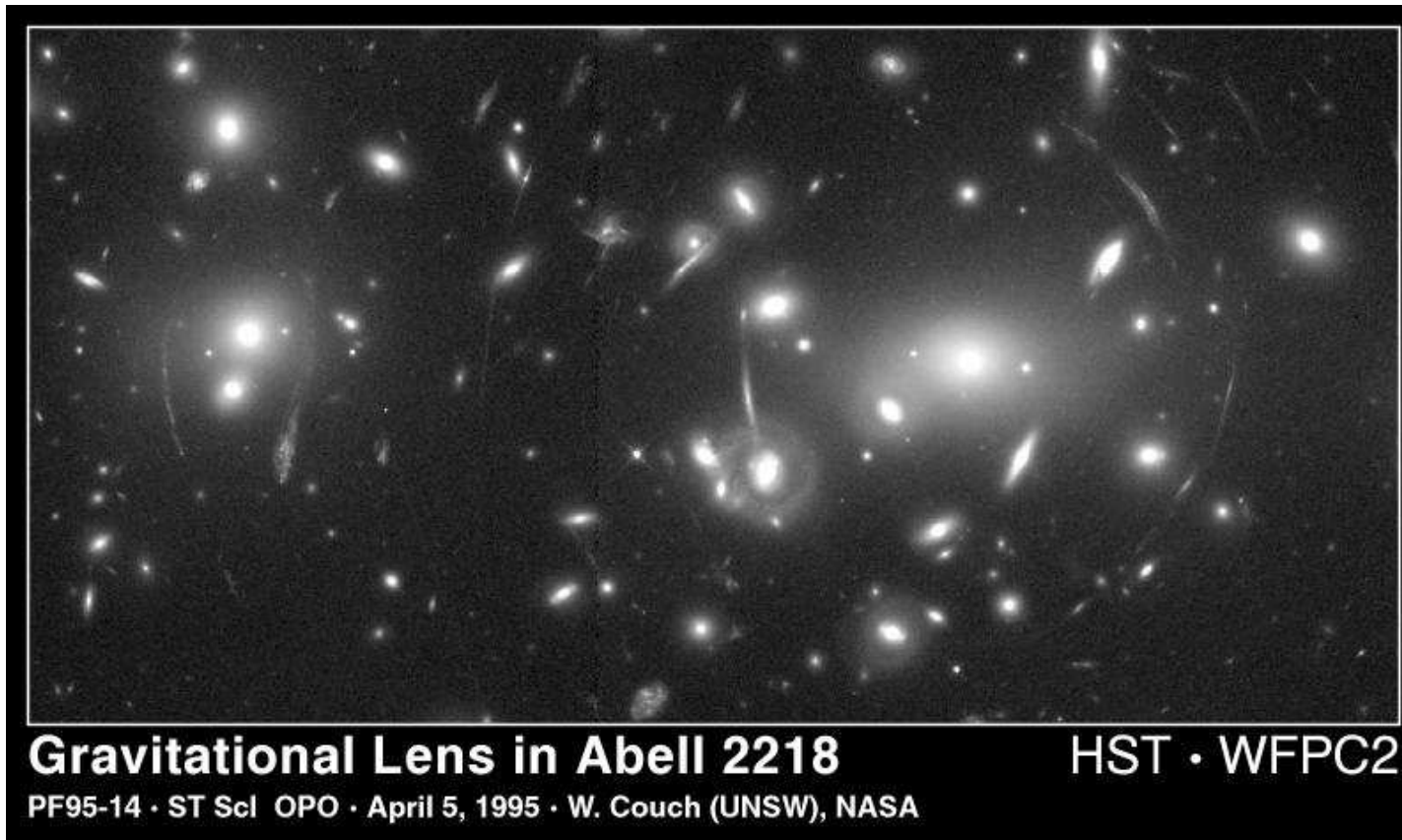


Gravitationslinsen – Hilfsmittel zum Auffinden dunkler Materie

Volker Perlick (ZARM, Universität Bremen)



Bremen, Haus der Wissenschaft, 20. Juli 2013

Newton'sche Lichtablenkung:

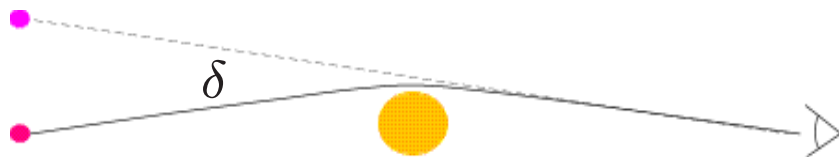
Henry Cavendish 1786, Johann v. Soldner 1801



Henry Cavendish
(1731 – 1810)

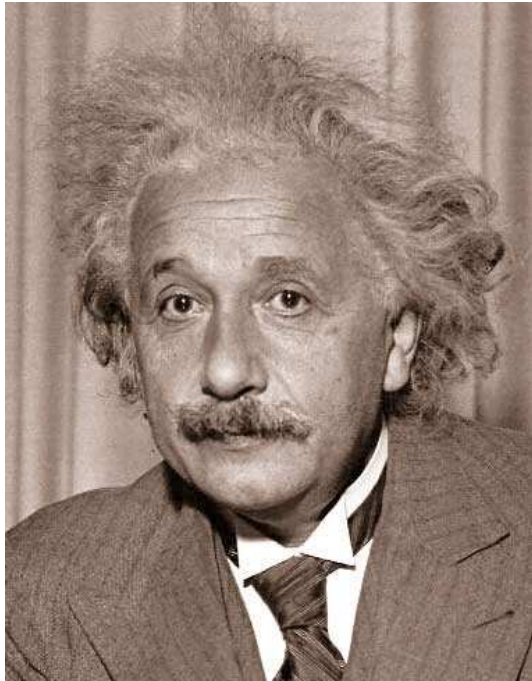


Johann v. Soldner
(1776 – 1833)

