GRAVITATIONAL LENSING

13 – PLANET MICROLENSING (I)

Massimo Meneghetti
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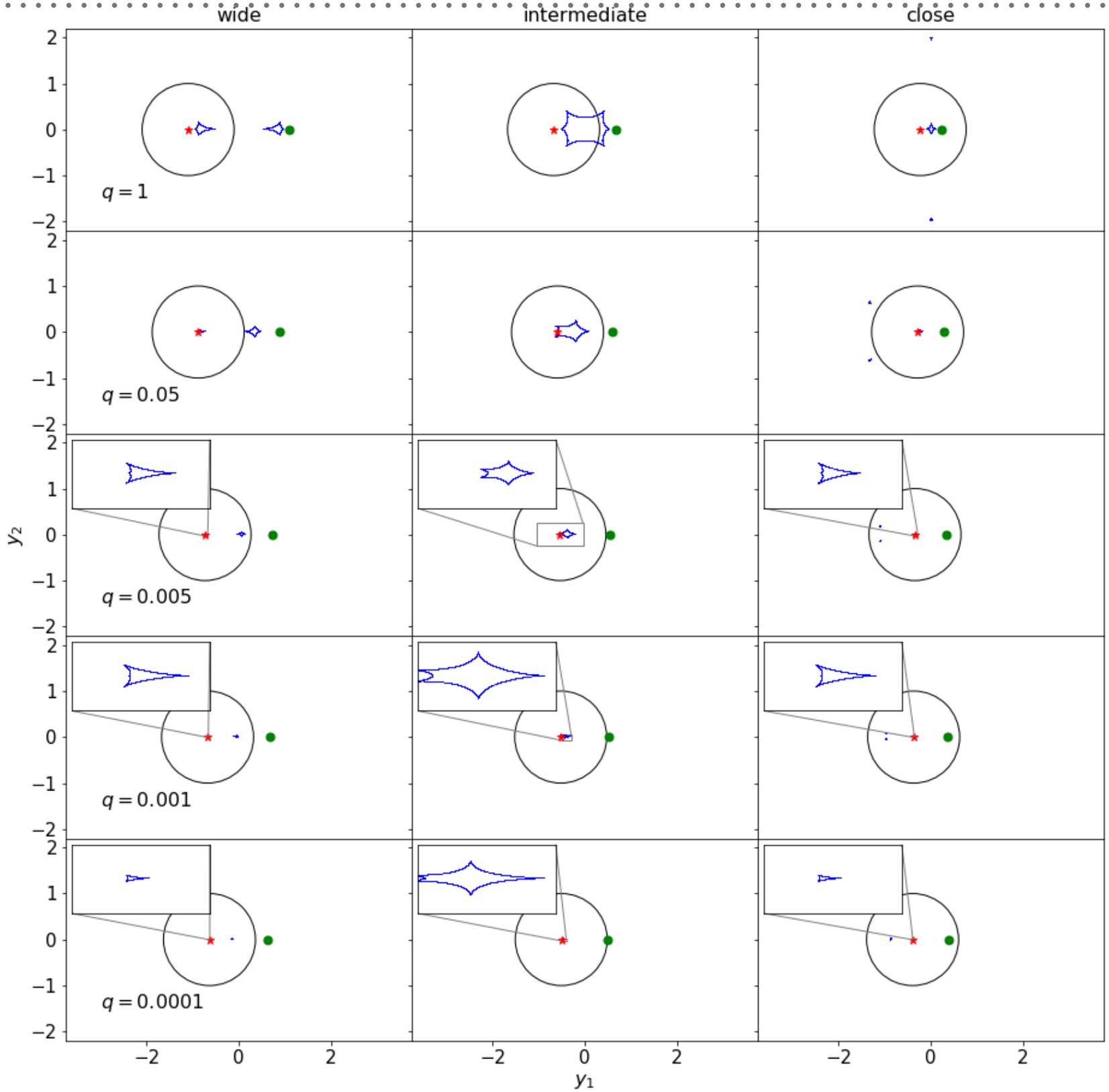
PLANETARY MICROLENSING

- Let us consider the system consisting of an host star and a planet orbiting around it.
- This is an example of **binary** lens
- The host star is of course much heavier than the planet!
  - example: for a Jupiter-like planet q=0.001 (solar mass star)
  - example: for a Earth-like planet q=0.000003

WHAT KIND OF SIGNAL?

