Gravitational lensing search for dark matter halos

3rd CosPa Meeting
Université de Liège
November 19, 2014

Judith Biernaux
Groupe OrCA - AGO

Spiral Galaxies

$$v(R) = \sqrt{\frac{GM(R)}{R}}$$

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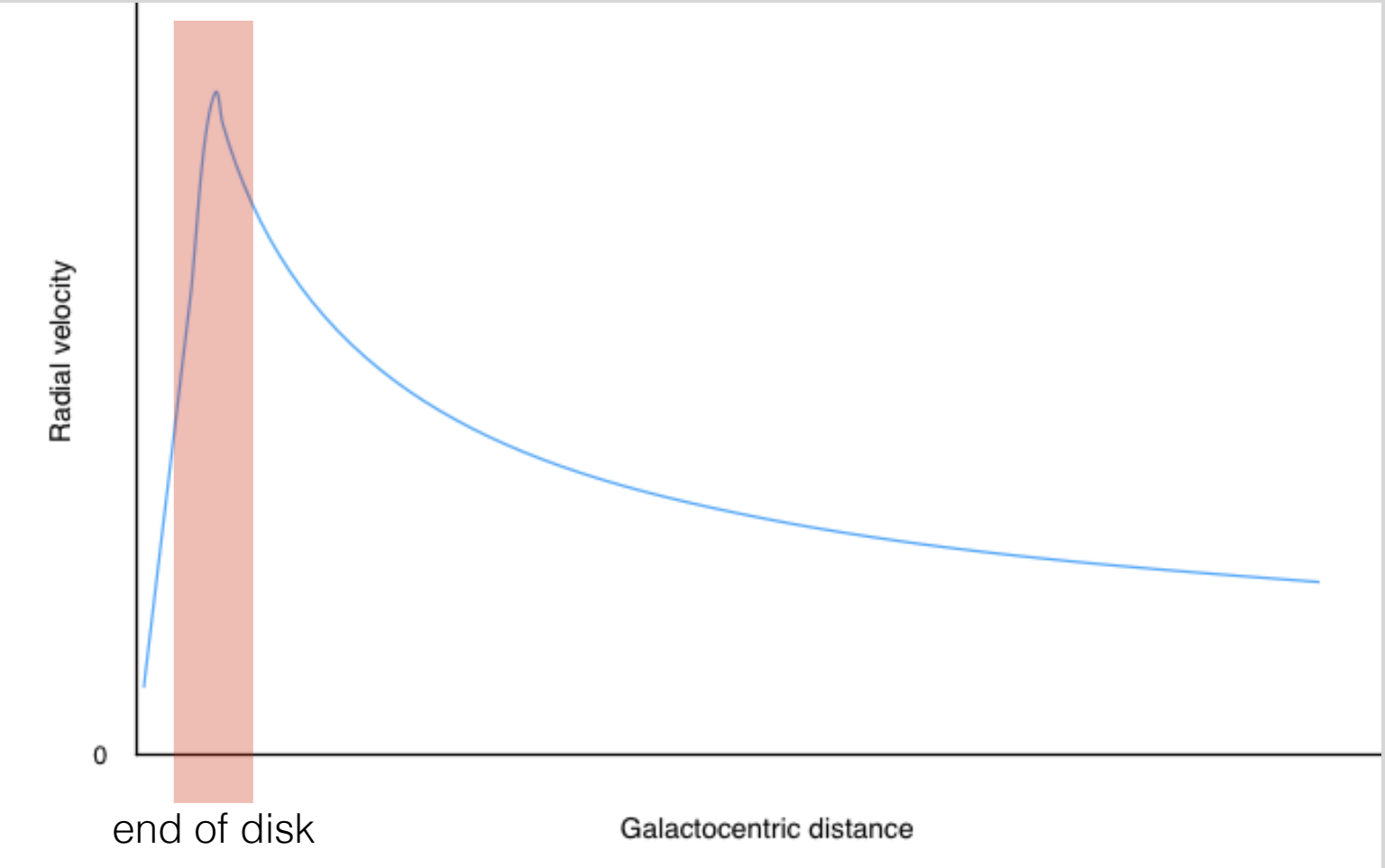
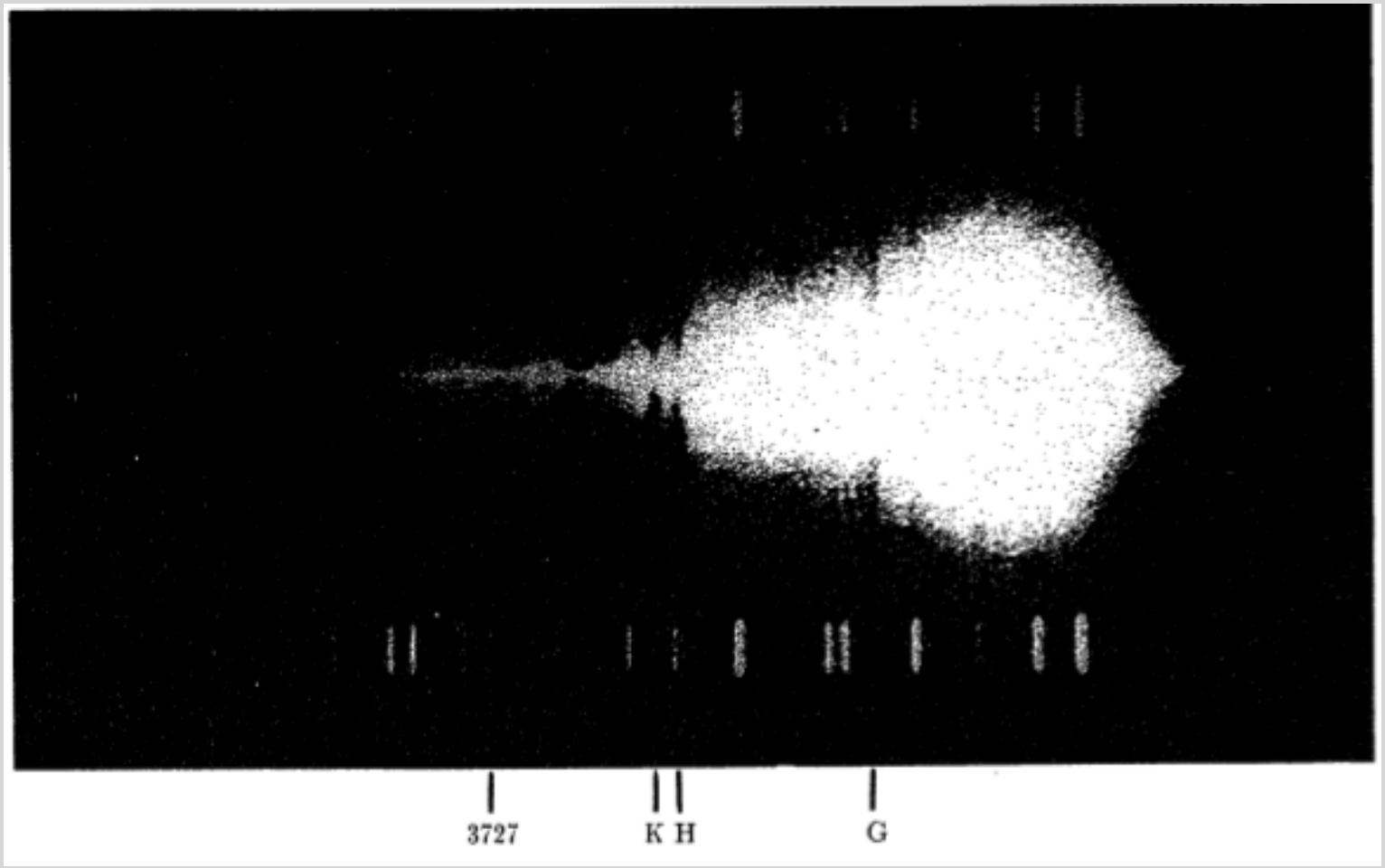


