GRAVITATIONAL LENSING

LECTURE 15

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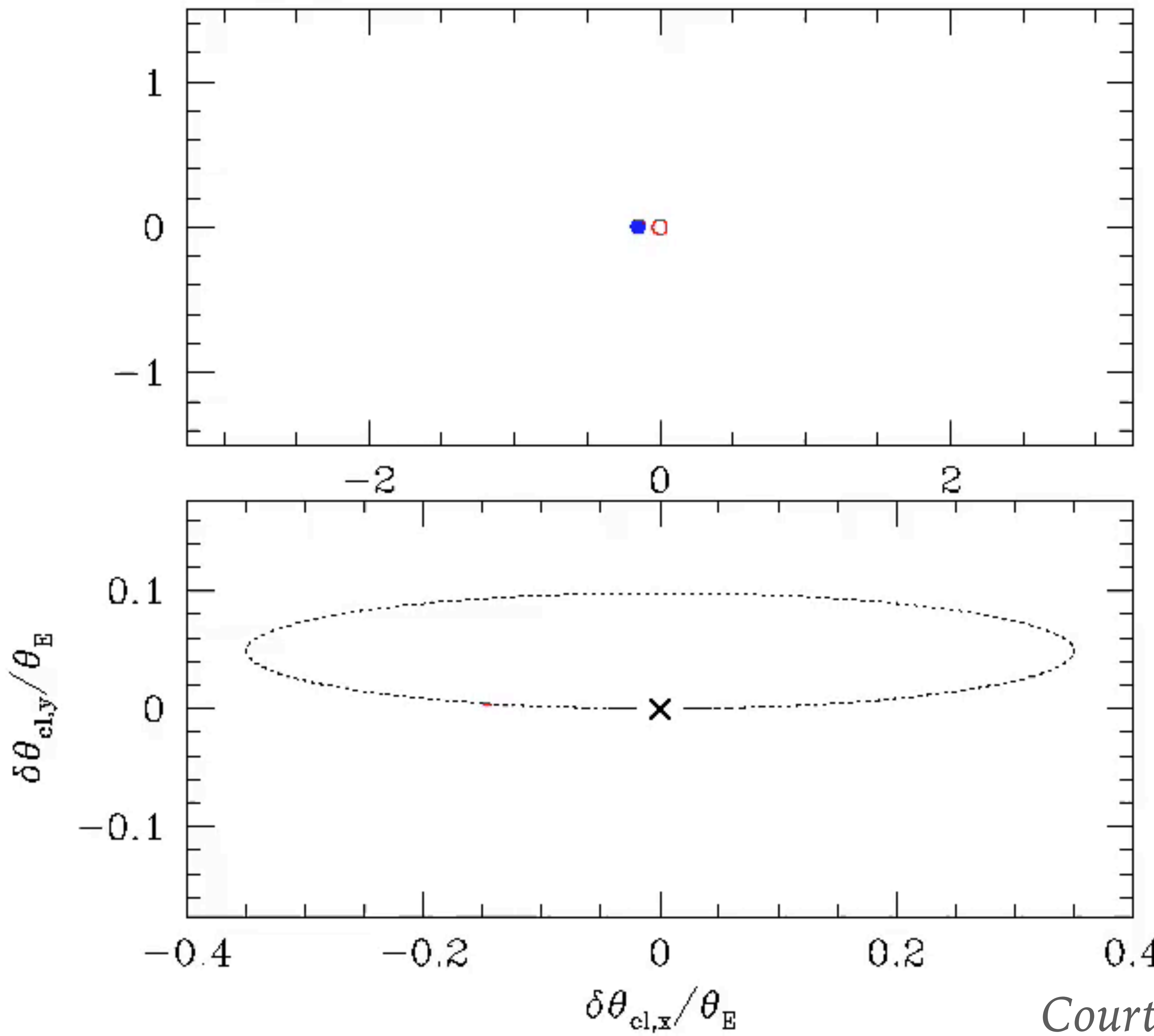
AA 2016-2017