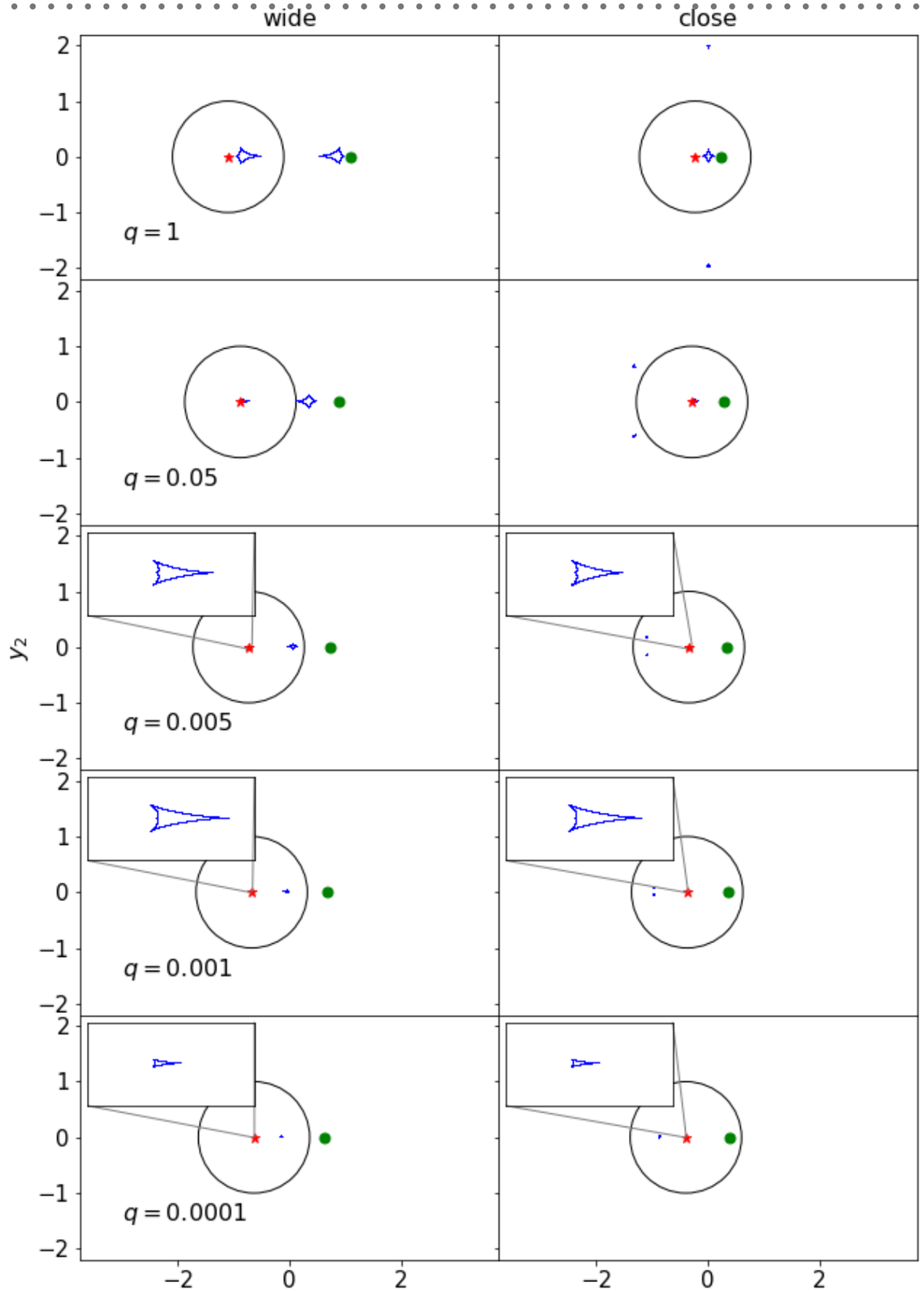
- **The light curve is that of the star…**
- The planet produces only a small perturbation to the magnification pattern, localized in a small region around the caustics
- Must cross one of these perturbed regions in order for the planet to be detected.
- The shape of the perturbation is determined by the caustic configuration…

CAUSTICS AS A FUNCTION OF $q = m_2/m_1$



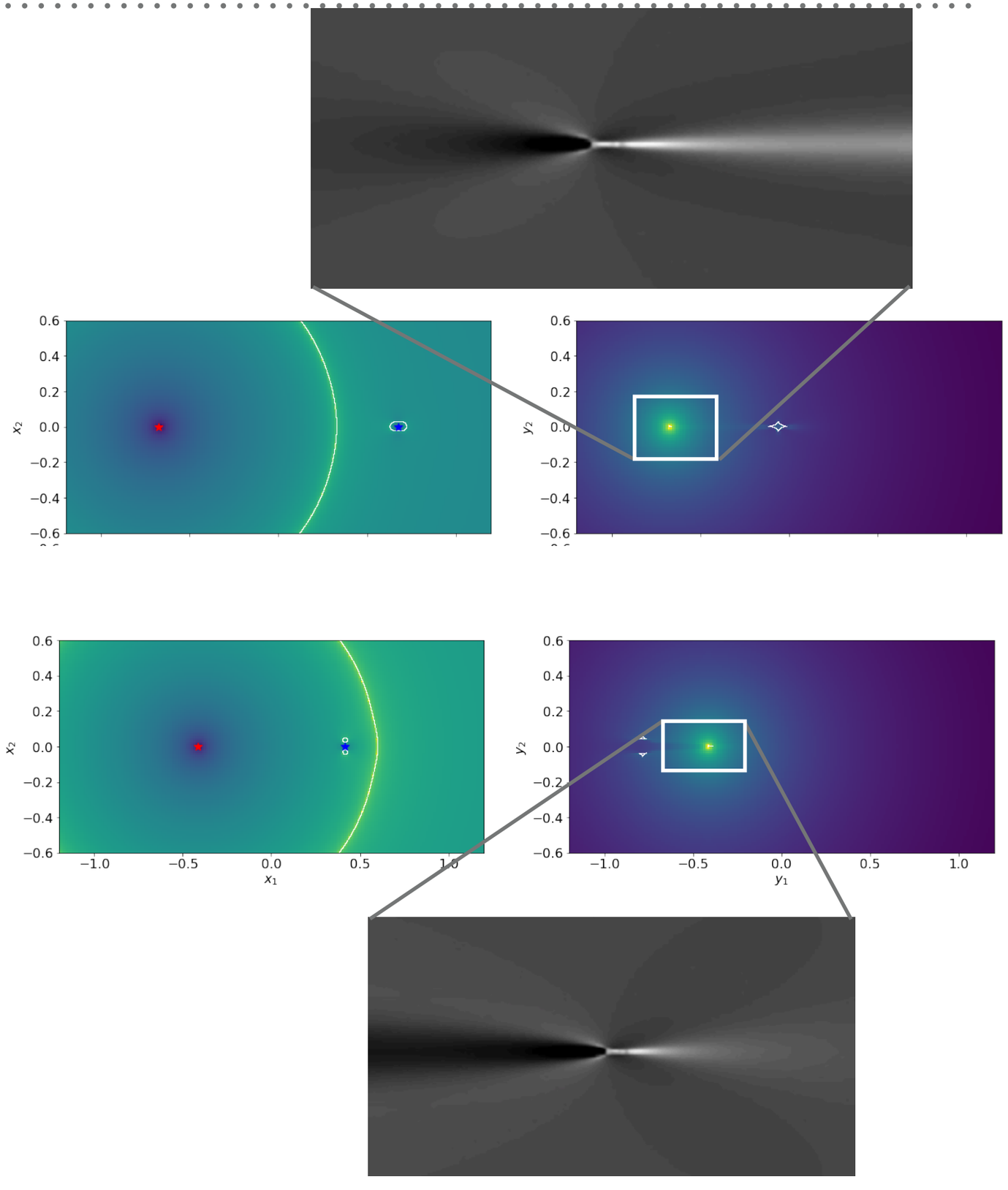
PERTURBATIONS OF THE CENTRAL CAUSTIC (WIDE/CLOSE SYSTEMS)

- As q decreases, we see that one caustic shrinks and approaches the primary lens (i.e. the star)
- This is what we call the ***"central caustic"*** in wide and close systems
- Four cusps and four folds
- One cusp is elongated towards the planet
- Three cusps on the back
- **Different from point-like caustic of a point lens!**