Spiral Galaxies

Horace Babcock (1912 - 2003)

Spiral Galaxies



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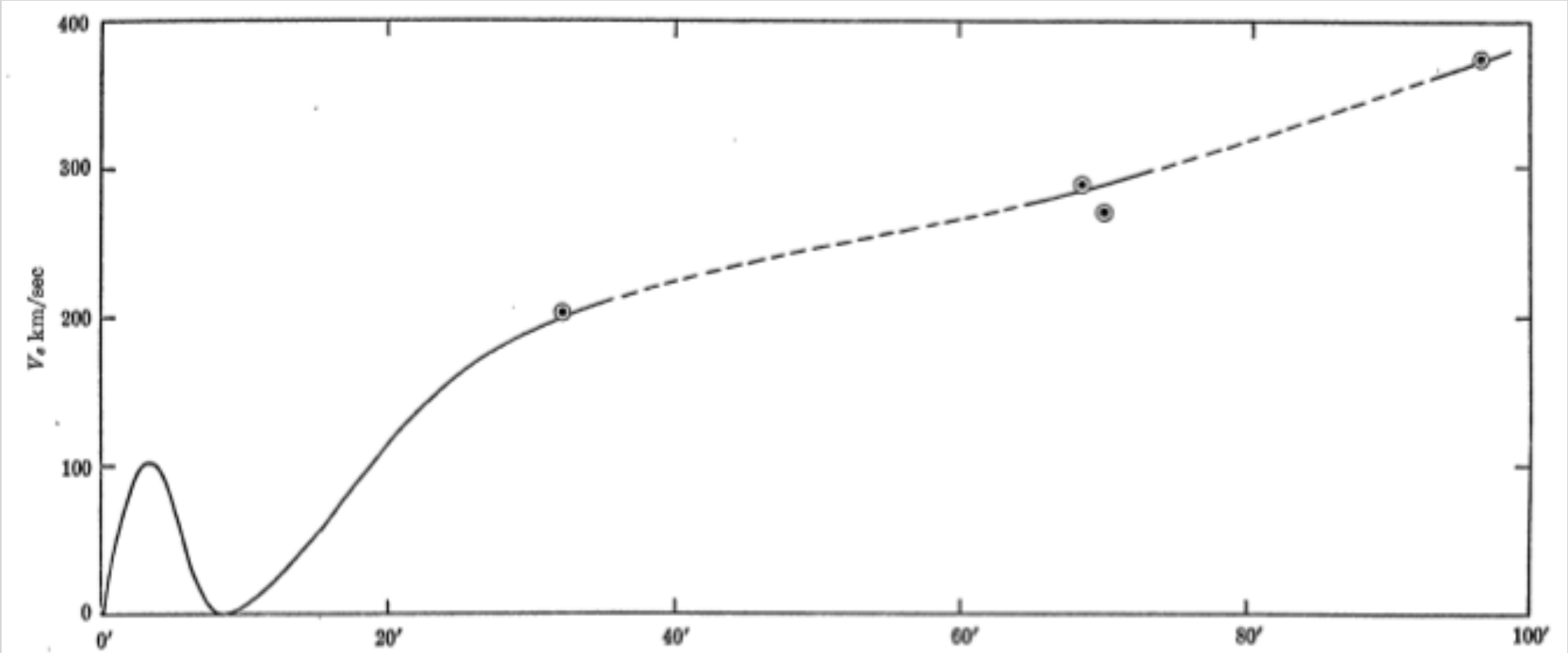


Fig. 4. Mean velocities of rotation in the plane of the spiral.

