Microlensing: Theory, Practice, Results, Future

Workshop 1

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Outline

In this workshop we will:

- Become familiar with the existing online survey and follow-up webpages
- Download and plot example lightcurves
- Fit single-lens lightcurves using Matlab
- Trace the degeneracy between fit parameters $u_{\rm min}$ and t_E

Investigate Survey data

1. Take a look at the following websites:
   - OGLE http://www.astrouw.edu.pl/ ogle/ogle3/ews/ews.html
   - MOA https://it019909.massey.ac.nz/moa/alert.php
   - PLANET http://planet.iap.fr/currentevents.html

   And look at the current and past events.
2. Download a photometry lightcurve data from either MOA or OGLE.
3. Take look at the structure of the datafile, and read it into Matlab using the `textread` function.

textread

From the command line:

- For OGLE data:

```
[JD Imag eImag f1 f2] =

textread('phot.dat','%f %f %f %f %f');
```

- or type

```
help textread
```

plot

Plot the data:

- `plot(JD,Imag,'.')`
- `errorbar(JD,Imag,eImag,'.')`
- `set(gca,'ydir','reverse')`

Produce single-lens lightcurves

1. Using the equations covered in lectures, create single lens lightcurves:
   - Parameters include $u_{\min}$, t_0, t_E
   - May want to work in normalised time $t_N = (JD - t_0)/t_E$
   - Hint: temporal scale $\equiv$ distance scale for normalised time units.
2. Can you create a Matlab function to do this?

Single lens formulae

$$u(t) = \left[u_{\rm min}^2 + \left(\frac{v_\perp \cdot (t - t_0)}{R_E} \right)^2 \right]^{\frac{1}{2}}$$

$$u(t) = \left[u_{\rm min}^2 + t_N^2 \right]^{\frac{1}{2}}$$

$$\mu = \frac{u^2 + 2}{u\sqrt{u^2 + 4}}$$

Fitting single-lens lightcurves

In order to to the non-linear fitting of single lens lightcurves, we will use the `fminsearch` Matlab function.

1. You will need to define a function to minimise, based on χ^2.
2. This function needs to produce amplifications, given $u_{\rm min}$, t_0 and t_E, at observed times JD_i, and compared to observed fluxes.

Fitting Single Lens

Look at:

- `singlefitter.m`
- `lensfn.m`
- `lensfitfnc.m`

Variation

By varying $u_{\min}$ and t_E on a grid, see how χ^2 changes with these two parameters for the given set of data.