Physics of Planetary Systems — Exercises — Set 8

Problem 8.1 *(2 points)*

Consider a lens at a distance of 2 kpc and a source at a distance of 10 kpc. Calculate the magnification and duration of a microlensing event where the lens passes at a closest distance of 0.01 milliarcseconds from the source for the following lenses:

(a) a Sun-like star,
(b) a Jupiter-mass planet, and
(c) an Earth-mass planet.

Problem 8.2 *(2 points)*

Imagine you measure the arrival times of pulses from a pulsar (with $\mathscr{M}_* = 1.4\ \mathscr{M}_\odot$) and you note that the times deviate periodically (with a period $P = 1$ yr) by up to ± 1 ms from those expected for constant intervals. What is the minimum mass of a possible companion that could cause this deviation. *Hint: assume a circular orbit.*

Problem 8.3 *(2 points)*

Instead of a 3-dimensional disk of planetesimals, consider a 2-dimensional one: all planetesimals are still spherical, but their centers all lie in one and the same plane. Show that in such a flat disk the runaway growth is not possible.
Hint: systematically replace all 3D quantities in the formulas of runaway growth by their 2D counterparts.

Problem 8.4 *(2 points)*

Assume the surface density of the planetesimal swarm in the early Solar System to be $\Sigma = 10$ g cm^{-2} at 1 au and 3 g cm^{-2} at 5 au. Estimate the masses and orbital separations of finished oligarchs at these distances.

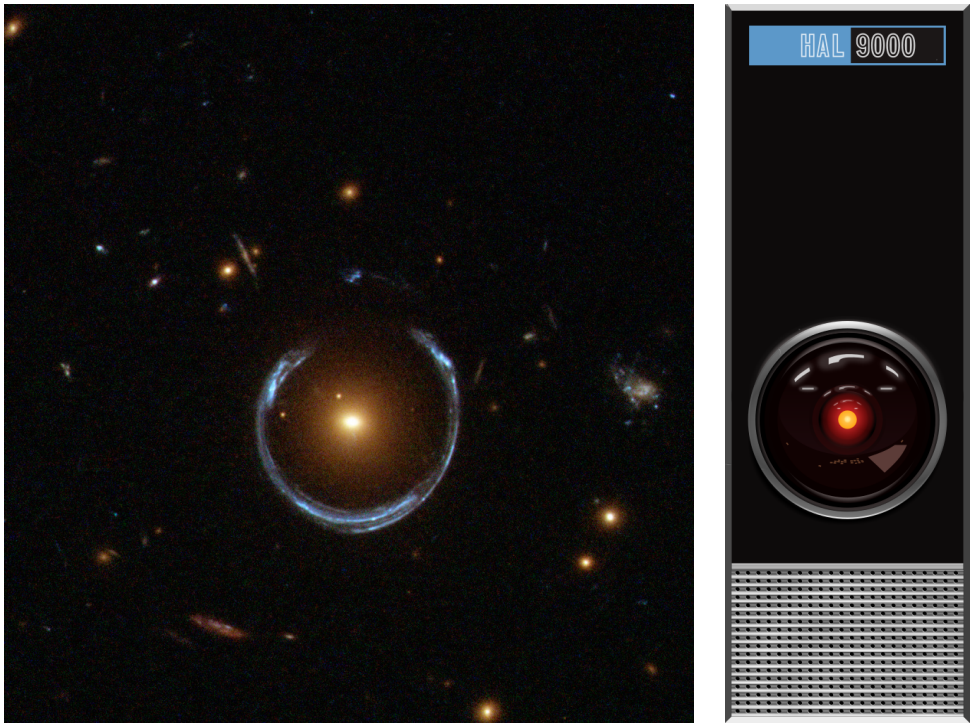

Figure 1: Left: Luminous Red Galaxy 3-757 bends the light of a bluish background galaxy into an Einstein ring/horseshoe (ESA/Hubble and NASA). Right: interface of HAL 9000 from "2001: A Space Odyssey" (Wikimedia Commons).

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