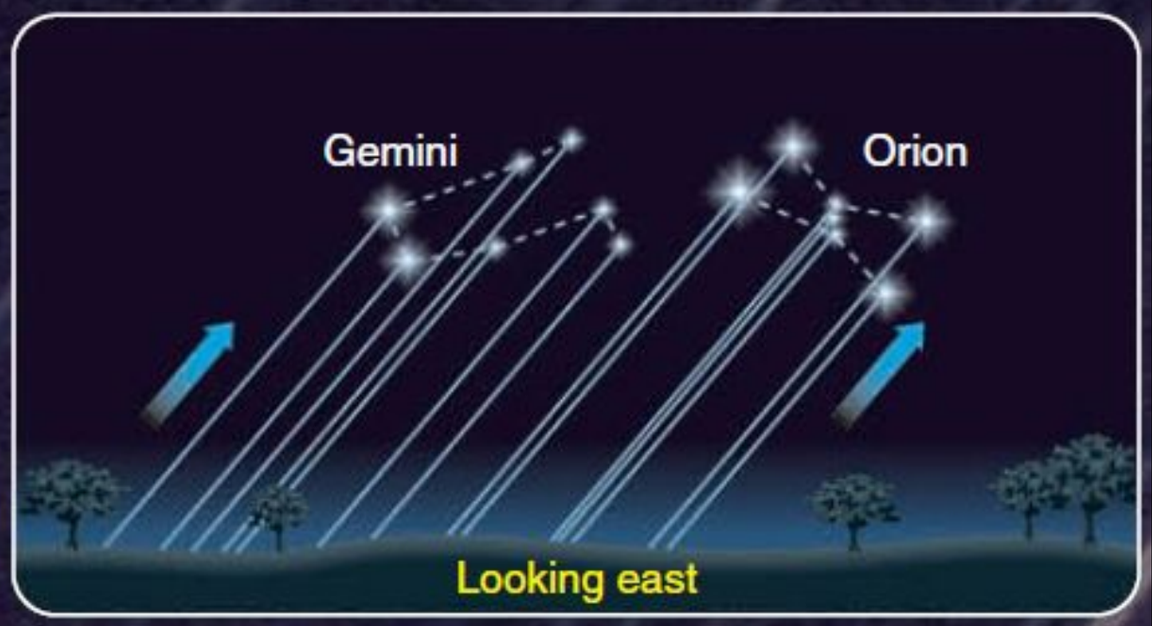
- Solar day: 24 hr
  The Sun reaches the same position in the sky.
- Sidereal day: 23 hr 56 min
  A distant star reaches the same position in the sky.