Spiral Galaxies

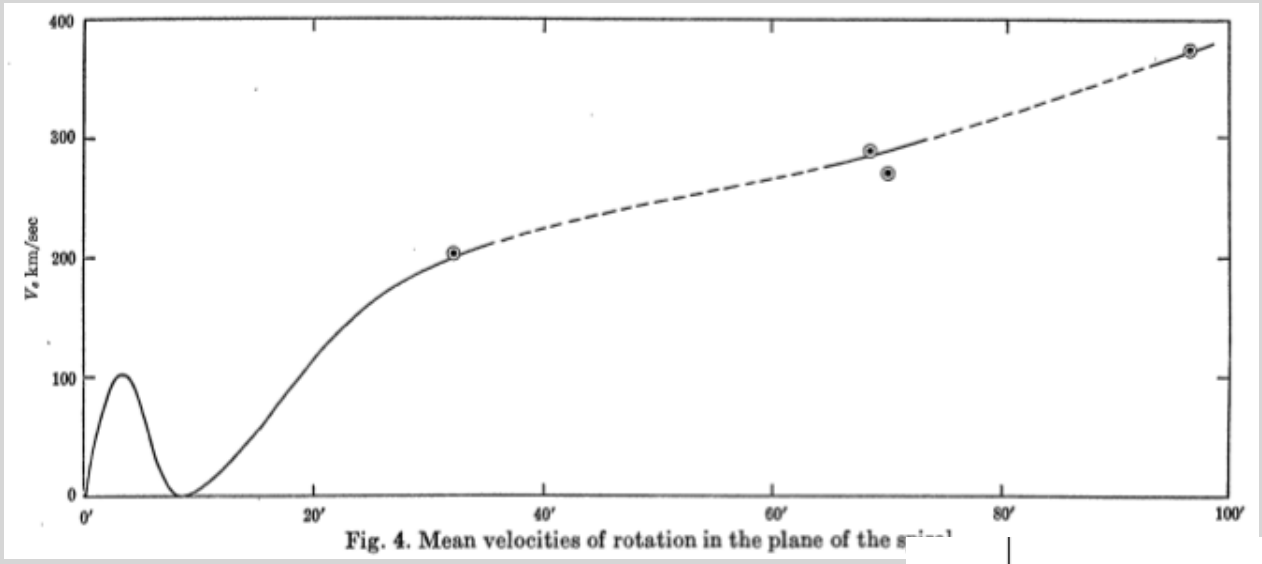
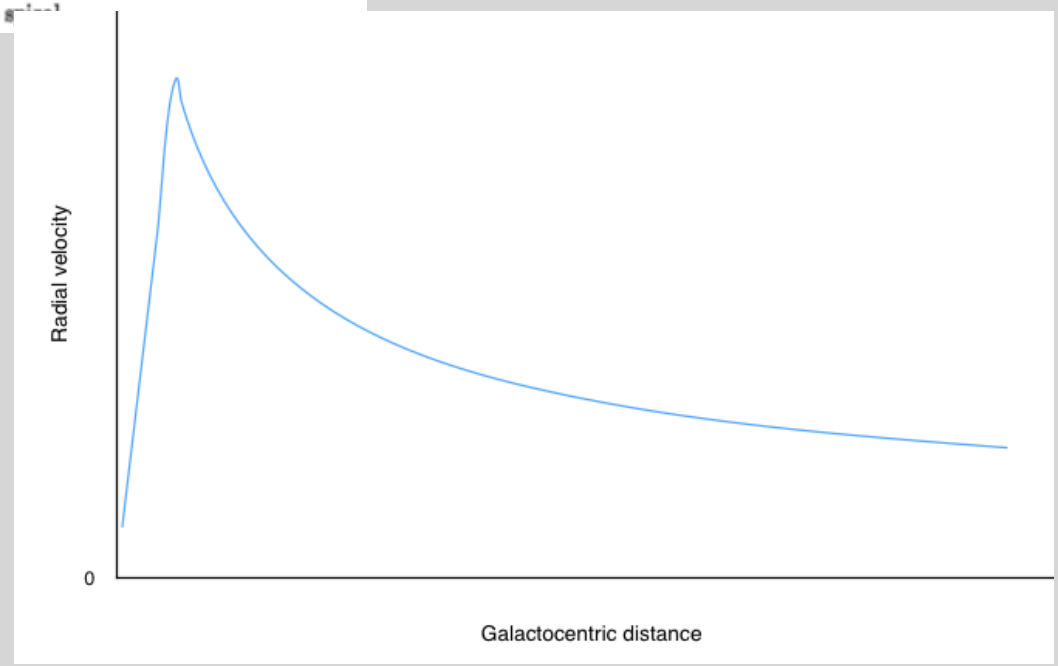


Fig. 4. Mean velocities of rotation in the plane of the s[illegible]



Spiral Galaxies

The rotation of the Andromeda Nebula (Lick Obs. Bulletin, Vol. XIX, 1939)

Lick Obs. and Mount Wilson Obs.

