

Celestial Mechanics – Exercises

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Unit 4

Problem 4.1

Use Kepler's equation to calculate the eccentric anomaly E and then the true anomaly θ for $e = 0.9$ and $M = 120^\circ$. (2 points)

Problem 4.2

Sketch the heliocentric orbits and current positions of two famous comets, Halley and Hale-Bopp (see Table 1, where θ is the true anomaly), projected into the ecliptic plane (i.e. with the observer along the positive z axis). Indicate the direction of the orbital motion. (2 points)

Table 1: Current (8 Nov 2023) orbital elements of comets Halley and Hale-Bopp

Object	a [au]	e	i [°]	Ω [°]	ω [°]	θ [°]
Halley	17.9	0.968	162	59	112	179.97
Hale-Bopp	177	0.995	89	283	130	165

Bonus: when will Halley's and Hale-Bopp's next aphelion passages take place? (+1 point)

Problem 4.3

Use $r = a(1 - e \cos E)$ to find the points in (complex!) time at which the Earth hits the Sun along its elliptic orbit. (2 points)

Bonus: Plot your result. (+2 points)

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