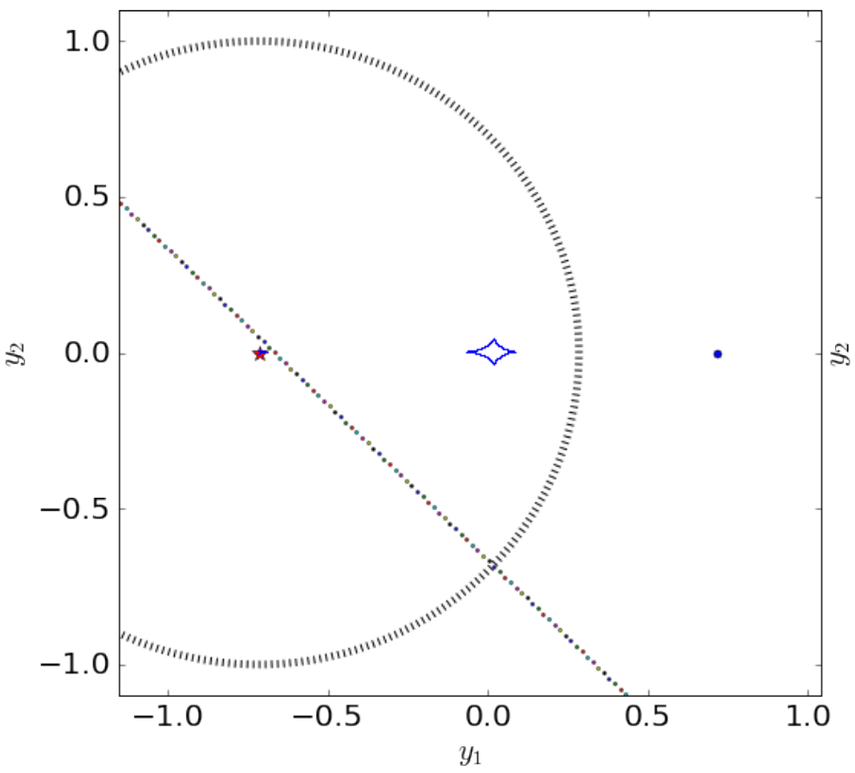


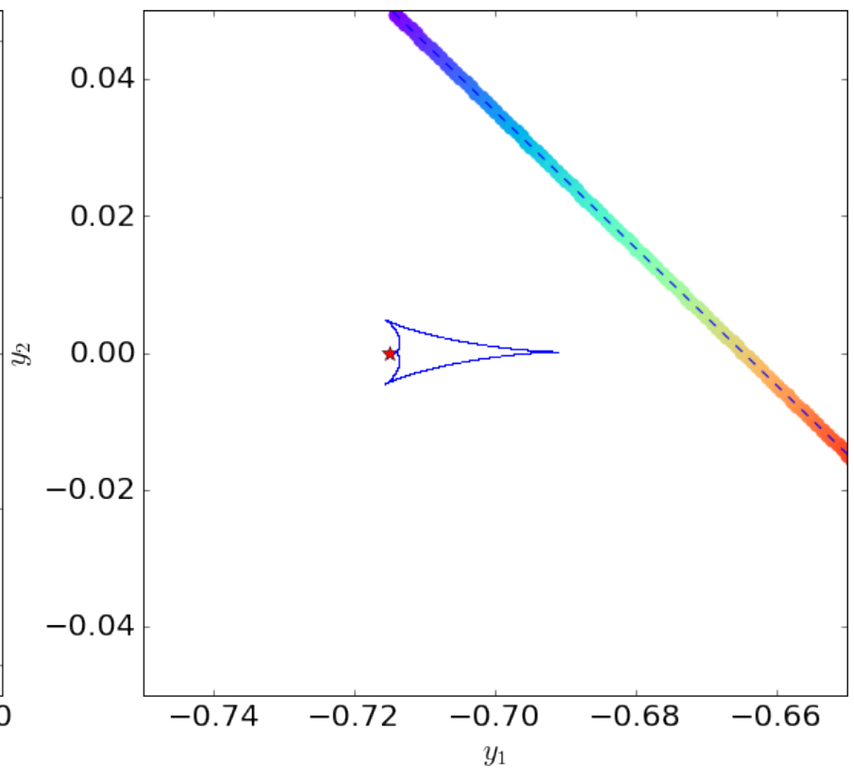
WHAT KIND OF SIGNATURES?

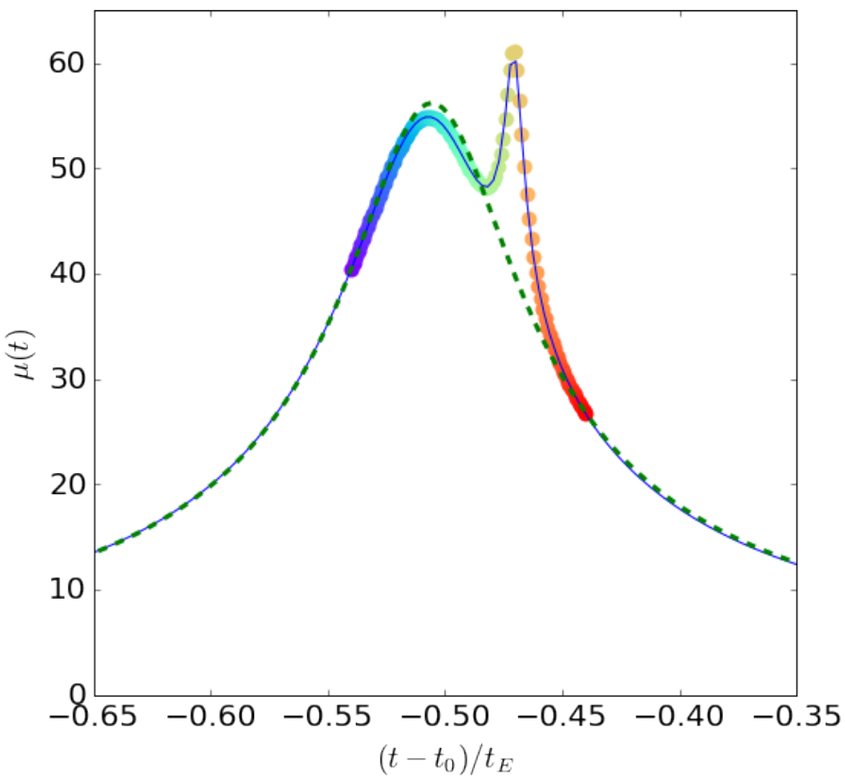
- Magnification if the sources passes in between the planet and the star
- De-magnification if the source passes on the back of the caustic!
- Some examples…