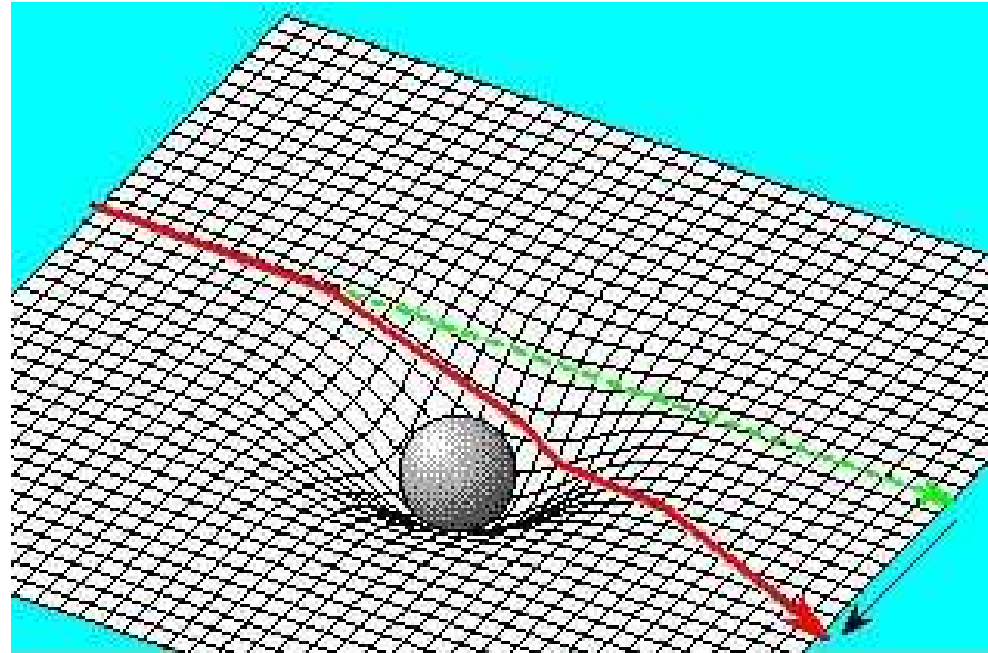


$$\delta = 0,87''$$

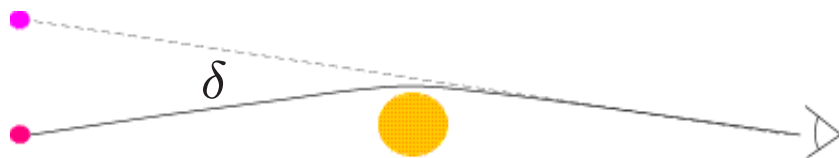
Einsteinsche Lichtablenkung: Albert Einstein 1915



Albert Einstein
(1879-1955)



Raumzeitkrümmung

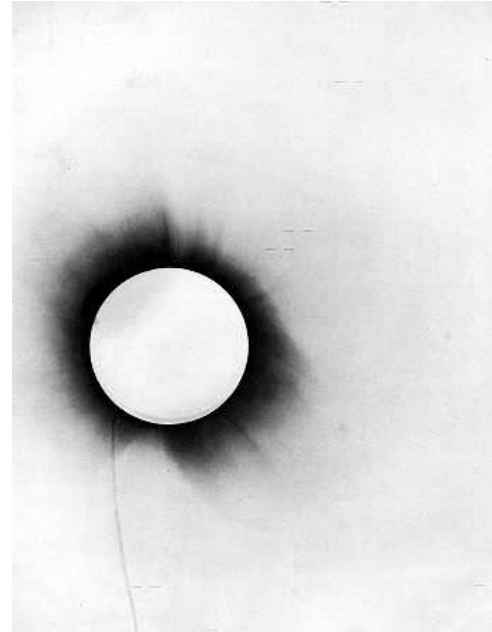


$$\delta = 1,75''$$

Bestätigung der Einsteinschen Lichtablenkung: Arthur S. Eddington 1919



Arthur S. Eddington
(1882 – 1944)

