

The logo for the MERLIN Lens Programme. It features a large, stylized blue 'e' on the left. A blue line starts from the bottom of the 'e', goes up and right, then curves down and right to end at a blue sunburst icon. To the right of the 'e' and the line, the word 'MERLIN' is written in a bold, blue, sans-serif font. Below 'MERLIN', the words 'Lens Programme' are written in a green, sans-serif font.

MERLIN

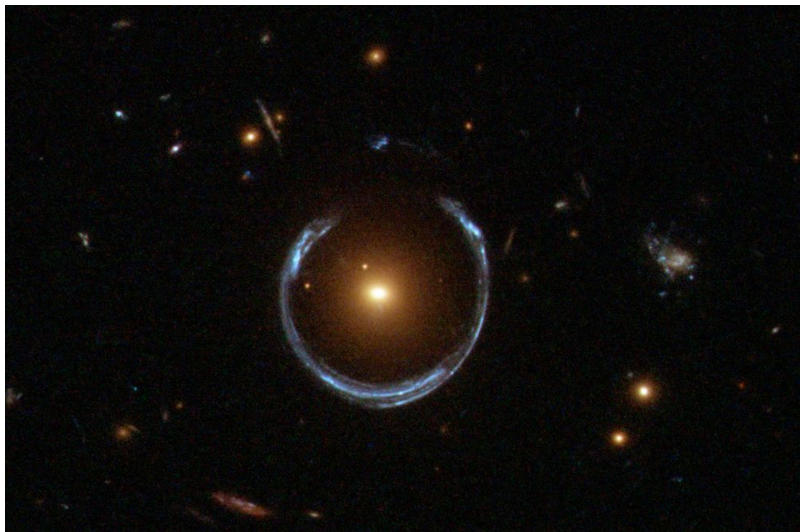
Lens Programme

- Jonathan Quinn
- PhD Supervisor: Dr Neal Jackson

PI: Neal Jackson, Stephen Serjeant

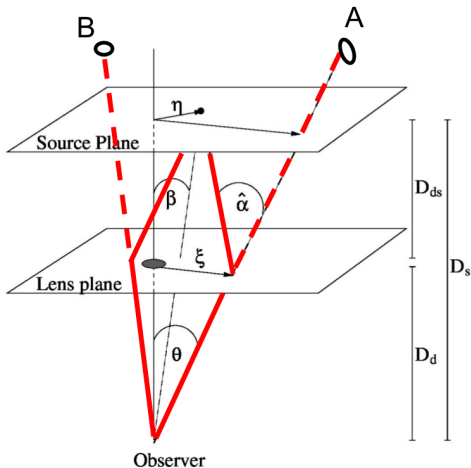
Co-I: David Bacon, Andrew Biggs, Andrew Blain, Mark Birkinshaw, Ian Browne, Nieves Castro-Rodriguez, Scott Chapman, David Clements, Kirsten Coppin, Simon Dye, Steve Eales, Ian Heywood, Rosalind Hopwood, David Hughes, John Mckean, Angela Mortier Mattia Negrello, Chris Pearson, Ismael Perez-Fournon, Douglas Scoot, Mark Thompson, Mattia Vaccari, Ludovic van Waerbeke, Steve Warren, Glenn White, Olaf Wucknitz, Ming Zhang, Gianfranco