CONTENTS

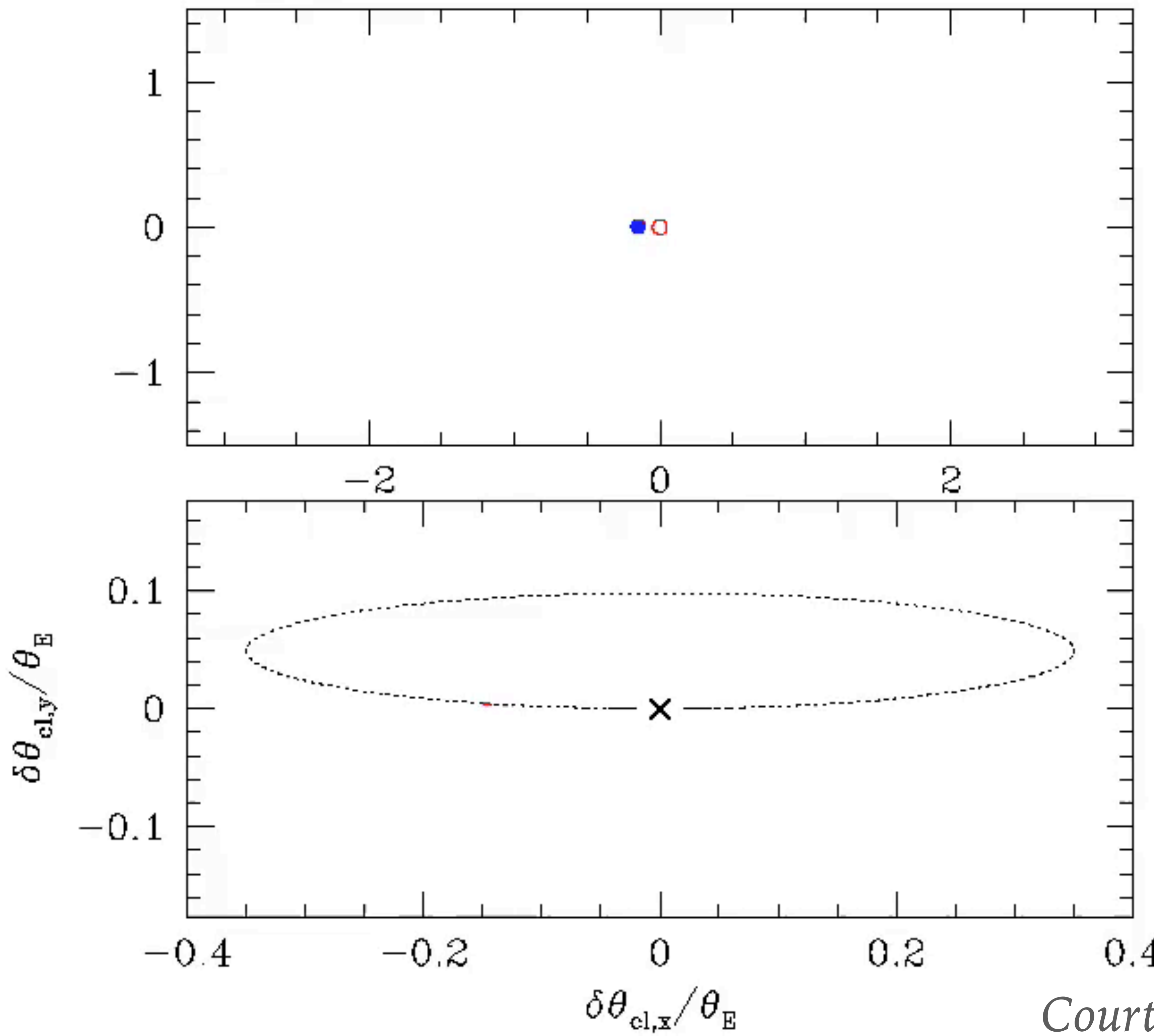
- astrometric microlensing (continue)
- multiple point lenses
- binary lenses

ASTROMETRIC MICROLENSING (ANIMATION)