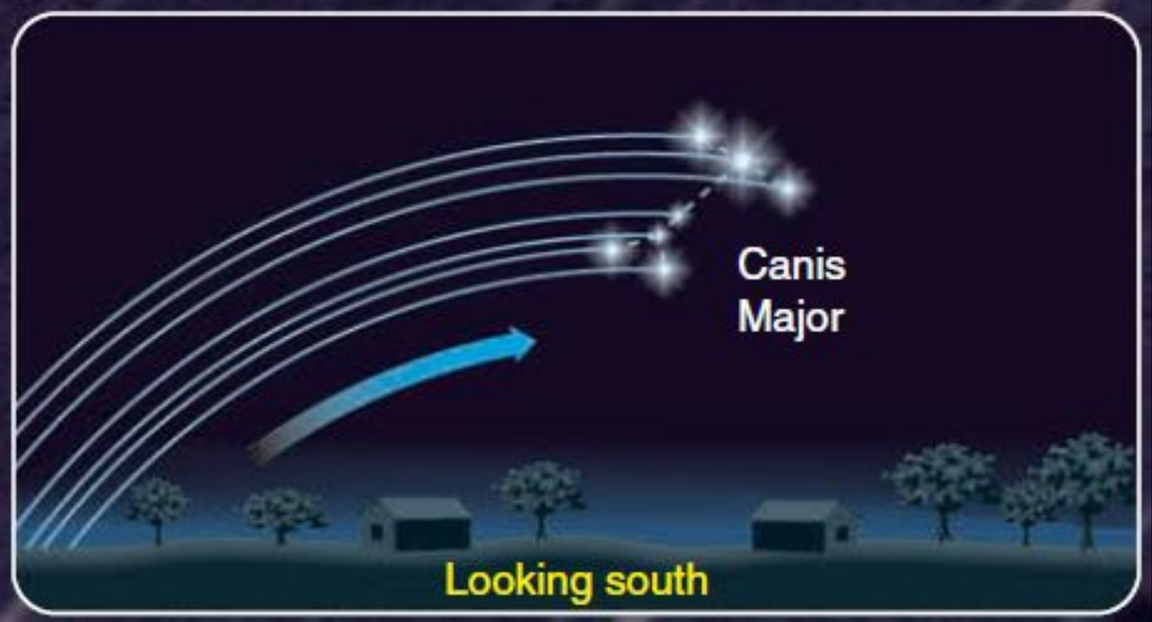
The celestial sphere

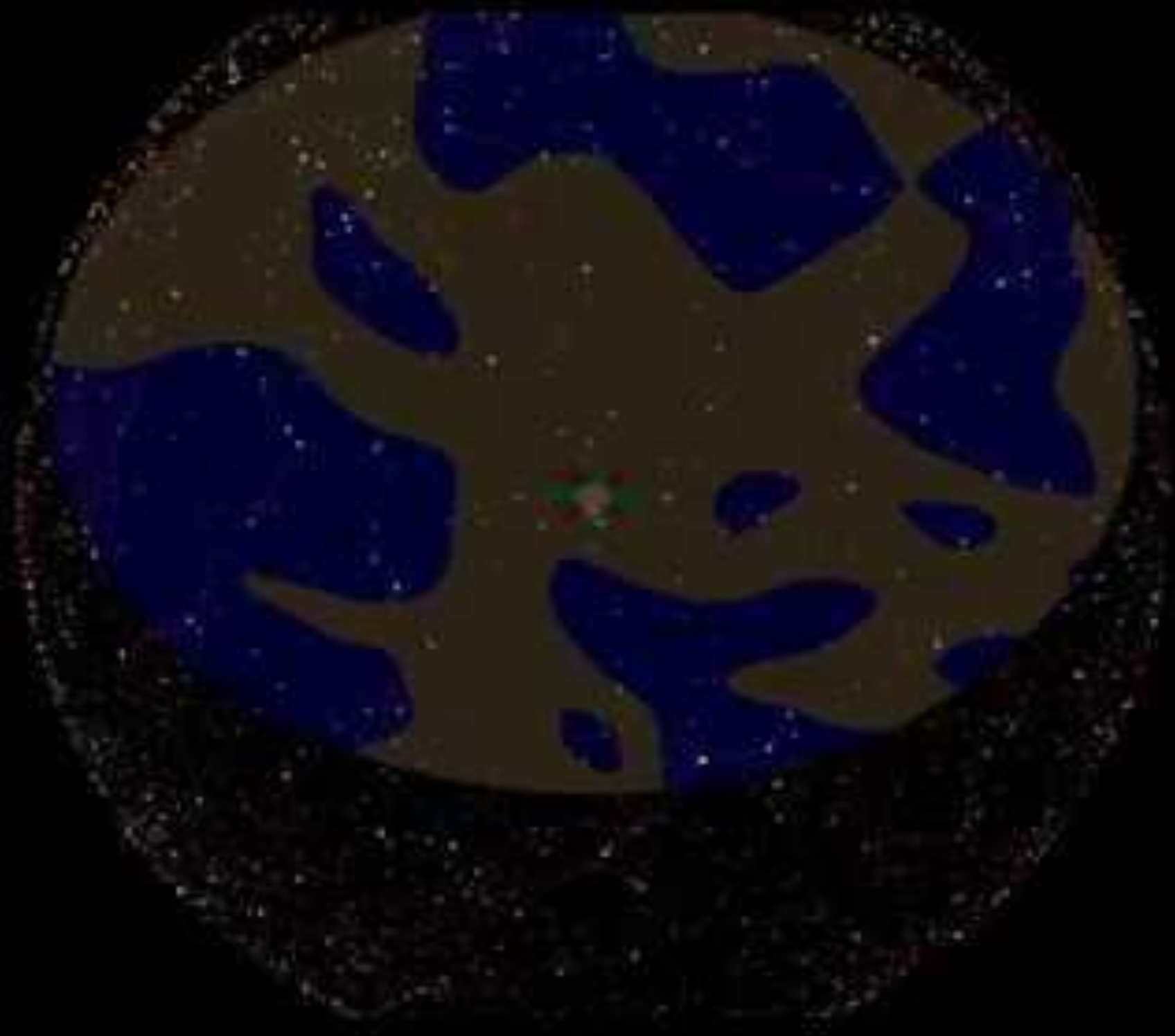


As the Earth spins on its axis the distant 'fixed' stars (called 'celestial sphere') seem to move.


North
celestial
pole
Ursa
Major
Ursa
Minor
Looking north


Gemini
Orion
Looking east


Canis
Major
Looking south



