SOLAR SYSTEM

Exercise Sheet 2

Distributed: 4 November, 2010. *Collected*: 18 November, 2010.

2.1 (60%)
Several advertisements were placed in British newspapers in 1994 by a person claiming that the unusual Comet Shoemaker-Levy 9 was part of Comet Halley. (a) Use the information in Section A.3 and the data in Table A.19 to calculate the heliocentric radial distance (in AU) of Comet Halley at 12h UT on July 16, 1994. (b) Assuming that the heliocentric semi-major axis of Comet Shoemaker-Levy 9 was the same as that of Jupiter ($a \approx 5.20$ AU), and that the masses of both comets are negligible compared to the mass of the Sun, estimate how much orbital energy per unit mass (in Joules per kg) would be required to change the orbit of Comet Shoemaker-Levy 9 to that of Comet Halley.

2.2 (40%)
Using the standard system of units for the planar, circular, restricted three-body problem, the equation defining the zero velocity curves is $C_{\rm J} = x^2 + y^2 + 2(\mu_1/r_1 + \mu_2/r_2)$ where $C_{\rm J}$ is the value of the Jacobi constant, and $r_1 = \sqrt{(x + \mu_2)^2 + y^2}$ and $r_2 = \sqrt{x - \mu_1)^2 + y^2}$ are the distances to the masses μ_1 and μ_2, respectively. The critical zero velocity curve that passes through the L_3 equilibrium point (where $C_{\rm J} \approx 3 + \mu_2$) has two branches. Use polar coordinates to show that for small mass ratios each of the curves crosses the unit semi-major axis at points with an angular separation of 23.9° from the secondary mass.

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