First recorded spiral galaxy rotation curve

"The obvious interpretation of the nearly constant angular velocity from a radius of 20 minutes of arc outward is that a very great proportion of the mass of the nebula must lie in the outer regions."

Spiral Galaxies

The rotation of the Andromeda Nebula (Lick Obs. Bulletin, Vol. XIX, 1939)

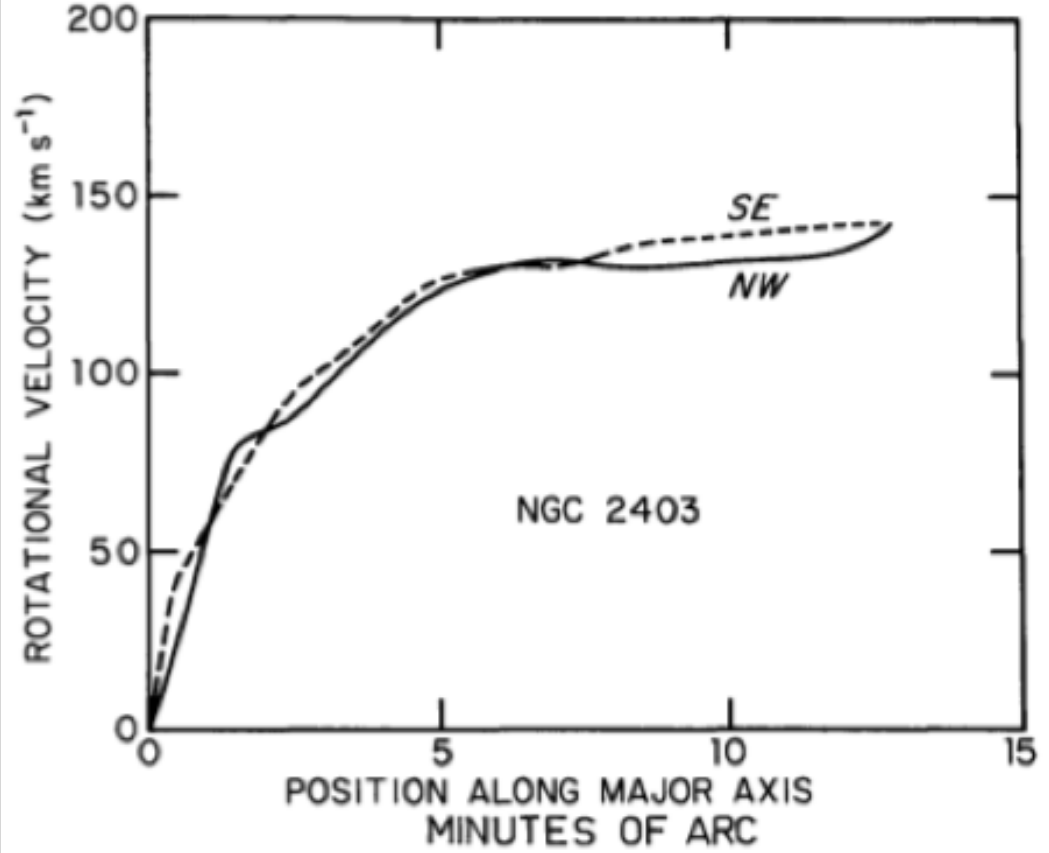
Lick Obs. and Mount Wilson Obs.

