Physics of Planetary Systems — Exercises

Astrophysikalisches Institut und Universitätssternwarte Jena
Thüringer Landessternwarte Tautenburg

Distributed: 2009-06-03; results due: 2009-06-10.

Set 6

Problem 6.1

Give at least 3 advantages and 3 disadvantages of the microlensing technique. *(1 point)*

Problem 6.2

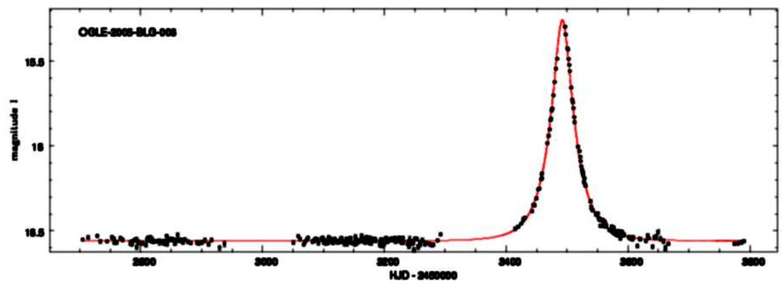
Consider a lens at a distance of 2 kpc and a source at a distance of 10 kpc. Calculate the magnification and duration of a microlensing event where the lens passes at a closest distance of 0.01 milliarcseconds from the source for the following lenses: (a) a solar type star, (b) a Jupiter-mass planet, and (c) an Earth-mass planet. *(2 points)*

Problem 6.3

It is usually assumed that gravity dominates the dynamics of planetesimals bigger than 1 km. Check this with a direct estimate. To this end, calculate the gas drag force on a planetesimal of radius s (in the solar nebula at 1 AU from the Sun, gas density $\rho_{\text{gas}} \sim 10^{-6}$ kg m^{-3}) and then the gravitational force between two planetesimals of size s during their close encounter. At which size are both forces equal? Why is the result far from the expected 1 km? *(2 points)*

Problem 6.4

Estimate the planetesimal radius s starting from which gravity becomes important with quite a different method. It is known that, if two planetesimals collide and destroy each other, the resulting fragments will have typical relative velocities ~ 10 m s^{-1}. However, the debris cloud might immediately reassemble by mutual gravity. What is the minimum radius s that makes such rebound possible? *(1 point)*



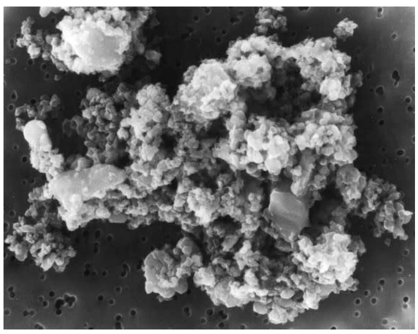


Figure 1: *(Left)* The light curve for the prominent microlensing event OGLE-2005-BLG-006. *(Right)* A micrometeorite 10 µm wide, collected from the antarctic snow. (D. Brownlee)

Web: `http://www.astro.uni-jena.de/Users/tloehne/planetensysteme/uebungen.html`
E-Mail: `tloehne@astro.uni-jena.de`