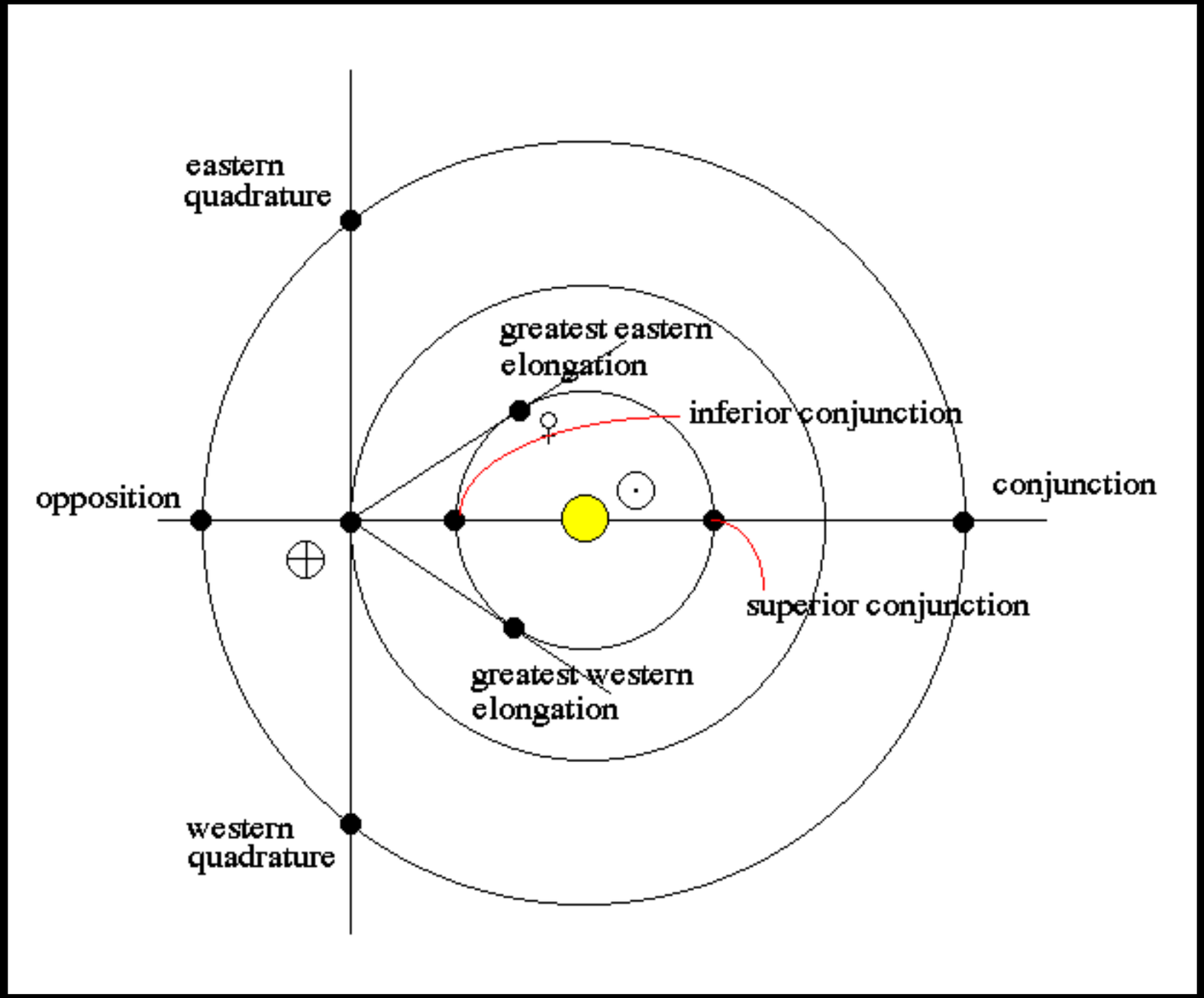
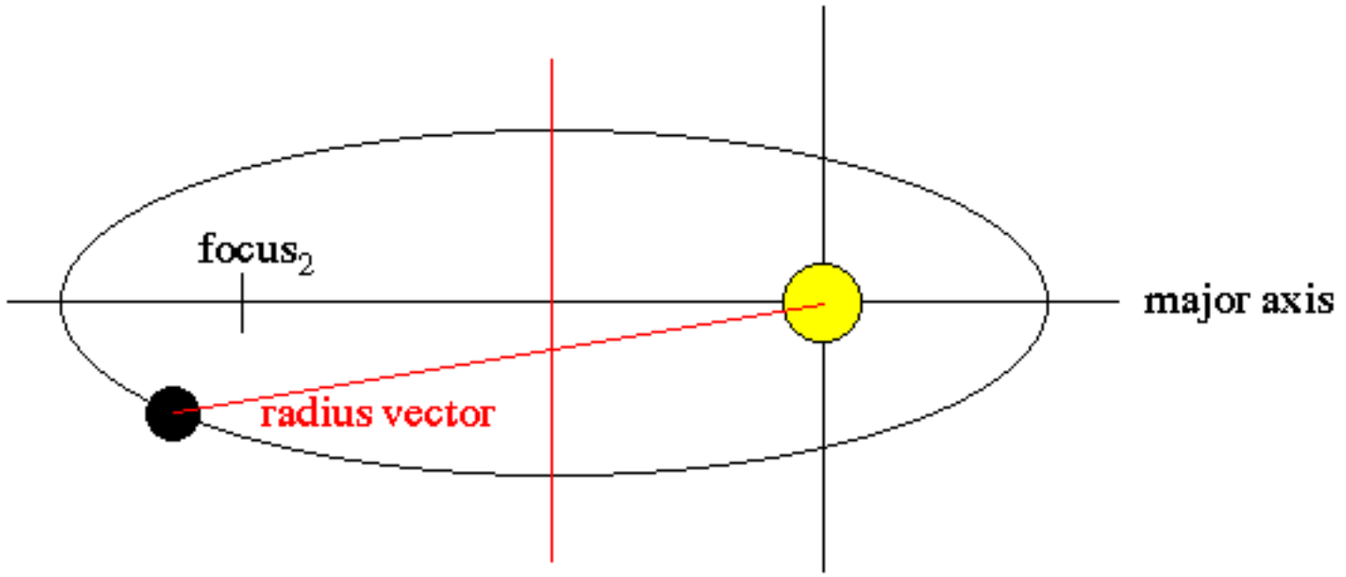



The planets outside of the Earth's orbit (Mars, Jupiter, Saturn, Uranus, Neptune) are called superior planets. The planets inside of the Earth's orbit (Mercury, Venus) are called inferior planets.