Precession of Earth's axis

Also known as precession of equinoxes.

Precession: the slow movement of the axis of a spinning body around another axis due to a torque (such as gravitational influence) acting to change the direction of the first axis.

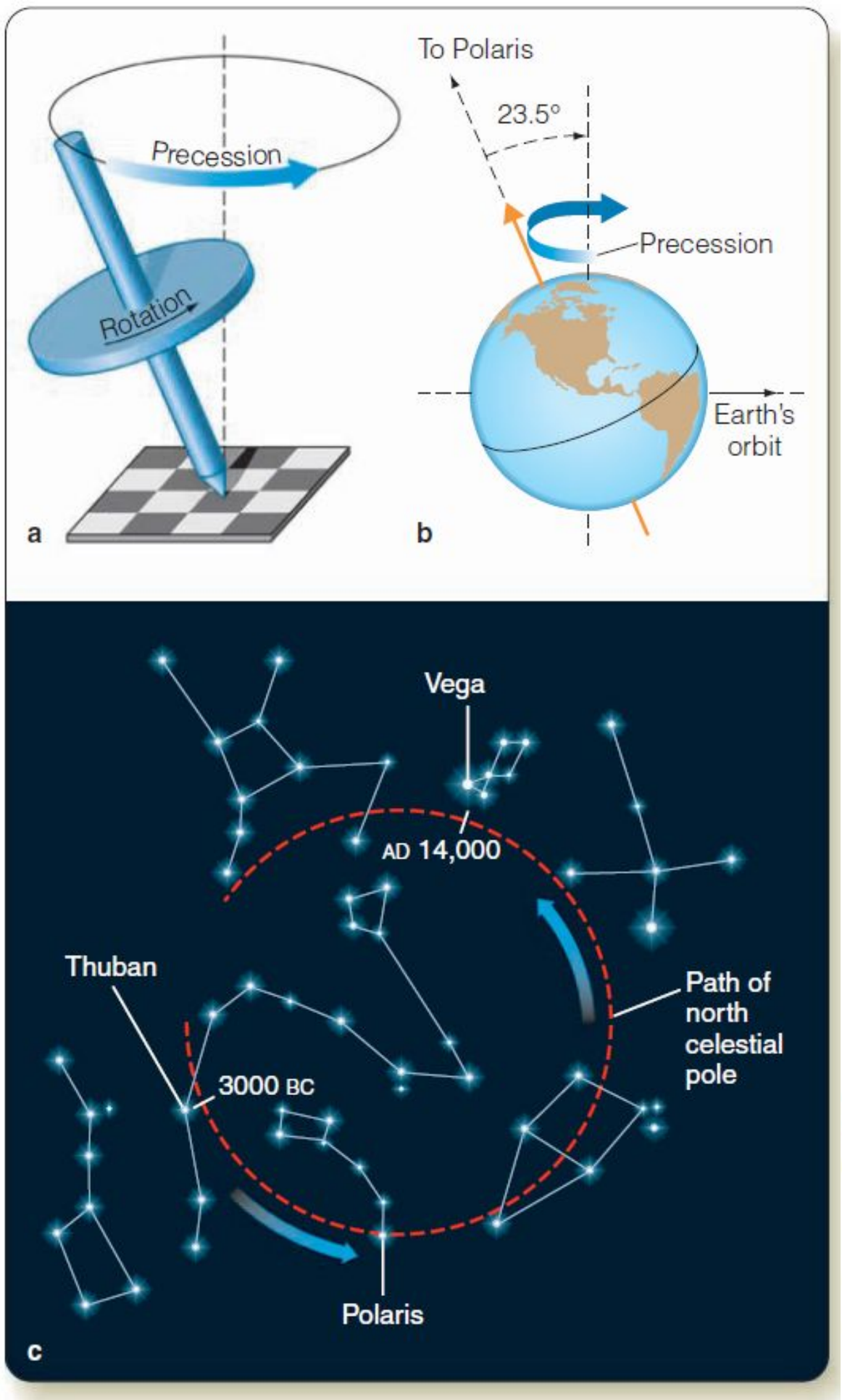
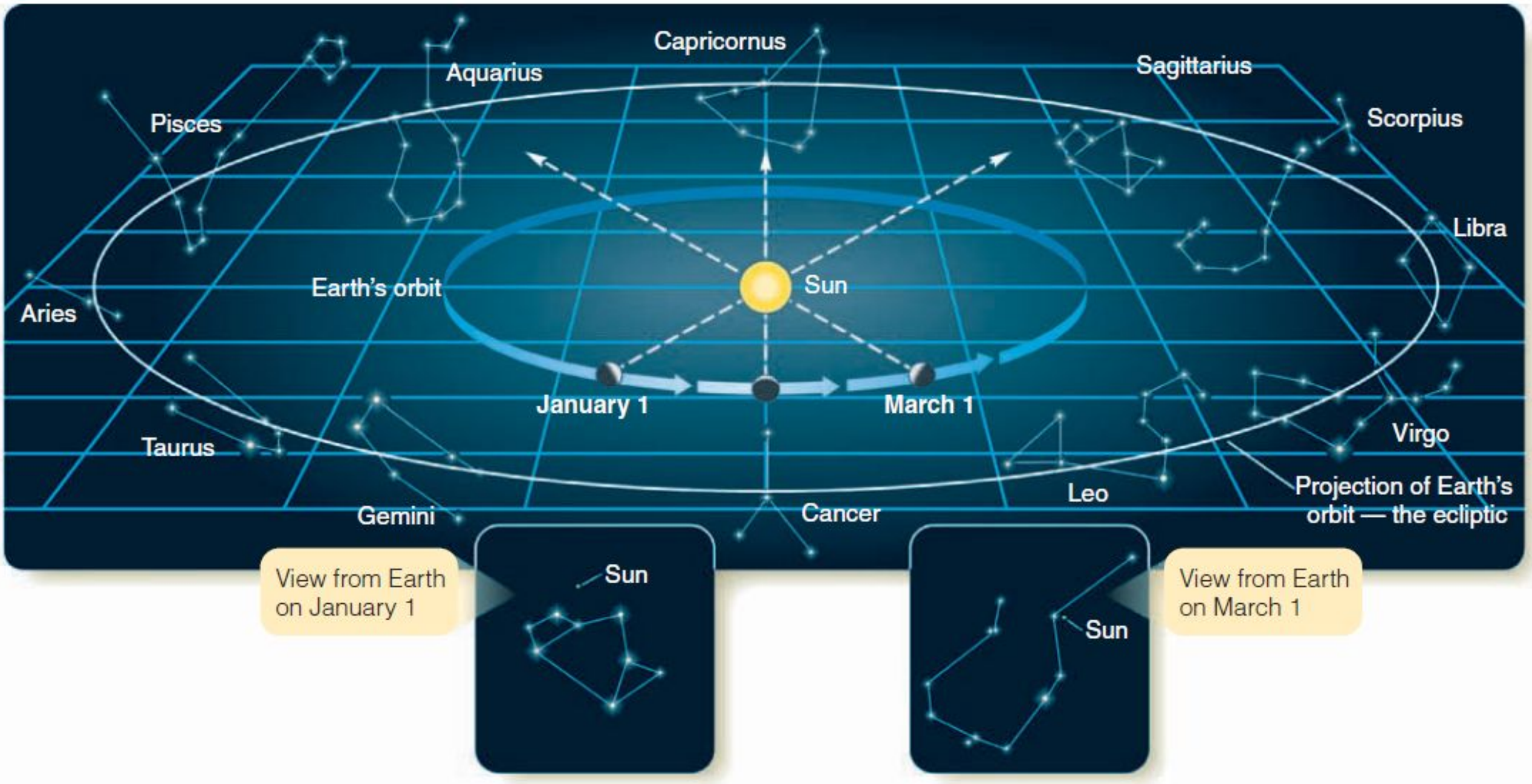