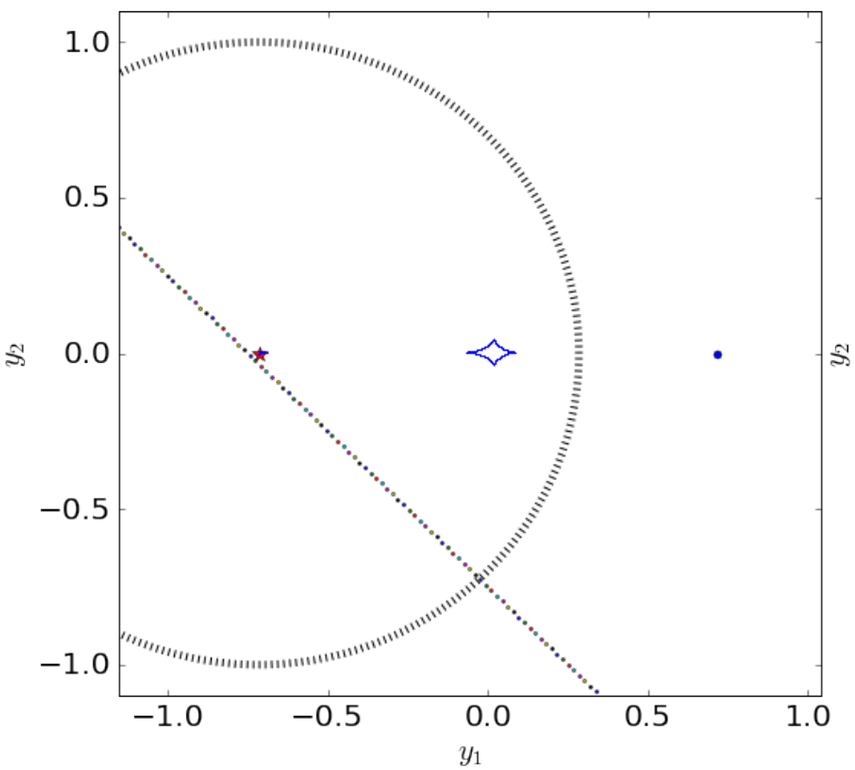


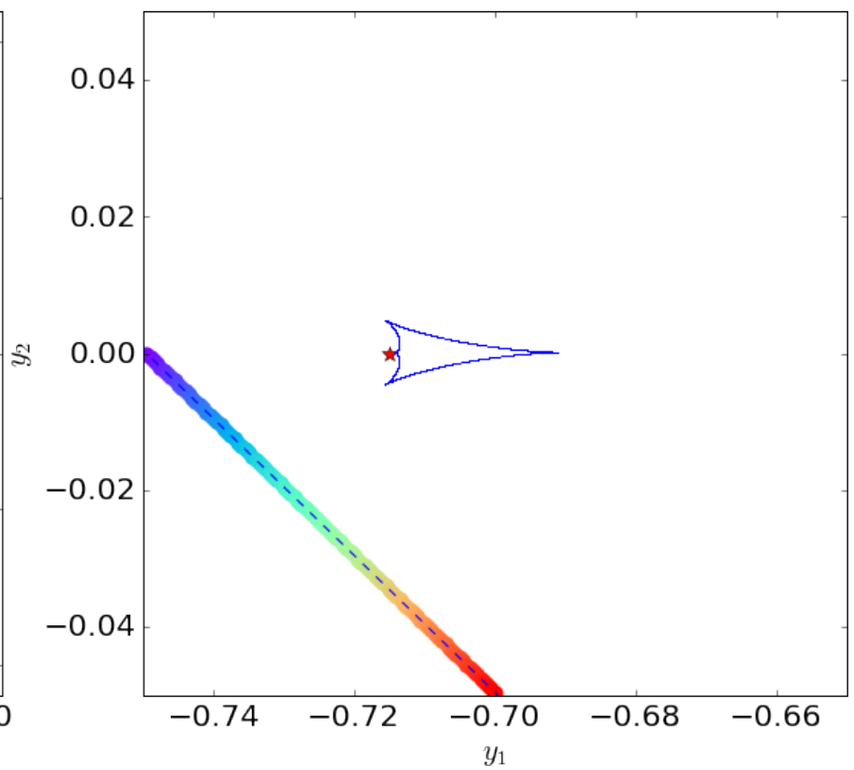
CENTRAL CAUSTIC PERTURBATIONS

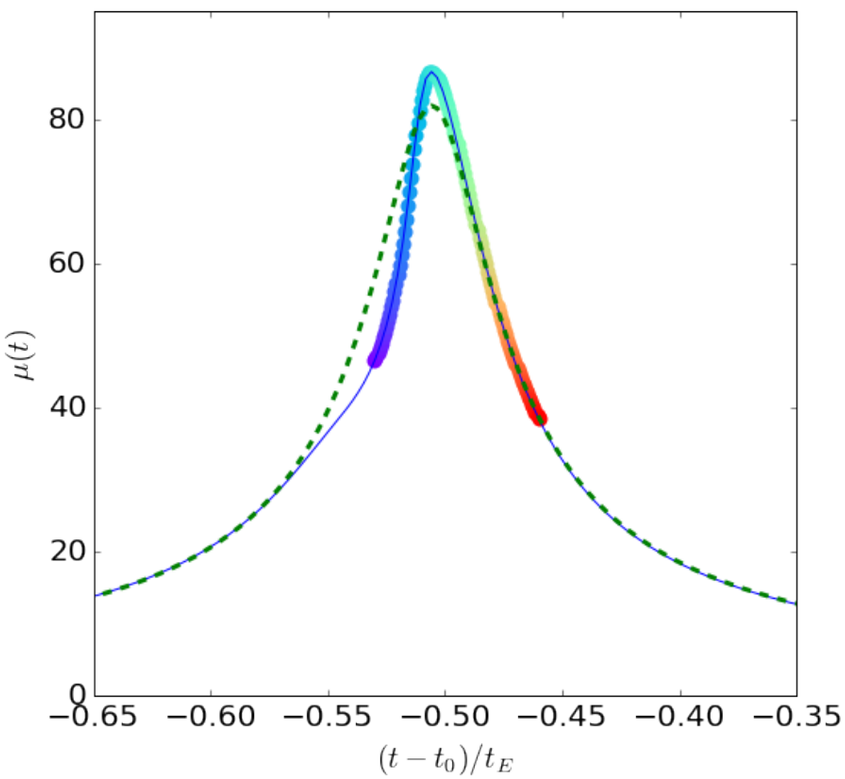












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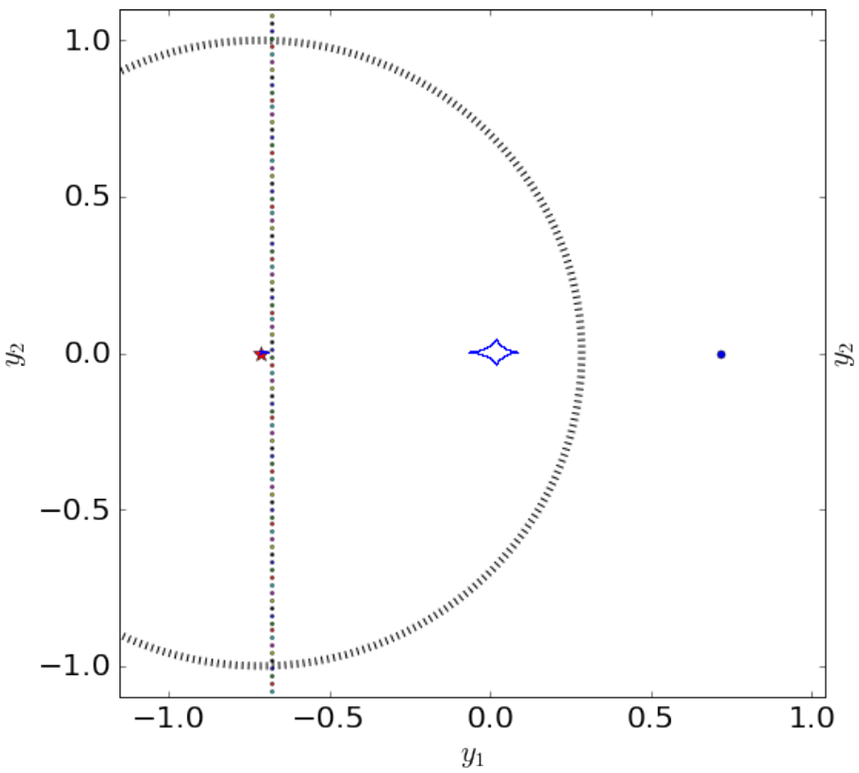

