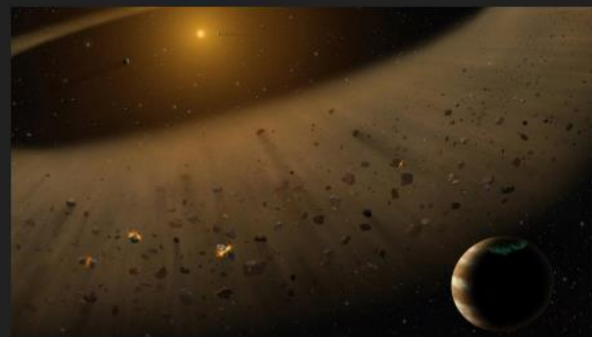
Orbital Dynamics

Everything in the universe with mass experiences the pull of gravity from other objects. This force is pretty accurately approximated with Newton's law of universal gravitation,

$$F_g = G\frac{m_1 m_2}{r^2},$$

where G is the gravitational constant, m_1 and m_2 are the interacting masses, and r is the distance between them. For consistency, m_1 is the more massive object and m_2 is the less massive object.



Credit: NASA/SOFIA/Lynette Cook

Orbital Dynamics

A simple, but useful, type of gravitational system to investigate is the orbit of a planet, comet, asteroid, or something similar around a much more massive star. In these extreme scenarios where one object is more massive than the other, you only need to calculate the motion of the less massive object.

Because F=m*a, where m is the small, orbiting mass and is the same as 'm_2', Newton's law of gravity can be reformulated for acceleration 'a',

$$a_2 = G\frac{m_1}{r^2},$$

which is simpler to calculate.

Other useful quantities that can be calculated are the angular momentum,

$$L = rm_2v,$$

and the total orbital energy,

$$E = -G\frac{m_1 m_2}{2r},$$

of the orbiting object, where 'v' is the orbital velocity.