Gravitational lenses



LRG 3-757

$$\hat{\alpha} = \frac{4GM}{c^2\xi}$$

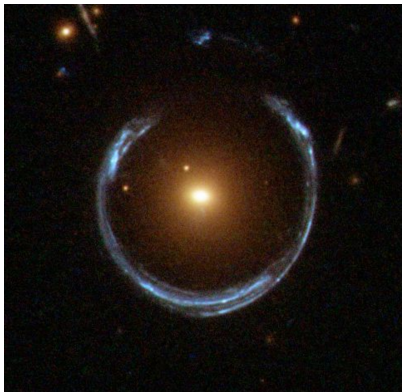


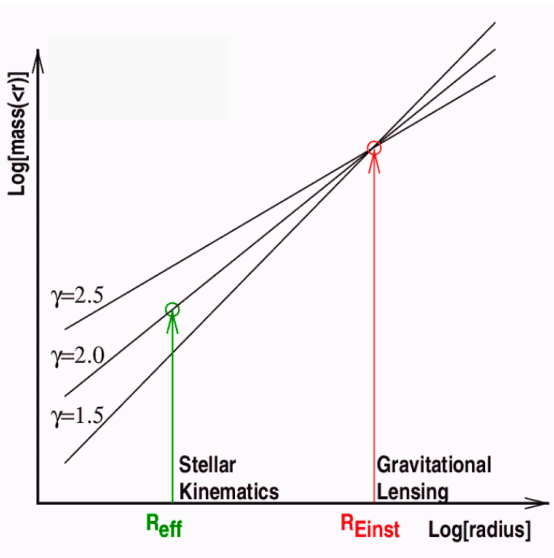
[Schneider et al. 2006]

$$\beta = \theta - \alpha$$

-

$$\theta_e = \sqrt{\frac{4GM}{c^2} \frac{D_{ds}}{D_d D_s}}$$



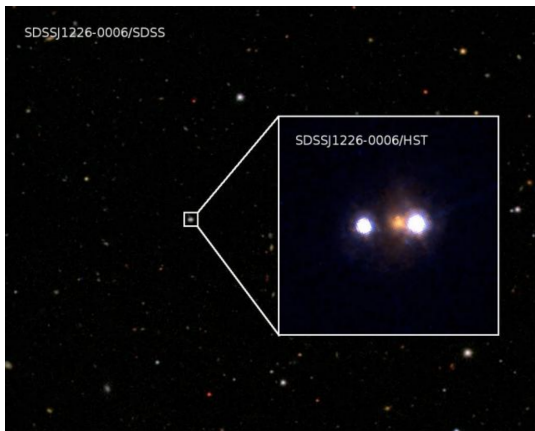


[credit: M. Barnabè]

- Gravitational lensing provides information on a lens, but only at the position of an image!

Lens Programme

- Double systems



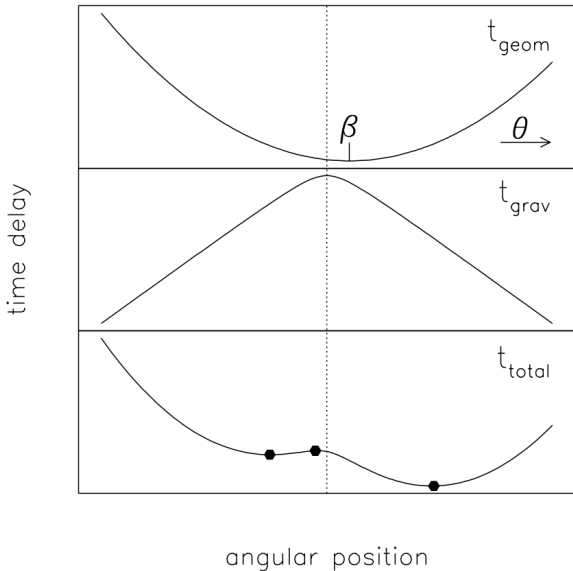
Masamune Oguri, Naohisa Inada et al

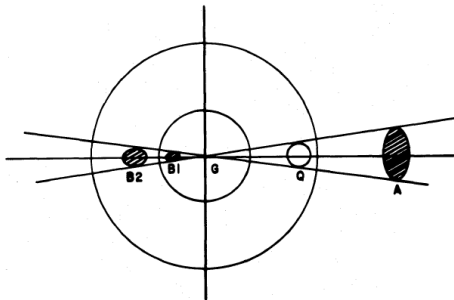
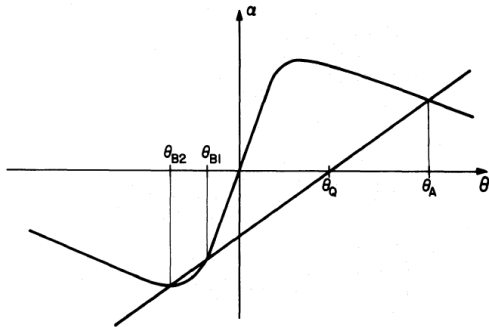
Central images