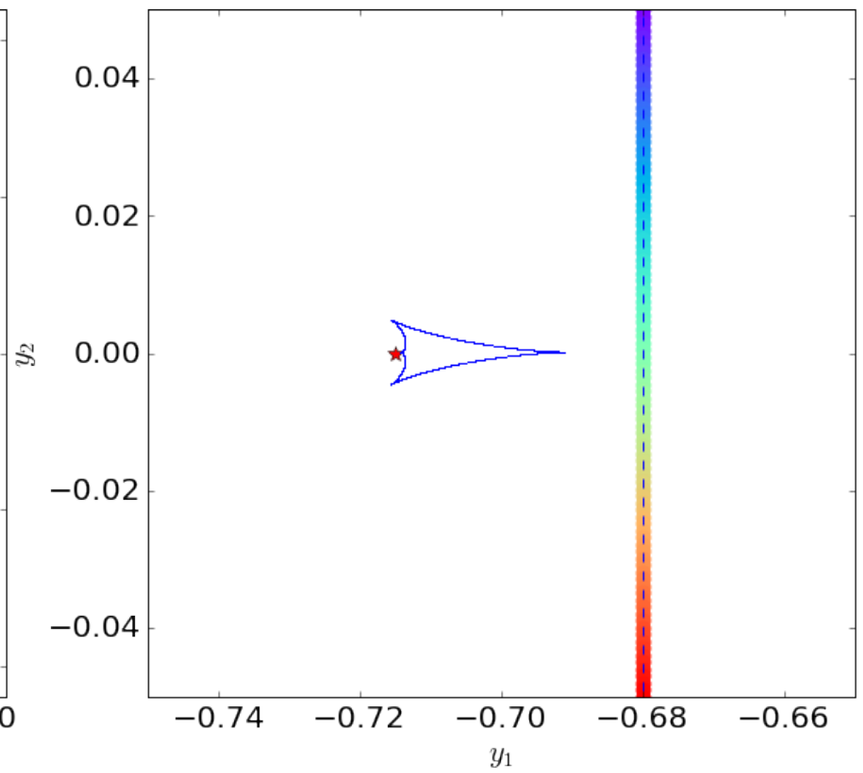

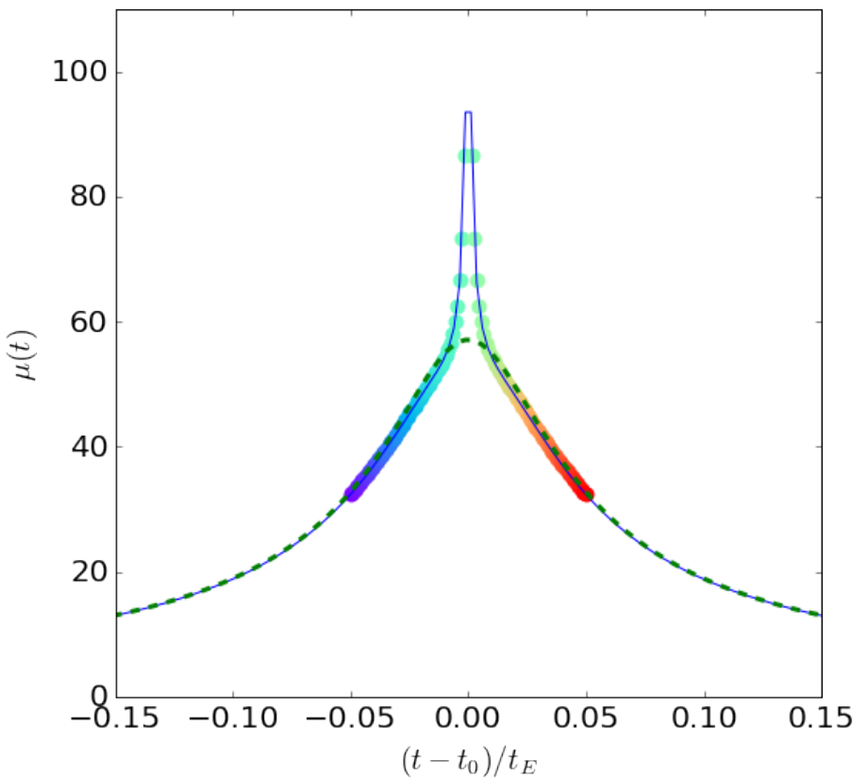

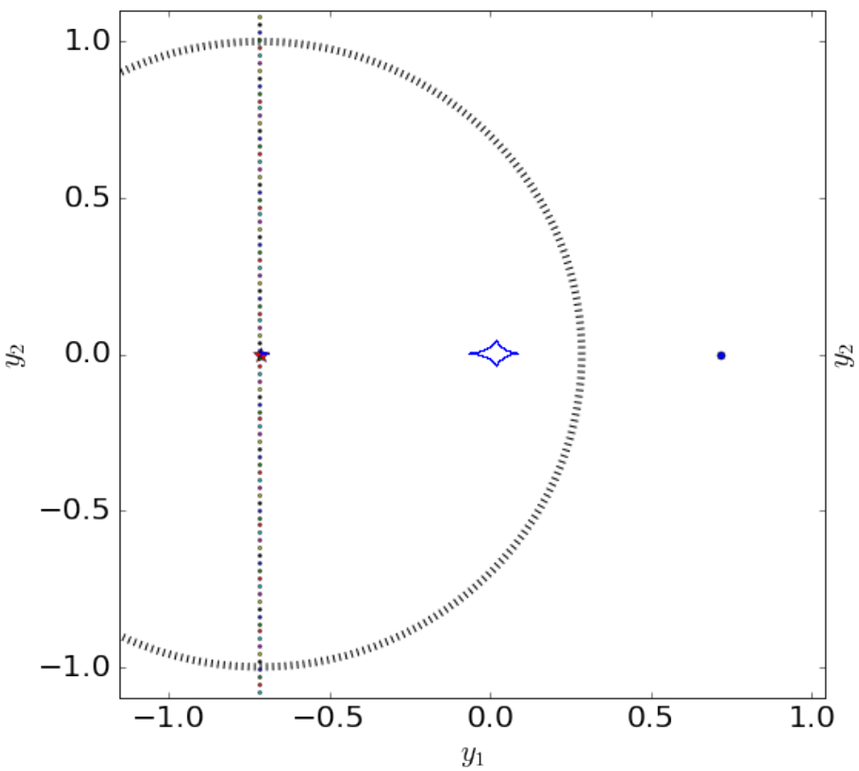