First recorded spiral galaxy rotation curve

"The great range in the calculated ratio of mass to luminosity in proceeding outward from the nucleus suggests that absorption plays a very important role in the outer portions of the spiral, or perhaps, that new dynamical considerations are required."

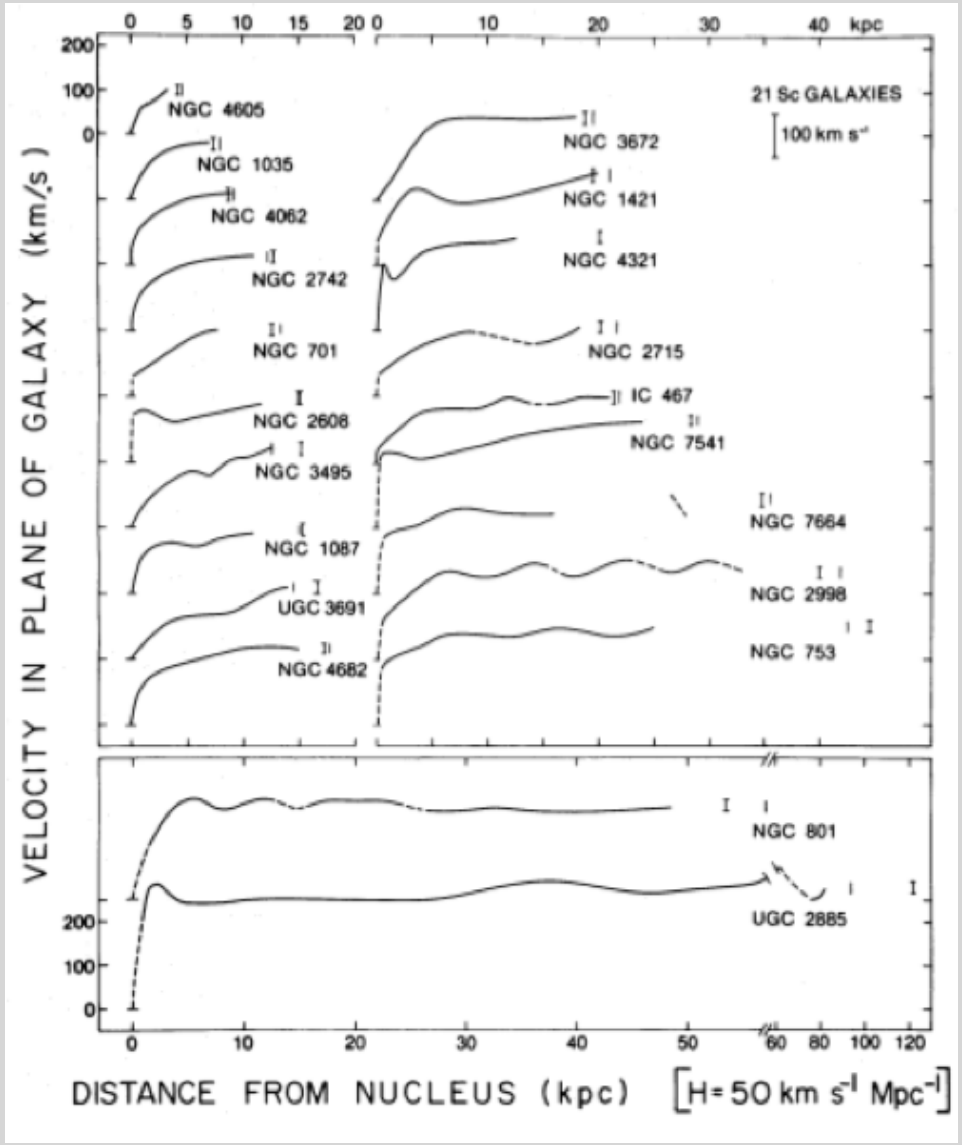