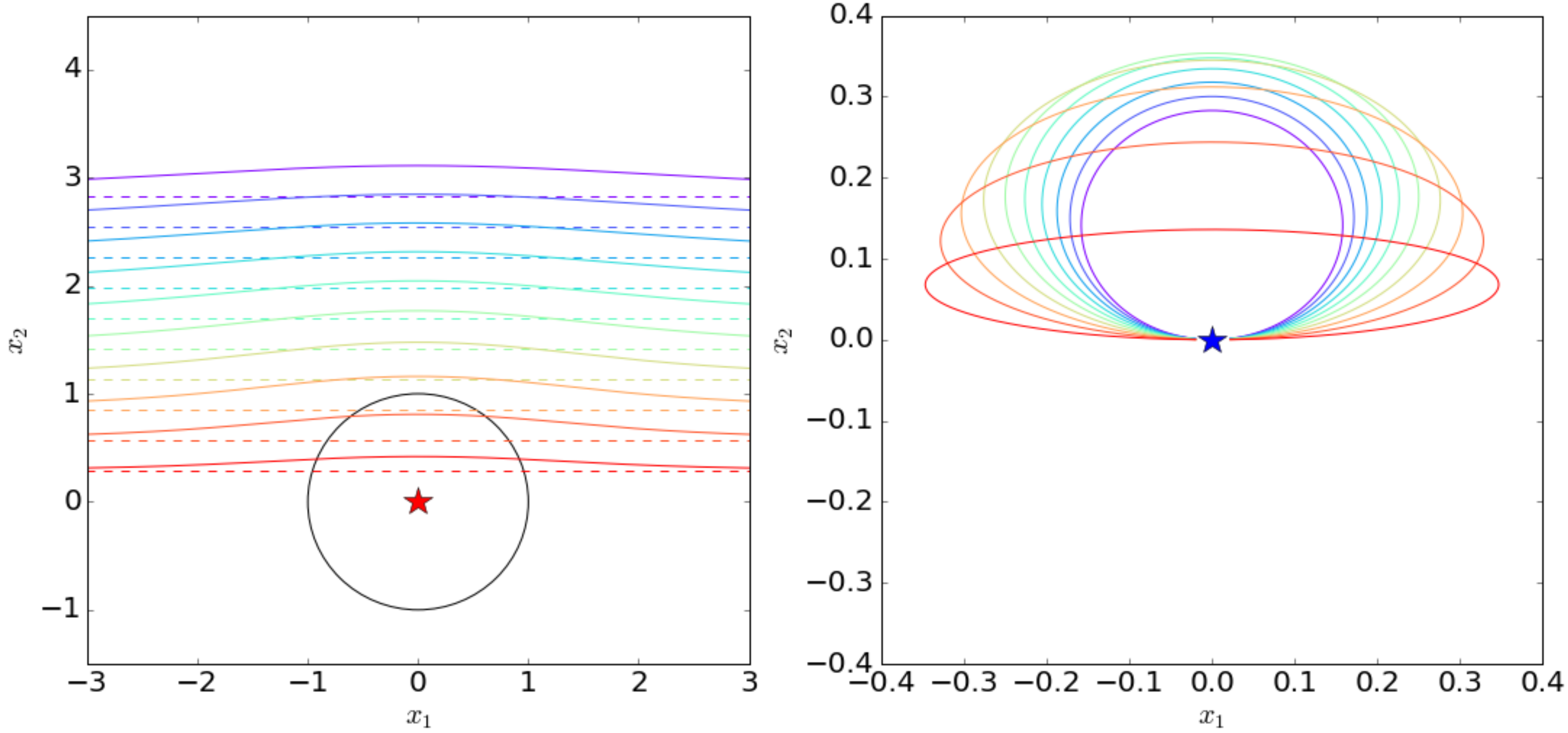
Courtesy of S. Gaudi

ASTROMETRIC MICROLENSING (ANIMATION)



Courtesy of S. Gaudi

WHAT IS THE PATH OF THE CENTROID SHIFT WITH RESPECT TO THE UNPERTURBED SOURCE?