Galileo laid down the first accurate laws of motion for masses. Galileo realized that all bodies accelerate at the same rate regardless of their size or mass.
Key among his investigations are:

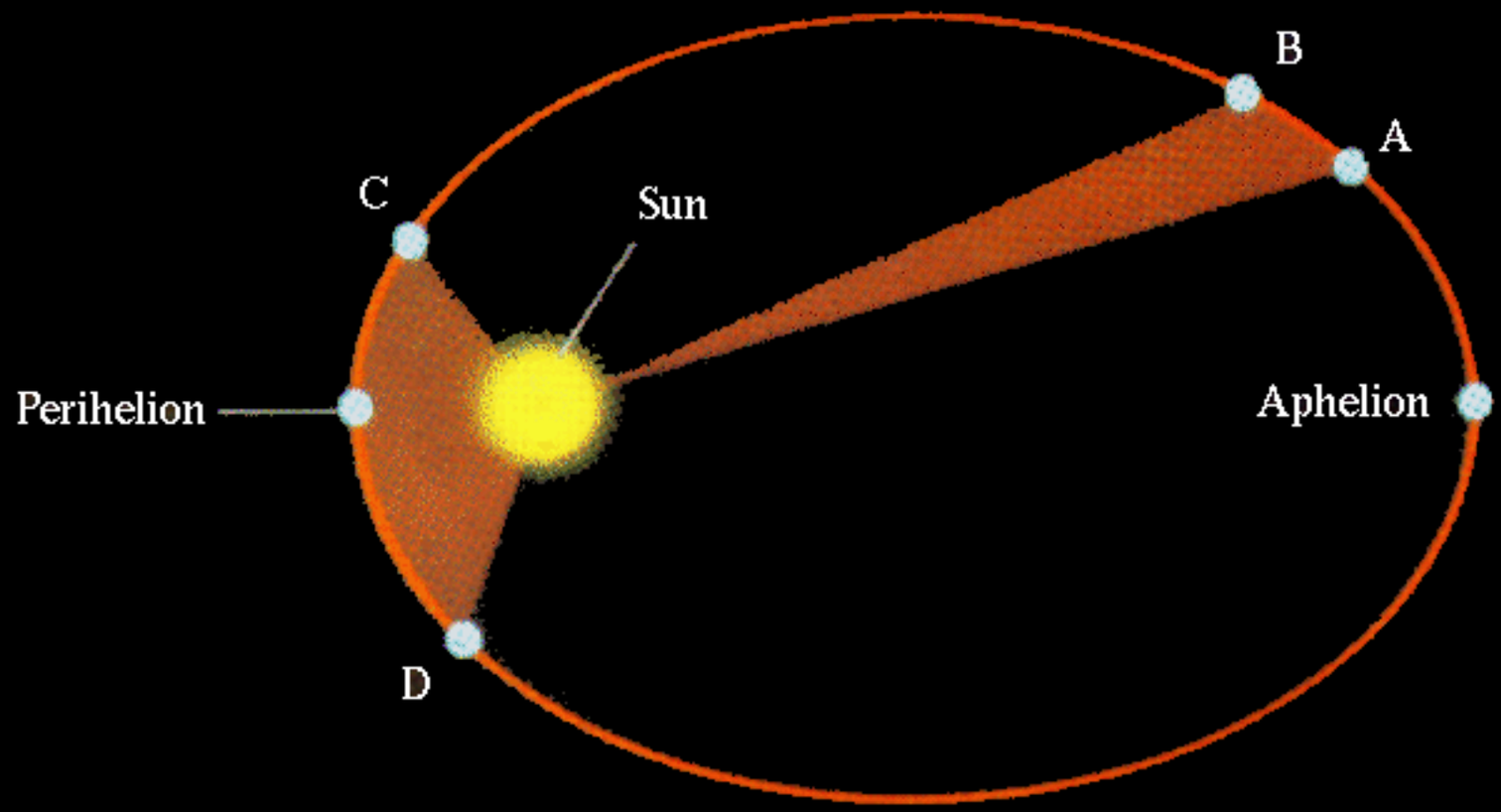
1) developed the concept of motion in terms of velocity (speed and direction) through the use of inclined planes.
2) developed the idea of force, as a cause for motion.
3) determined that the natural state of an object is rest or uniform motion, i.e. objects always have a velocity, sometimes that velocity has a magnitude of zero = rest.
4) objects resist change in motion, which is called inertia.

Ellipse = member of a family of mathemathical curves called conic sections



Kepler formulated three laws of planetary motion (that also applies to asteroids, comets and spacecraft).

1st law (law of elliptic orbits): Each planet moves in an elliptical orbit with the Sun at one focus.




2nd law (law of equal areas): a line connection the Sun and a planet (called the radius vector) sweeps out equal areas in equal times

- 3rd law (law of harmonics): The square of a planet's orbital period (the time it takes to go around the Sun) is proportional to its mean distance from the Sun cubed.

