

## 57.13: Lagrange Points

In any two-body system (the Sun-Earth system, for example), there are five points called Lagrange points (or libration points) where the net force on a body at that point would be zero. For example, the Sun-Earth Lagrange points are (see Figure 54.2):

1. The  $L_1$  point is between the Sun and the Earth.
2. The  $L_2$  point is on the Sun-Earth line, but farther from the Sun than the Earth.
3. The  $L_3$  point is also on the Sun-Earth line, but on the other side of the Sun.
4. The  $L_4$  point forms an equilateral triangle with the Sun and Earth, and leads the Earth.
5. The  $L_5$  point, like  $L_4$ , forms an equilateral triangle with the Sun and Earth, but trails the Earth.

There is a similar set of five Lagrange points for the Earth-Moon system: the Earth-Moon  $L_1$  point is between the Earth and Moon, etc. One distinguishes between these two sets by referring to them as the "Sun-Earth Lagrange points" and the "Earth-Moon Lagrange points."

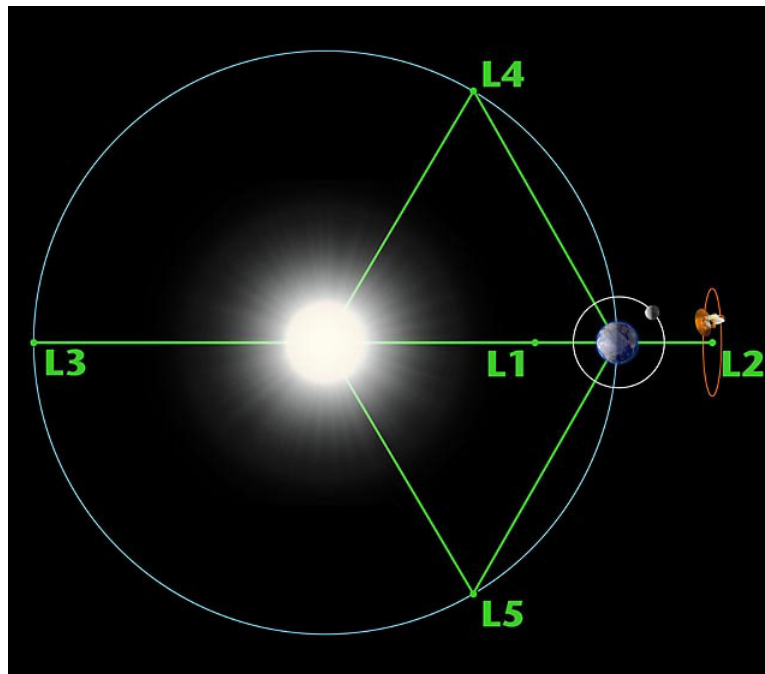


Figure 57.13.1: The Sun-Earth Lagrange points. The Wilkinson Microwave Anisotropy Probe (WMAP) spacecraft is shown orbiting the  $L_2$  Lagrange point in a halo orbit. (Credit: NASA.)

The Lagrange points  $L_1$ ,  $L_2$ , and  $L_3$  are unstable: a body placed at any of those points would experience zero net force, but if it were moved slightly away from the Lagrange point it would continue to move farther away. Lagrange points  $L_4$  and  $L_5$  are both stable: if a body placed at either of these points were moved slightly away from the Lagrange point, the forces present would tend to push it back toward the Lagrange point.

Although Lagrange points  $L_1$ ,  $L_2$ , and  $L_3$  are unstable, spacecraft are often placed at these (Sun-Earth) positions in so-called halo orbits, where the various forces present cause them to move in closed "orbits" around the Lagrange point.

A number of asteroids called Trojan asteroids have accumulated at the Sun-Jupiter  $L_4$  and  $L_5$  Lagrange points.<sup>1</sup> One asteroid (called 2010 TK7) has recently been discovered at the Sun-Earth  $L_4$  point.

<sup>1</sup> By convention, the Trojan asteroids near the  $L_4$  point are given names of characters from the Greek side of the Trojan War chronicled in Greek mythology; the Trojan asteroids near the  $L_5$  point are given names from the Trojan side of the war.