Microlensing Parallax for Observers in Heliocentric Motion

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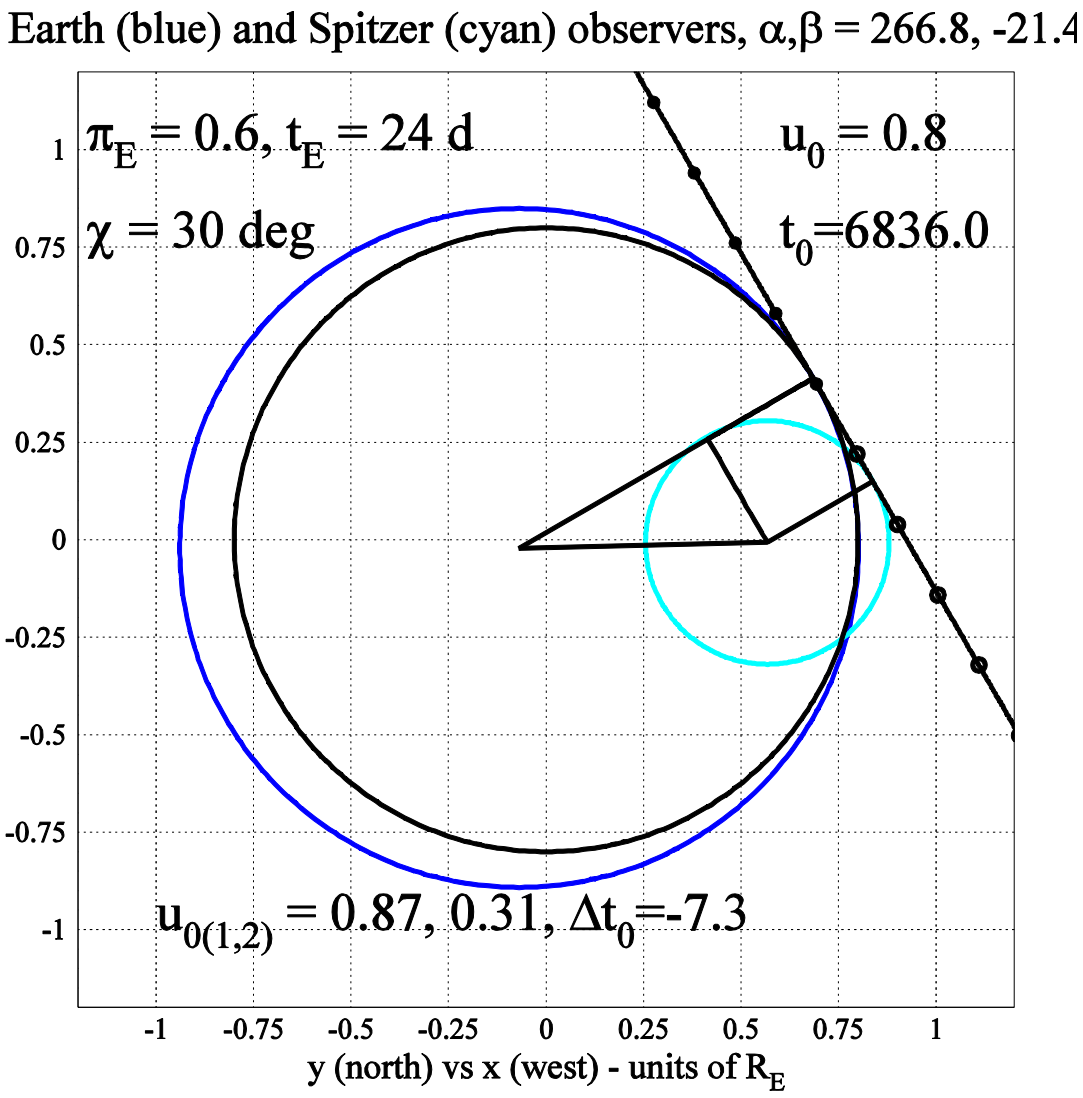