Figure 2-7

Precession. (a) A spinning top precesses in a conical motion around the perpendicular to the floor because its weight tends to make it fall over. (b) Earth precesses around the perpendicular to its orbit because the gravity of the sun and moon tend to twist it upright. (c) Precession causes the north celestial pole to drift among the stars, completing a circle in 26,000 years.

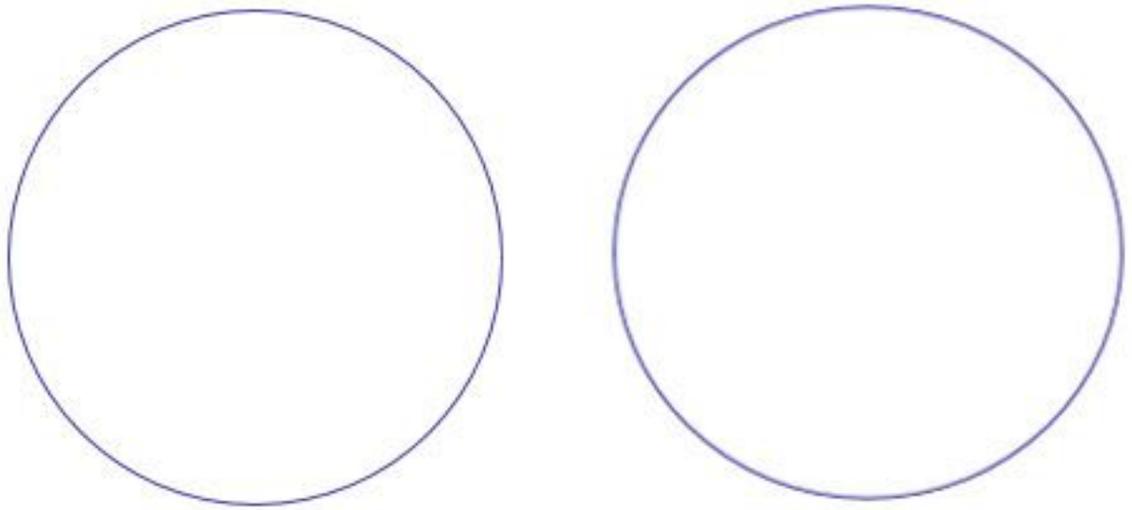
Revolution: annual motion around the sun

Revolution is the motion of a body around a point outside the body.



Elliptical orbits

The eccentricity *e* measures how much the orbit departs from a circle



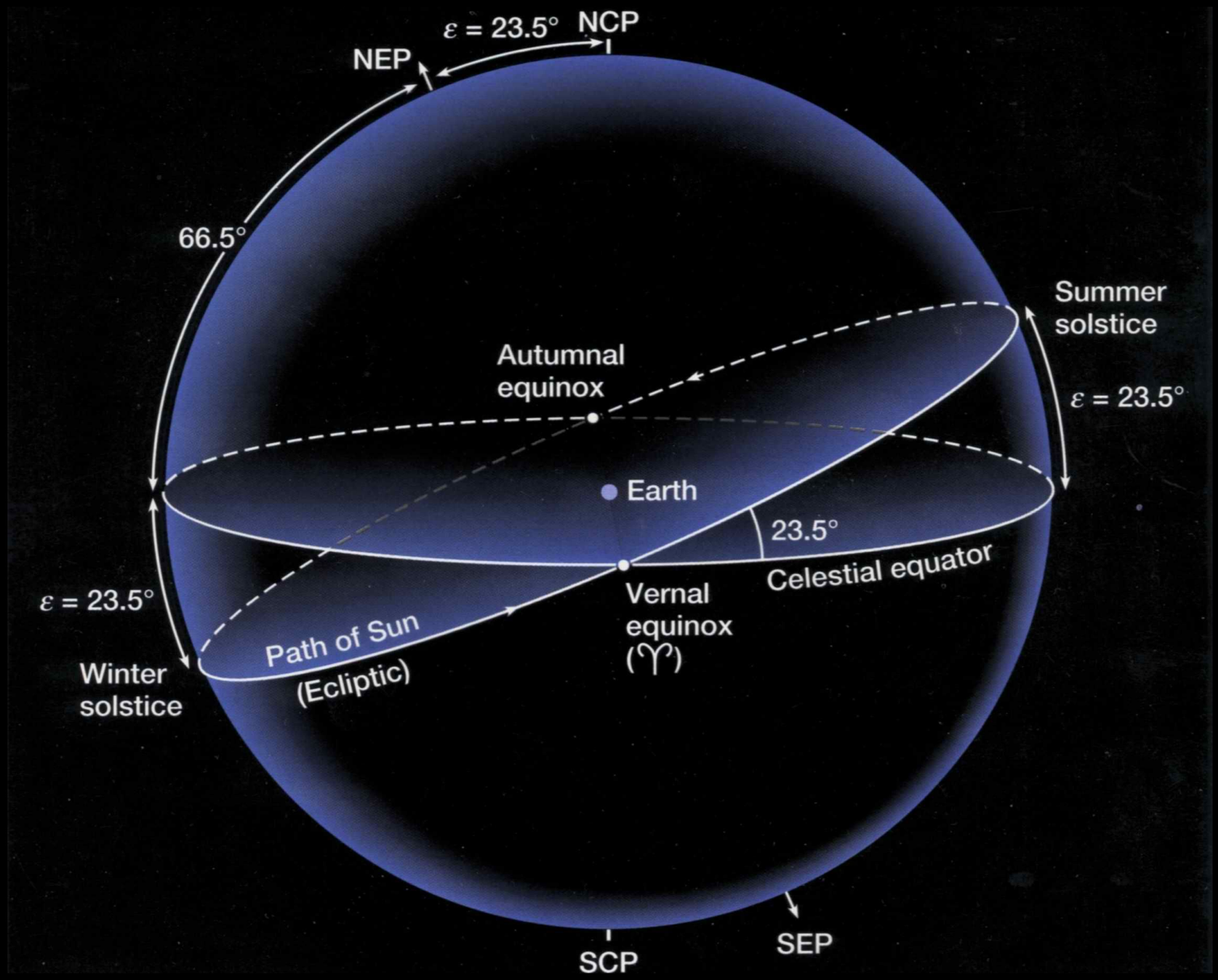
$$e = \sqrt{1 + \frac{2EL^2}{m_{\text{red}}\alpha^2}} \qquad F = \frac{\alpha}{r^2}$$