  The mathematical way to describe Kepler's 3rd law is:

$$P^2 \alpha R^3$$

  where the $\alpha$ symbol means `proportional to'. Proportions are expressions that imply there exists some constant, $k$, that relates the period, P, and the radius, R, such that

$$P^2 = kR^3$$

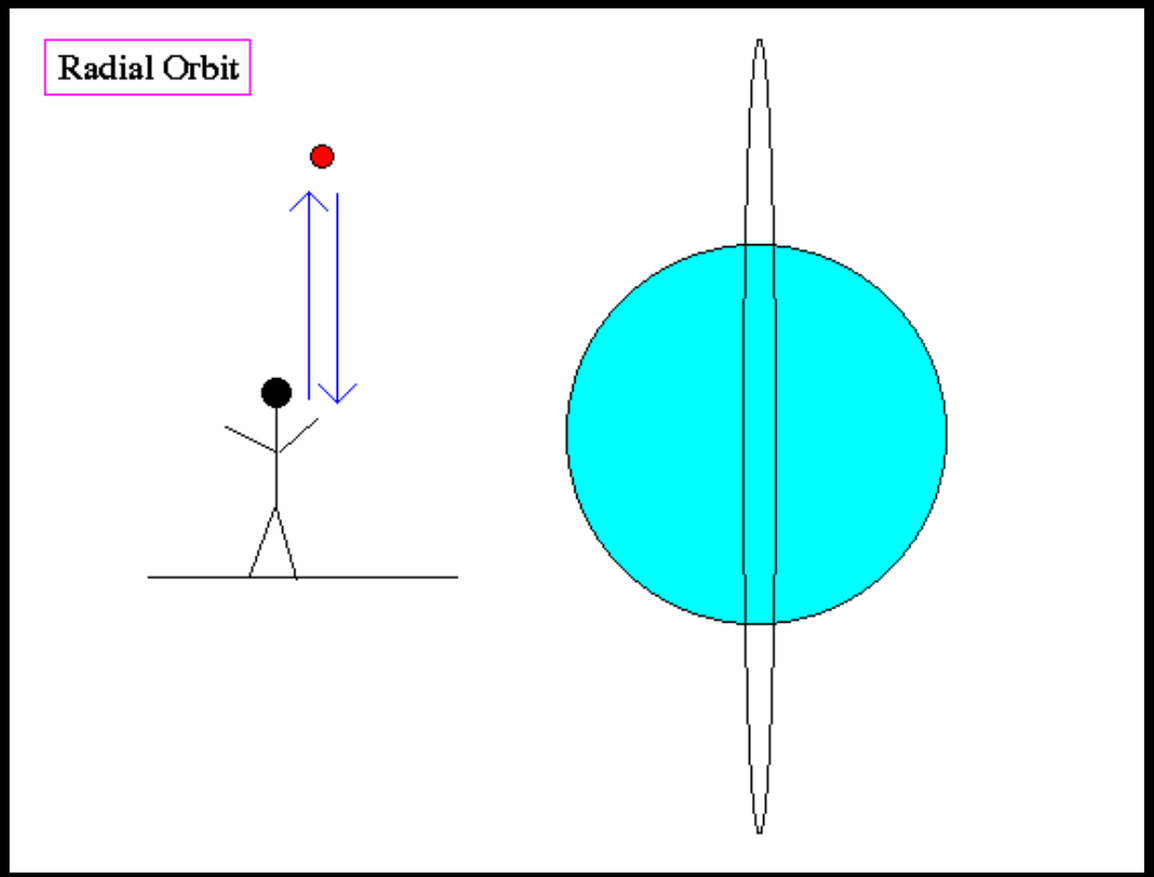
  We can determine $k$ by expressing the formula in units of the Earth and its orbit around the Sun, such that

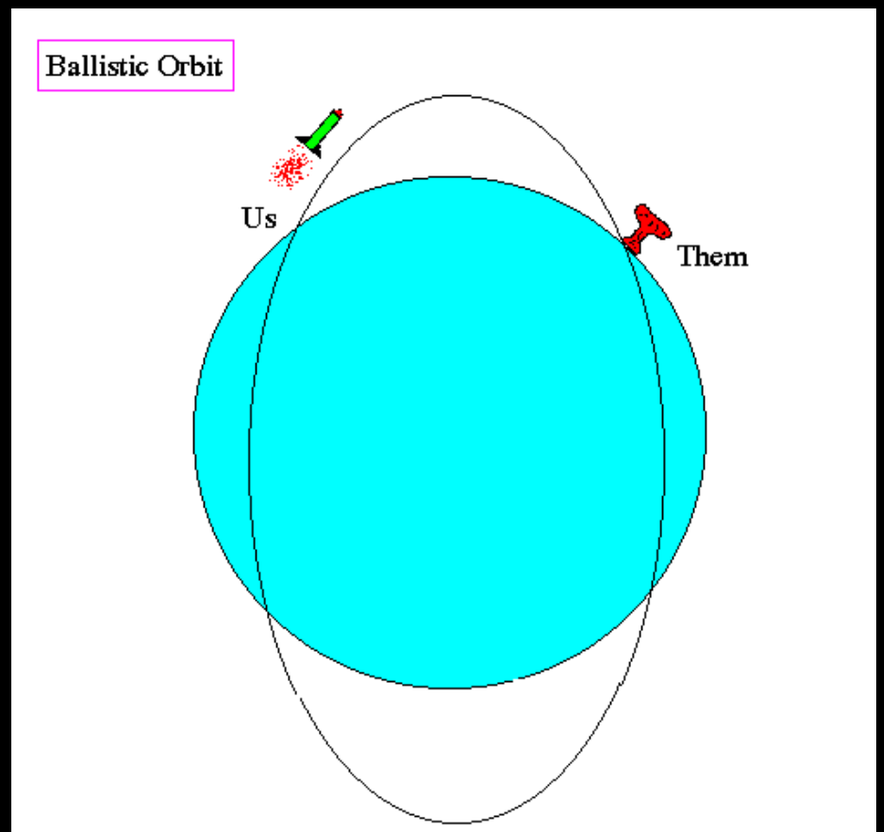
$$(1\ \mathrm{yr})^2 = k\ (1\ \mathrm{A.U.})^3$$

  so $k$ is equal to one, as long as we use units of years and A.U.'s (the Astronomical Unit, i.e. the distance from the Earth from the Sun). With $k$=1, then Kepler's 3rd law becomes