- An arbitrary, transparent distribution of mass, as part of a lensing trio, will result in the production of an odd number of images
- Odd image Theorem: $2n + 1$ images

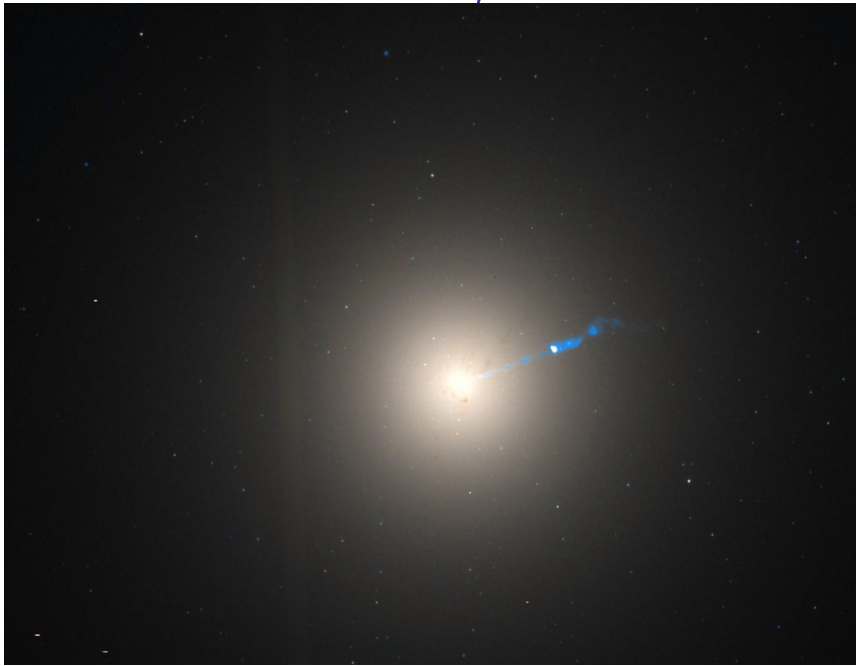
Burke, 1981

Fermat's Principle

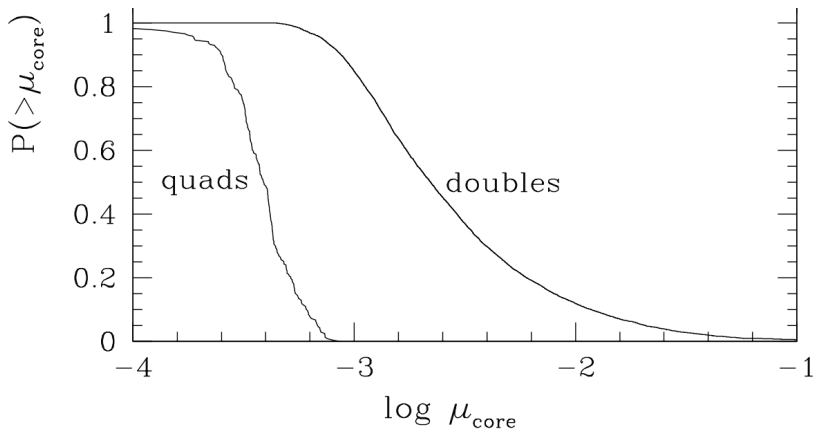




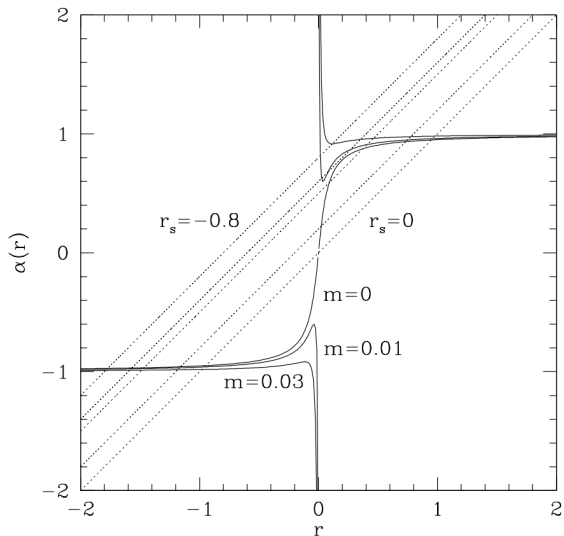
NGC 4486, M87