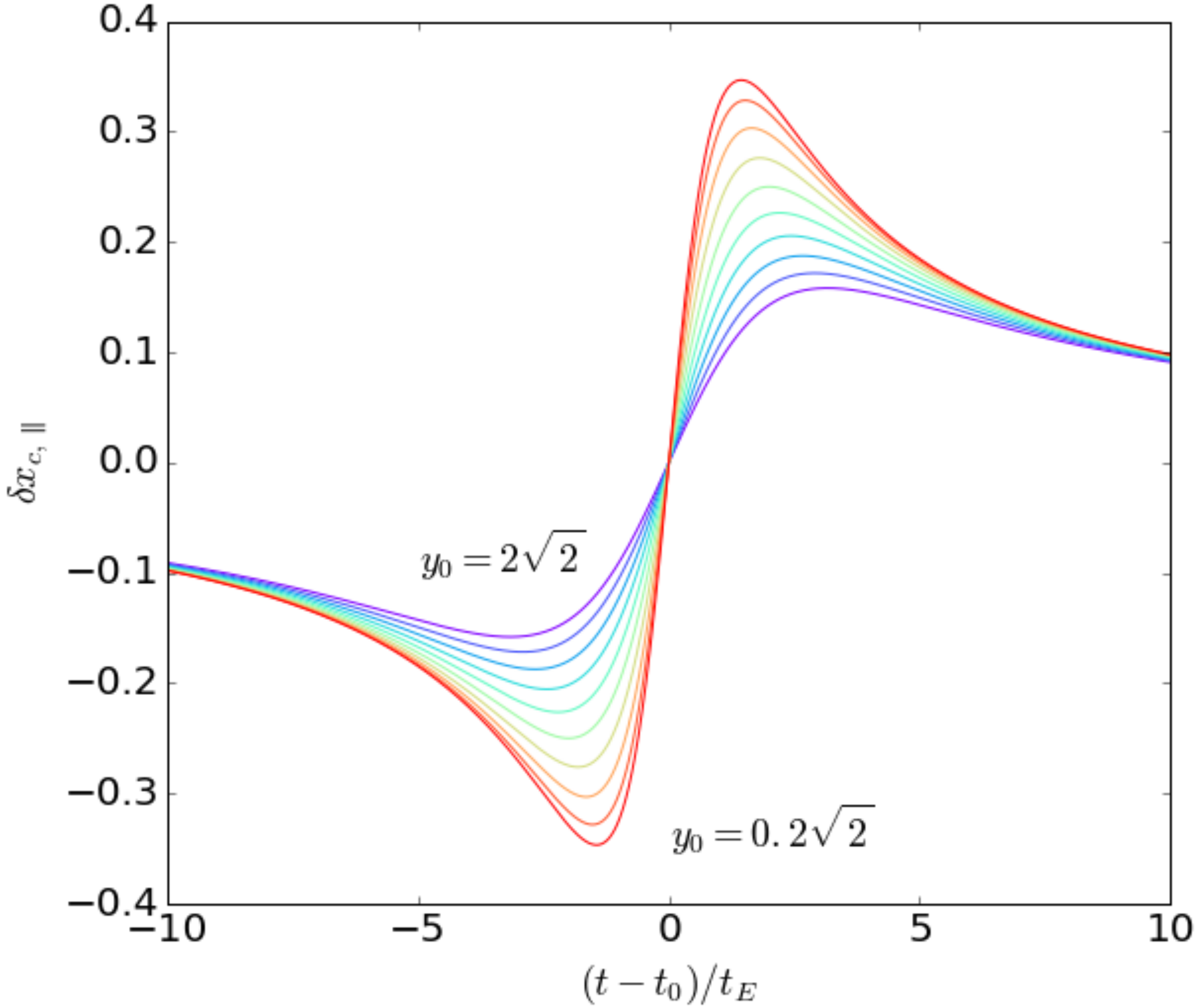


HOW DO WE EXPLAIN THIS PATH?

We can decompose the shift into the components parallel and perpendicular to the motion of the source:

$$
\begin{aligned}
\delta x_{c,\parallel} &= \frac{y_\parallel}{y^2+2} = \frac{(t-t_0)/t_E}{[(t-t_0)/t_E]^2+y_0^2+2} \\
\delta x_{c,\perp} &= \frac{y_\perp}{y^2+2} = \frac{y_0}{[(t-t_0)/t_E]^2+y_0^2+2}
\end{aligned}
$$

RESULTS



Antisymmetric!

Taking the derivative:

$$\frac{d(\delta x_{c,\parallel})}{dt} = \frac{y_0^2 + 2 - [(t - t_0)/t_E]^2}{\{[(t - t_0)/t_E]^2 + y_0^2 + 2\}^2}$$