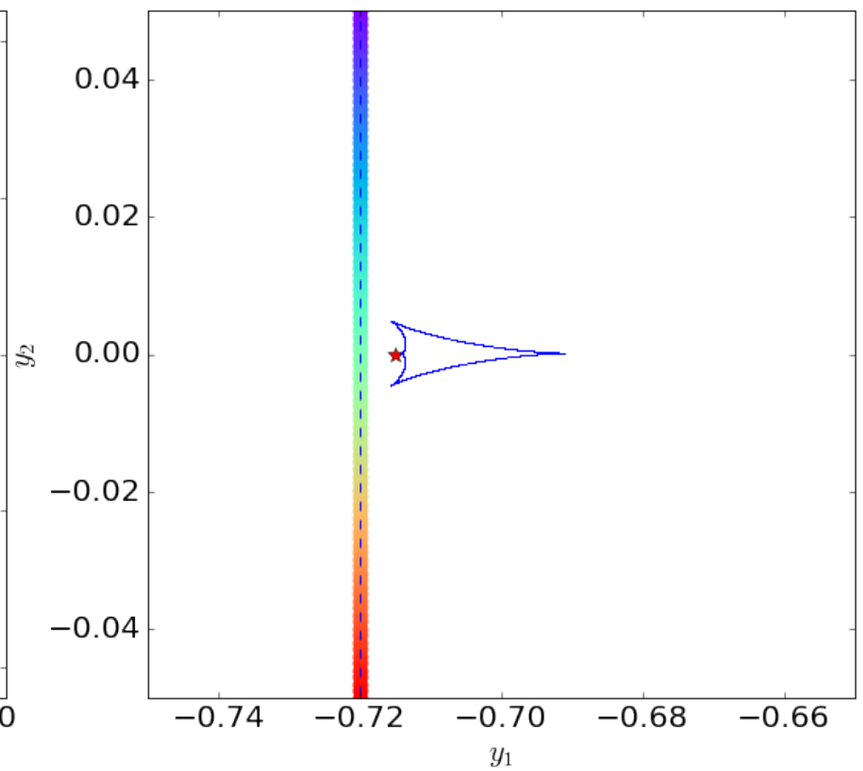

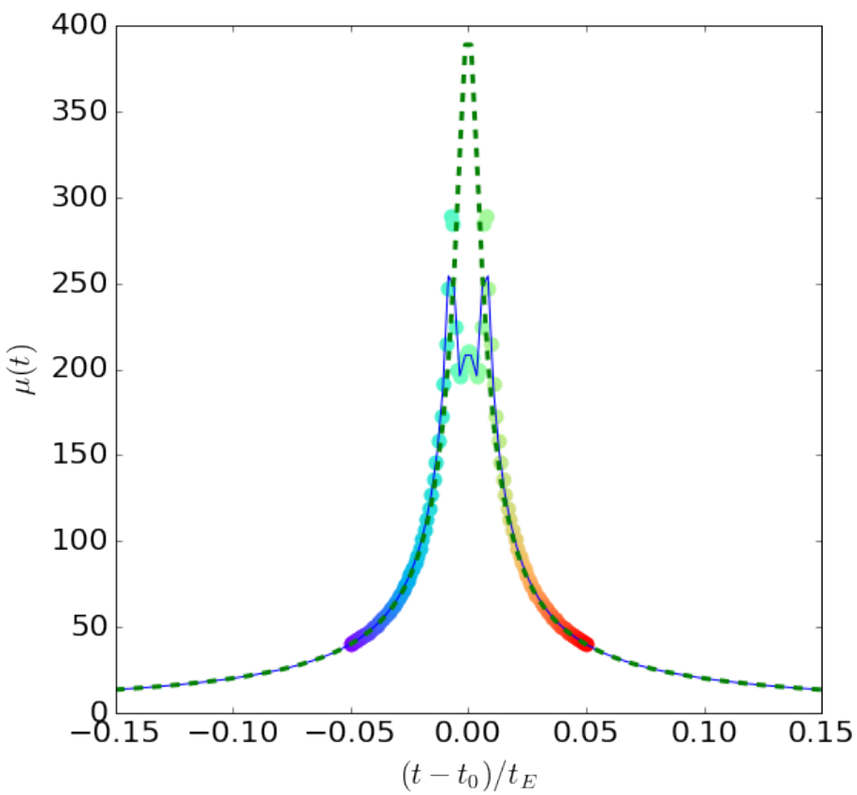

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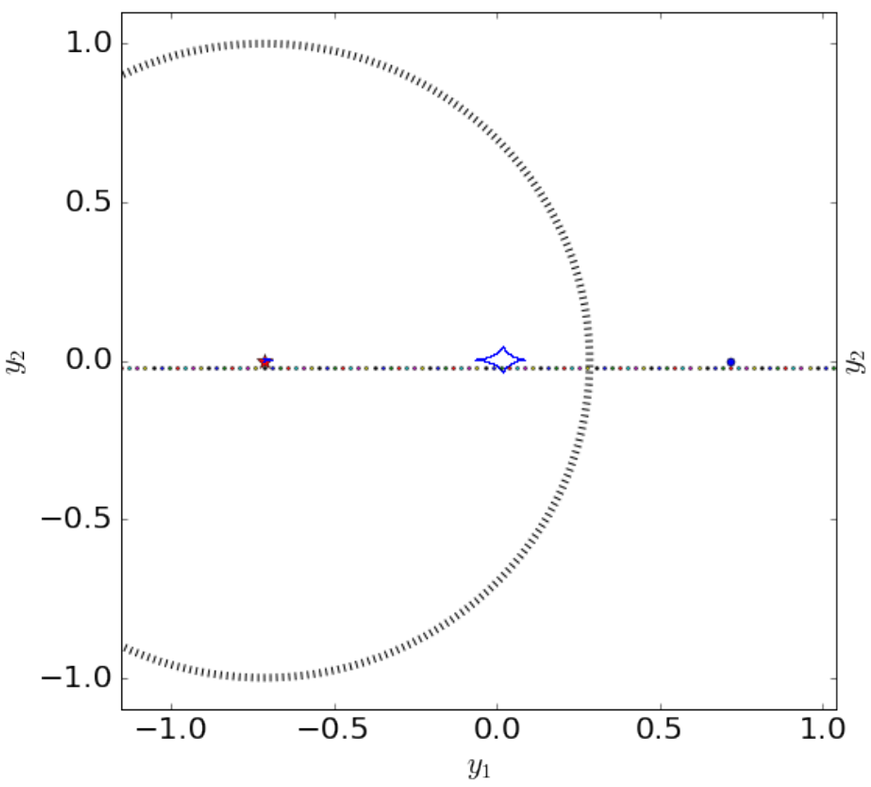