Central images



Keeton, 2003

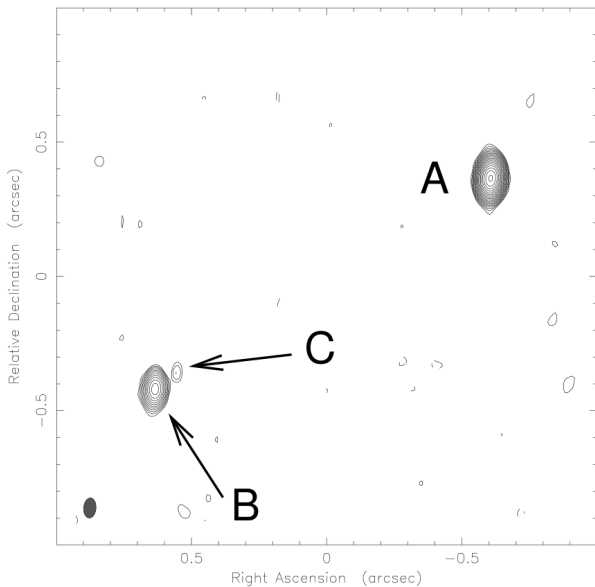


Mao, Witt & Koopmanns, 2001

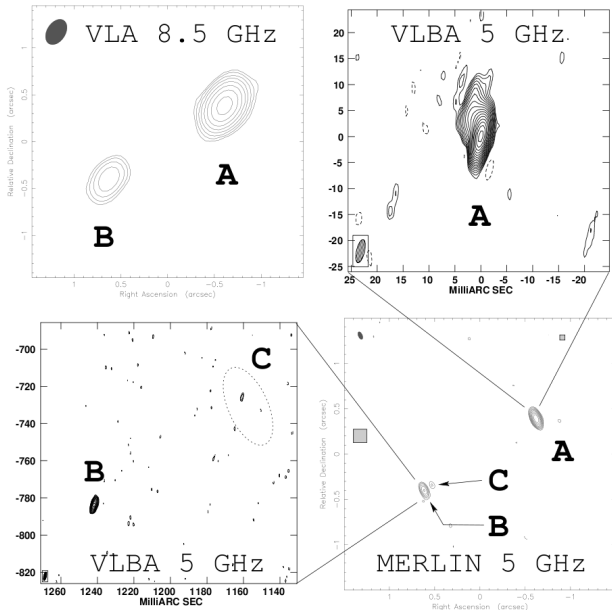
Central images

- Detection of a central image places limits on....
- The mass of the central Black hole
- The central surface mass density
- OR, central power law slope, black hole mass

