OGLE-2015-BLG-0845: A Bulge M dwarf Lens From Combination of Xallarap and Parallax Effect

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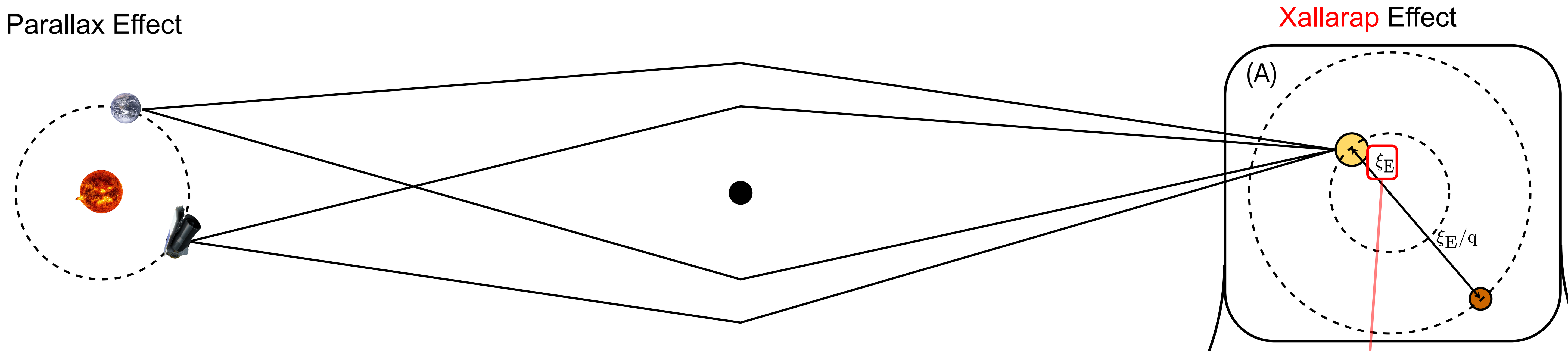
Motivation: Einstein radius θ_E is the only observable available to measure the mass and distance of a single dark lens together with the parallax parameter π_E.

Result: Here we show that, the microlensing event OGLE-2015-BLG-0845 is affected by both the parallax and xallarap effects, where **the xallarap effect provides extra information on the Einstein radius θ_E.**