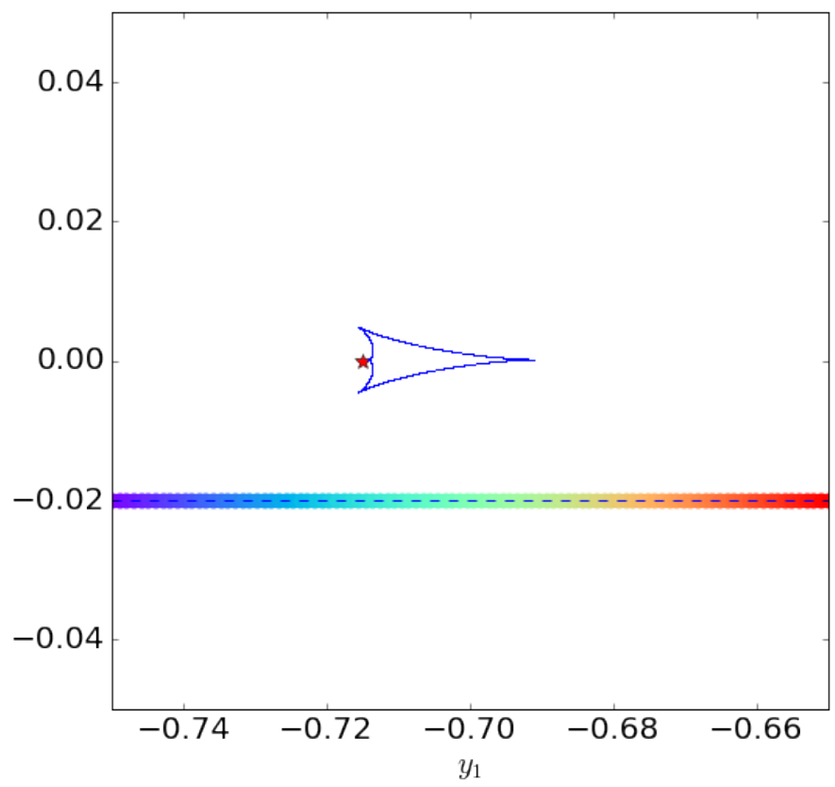
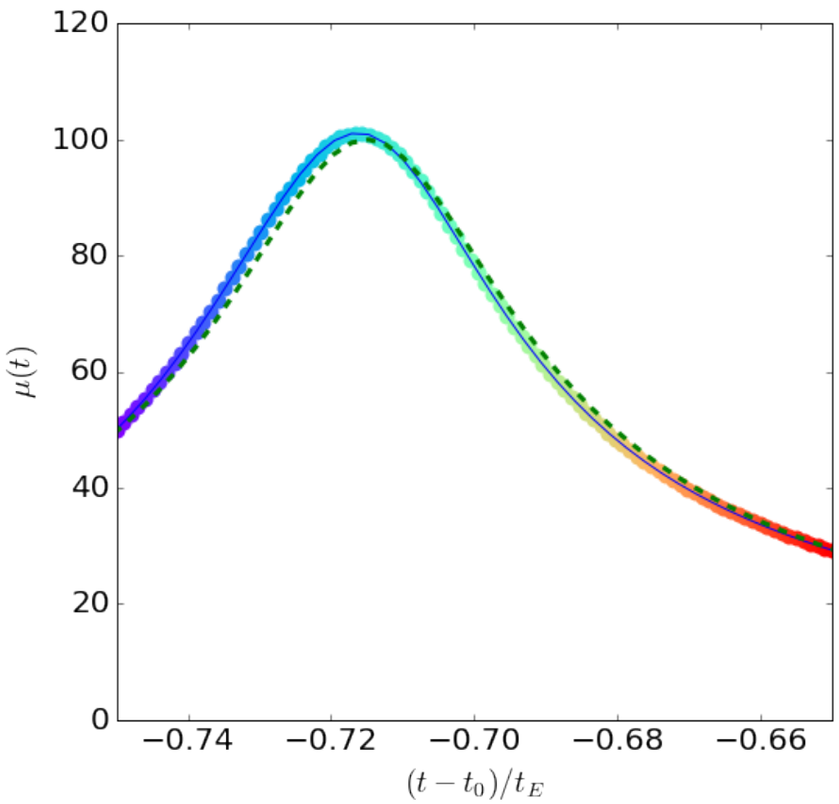
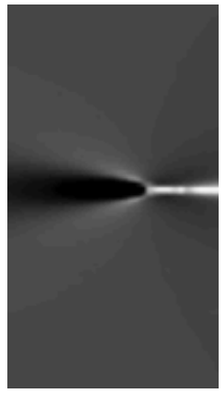