PMNJ 1632-0033



PMNJ 1632-0033



PMNJ 1632-0033

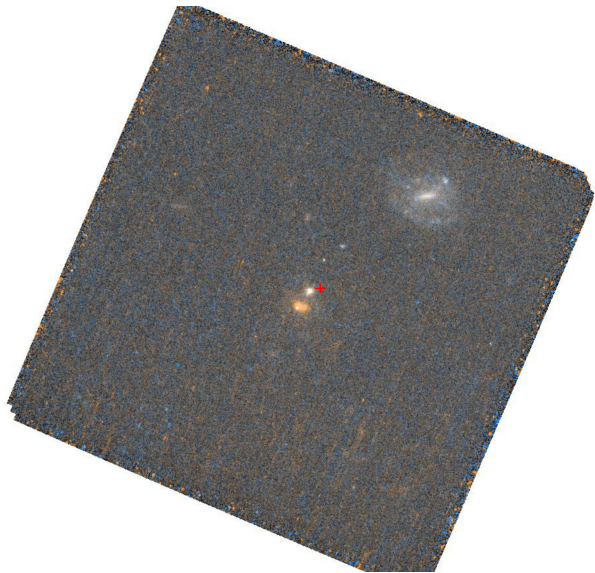
- SMBH $< 2 \times 10^8 M_{\odot}$
- Surface density $> 20,000 M_{\odot}$

JVAS B1030+074

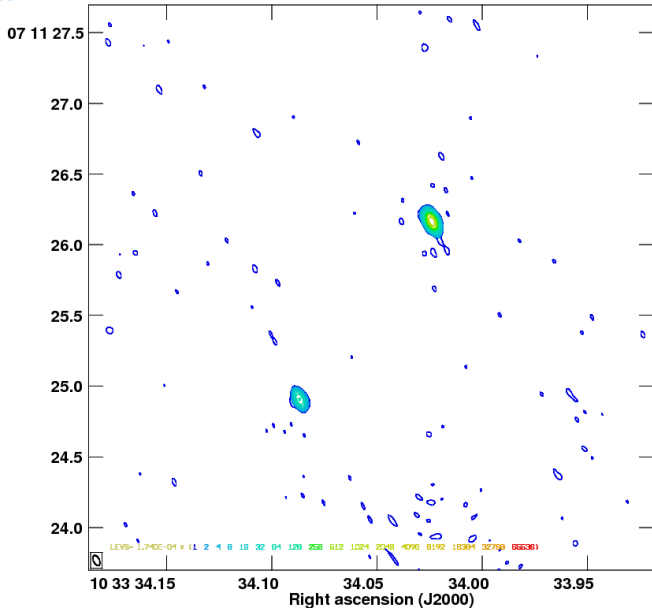
- Jodrell-VLA Astrometric Survey (JVAS)
- Double image System
- Previous work, Central image non-detection (Zhang et al, 2007)
- Upper limit on central image of $180 \mu Jy$