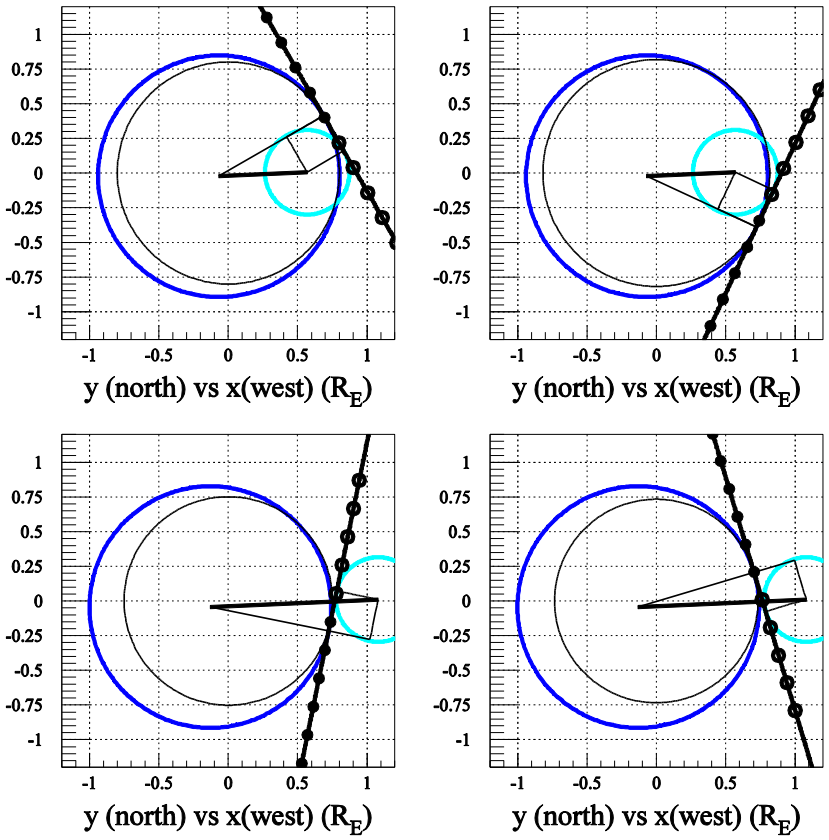
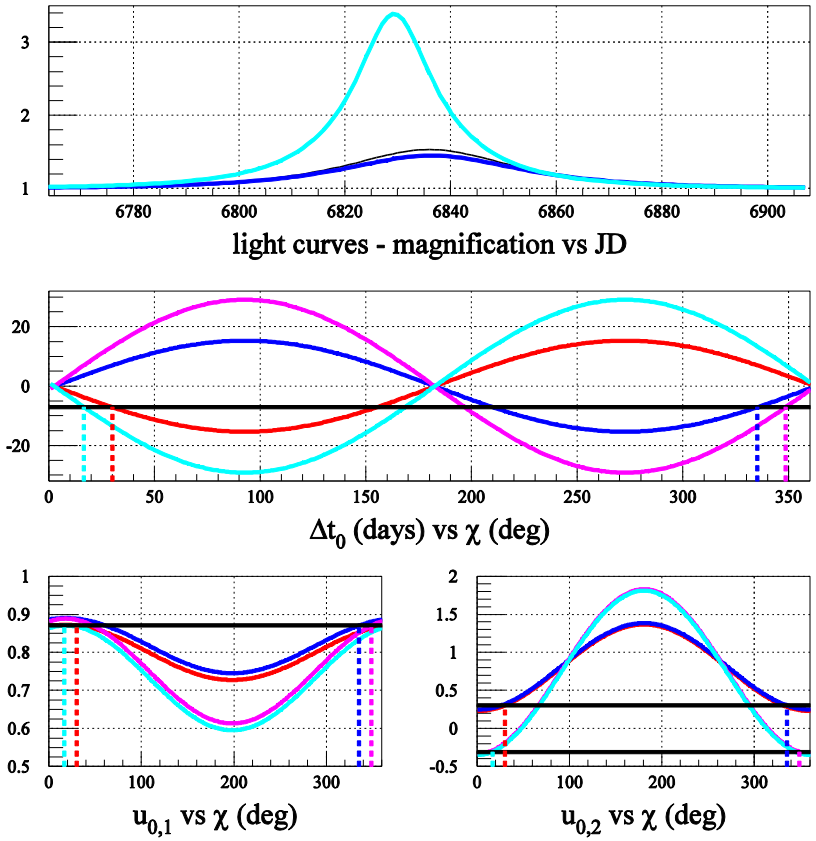
The Microlensing Parallax in an Heliocentric Reference System