$$(t - t_0)/t_E = \pm\sqrt{y_0^2 + 2},$$

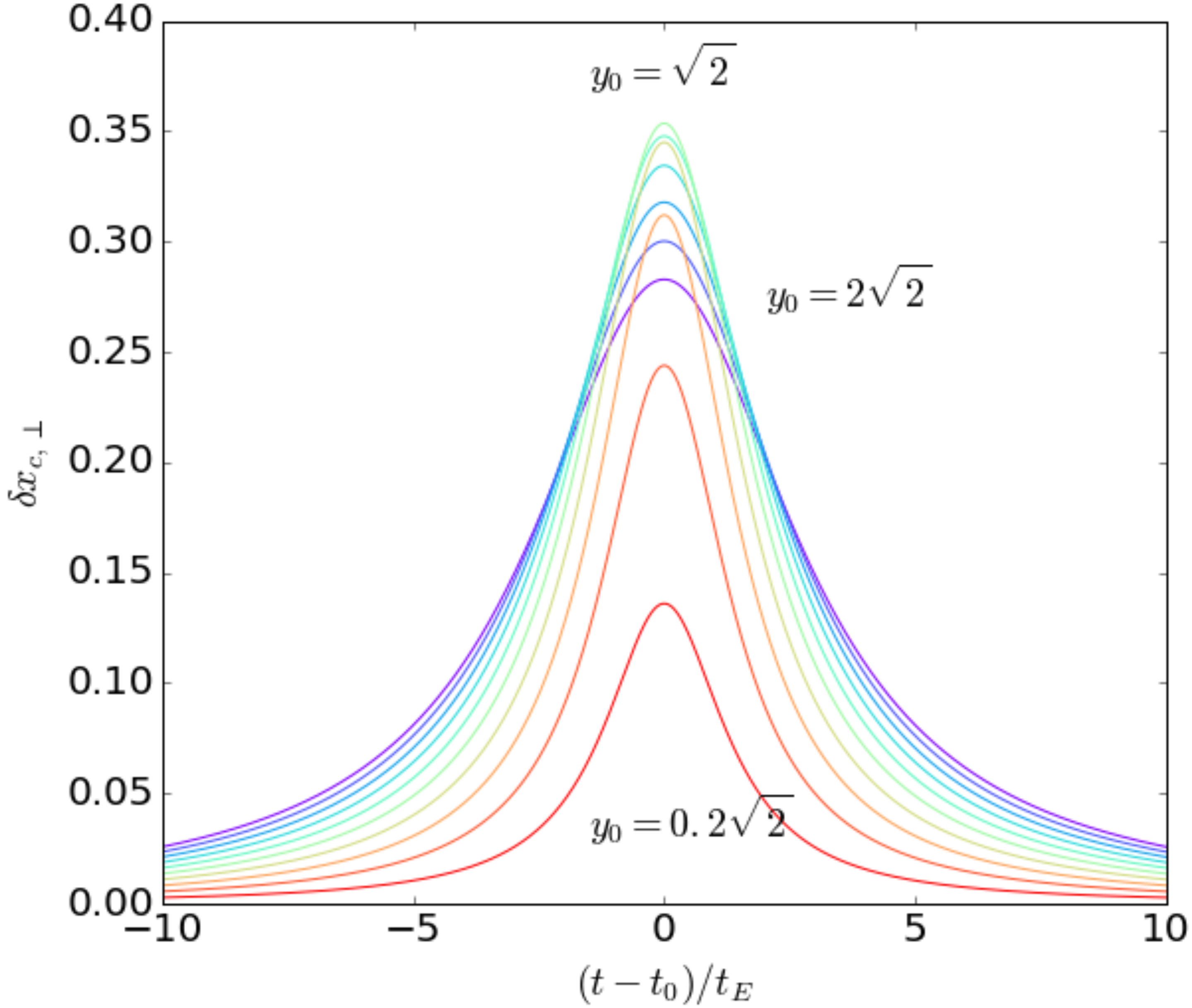
$$\delta x_{c,\parallel} = \pm\frac{1}{2\sqrt{y_0^2 + 2}}$$

For small y_0:

$(t - t_0)/t_E \approx \pm\sqrt{2}$ and $\delta x_{c,\parallel} \approx \delta x_{c,max}$.