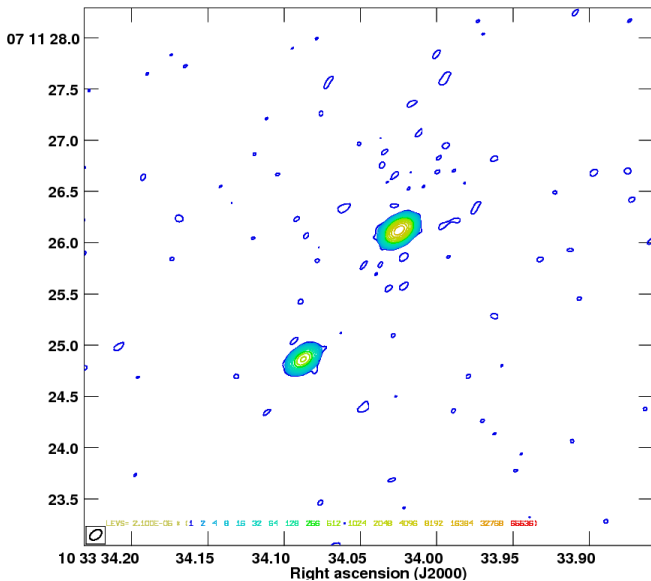
JVAS B1030+074

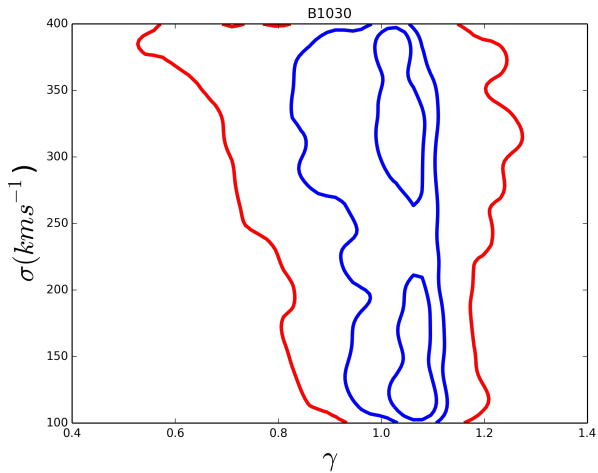
- Break radius $> 130\text{pc}$
- (inner) Power law slope > 1.8
- Zhang et al, 2007

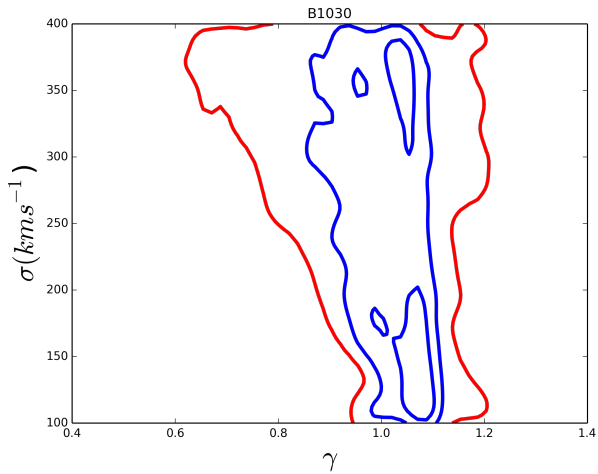


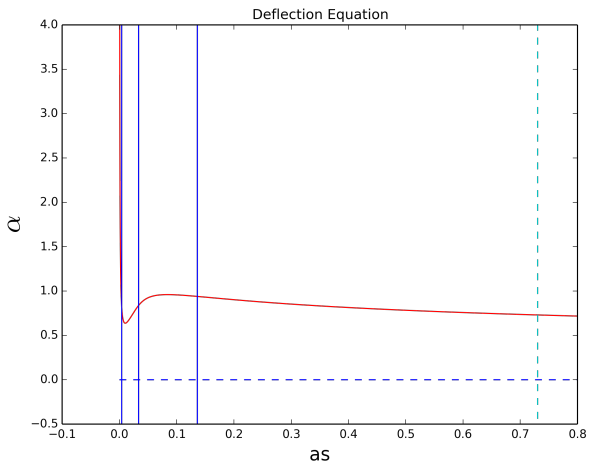
HST 1033 +0711

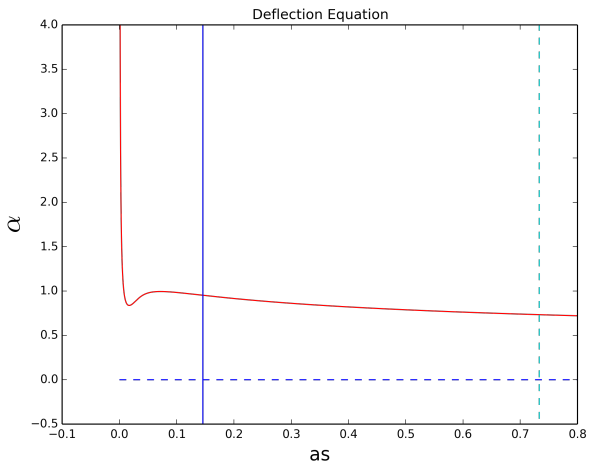












WHY?

- Galaxy Evolution
- $M_{BH} - \sigma$
- Feedback
- Cusp - Core