The Microlensing Parallax Degeneracy

Observers at rest





$$\vec{\pi}_{E,\pm,\pm} = \frac{AU}{D_\perp}\left(\tau, \Delta u_{0,\pm,\pm}\right) \quad \tau = \frac{t_{0,2} - t_{0,1}}{t_E}$$

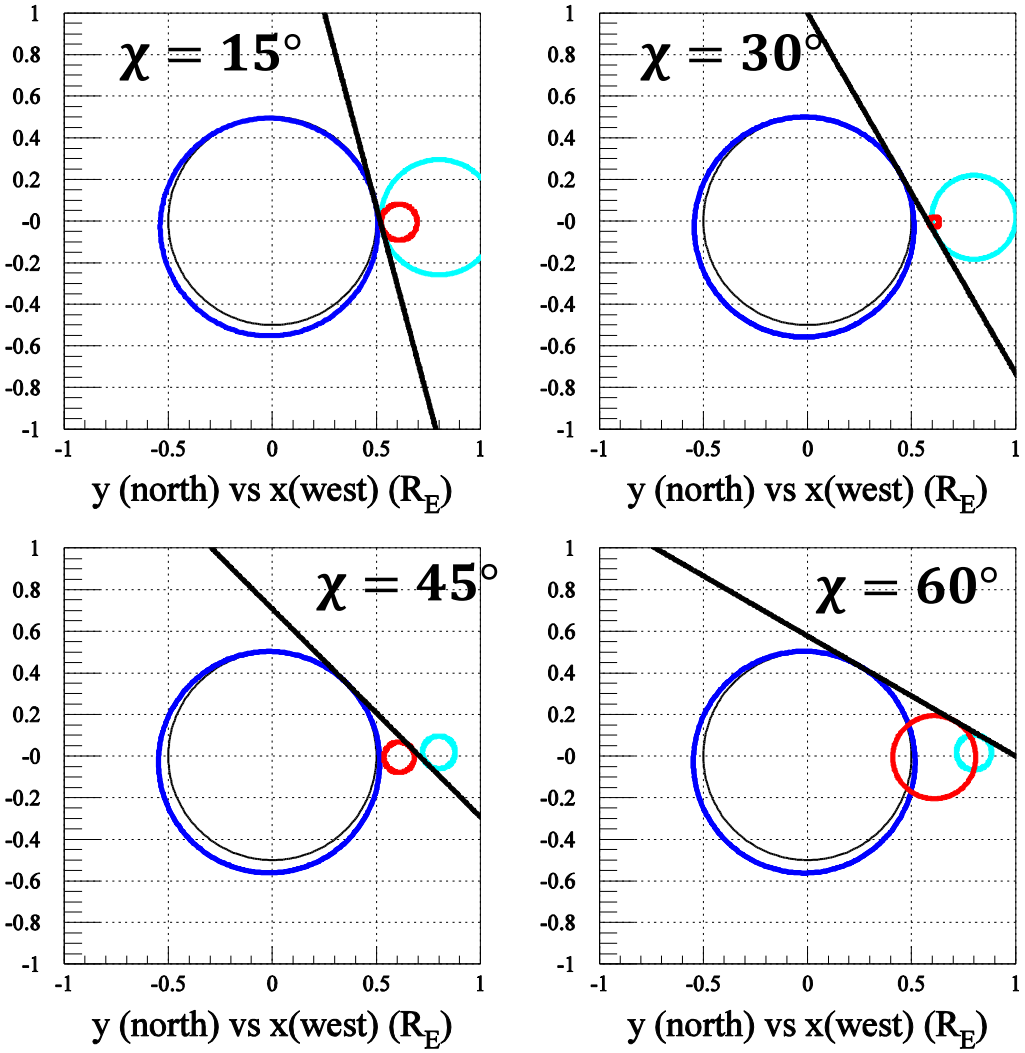
$$\Delta u_{0,\pm,\pm} = \pm\left(|u_{0,2,\perp}| \pm |u_{0,1,\perp}|\right)$$