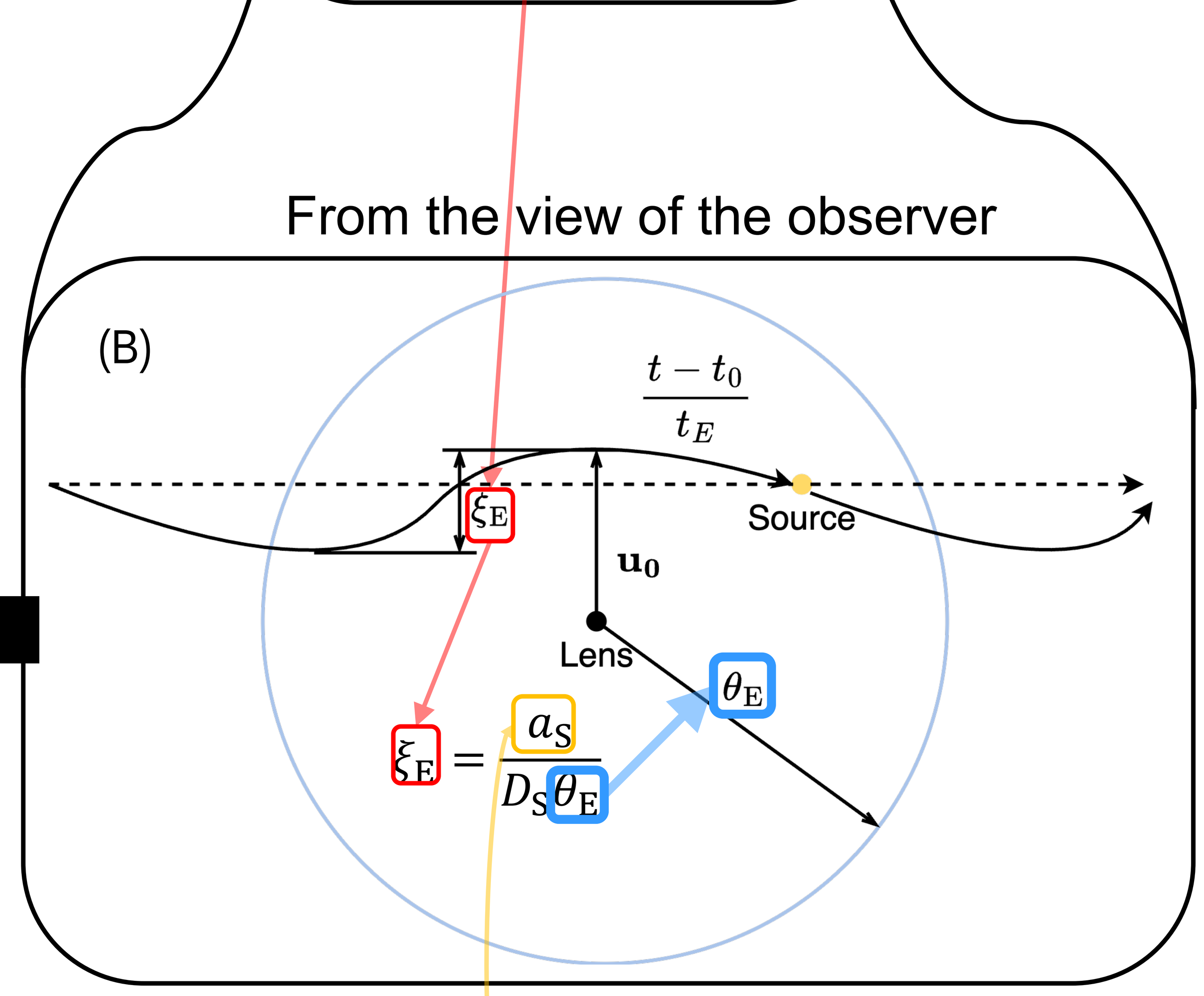
Modeling



Scan the QR code to see how xallarap works (YouTube video)

Xallarap Effect

Binary motion (A) → Perturbed Trajectory (B) → Perturbed Magnification (C)

