

# 9 Orbits and Astrodynamics

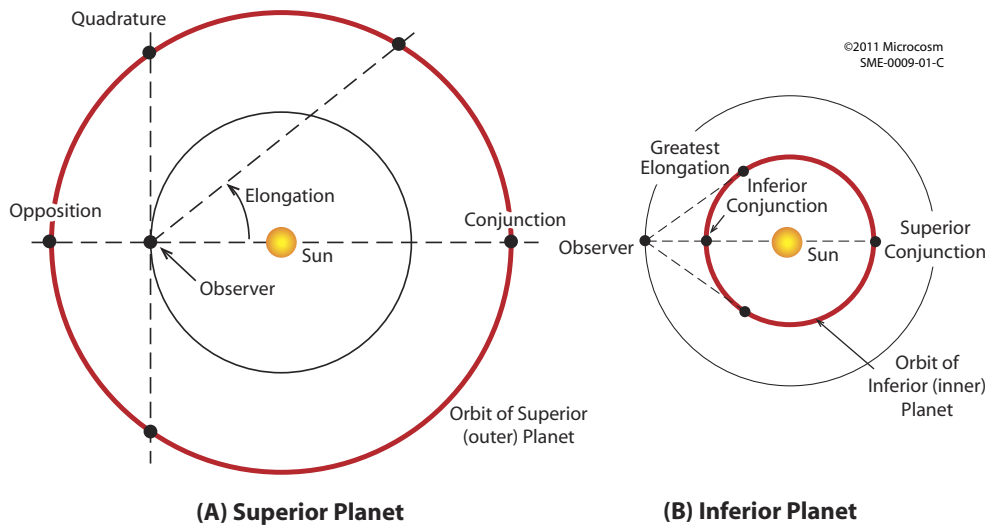
## 9.2 Orbits of the Moon and Planets

### Planetary Configurations

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An *inferior planet* is one with an orbit closer to the Sun than the observer, and a *superior planet* is one farther from the Sun.

*Conjunction* and *opposition* occur when the planet and the Sun are in the same and opposite directions, respectively.\* “The same direction” throughout this discussion is in terms of the relative planet-observer orientation around the ecliptic regardless of the distance above or below the ecliptic plane. Thus, a full Moon occurs when the Moon is at opposition.



**Fig. 9web-1. Planetary Configurations Refer to the Position of other Planets with Respect to the Earth.** They could also be applied to observers on other planets.

Conjunction and opposition may also be applied to two planets. For example, Mars and Jupiter are in conjunction for a particular observer if both planets are in the same direction from the observer. (If only one planet is mentioned, the implied second object is the Sun. “Mars at opposition” means that Mars and the Sun are in opposition.) For an inferior planet, *inferior conjunction* occurs when the planet is between the Earth and the Sun and *superior conjunction* occurs when the Sun is between the Earth and the planet. *Elongation* is the angular separation between a planet and the Sun measured in the plane of the ecliptic. A superior planet will be brightest near opposition, and an inferior planet will be brightest near greatest elongation when it is at the farthest angular separation from the Sun. *Quadrature* occurs when the Sun-observer-planet angle is 90 deg. In astronomical tables the standard symbols defined in Fig. 9web-2 are frequently used for various aspects of the planets. For example, ♀♃♄ is read “Venus and Saturn in conjunction.” For a discussion of visual magnitude and the observability of planets and spacecraft, see Wertz [2009].

♁	☉	●	☾	☽	☾
Conjunction	Sun	New Moon	First Quarter Moon	Full Moon	Last Quarter Moon
♿	♀	♁	♂	♃	♄
Mercury	Venus	Earth	Mars	Jupiter	Saturn
♅	♆	♇	★	☄	◻
Uranus	Neptune	Pluto	Star	Comet	Quadrature
♊	♋	♌	♈	♎	
Ascending Node	Descending Node	Opposition	Aries: Vernal Equinox	Libra: Autumnal Equinox	

**Fig. 9web-2. Standard Astronomical Symbols.**

\* *Syzygy*, an astronomical contribution to crossword puzzles, refers to either conjunction or opposition, i.e., when the planet, the Sun and the observer lie on a straight line. The term is derived from the Greek expression for putting two oxen together (“syn”) on one yoke (“zygnymai”). A bit strange, but then most constellations are named after animals.