Gould, 1994

$$\tau = \pi_E\left(\cos(\chi)\,\Delta y_0 - \sin(\chi)\,\Delta x_0\right)$$

SCN and Scarpetta, ApJ 2016

The three Observers case: Breaking the parallax degeneracy



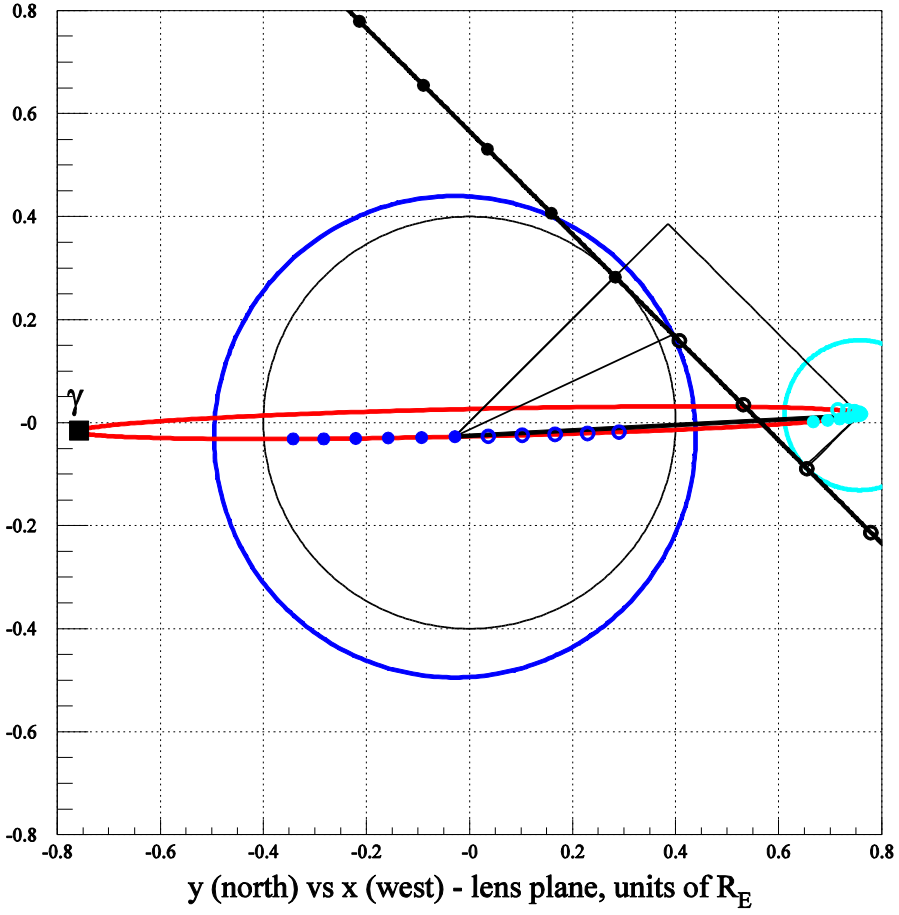
Earth + Spitzer + K2

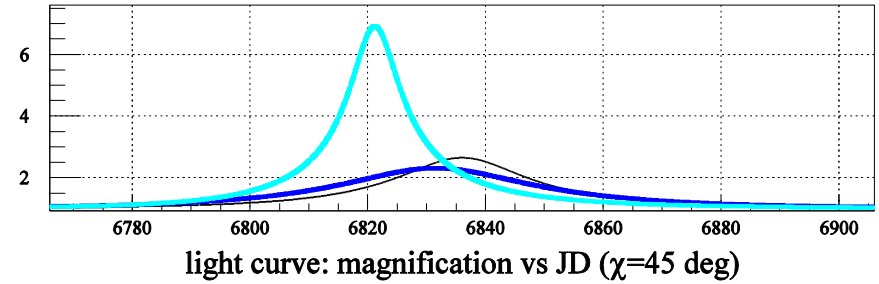
χ	π_E	χ	π_E
15.0	**0.80**	**15.0**	**0.80**
-11.3	0.80	-13.2	0.80
42.0	0.28	24.8	0.48
-38.3	0.28	-23.0	0.48

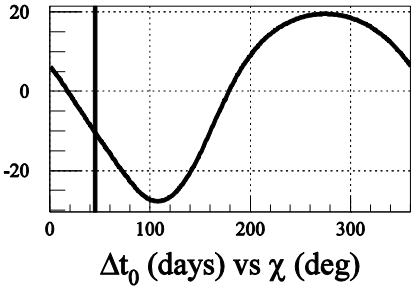
The Microlensing Parallax - Observers in motion

