GRAVITATIONAL LENSING

11 - MICROLENSING LIGHT CURVES: BREAKING THE MICROLENSING DEGENERACIES

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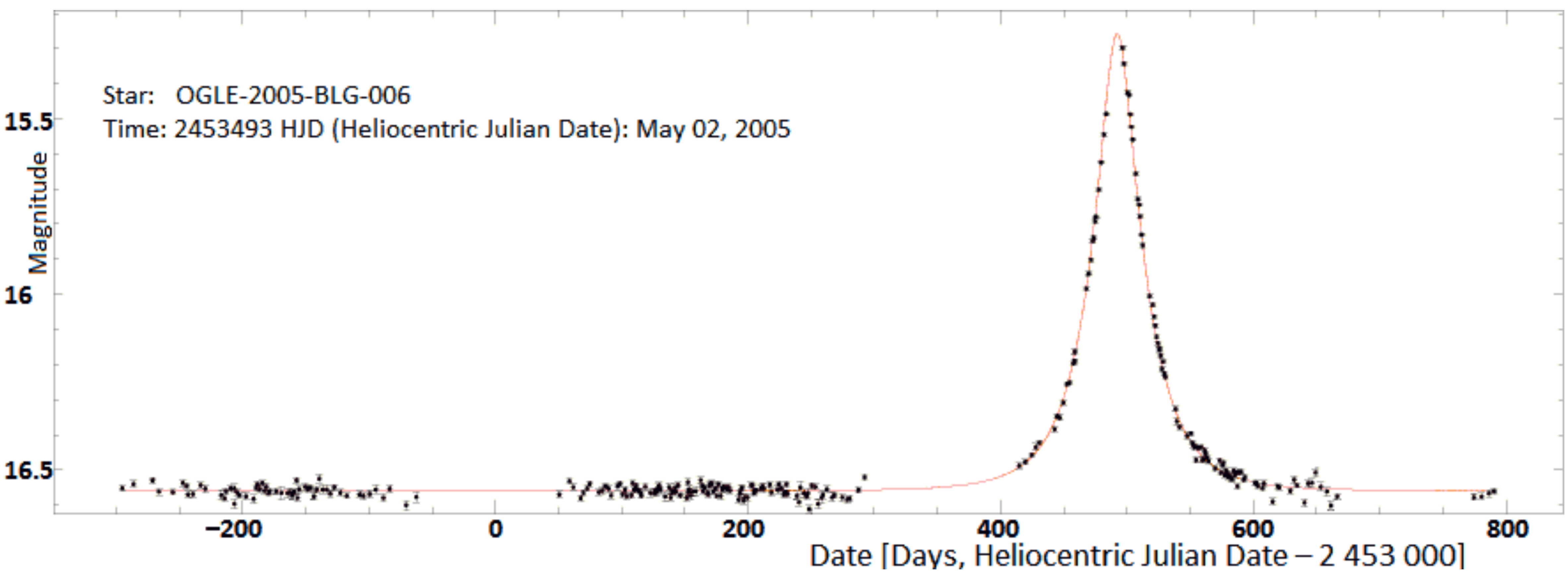
EXAMPLE OF STANDARD LIGHT CURVE



MICROLENSING DEGENERACY AND ITS BREAKERS

- As seen, from the standard light curve we can measure the Einstein crossing time, which is a degenerate combination of the lens mass, distance and velocity
- Thus it is impossible to characterise the lens and the source of a single event through light curve measurement alone…
- … unless special circumstances are present!