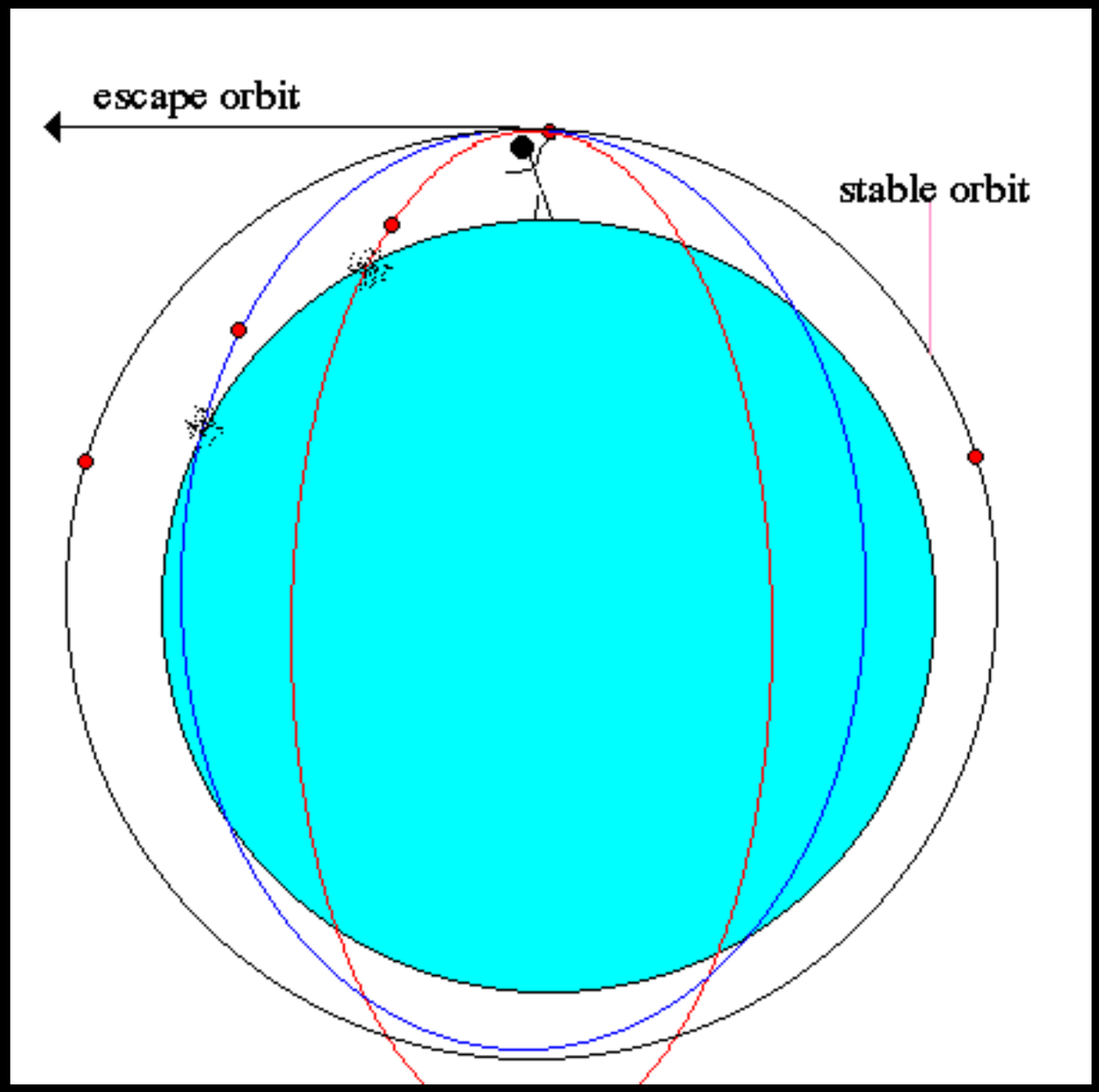
$$P^2 = R^3$$

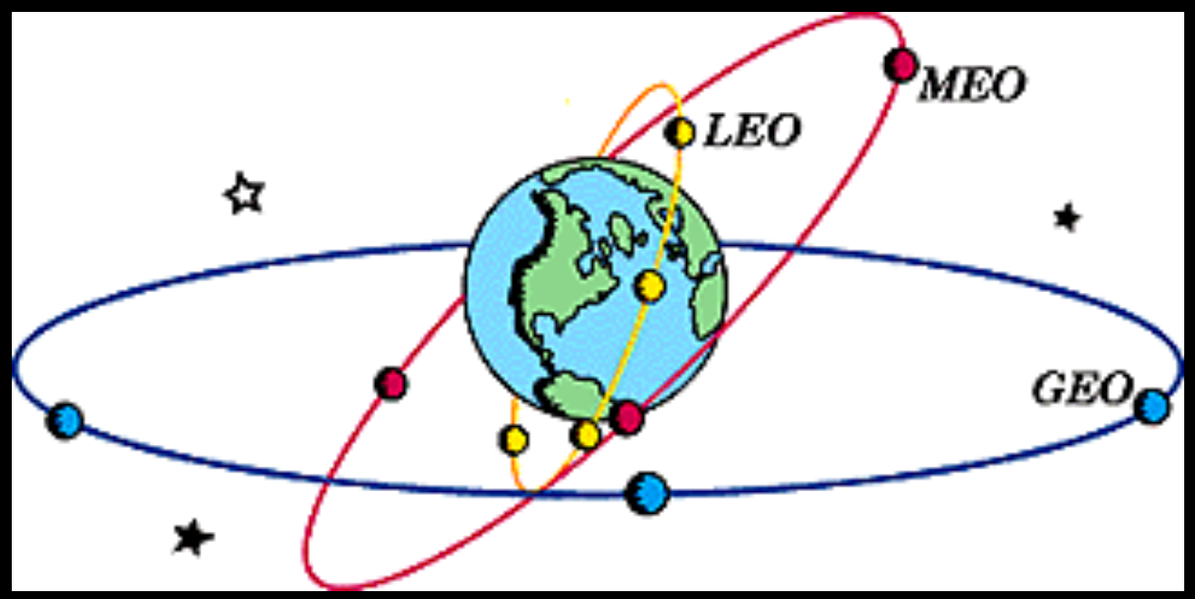
  The 3rd law is used to develop a ``yardstick'' for the Solar System, expressing the distance to all the planets relative to Earth's orbit by just knowing their period (timing how long it takes for them to go around the Sun).