$$\delta x_{c,max} = (2\sqrt{2})^{-1} \quad \sim 0.354\theta_E$$

RESULTS



One maximum in $t = t_0$

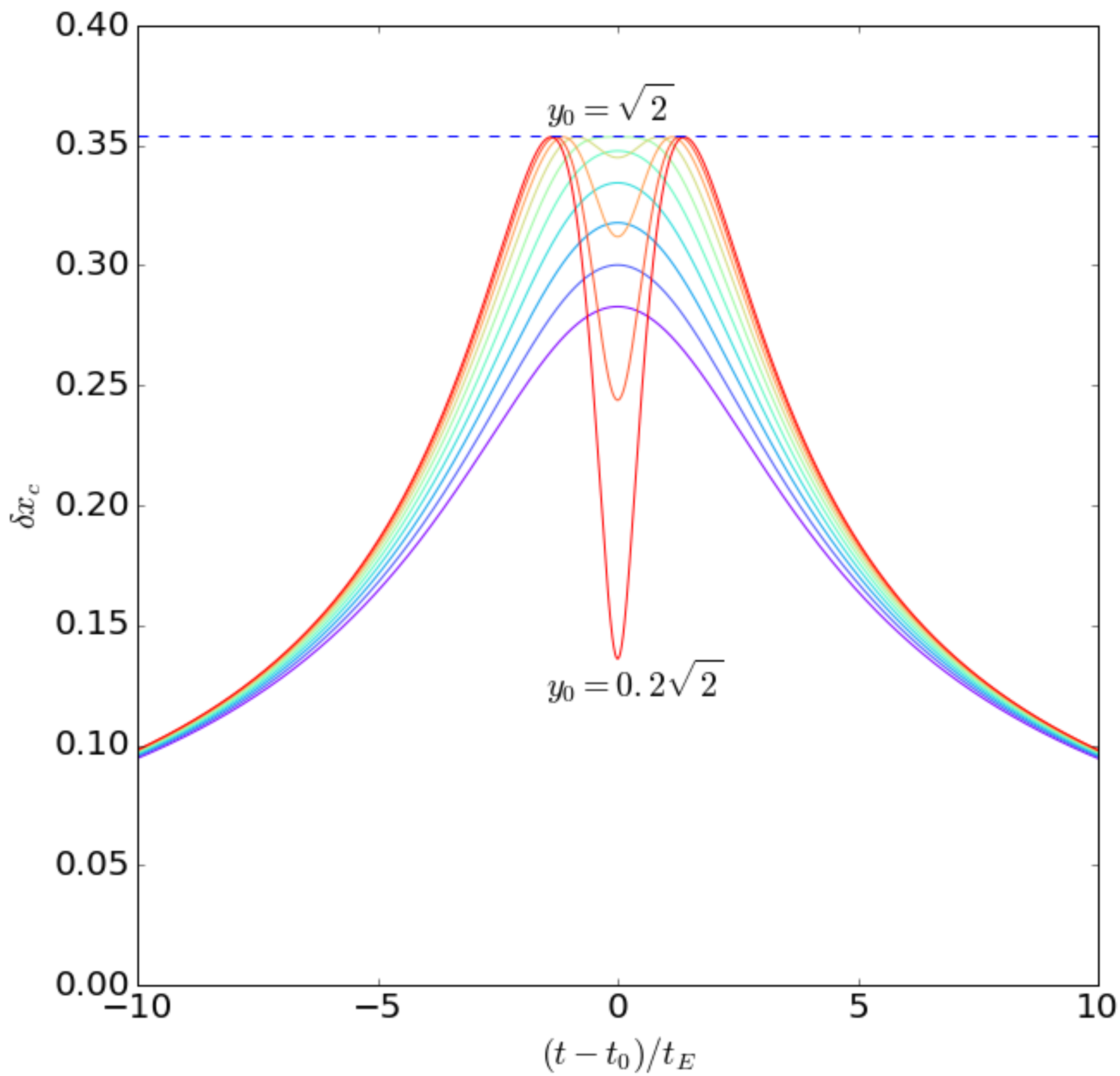
$$\delta x_{c,\perp,max} = \frac{y_0}{y_0^2 + 2}$$