FINITE SOURCE EFFECTS

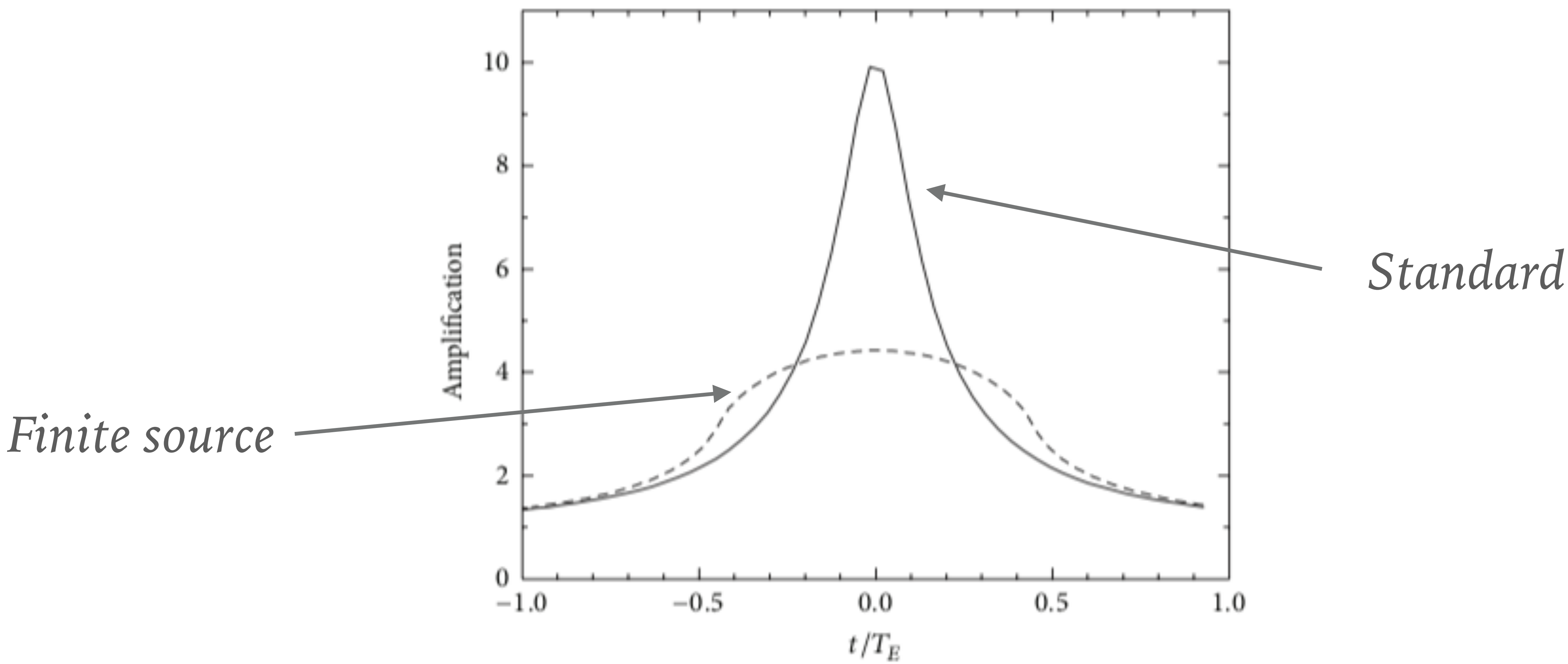
- So far, we have assumed that source are point-like
- In practice, while the lens transits the surface of an extended source during the course of microlensing, this approximation is no longer valid
- The correct calculation of the source magnification in this case requires to integrate the magnification over the surface of the source:

$$\mu_{FS}(y\,|\,\rho_s) = \frac{\int_0^{2\pi}\int_0^{\rho_s} d\varphi dr r \mu\left(\sqrt{(y + r\cos\varphi)^2 + (r\sin\varphi)^2}\right)}{\int_0^{2\pi}\int_0^{\rho_s} d\varphi dr r}$$

$$\rho_s = \frac{\beta_*}{\theta_E}$$

FINITE SOURCE EFFECTS

Hamolli et al (2015)



We can fit the light curve with an additional parameter (ρ_S), and use some empirical relation to measure the source size from the source color and magnitude. For example, Kervella et al. (2004) find:

$$\log(2\beta_*) = 0.0755(V - K) + 0.517 - 0.2K$$

Then, we can infer the Einstein radius.

ASTROMETRIC MEASUREMENT OF THE RELATIVE PROPER MOTION

- Another method to measure the Einstein radius is by measuring the relative proper motion of source and lens.
- This requires to see the lens!
- If we have high resolution imaging with HST or ground based AO, we can measure the position of lens and source at some time after the maximum of the light curve Δt
- If we measure a shift $\Delta\theta$ then $\mu_{rel} = \Delta\theta/\Delta t$ and

$$\theta_E = t_E \times \mu_{rel}$$