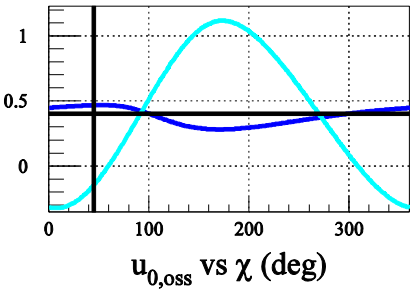
Gould 1992, Gould 1995, Dominik 1998

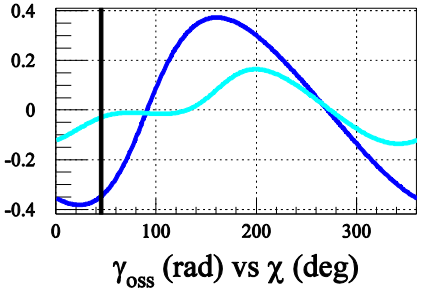
Breaking the parallax degeneracy

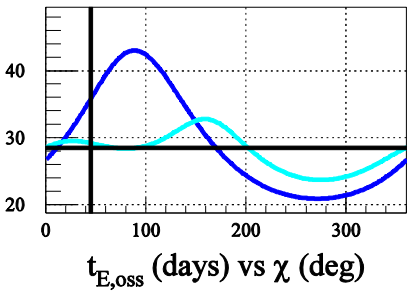












SCN and Scarpetta, ApJ 2016

The Microlensing Parallax - Observers in motion

Extending the Gould 1994 expression

$$\vec{\pi}_{E,\pm} = \frac{AU}{D_\perp}\left(\tau - \Delta u_{0,\parallel}, \left|u_{0,2,\perp}\right| \pm \left|u_{0,1,\perp}\right|\right)$$

$$\Delta u_{0,\parallel} = u_{0,2,\parallel} - u_{0,1,\parallel} \qquad \tau = \frac{\Delta t_0}{t_E} = \frac{t_{0,2} - t_{0,1}}{t_E}$$

$$u_{0,oss,\parallel} = \left|u_{0,oss}\right| \sin(\gamma_{oss})$$

$$u_{0,oss,\perp} = \left|u_{0,oss}\right| \cos(\gamma_{oss})$$

$$\tau - \Delta u_{0,\parallel} = \pi_E \left(\cos(\chi)\, \Delta y_0 - \sin(\chi)\ \Delta x_0\right)$$