For Earth *e*=0,0167

- Circle: *e*=0
- Ellipse: 0<*e*<1
- Parabola: *e*=1
- Hyperbole: *e*>1

Ecliptic plane

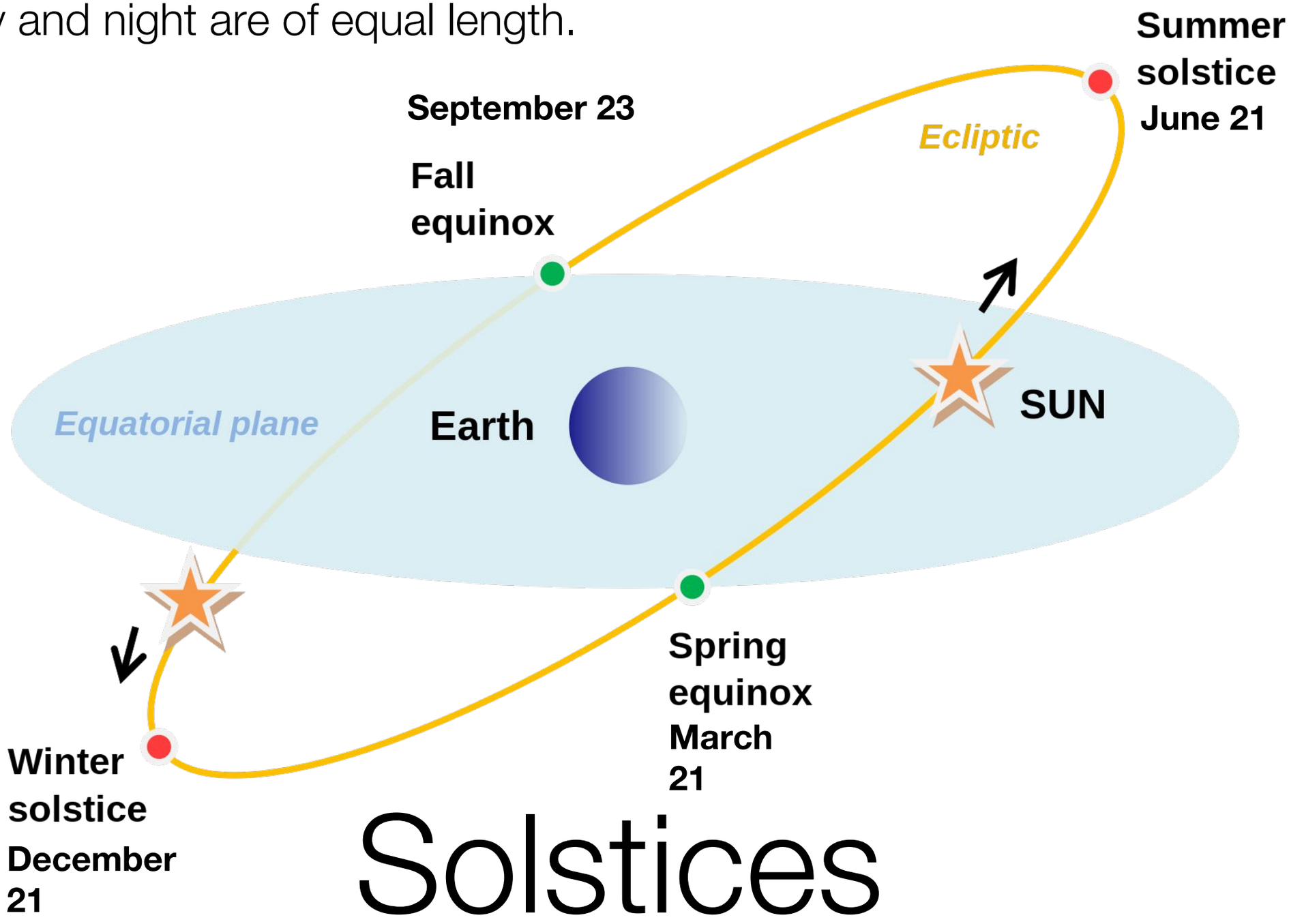
The apparent path of the Sun's motion on the celestial sphere as seen from Earth is called the ecliptic. It is the plane spanned by the Earth-Sun vector.



The ecliptic plane is tilted 23.5° with respect to the plane of the celestial equator.

Equinoxes

The equinox is the time of the year at which the sun crosses the celestial equator, when day and night are of equal length.



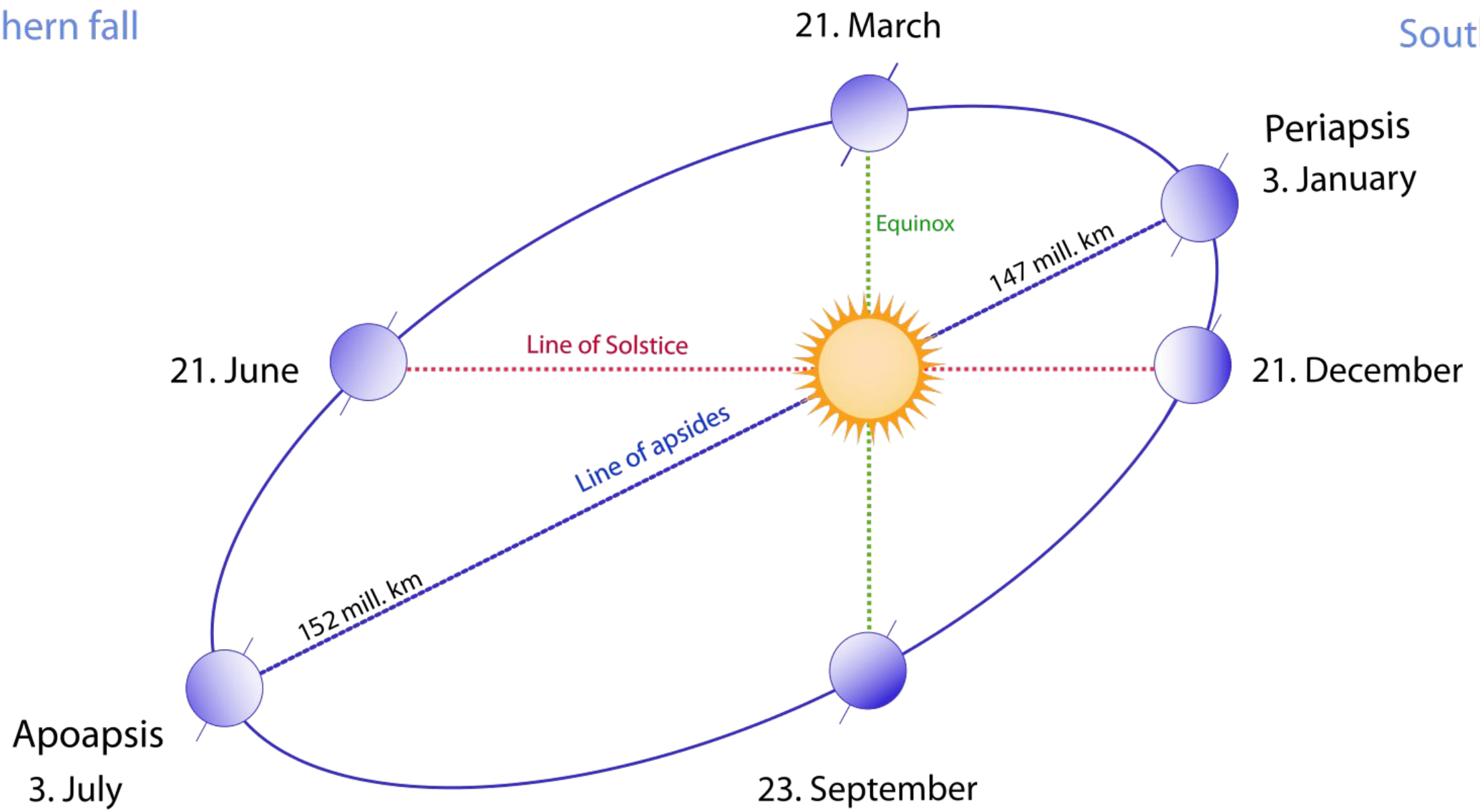
Solstices

A solstice is either of the two times in the year when the sun reaches its highest or lowest point in the sky at noon, marked by the longest and shortest days.