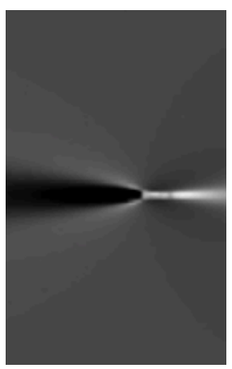


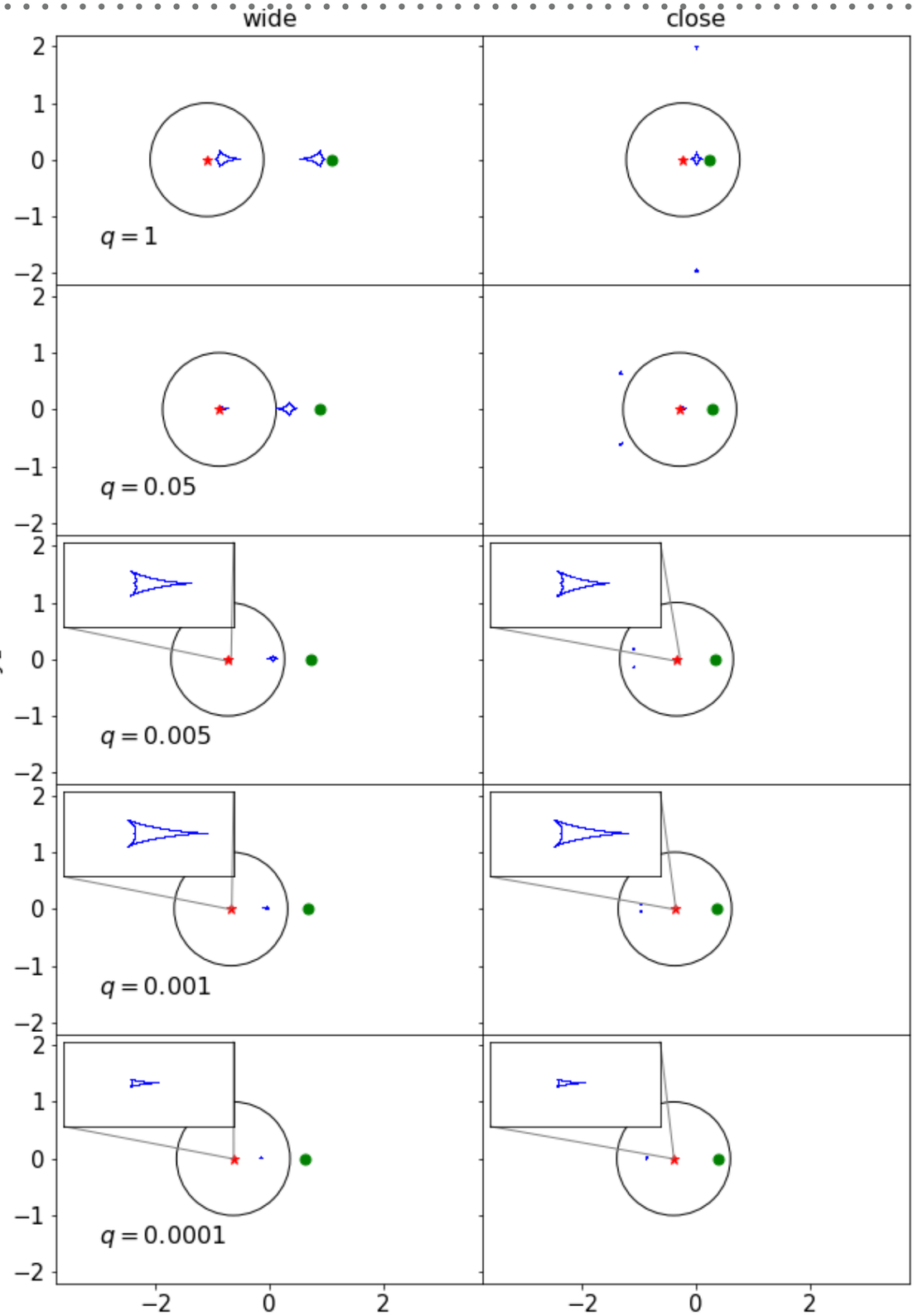


WIDE-CLOSE DEGENERACY!

- Caustics and magnification patterns are identical in wide and close systems with $d_w = d_c^{-1}$







PLANET DETECTION THROUGH CENTRAL CAUSTICS PERTURBATIONS

- Only possible in the case of high magnification events (sources passing very close to the host stars)
- For this reason, they are rare events
- Advantages:
  - near the peak of the event
  - can sometimes be predicted in advance
  - high magnification makes possible to follow-up the events using small telescopes
  - more accurate photometry
- Disadvantages:
  - degeneracy wide-close topologies