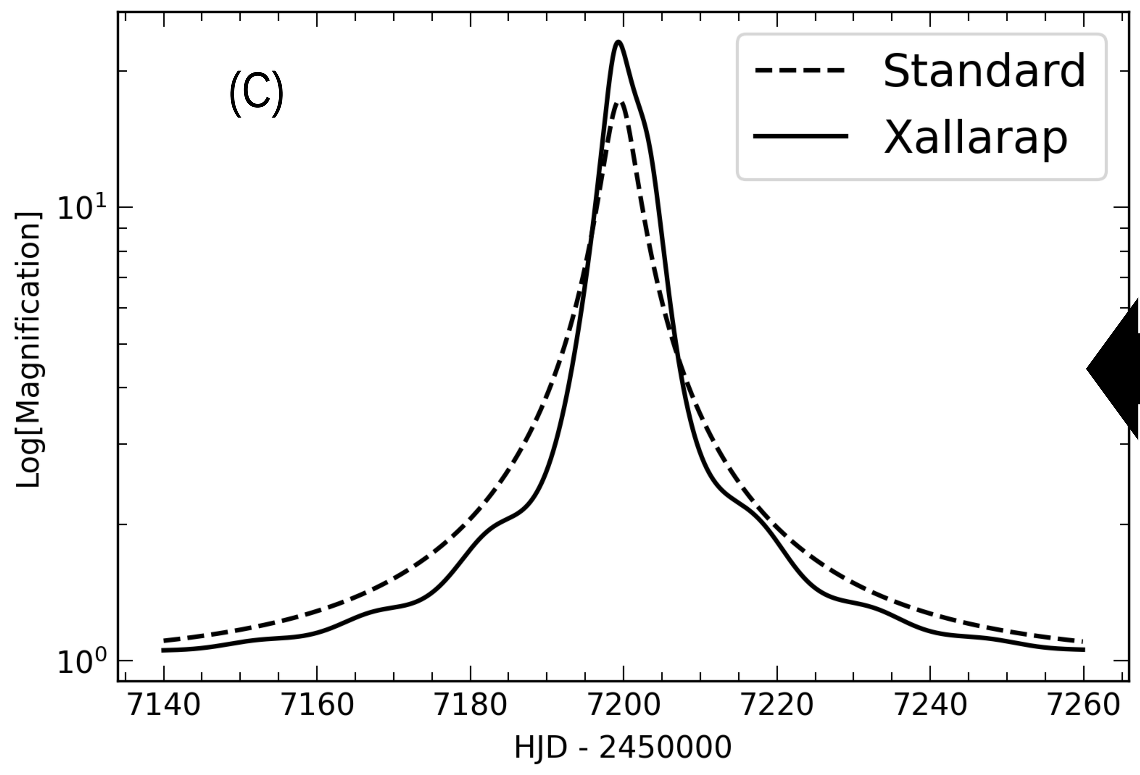


Key Parameters

ξ_E : The angular size of the semi-major axis of the primary source relative to the Einstein radius

