Faint images of pulsars from strong plasma lenses

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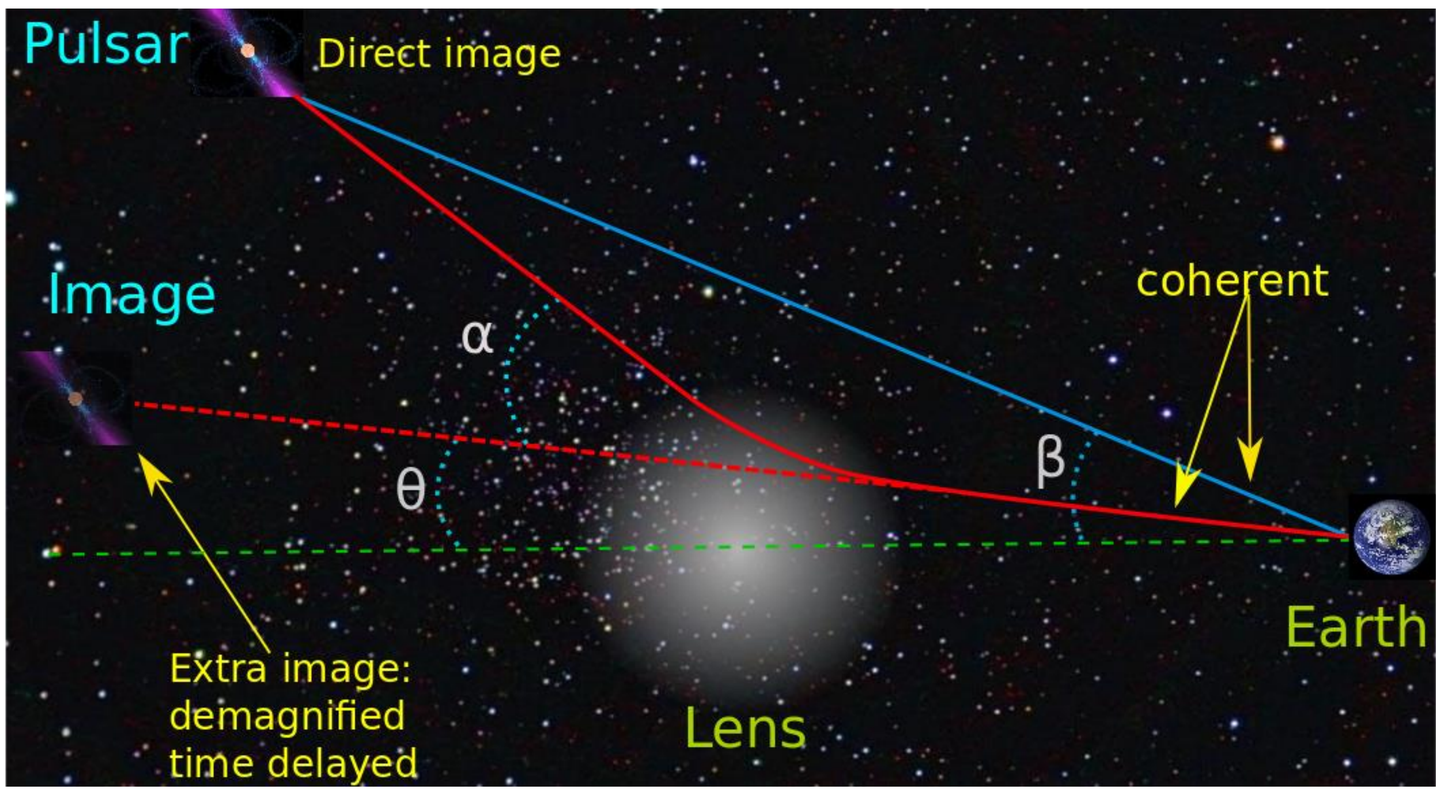
Extreme Scattering Events (ESE), first observed by Fiedler et al. (1987), are thought to occur when the line of sight to background point sources (pulsars, quasars) passes directly through small (AU-sized), dense and ionised refractive lenses. The exact nature and number of these lenses remains unclear, mainly due to the rarity of such events. We propose here a strategy to constrain the properties of refractive lenses thought to be responsible for ESEs, by searching for, and characterising faint refracted images of pulsars at large scattering angles. We show that the cross-section of large angle scattering is much greater than the cross-section of ESEs. These lenses are far more numerous than the stars in our Galaxy and it has been suggested that they contain a significant fraction of the Galaxy's mass.