Seasons

Northern spring/
Southern fall

Northern winter/
Southern summer



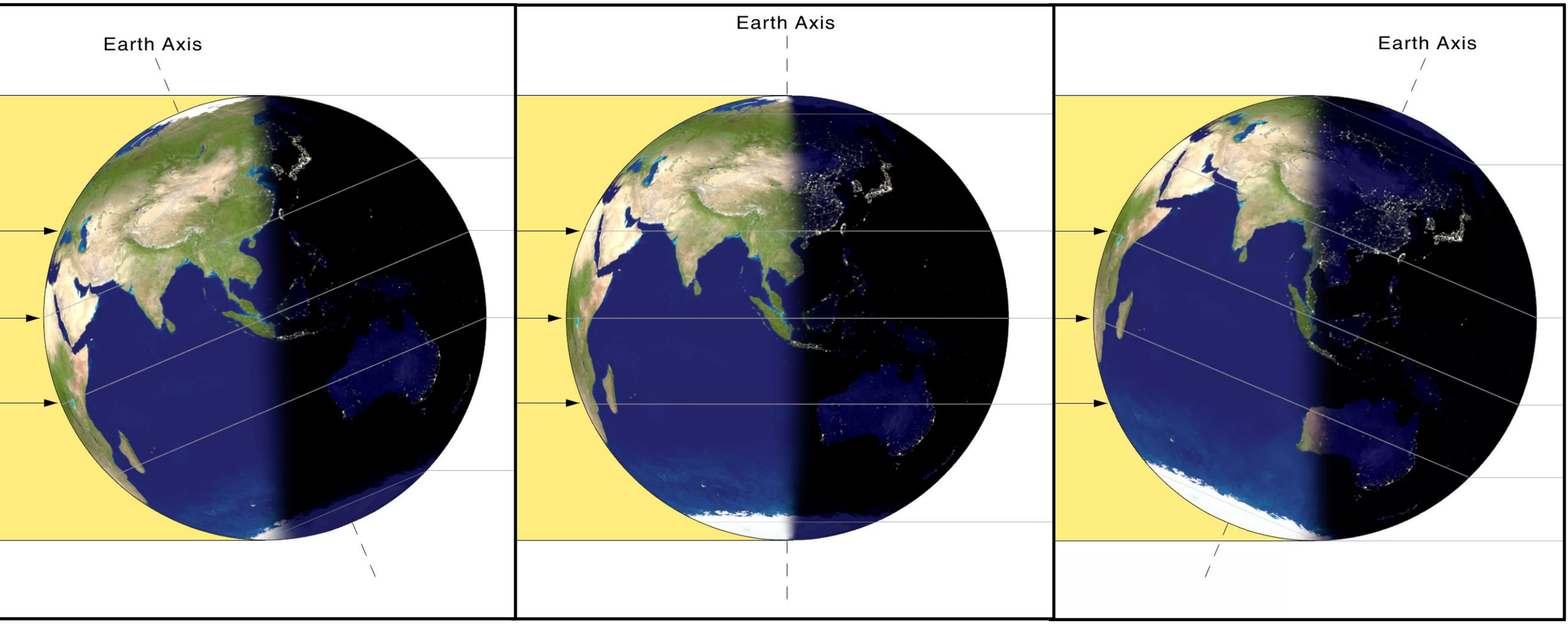
Northern summer/
Southern winter

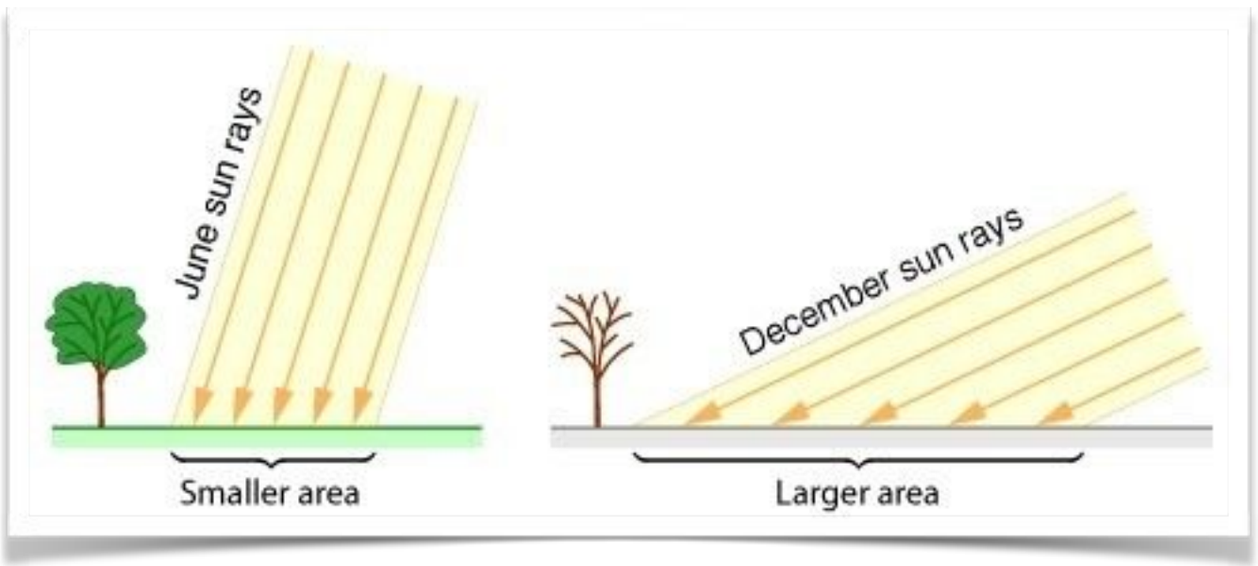
Northern fall/
Southern spring

Solstice

Equinox

Solstice

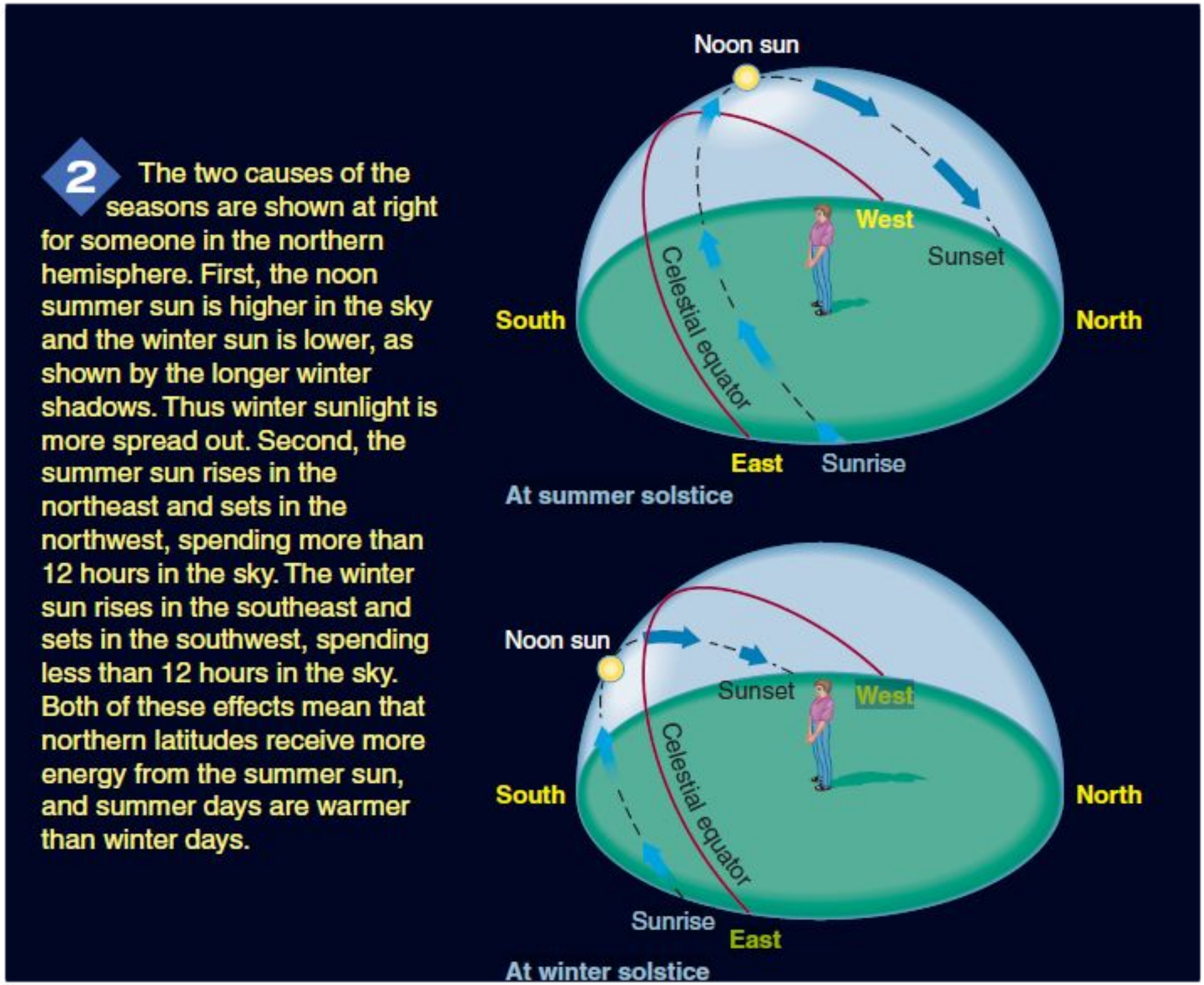




Why Summer is hot?

It's because of the inclination of the Earth's axis.

In summer one hemisphere is hit by more radiation from the Sun with respect to the other.

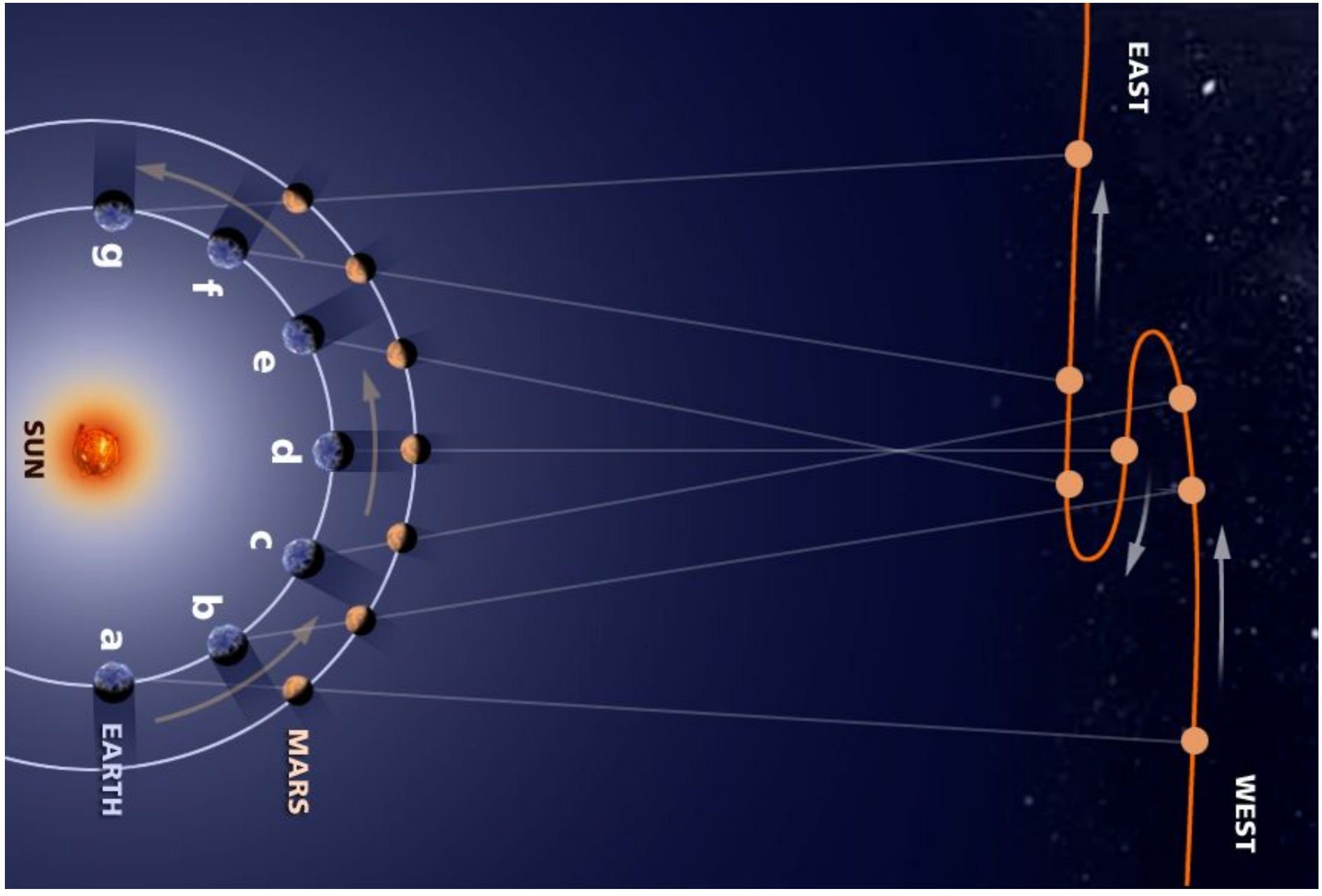


In the northern hemisphere in summer, the Sun spends more time in the sky and sunlight is spread over a smaller area with respect to winter.