θ_E: Einstein radius

a_S : Absolute value of the semi-major axis of the source



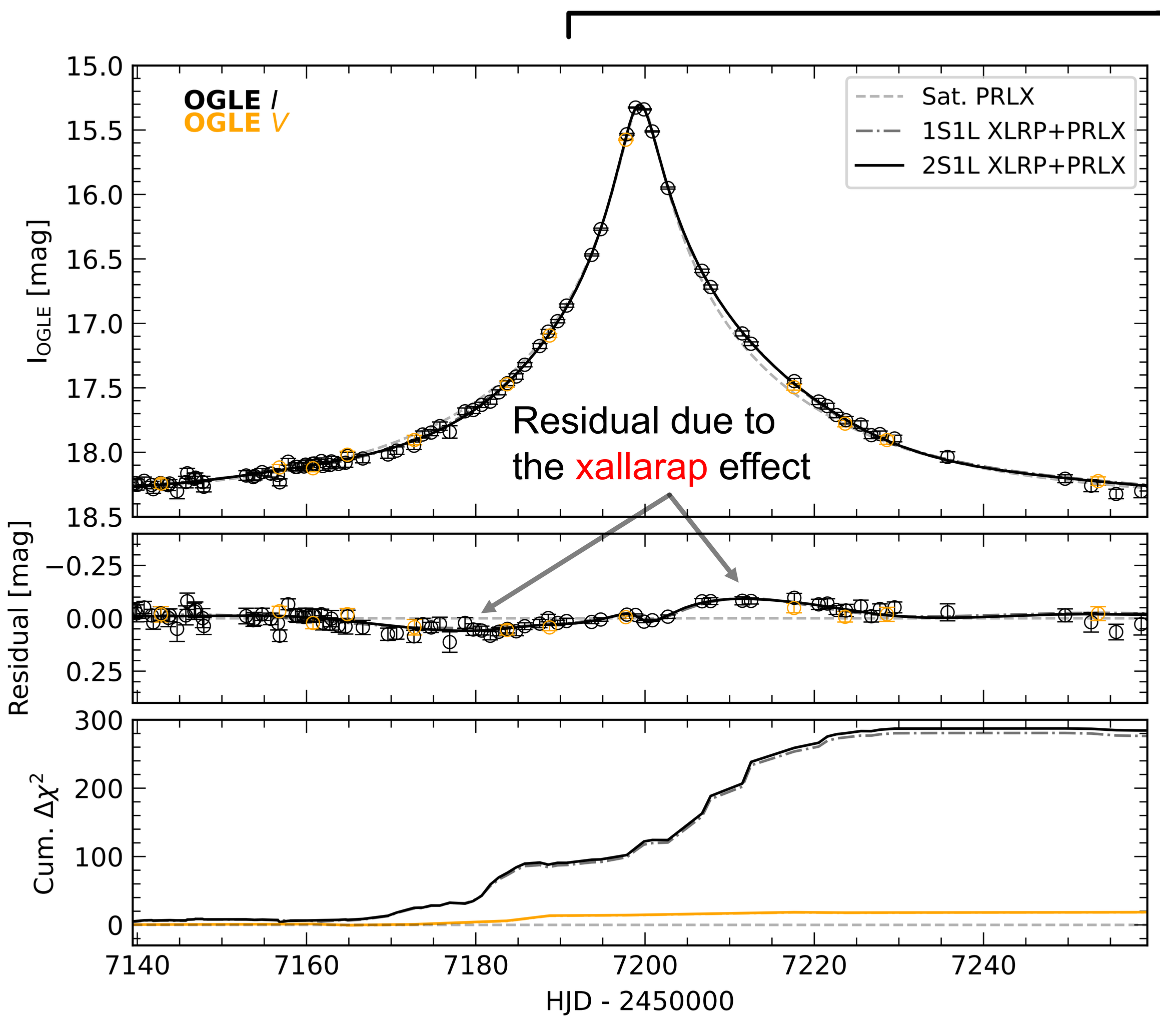
From Xallarap to Einstein Radius