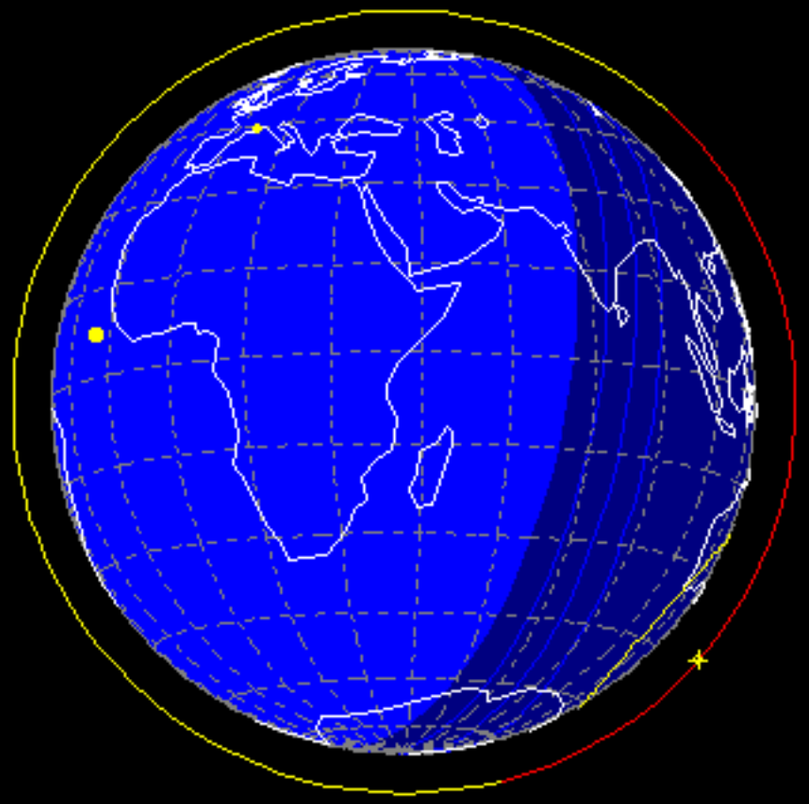


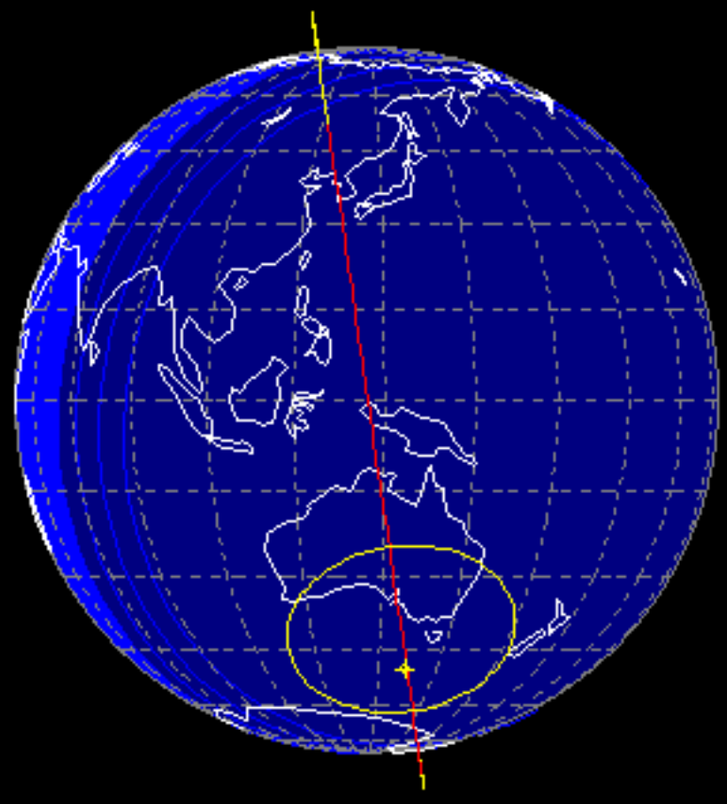



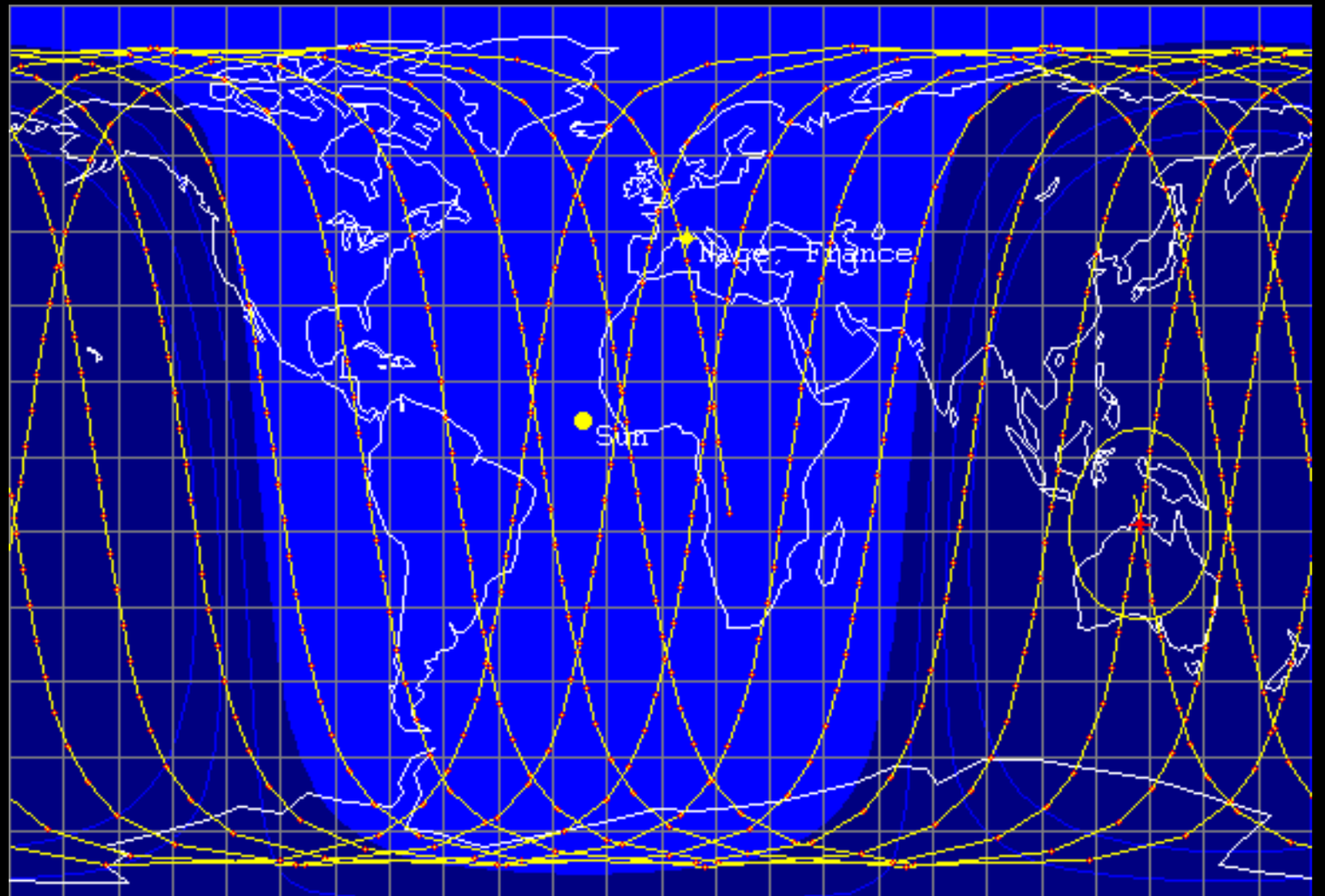

Many years after Kepler, it was shown that orbits actually come in many flavors, ellipses, circles, parabolas and hyperbolas; a family of curves called conic sections. There are three basic types of simple orbits: radial, ballistic, and stable.