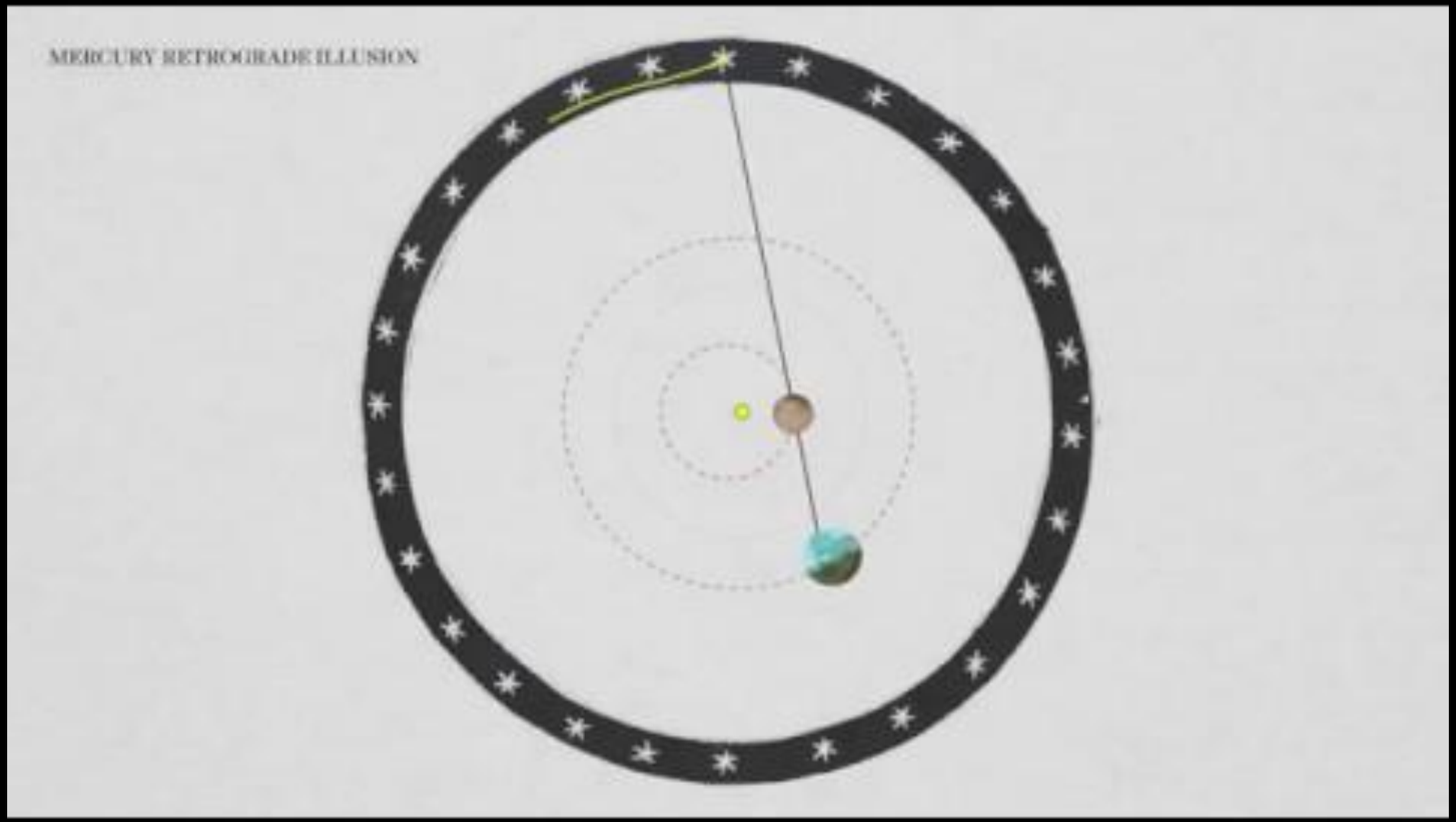
Motion of planets

The planets in the Solar System move with respect to the fixed stars

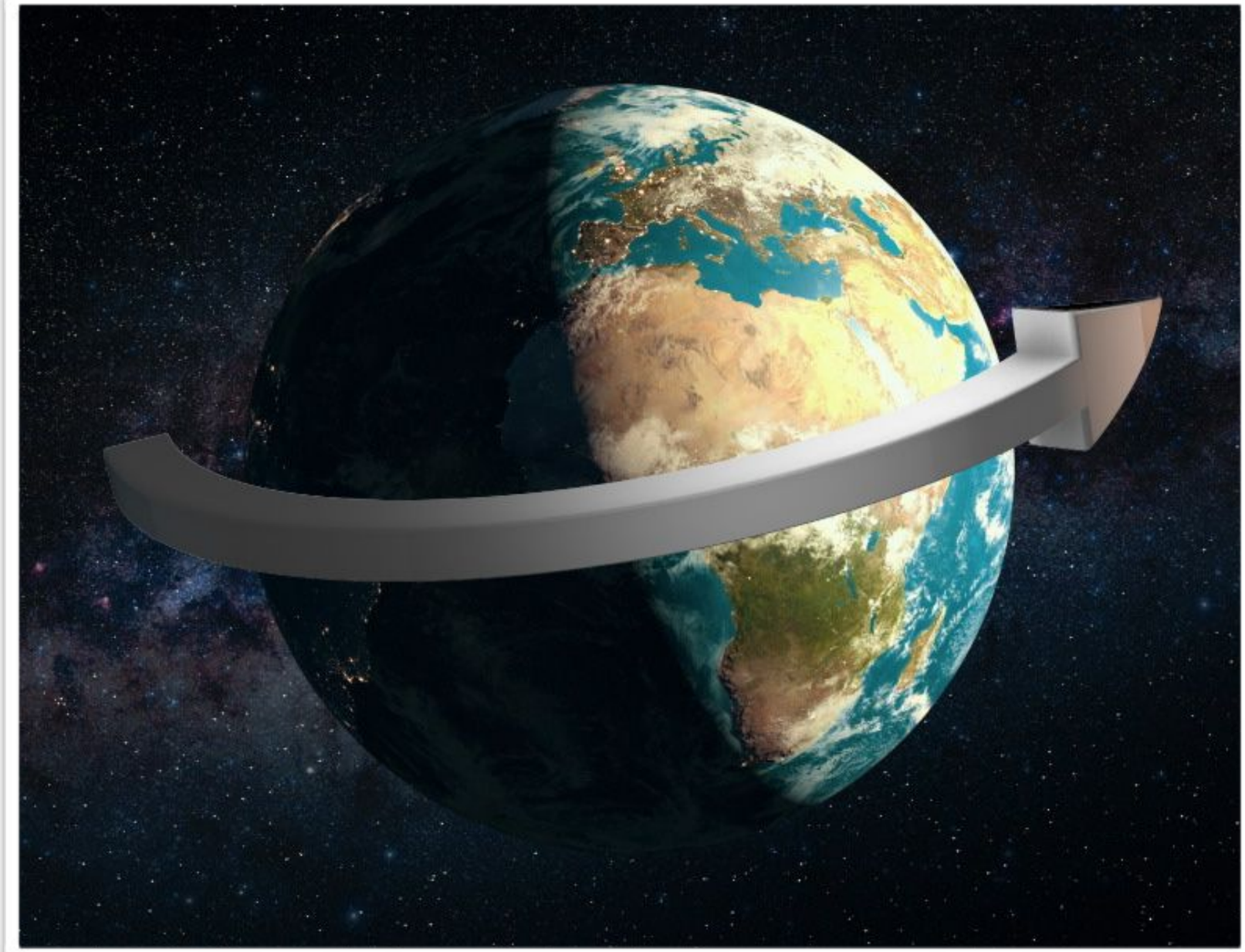
Motion of planets



The planets in the Solar System move with respect to the fixed stars

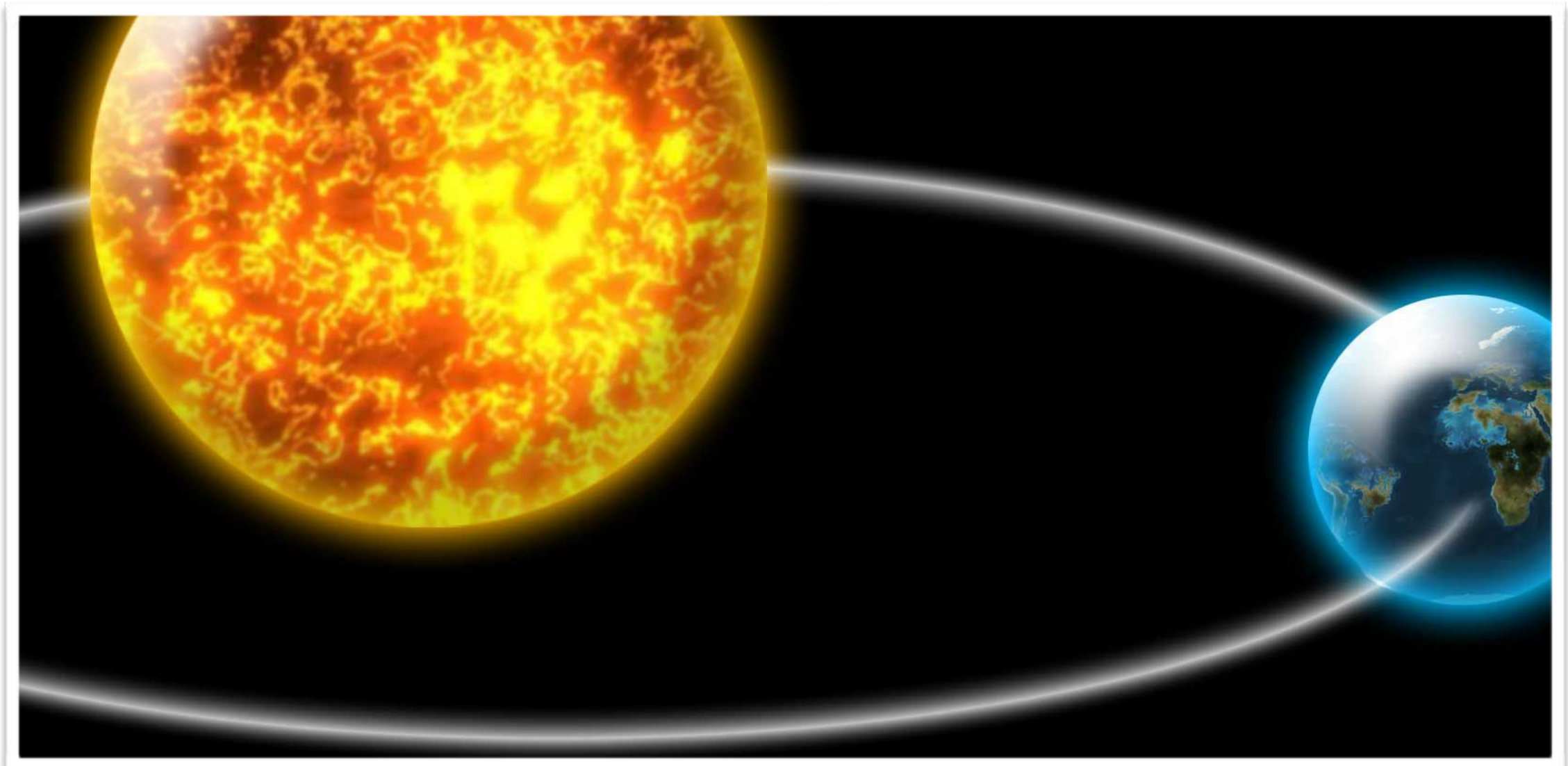