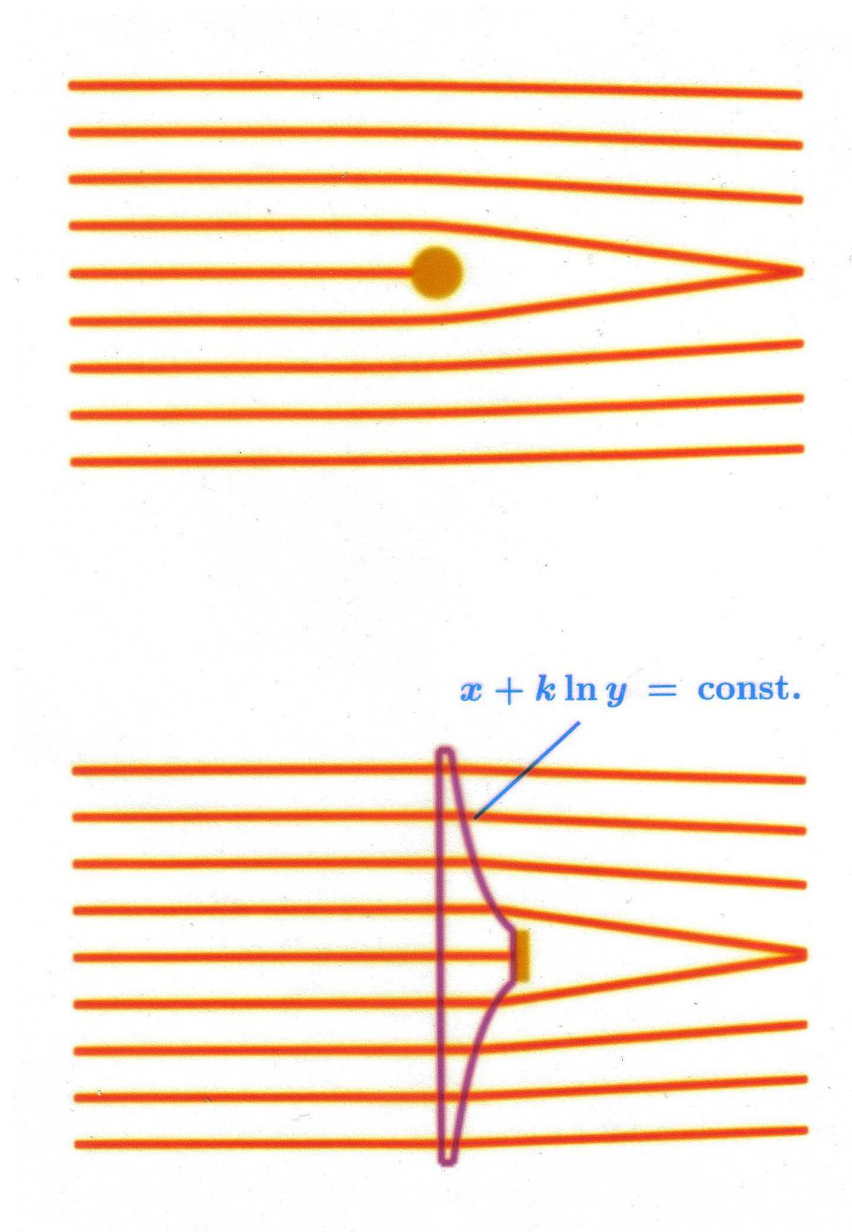


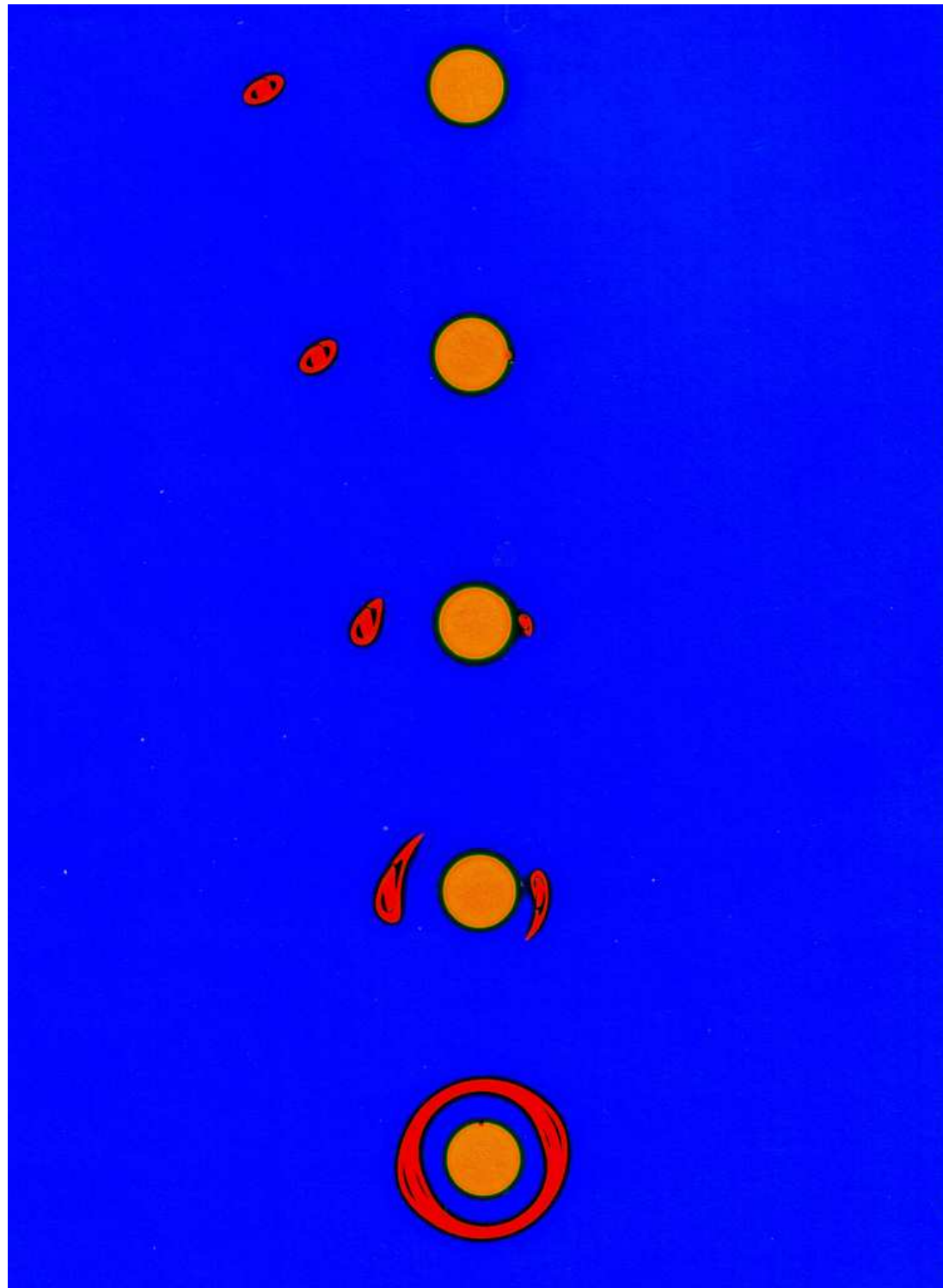
Sonnenfinsternis
1919

Principe: $\delta = 1,61'' \pm 0,40''$, Sobral: $\delta = 1,98'' \pm 0,16''$

D. Lebach et al. (1995): $\left| \frac{\delta - \delta_{\text{Einstein}}}{\delta_{\text{Einstein}}} \right| \leq 0,02\%$

Simulation der Lichtablenkung mit Plastiklinse:





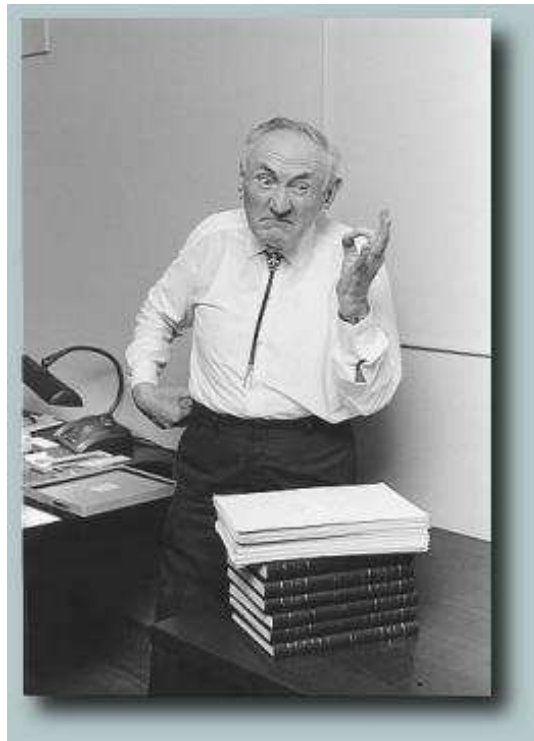
Sind Mehrfachbilder oder Ringe beobachtbar?