Lensing Process

- Lens: spherical dense gas cloud (Walker 2001,2007) acting as a diverging lens.
- Lens refracts rays creating extra images.
- Extra images are time delayed and de-magnified.
- Both direct and extra images are coherent which enhances image detection in the secondary spectra regime.

Results for 25 cm calculations

1

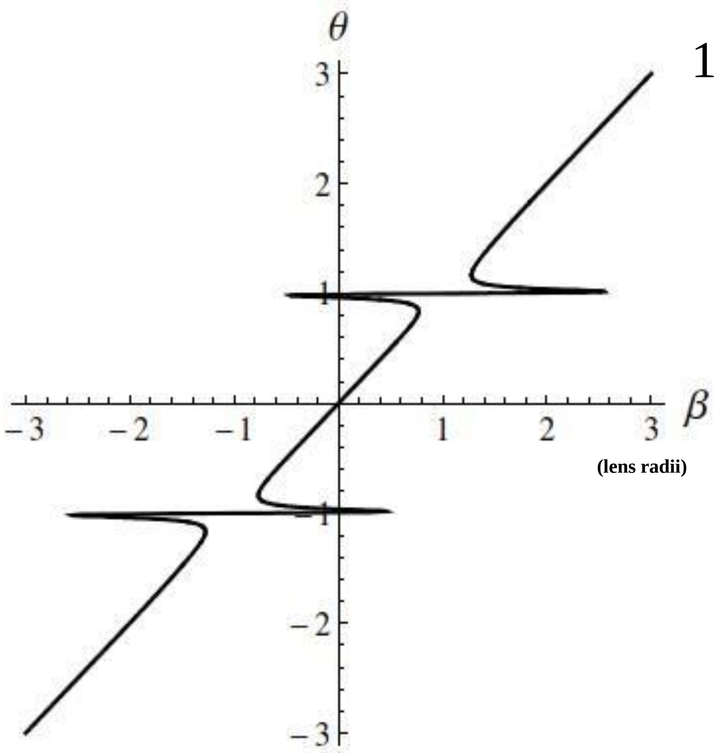
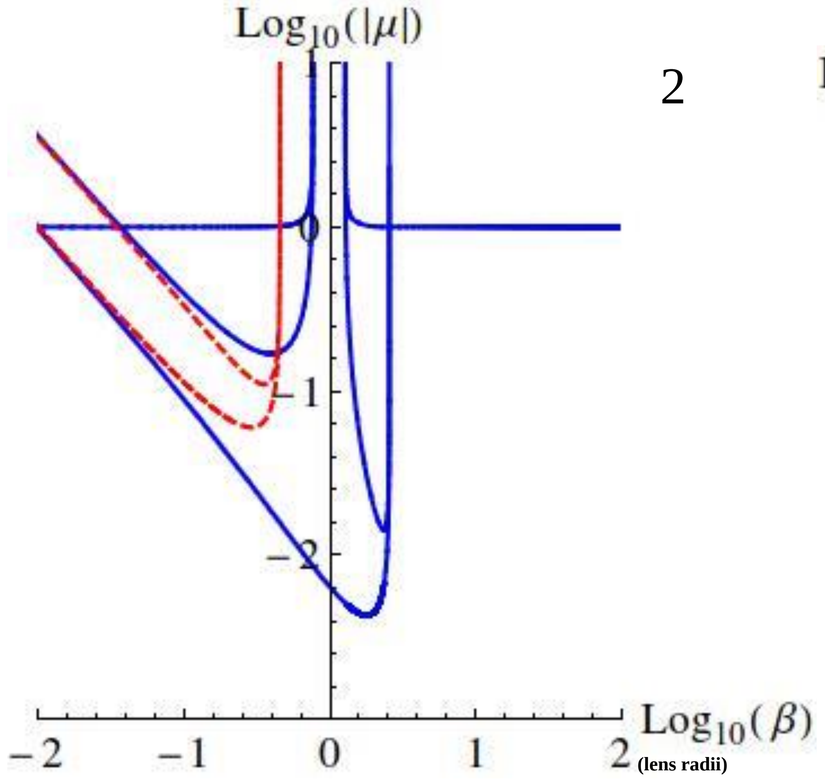