MERCURY RETROGRADE ILLUSION

Rotation



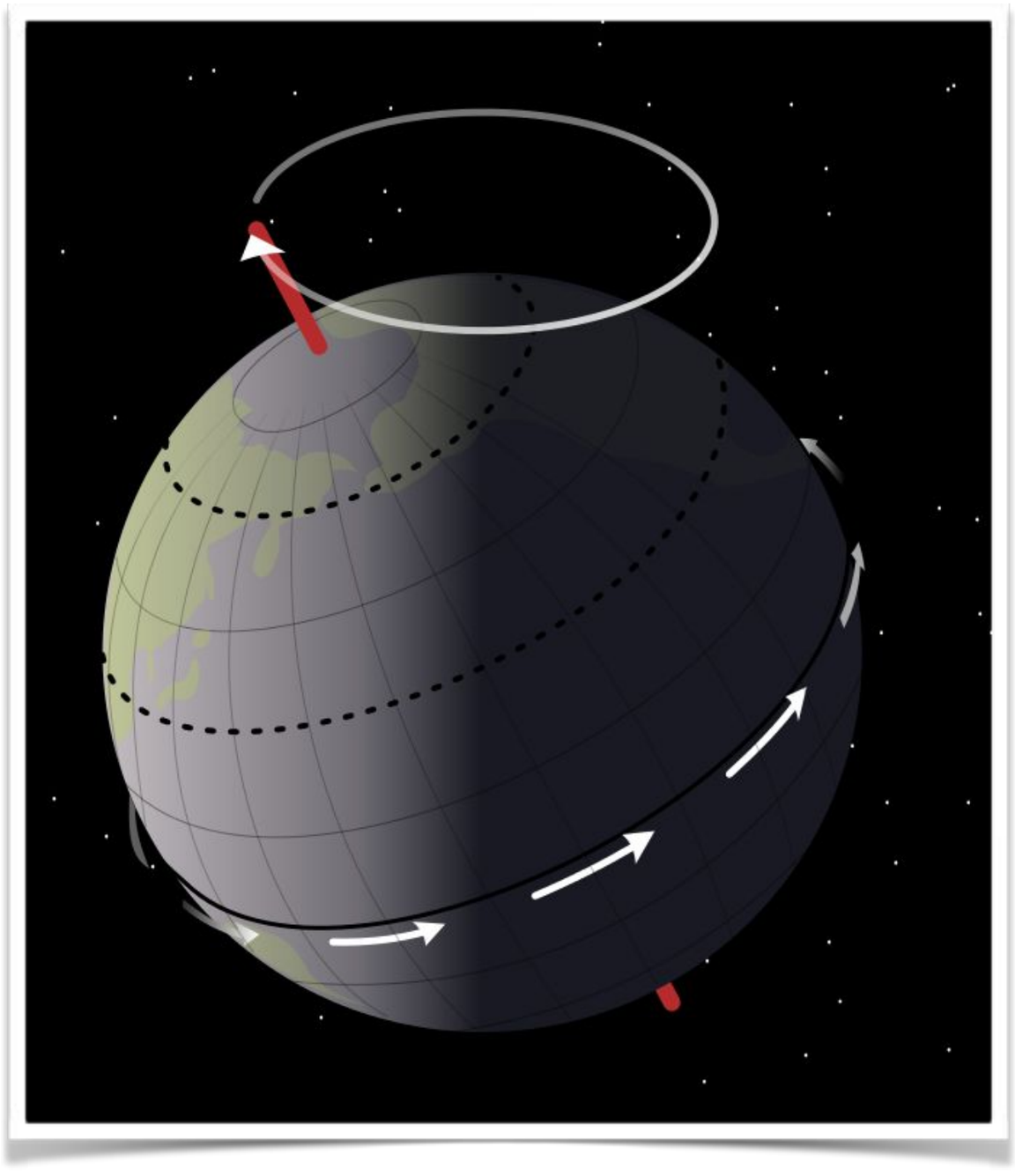
The Earth takes 24 hours to complete one rotation about its axis.

Revolution



The Earth takes 365 days to complete one revolution around the Sun.

Precession



The Earth's axis takes 26,000 years to complete one cycle of precession.