escape orbit
stable orbit

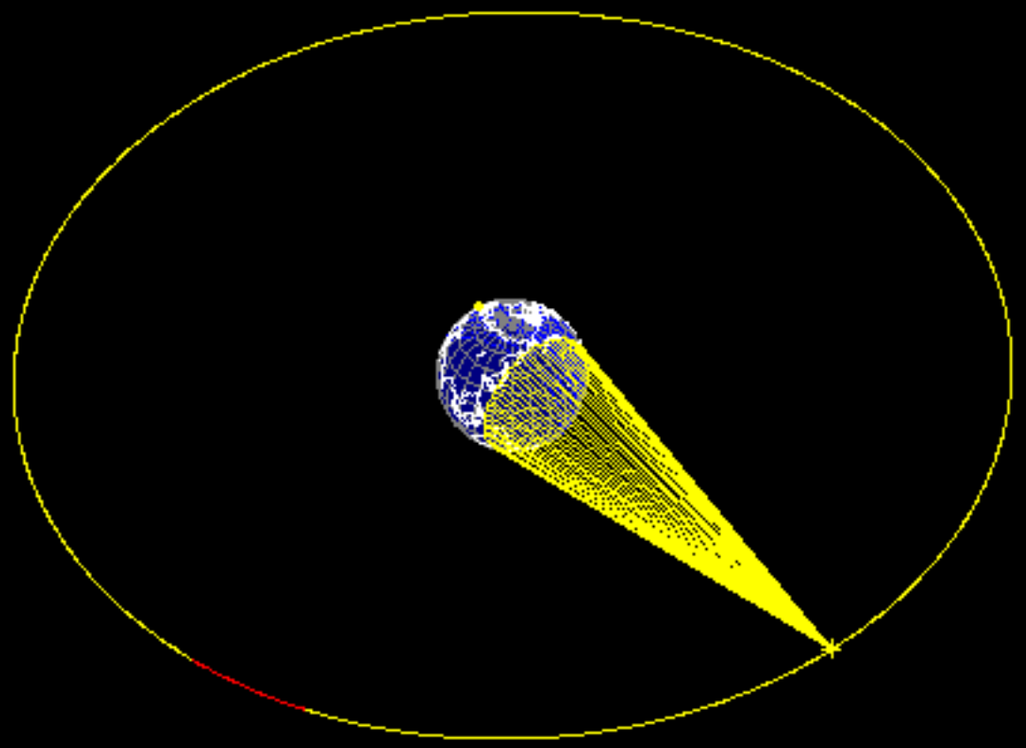

MEO
LEO
GEO

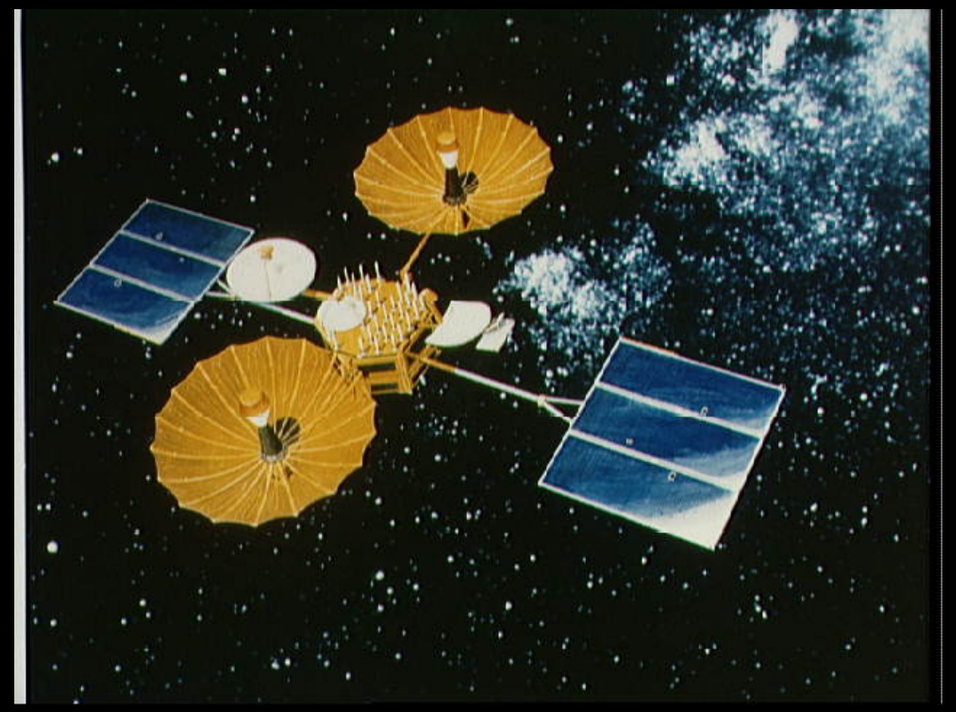




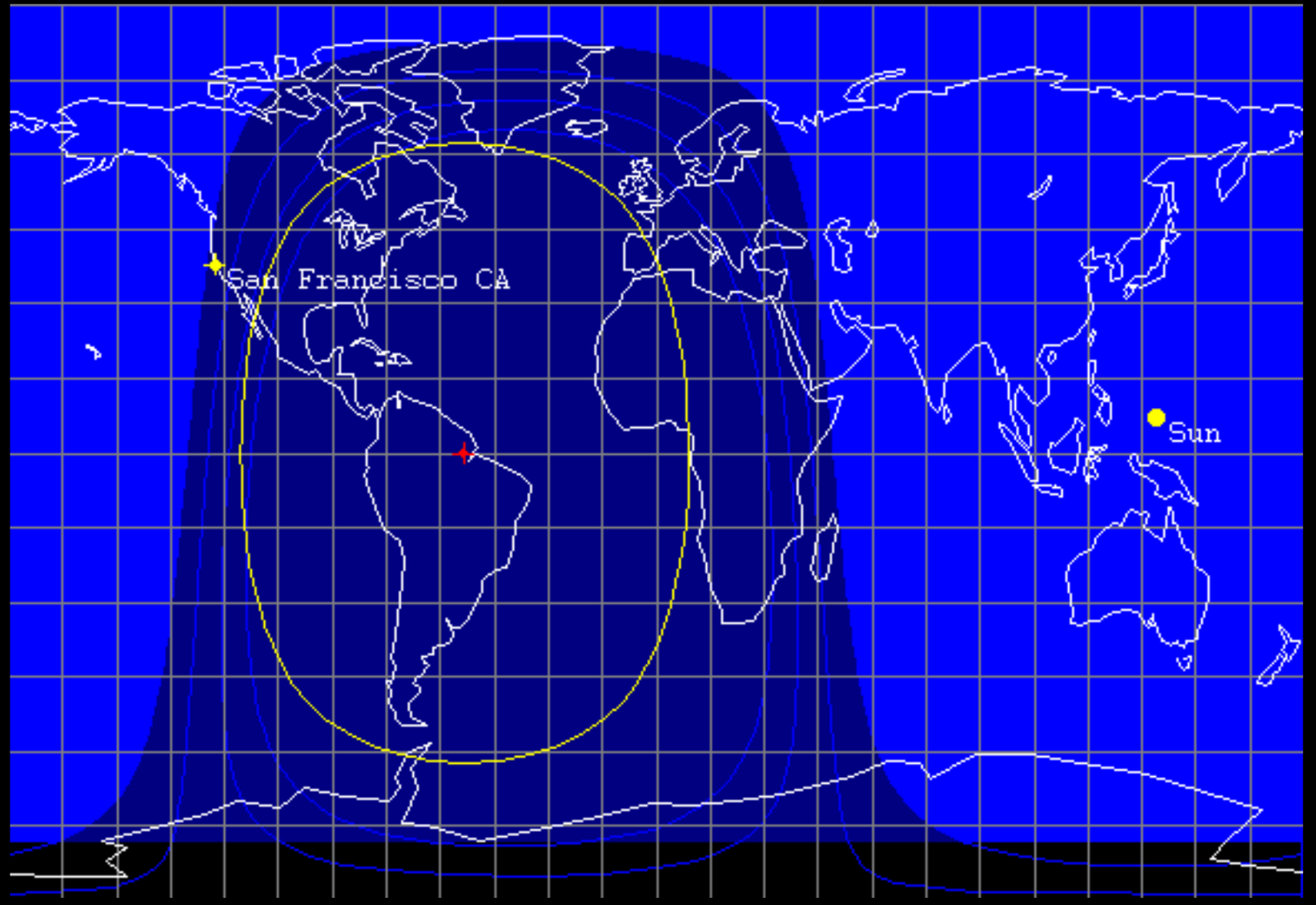


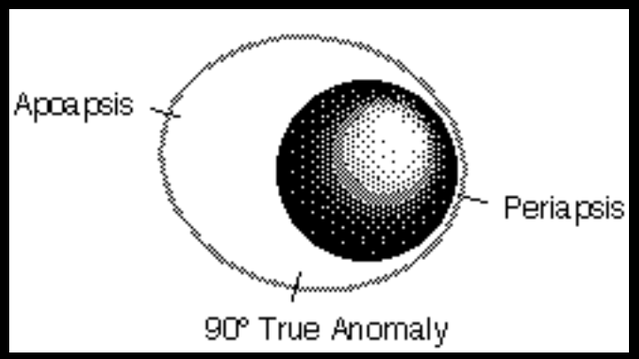

Landsat-7

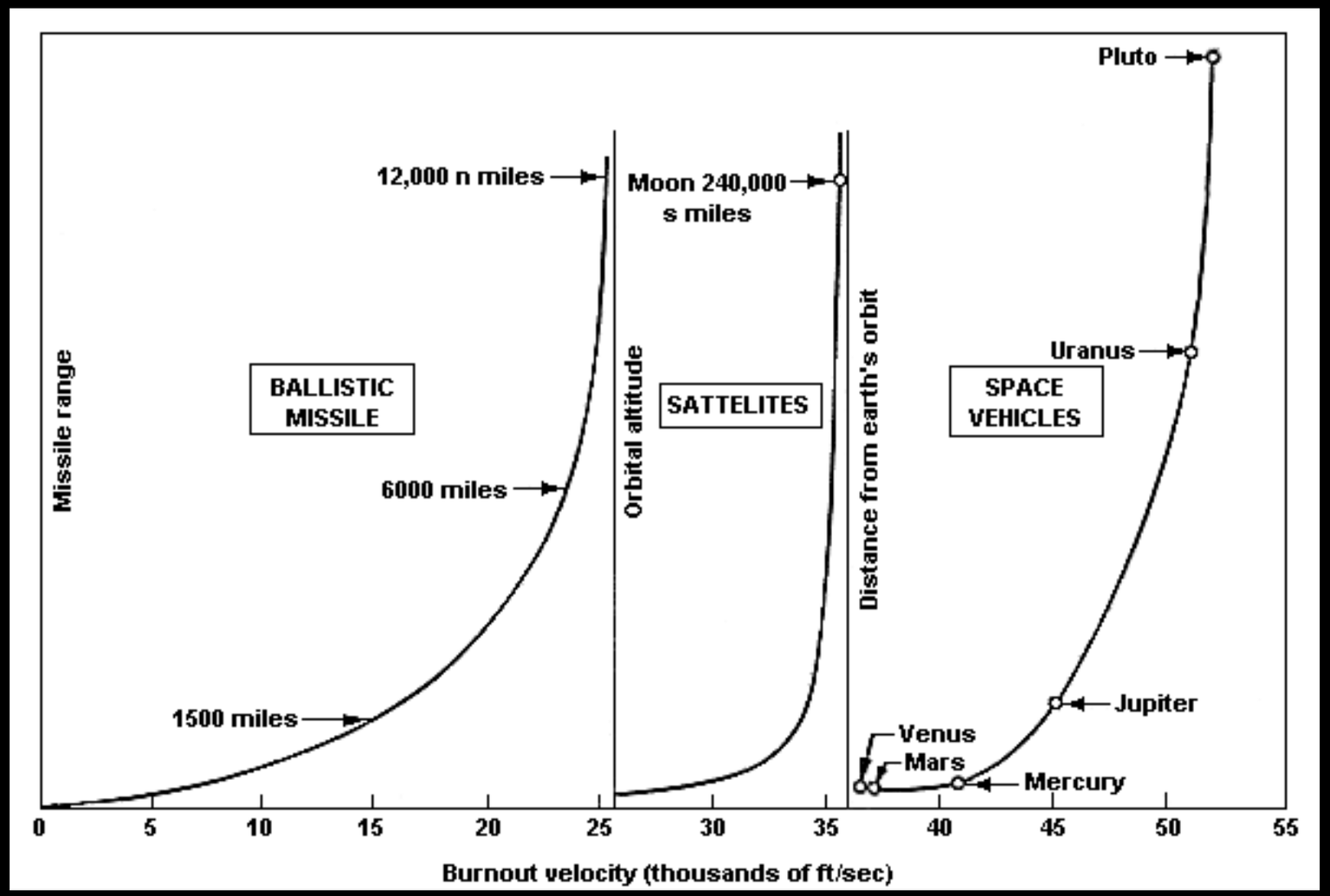




TDRS-7




Apoapsis
Periapsis
90° True Anomaly


Pluto
12,000 n miles
Moon 240,000
s miles
Missile range
BALLISTIC
MISSILE
6000 miles
1500 miles
Orbital altitude
SATTELITES
Distance from earth's orbit
Uranus
SPACE
VEHICLES
Jupiter
Venus
Mars
Mercury
0
5
10
15
20
25
30
35
40
45
50
55
Burnout velocity (thousands of ft/sec)