SCN and Scarpetta, ApJ 2016

The Microlensing Parallax - Observers in motion

A new parametrization and an extension of the fourfold degeneracy

$$\{evt\} = \{t_0, u_0, t_E, \pi_E, \chi\}$$

$$\{obs\} = \{t_{0,1}, t_{0,2}, u_{0,1}, u_{0,2}, t_{cross}\}$$

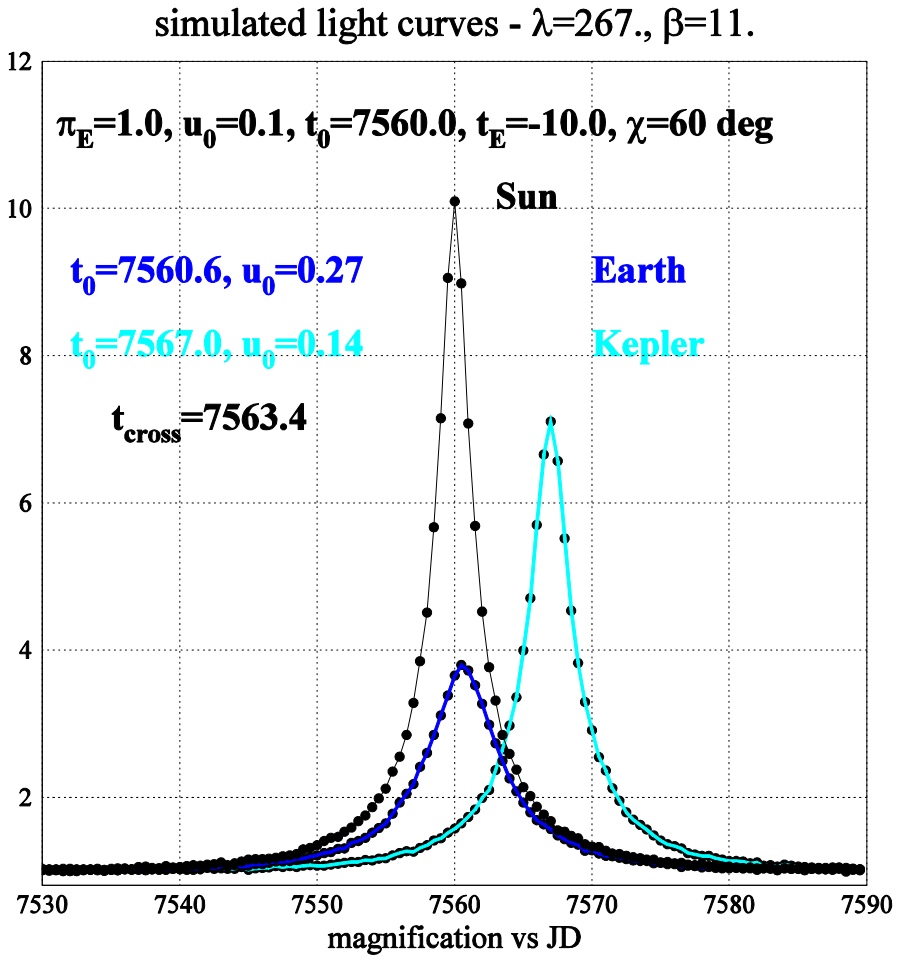
$$F_1(\{evt\}, \{obs\}) = 0$$
$$F_2(\{evt\}, \{obs\}) = 0$$
$$F_3(\{evt\}, \{obs\}) = 0$$
$$F_4(\{evt\}, \{obs\}) = 0$$
$$F_5(\{evt\}, \{obs\}) = 0$$

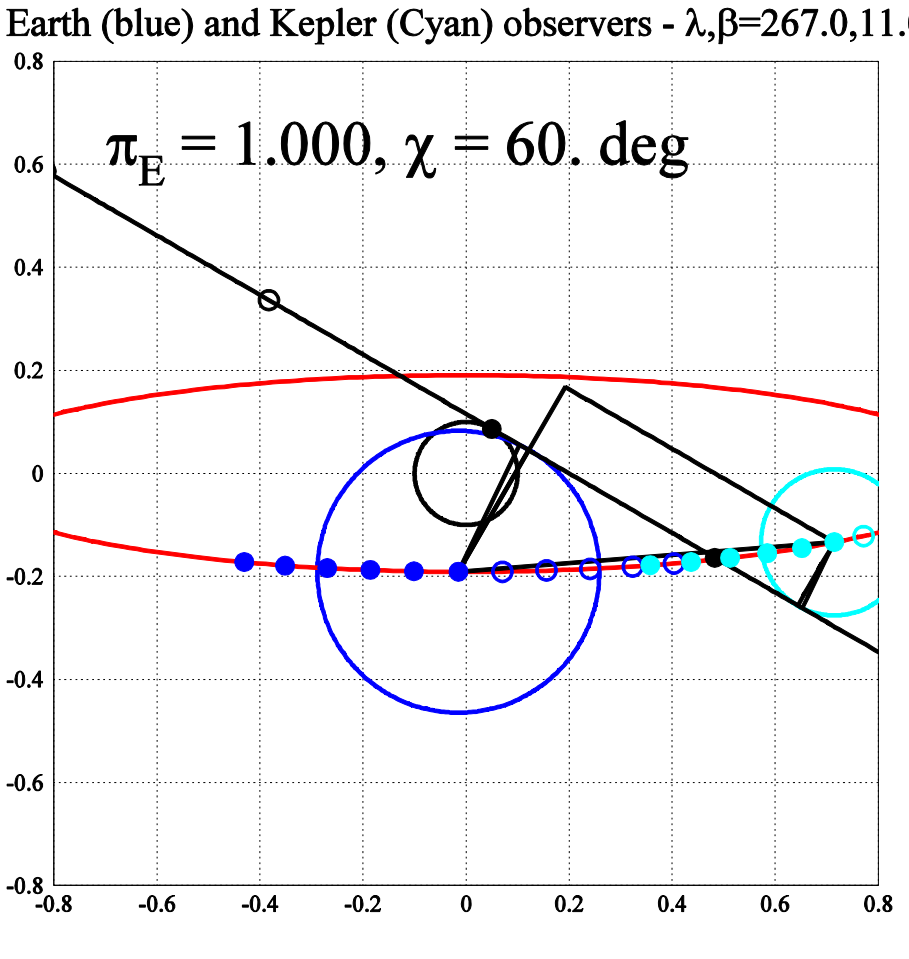
Conjecture: the (analytical) non-linear system admits only 4 independent solutions