Image and source position

2



Magnification of images

3

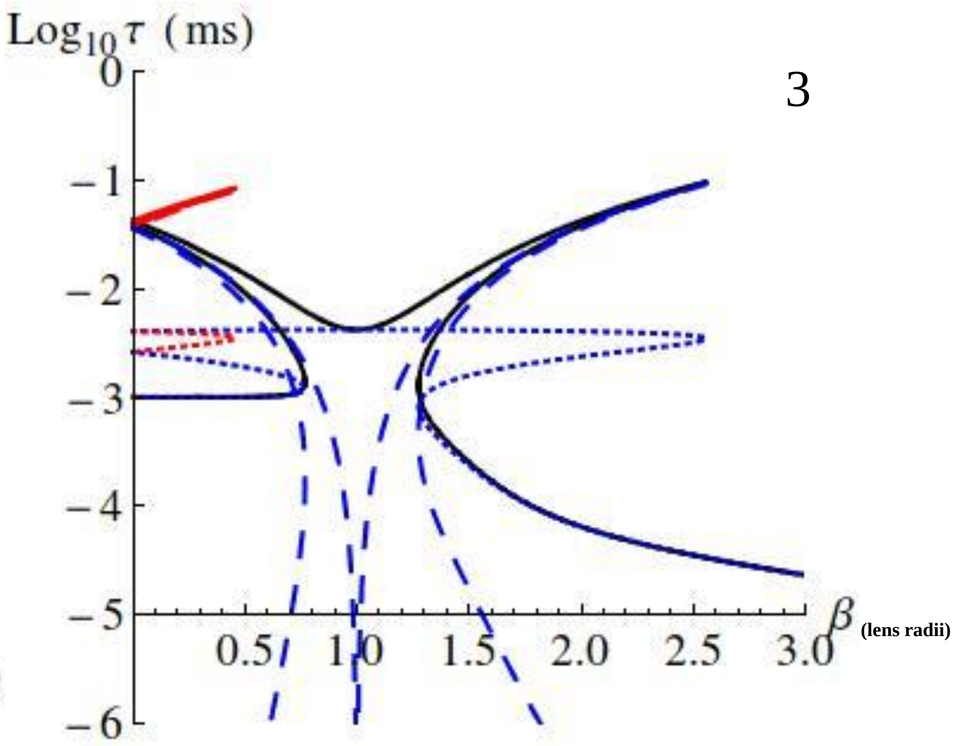


Image time delay and source position

1. Extra images are detected when the lens is up to ~2.5 lens radii away from the observer-source line-of-sight.
2. Extra images are de-magnified by down to ~ 10^{-2} compared to the direct image. They can still be detected by using the cyclic spectroscopy that coherently adds the extra and direct images.
3. Each image is geometrically and due to dispersion time delayed.
4. Observations will be analysed using cyclic spectroscopy (Demorest 2011), which gives an image of the received electric field as a function of time delay and Doppler-shift.

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