the peak is the highest for

$y_0 = \sqrt{2}$,

$\delta x_{c,max}$

RESULTS



$$\frac{d(\delta x_c)}{dp} = 2p\frac{2 - y_0^2 - p^2}{2\sqrt{y_0^2 + p^2}(y_0^2 + p^2 + 2)^2}$$

For small y_0: two maxima and one minimum

In this case, the shift is mainly parallel to the motion of the source

For large y_0: one maximum

In this case, the shift is mainly perpendicular to the motion of the source

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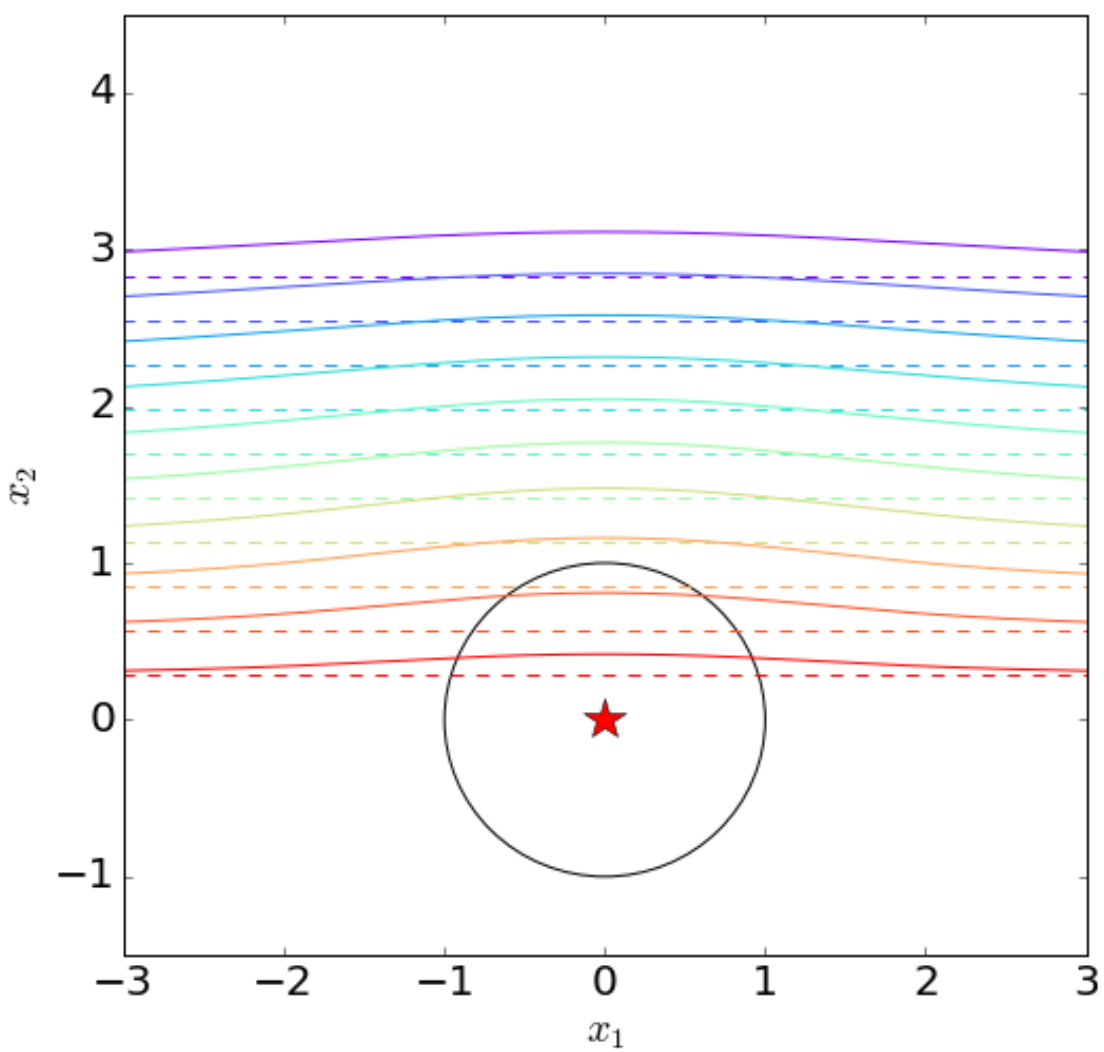
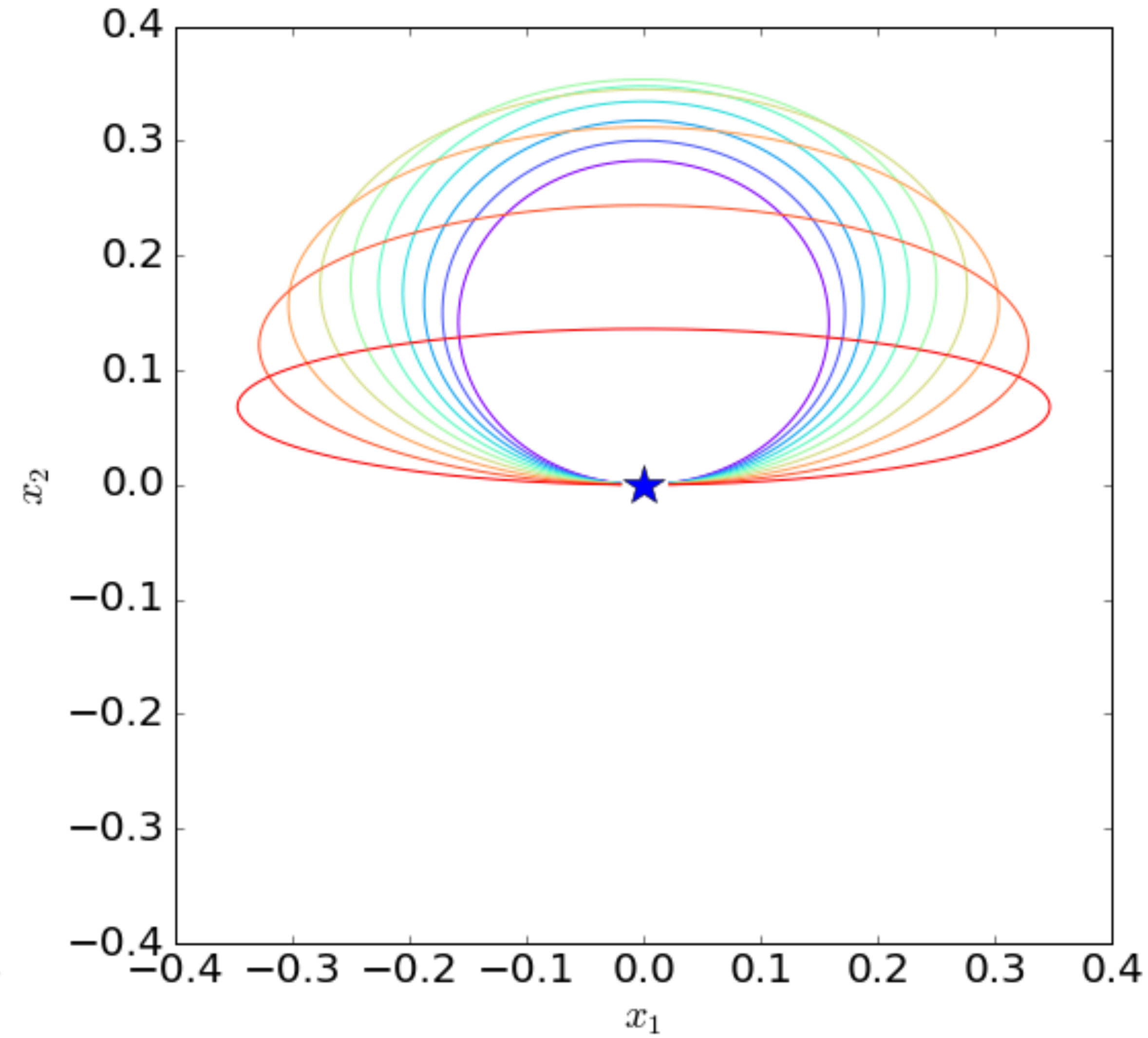