Stern "linst" Stern

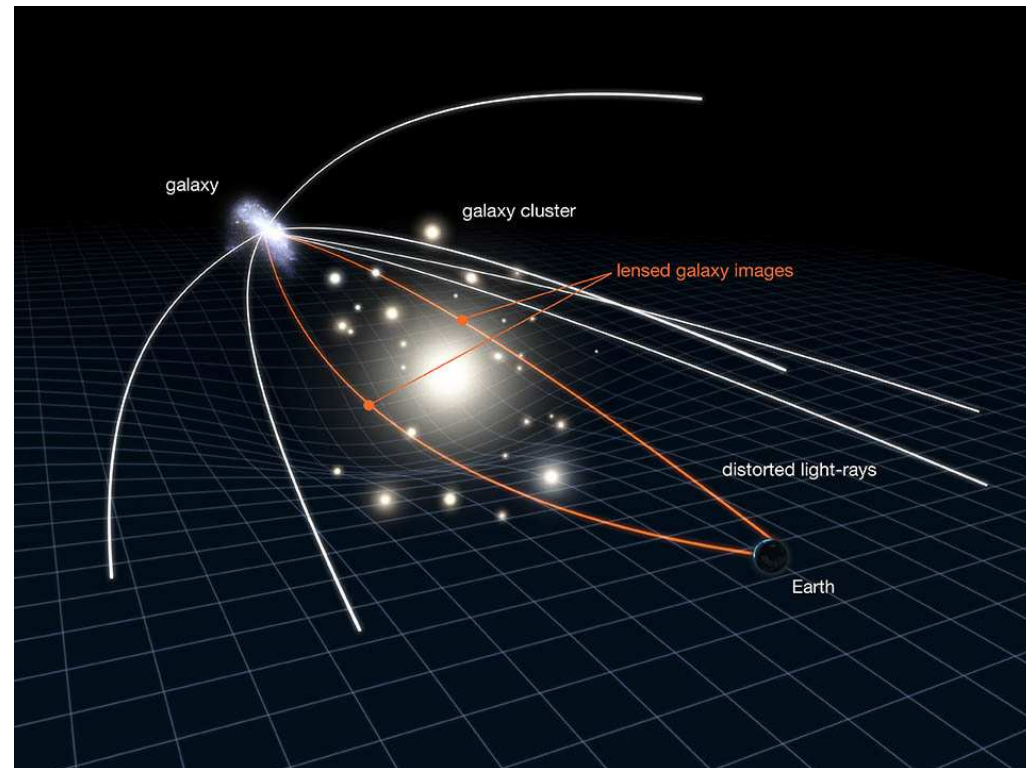
Albert Einstein (1936):
praktisch unbeobachtbar

Galaxie "linst" Galaxie

Fritz Zwicky (1937):
wahrscheinlich beobachtbar

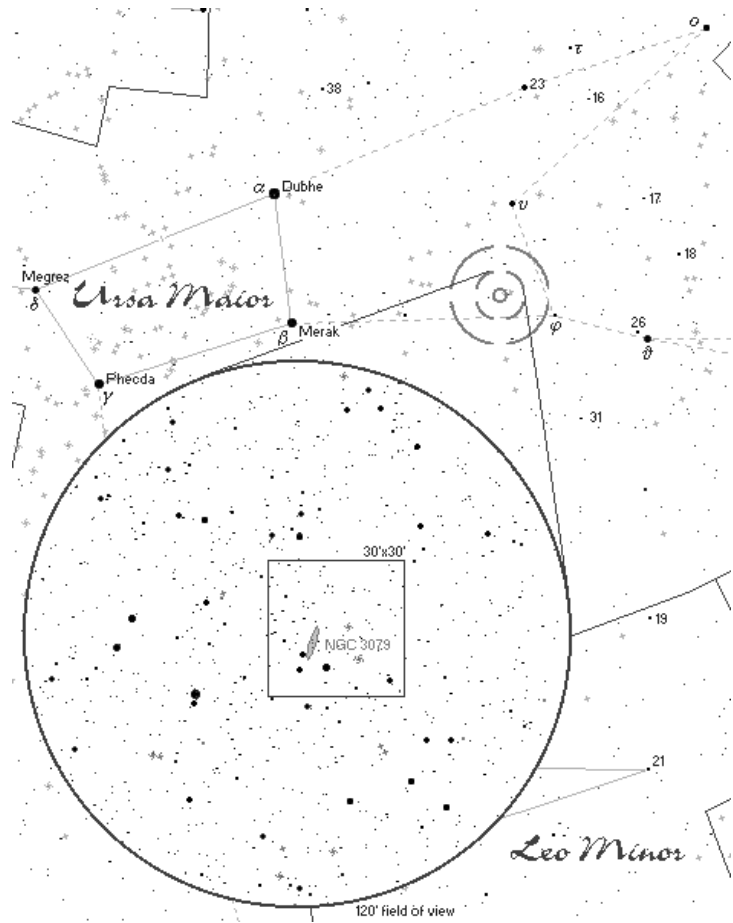


Fritz Zwicky
(1898 – 1974)

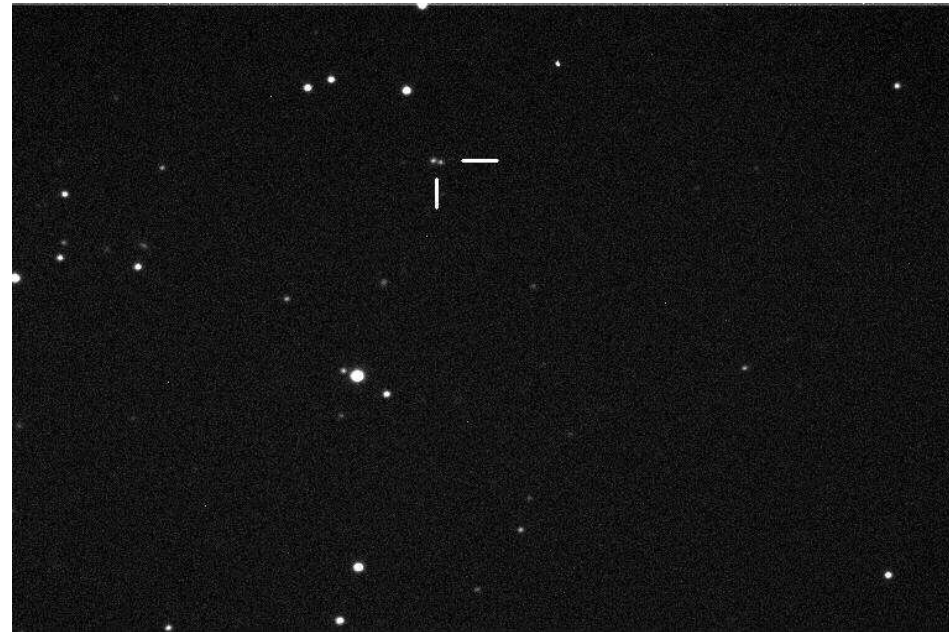


Erstes Mehrfachbild entdeckt:

D. Walsh, R. Carlswell, R. Weyman (1979)



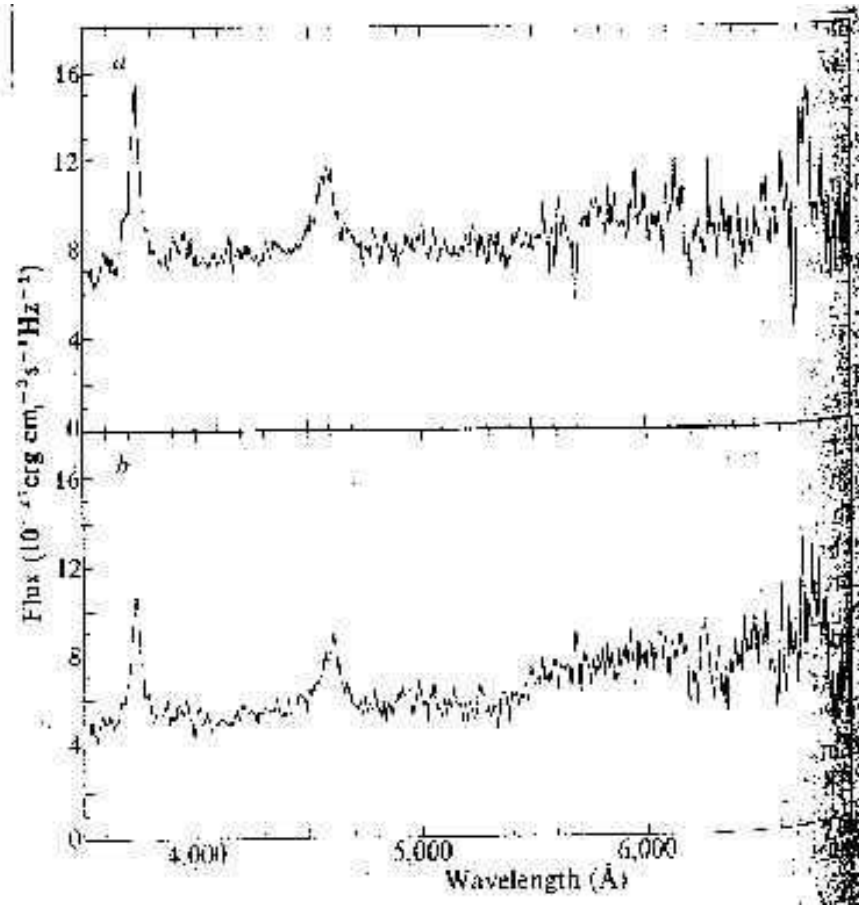
Doppelquasar QS0 0957 +561



Winkelabstand = $6''$

Helligkeit = 17^m

Spektren

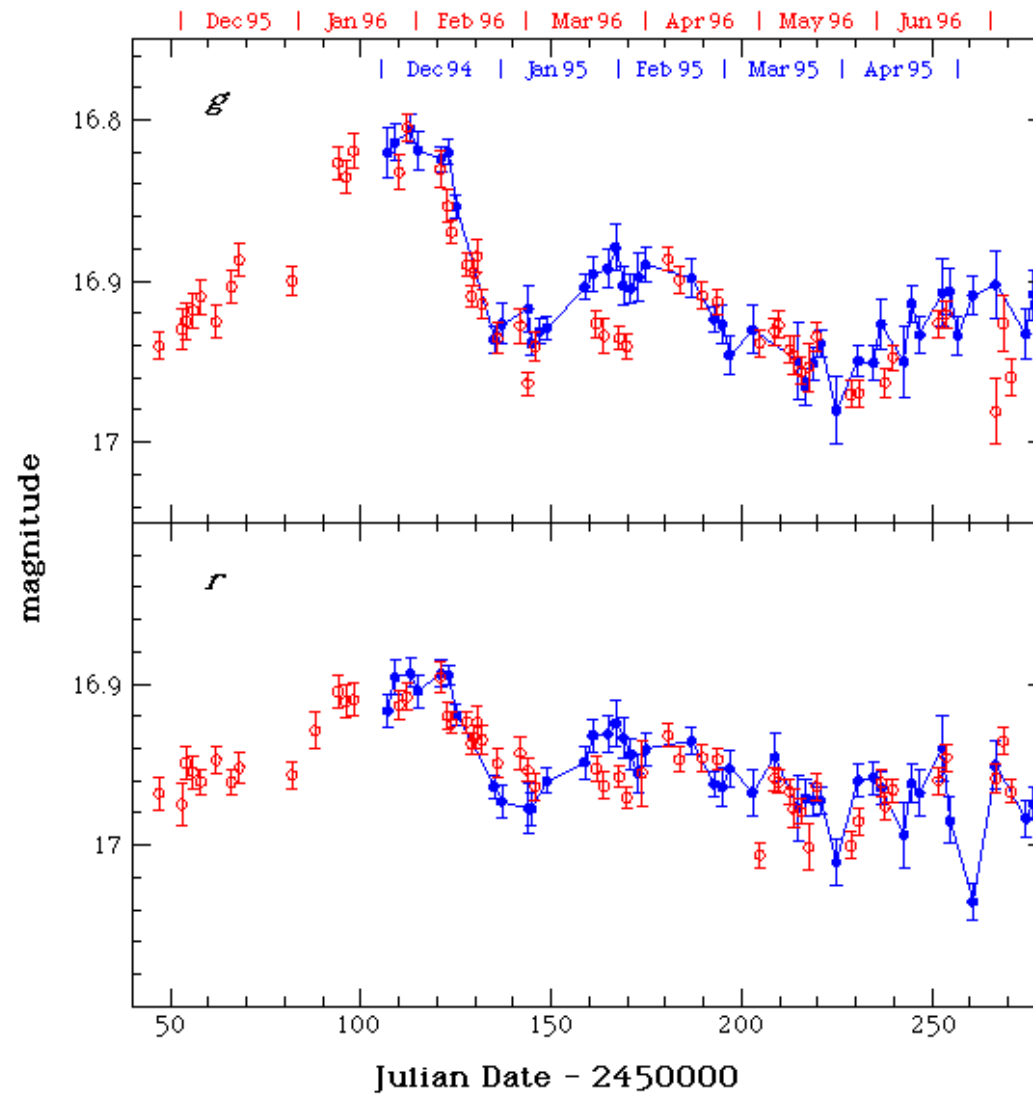


Rotverschiebung:

$$z_{\text{Quasar}} = 1,4$$

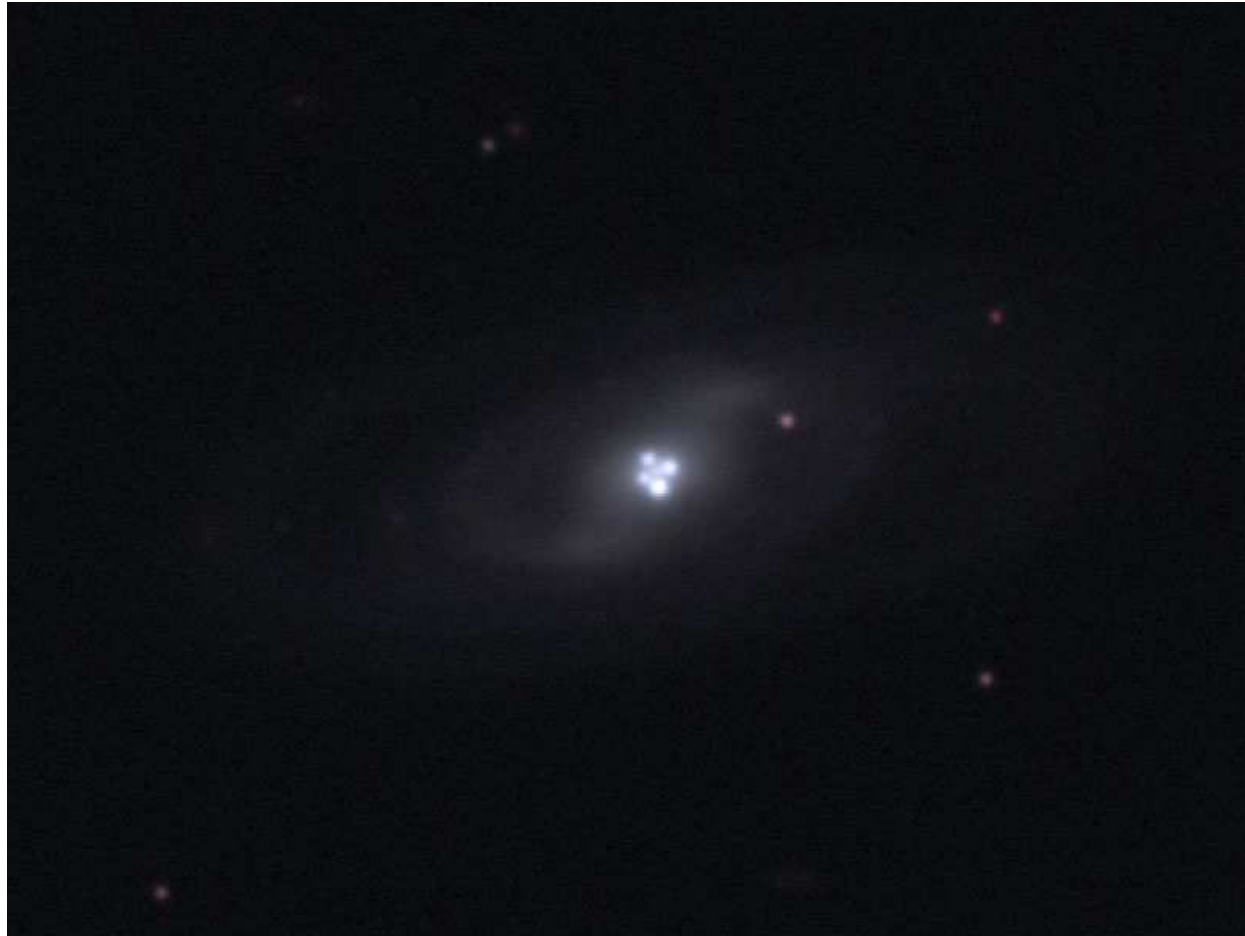
$$z_{\text{Galaxie}} = 0,4$$

Lichtkurven



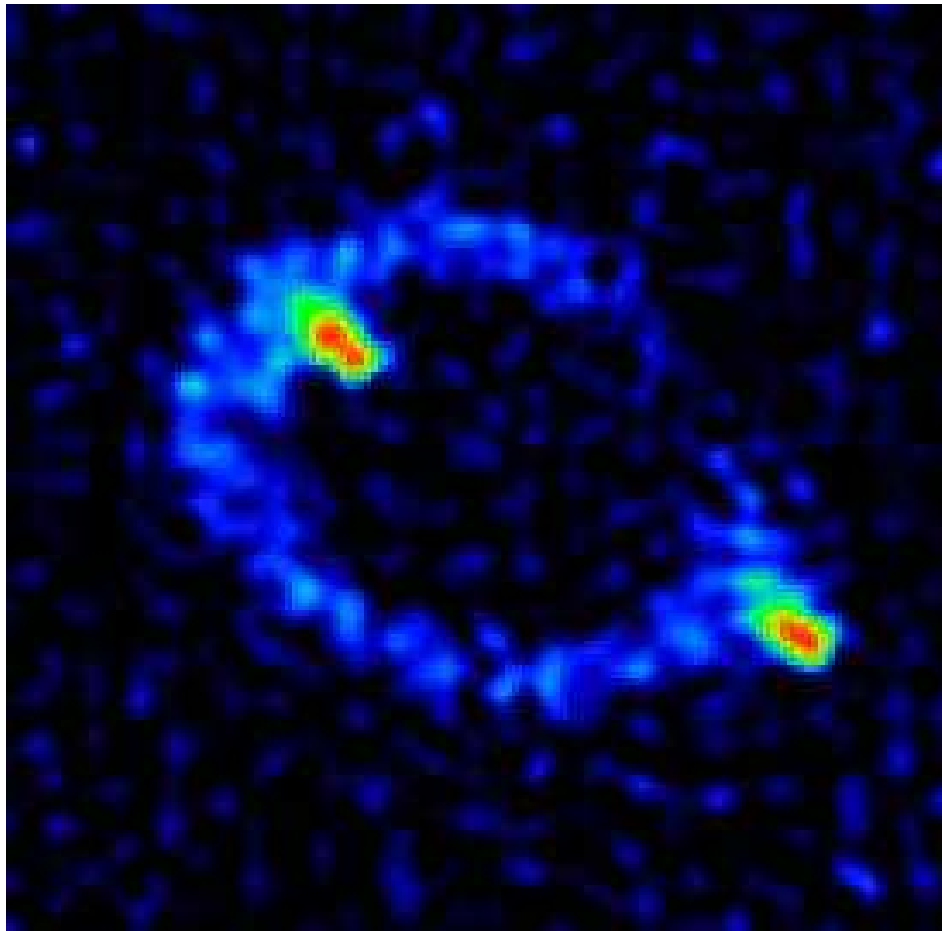
Laufzeitunterschied = 417 Tage

Anderes Beispiel für Mehrfachbild:



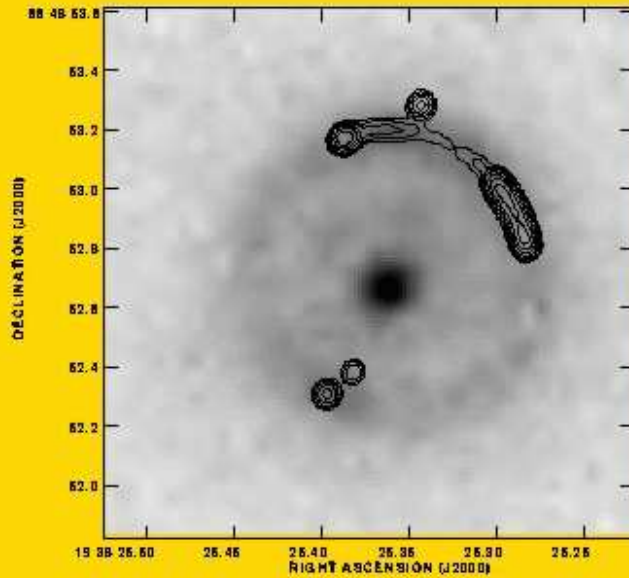
Einstein-Kreuz

Erster Einsteinring beobachtet:
Jacqueline Hewitt et al. (1988)



MG1131+0456

Anderes Beispiel für Einsteinring:



The gravitational lens JVAS B1938+666

Left: HST/NICMOS greyscale with MERLIN radio contours

Right: Colour image of the HST/NICMOS image

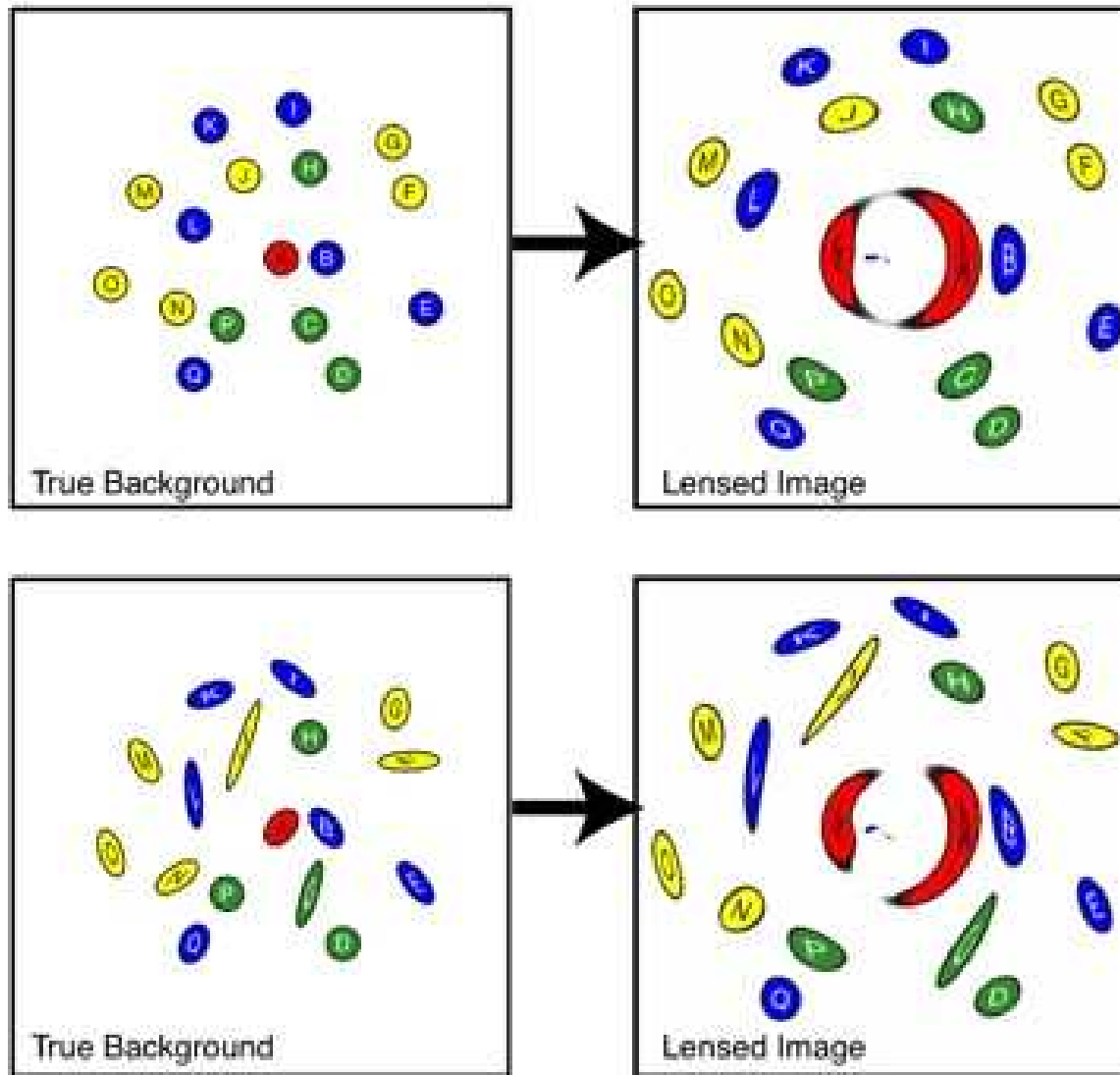
Entdeckung von “Giant Luminous Arcs”:

