

## Lagrangian Point 2 (L2)

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Sky observations with a satellite telescope require careful design of the satellite structure and its orbit in terms of eliminating light and thermal effects from the sun and the earth. The Lagrangian point 2 (L2) is an excellent position for this purpose.

The two-body problem, such as between the sun and the earth, is analytically solved. Although there is not a general analytical solution on the three-body problem, when three bodies are located in certain special positions, the relative positions of these bodies are kept unchanged in the rotating system. Such positions are points where the sum of gravitational forces from the sun and the earth on the third body, such as a satellite, is balanced with the centrifugal force seen from the satellite. In particular, the circular restricted three-body problem is solved analytically. In this case we assume that the satellite mass is negligible with respect to the masses of the sun and the earth and that their motions can be described as circular. These special points are then called Lagrangian points. At one of five Lagrangian points, L2, a satellite telescope can observe the deep space side at all times against the sun and the earth because they are seen in the same direction from L2. LiteBIRD will use this Lagrangian point.

When 3 bodies located in certain special positions, relative positions kept unchanged.

Particularly (circular restricted 3-body) solved analytically.

sum of gravitational forces balanced with centrifugal force

2-Body  
Isaac Newton

3-Body  
No general analytical solution

$$f_s + f_e = m\omega^2(l_2 - l_e)$$

$$\therefore \frac{GmM_s}{l_2^2} + \frac{GmM_E}{(l_2 - L_0)^2} = \frac{m\omega^2(l_2 - L_0)}{L_0^3} = \frac{mG(M_s + M_E)}{L_0^3} \left( l_2 - \frac{M_E}{M_s + M_E} L_0 \right)$$

$$\frac{M_E}{M_s} = 3.0 \times 10^{-6}$$

$$\therefore l_2 = 1.010 L_0$$

$$\therefore l_2 - L_0 = 0.010 L_0 = 1.5 \times 10^6 \text{ km}$$

Satellite telescope can observe deep space side all the time against sun and earth because they are seen in same direction from L2