$$a = \frac{1}{2}\frac{1}{\sqrt{y_0^2+2}}$$

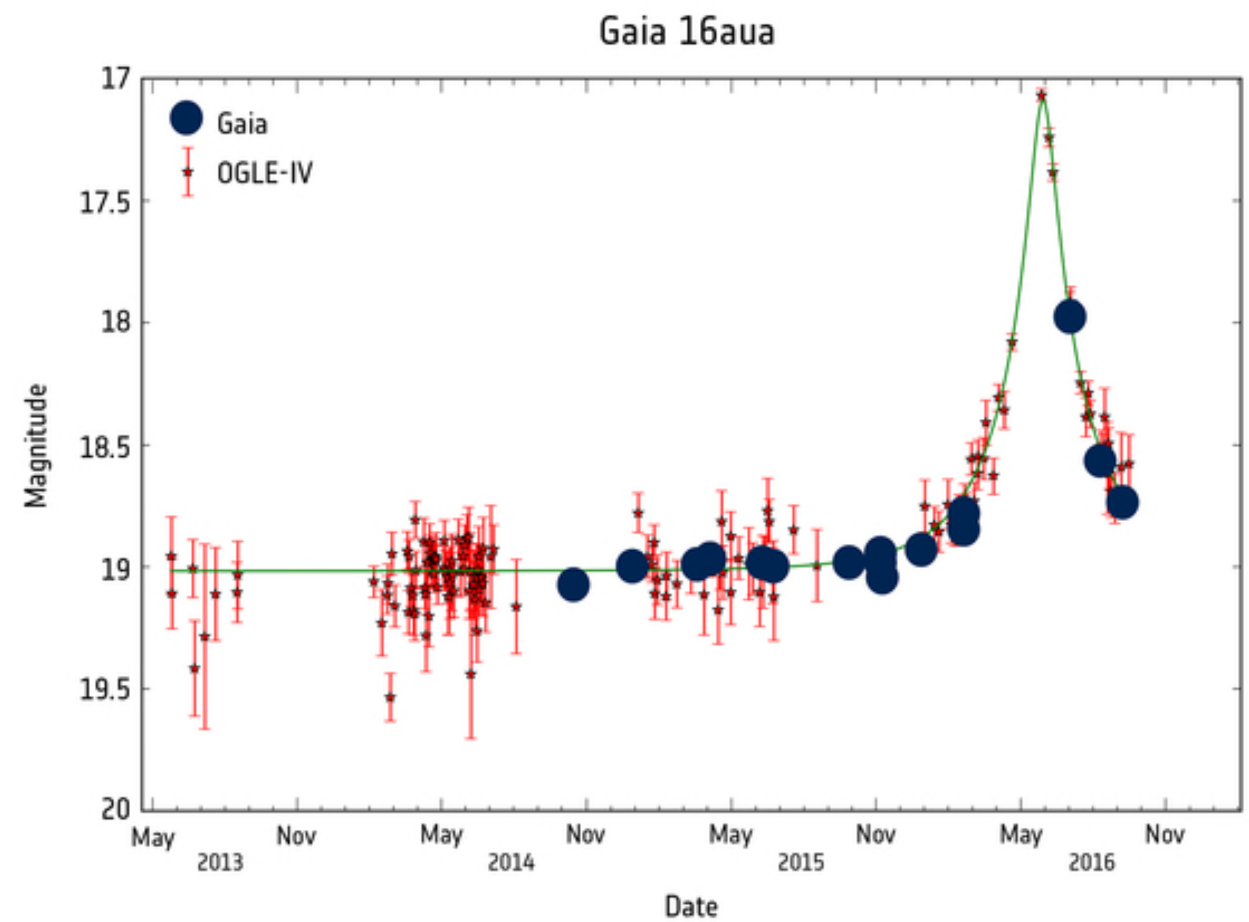
$$b = \frac{1}{2}\frac{y_0}{y_0^2+2}.$$

For large impact parameters, the ellipse becomes a circle.

For small impact parameters, it becomes a straight line of length 0.5

GAIA AND MICROLENSING

- GAIA has made the first photometric microlensing detection recently…
- Will it be able to detect the astrometric effect too?



GAIA + OGLE IV