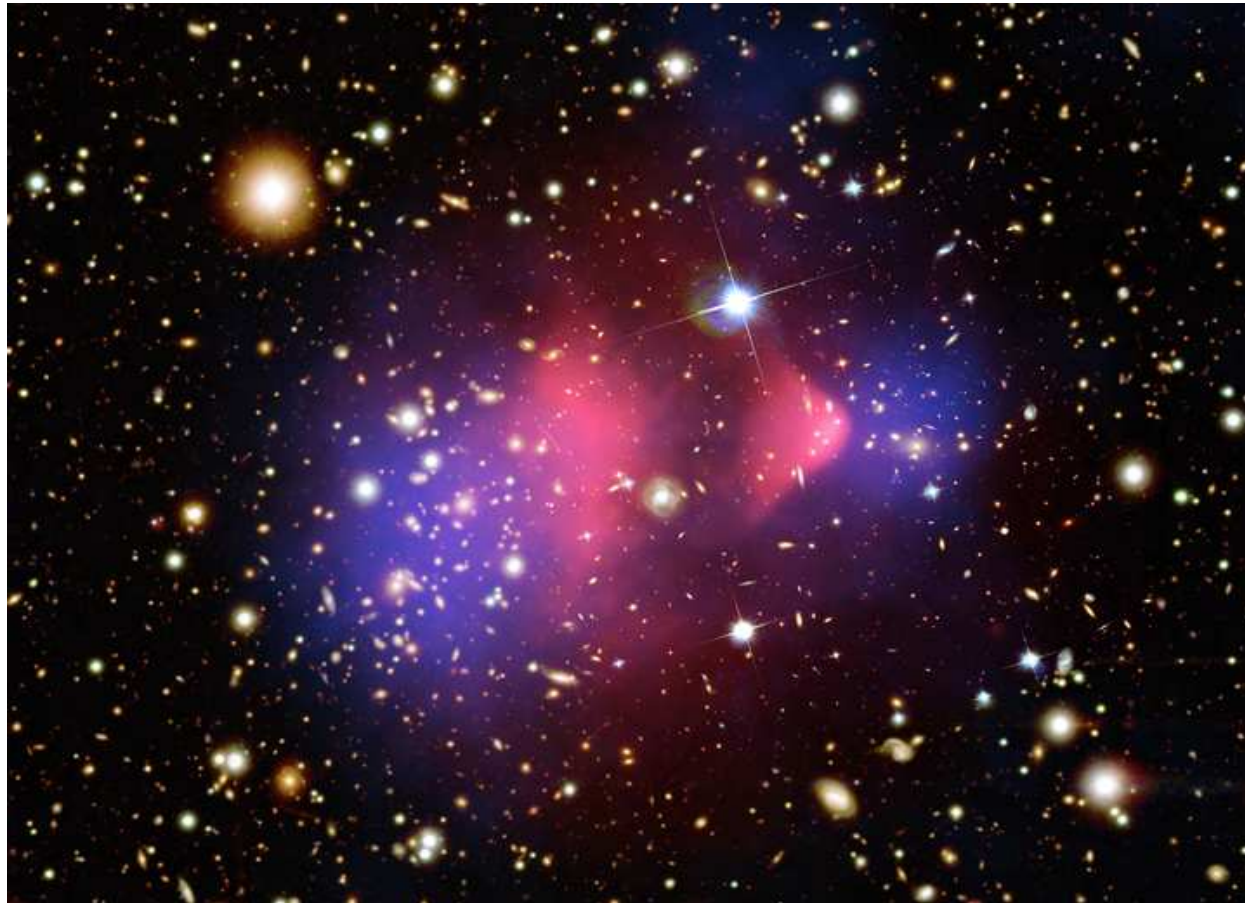
R. Lynds, V. Petrosian (1986), G. Soucail et al. (1987)



Abell 370

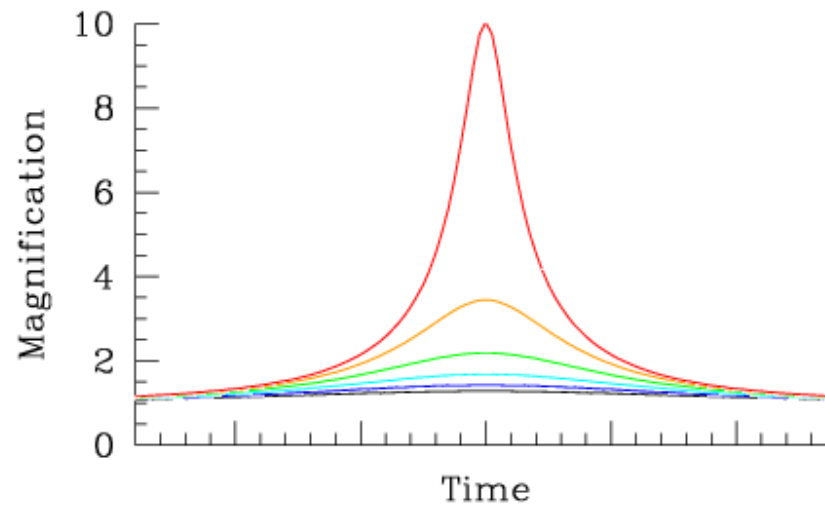
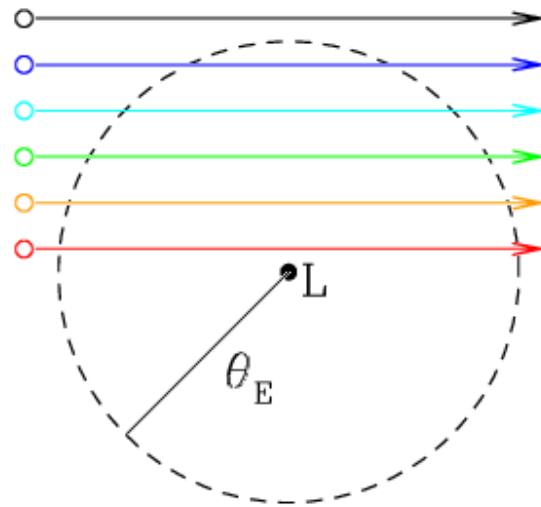
Aufspüren von Dunkler Materie in Galaxienhaufen





Bullet Cluster

Aufspüren von Braunen Zwergen, Exoplaneten, etc.



“Microlensing”