Empirically we find these 4 solutions to be quasi-degenerate

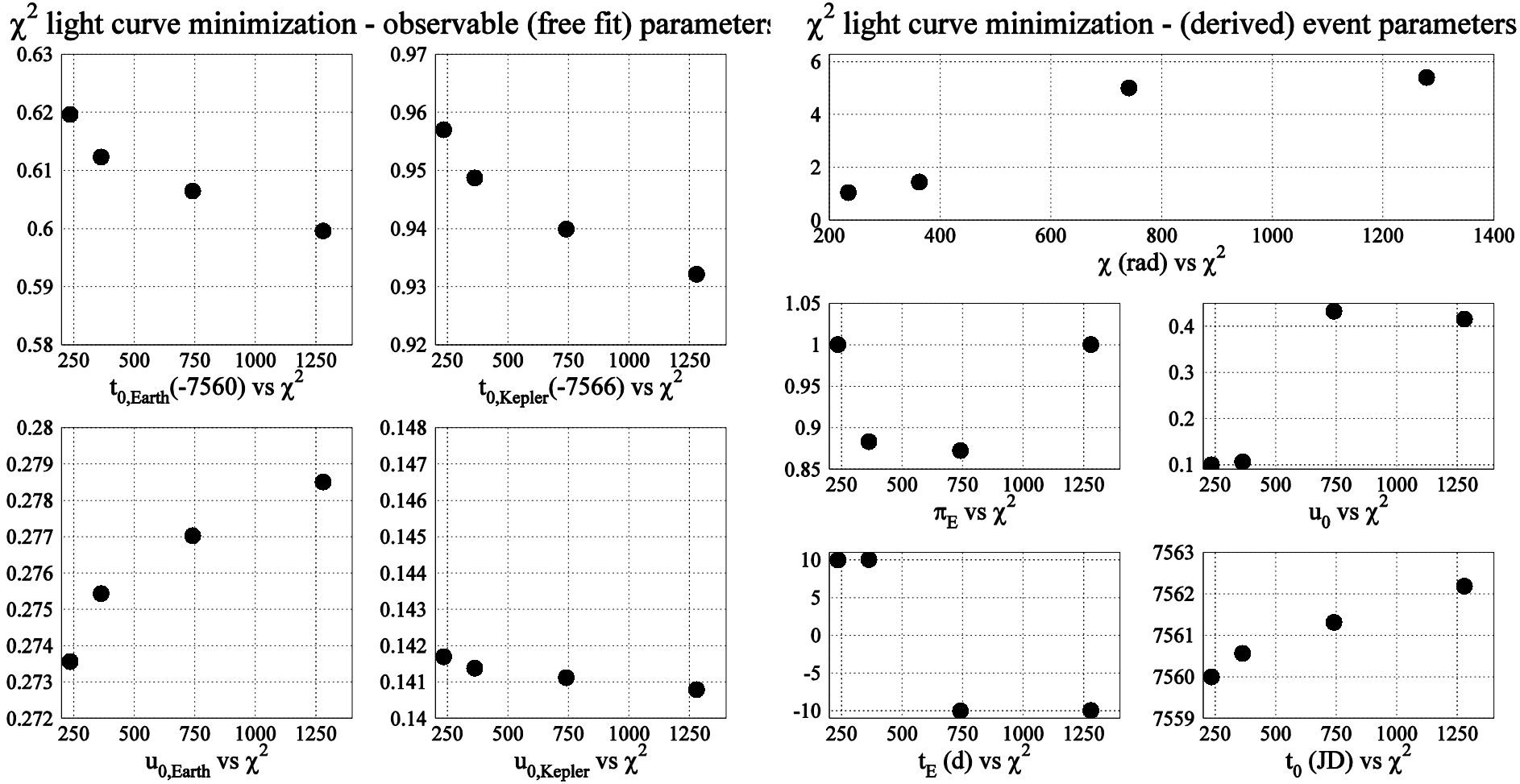
SCN +, in prep

A case study: simulated data





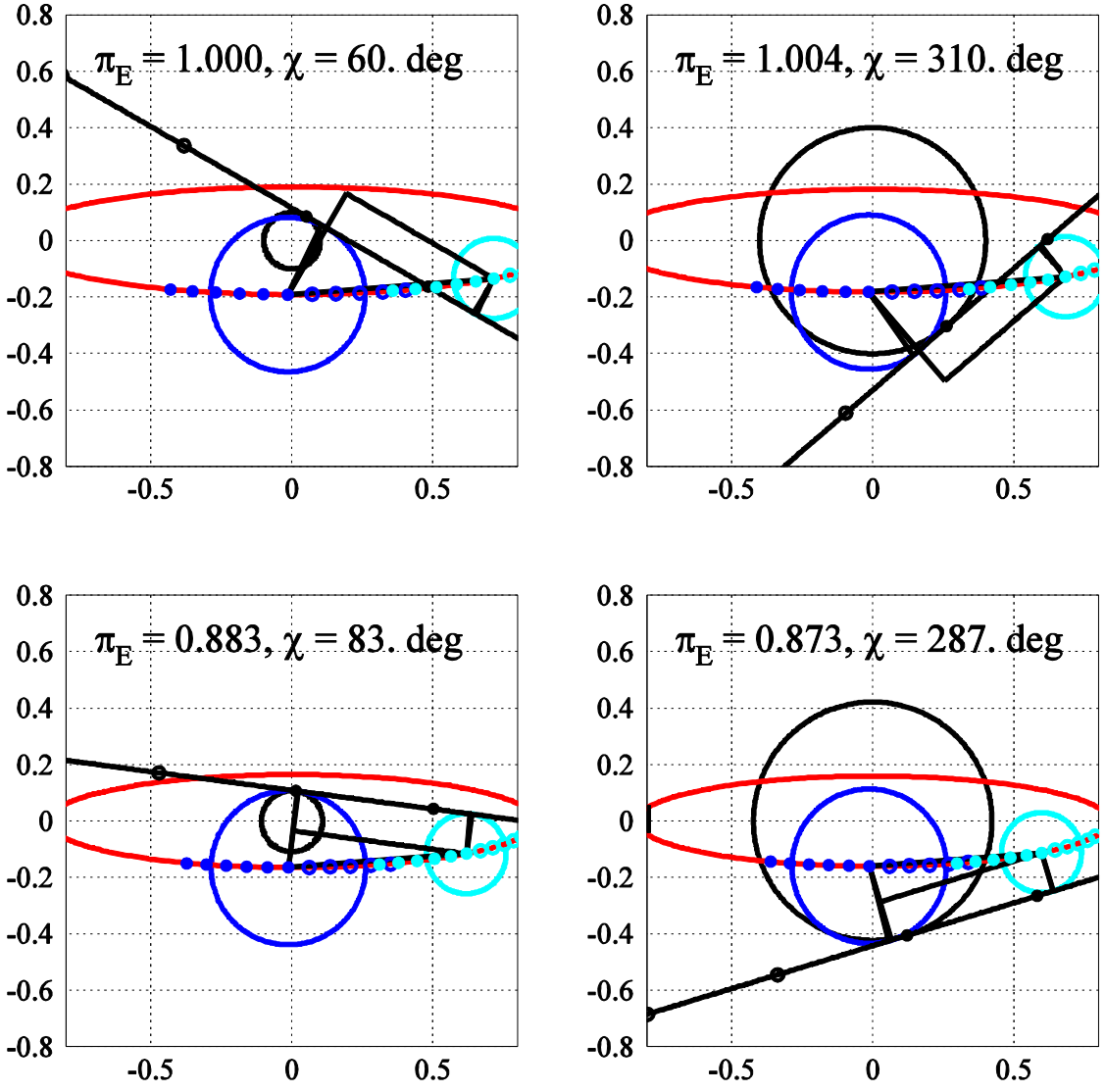
χ^2-minimization - $\{obs\}$ as the free fit parameters



Calchi Novati +, in prep

The Microlensing Parallax - Observers in motion

Earth (blue) and Kepler (Cyan) observers - λ,β=267.0,11.0



The 4 quasi-degenerate configurations