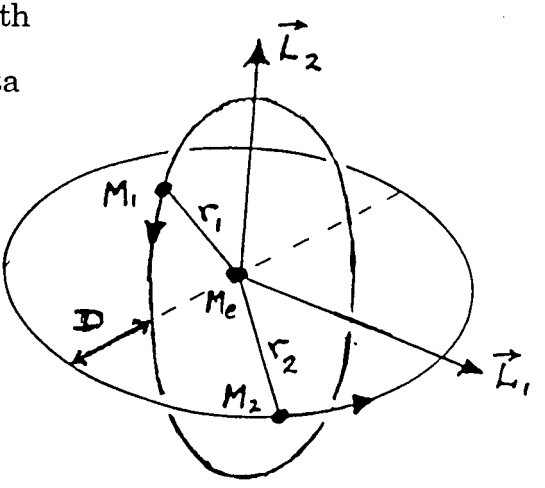
CM Spring98A

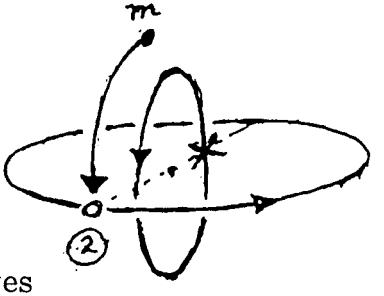
Two satellites with masses (M_1,M_2) orbit the Earth at constant radii ($r_1<r_2$). Their angular momenta ($\vec{L}_1$,$\vec{L}_2$) are perpendicular to each other. Treat the Earth as a point source at r = 0, with a mass M_e and let G be the gravitational constant. Only consider the gravitational attraction of the Earth. All velocities are expressed in the inertial rest frame of the Earth.



(a) Determine the magnitudes of ($\vec{L}_1$,$\vec{L}_2$) in terms of (M_1, M_2, r_1, r_2, G, M_e).

(b) The two orbits have a distance of closest approach, D (see figure). What are the possible values of r_1/r_2, if satellite 1 is at distance D from satellite 2 at every period of satellite 2?

(c) Satellite 1 is at an arbitrary $r_1<r_2$. It ejects a canister of mass m along it's direction of motion at the point marked X, (see figure) in such a way that the canister arrives at 2 perpendicular to satellite 2's plane of motion. Determine the initial velocity of the canister with respect to the Earth.



(d) Determine the time of flight of the canister from satellite 1 to satellite 2 in terms of (M_e, G, r_1, r_2).

[Hint: The period T of a particle in an elliptical orbit is given by $T \propto a^{3/2}$, where a is the semi-major axis of the ellipse.]