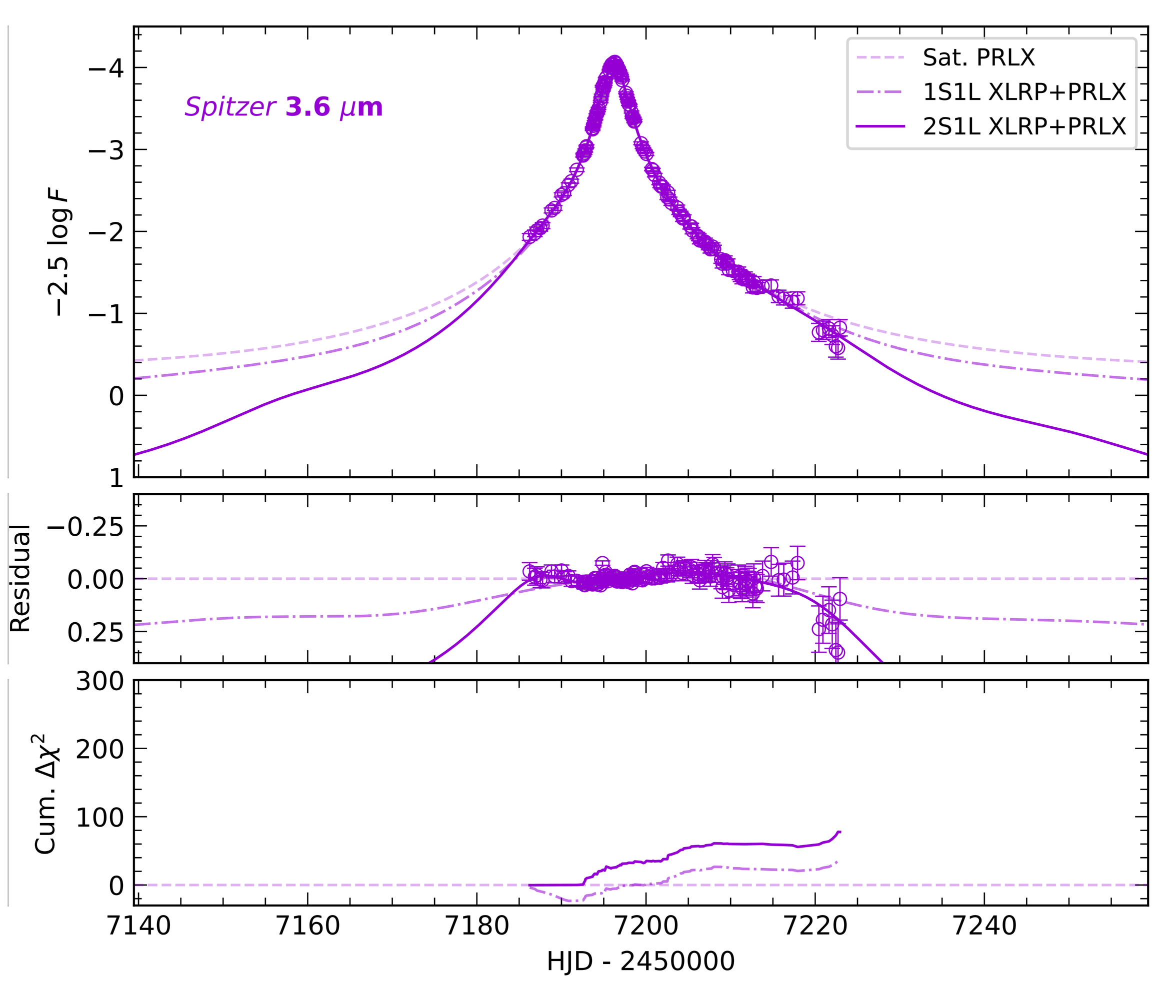
1. model light curve → ξ_E and orbital period P_ξ
2. Model CMD → M_1, M_2
3. Kepler's third law → a_S.
4. $\theta_E = \frac{a_S}{D_S \xi_E}$

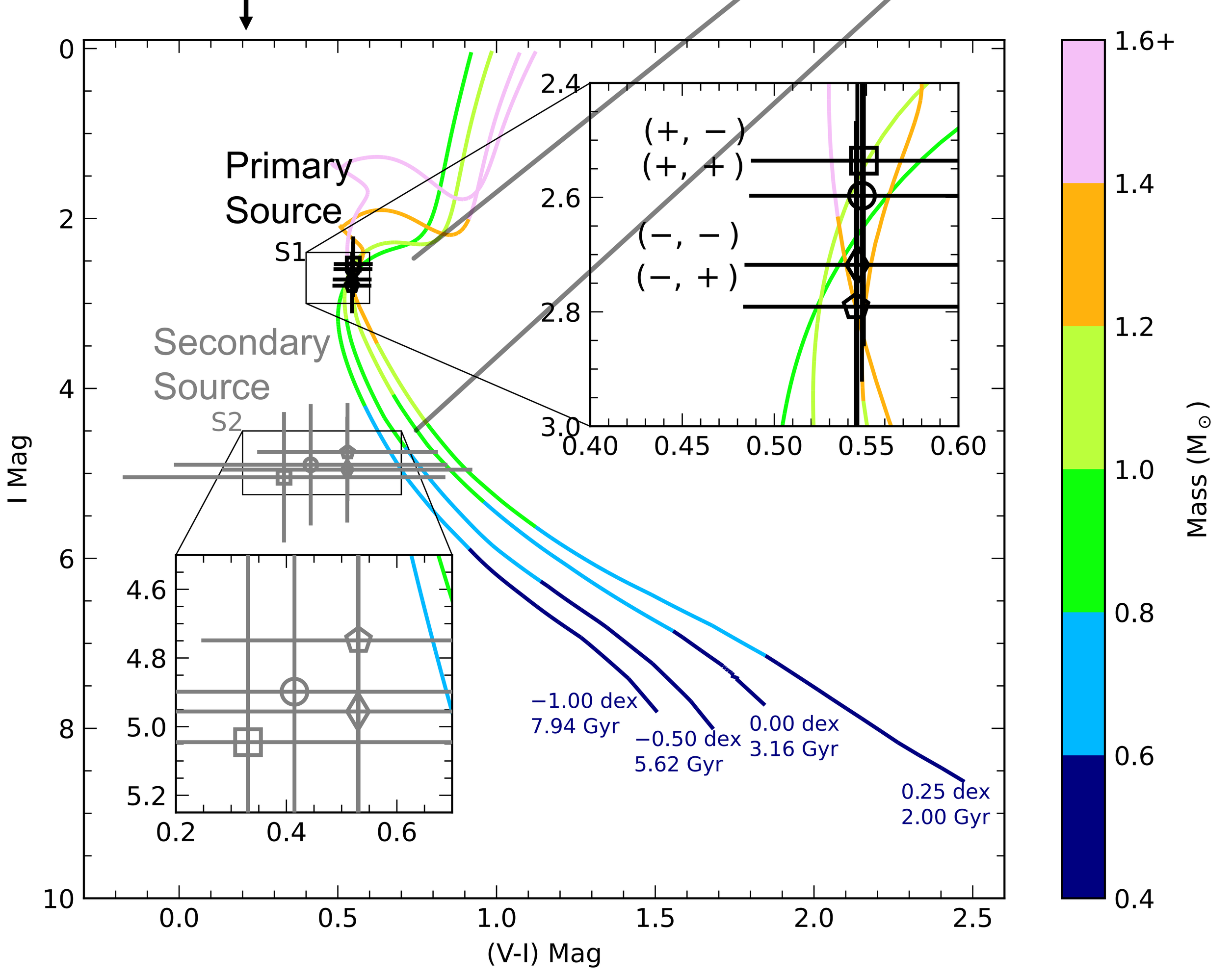
Orbital period p_ξ

$$\frac{P_\xi^2}{\mathrm{year}^2}\frac{\mathrm{AU}^3}{a_S\left(1+\frac{M_1}{M_2}\right)} = \frac{M_\odot}{M_1+M_2}$$

I and V band magnitude





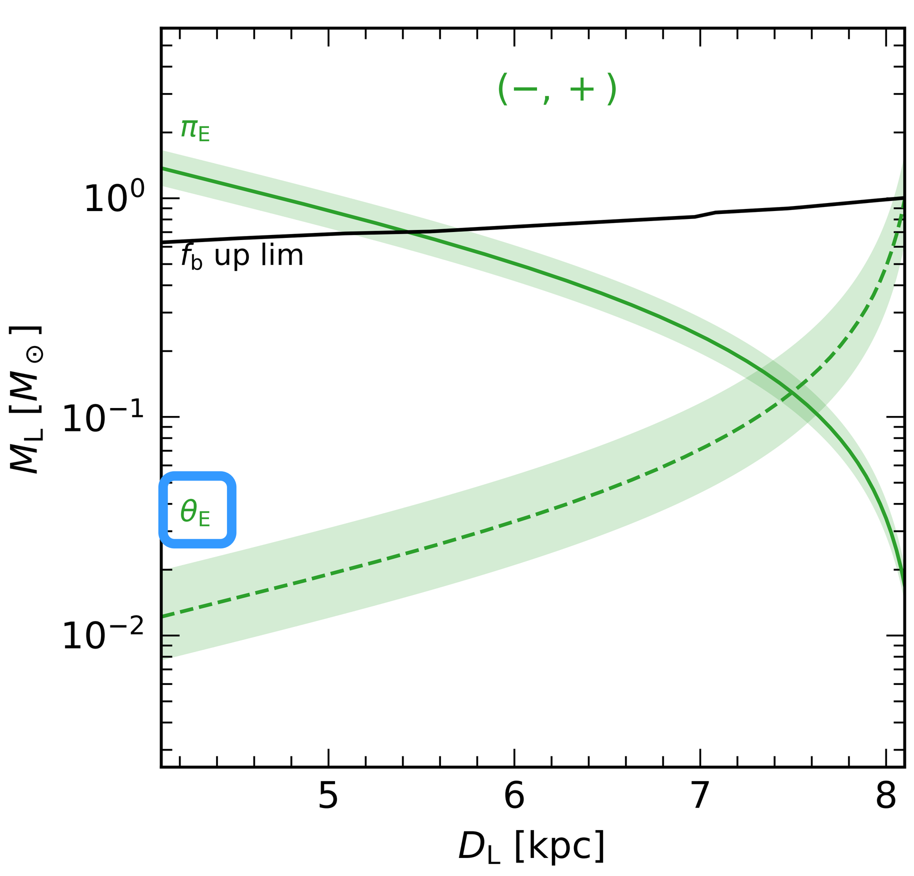


Result

The constraints of mass and distance of the lens from the parallax parameter and the Einstein radius θ_E for one of the four degenerate solutions.

All degenerate solutions agrees that the lens is likely an M-dwarf in the Bulge.

$$M_L = 0.14 \pm 0.05\ M_\odot$$



Discussion

The detection rate of the xallarap effect with respect to the ratio between orbital period and Einstein crossing time.

The figure shows that the xallarap effect is nearly undetectable with

$$P_\xi \geq t_E$$

The overall detection rate is about 2%.