Spiral Galaxies

- Shostak and Rogstad, 1973



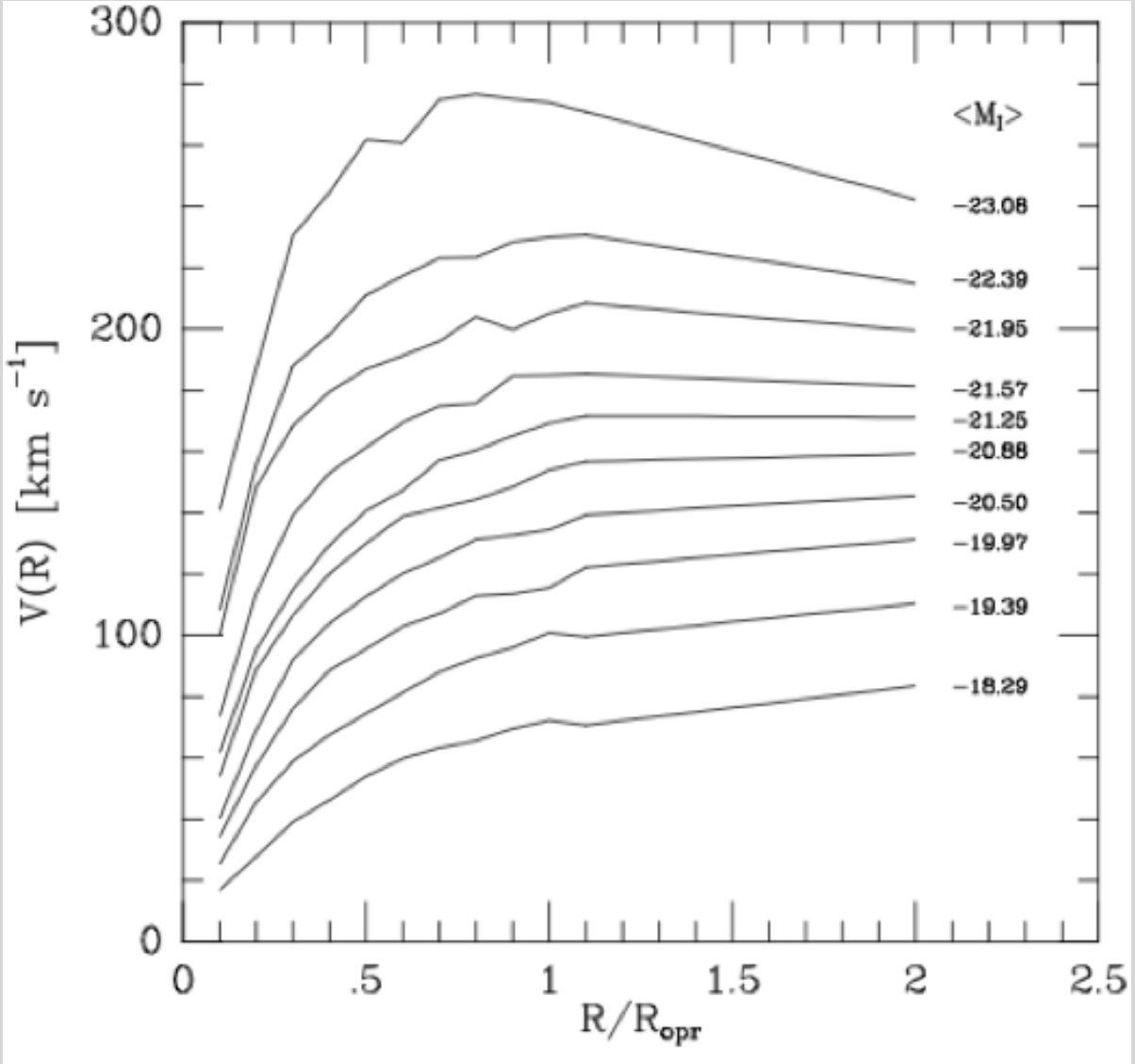
Spiral Galaxies

- Shostak and Rogstad, 1973
- Rubin, Ford and Thonnard, 1980



Spiral Galaxies

- Shostak and Rogstad, 1973
- Rubin, Ford and Thonnard, 1980
- Persic, Salucci and Stel, 1995
  (987 galaxies !)



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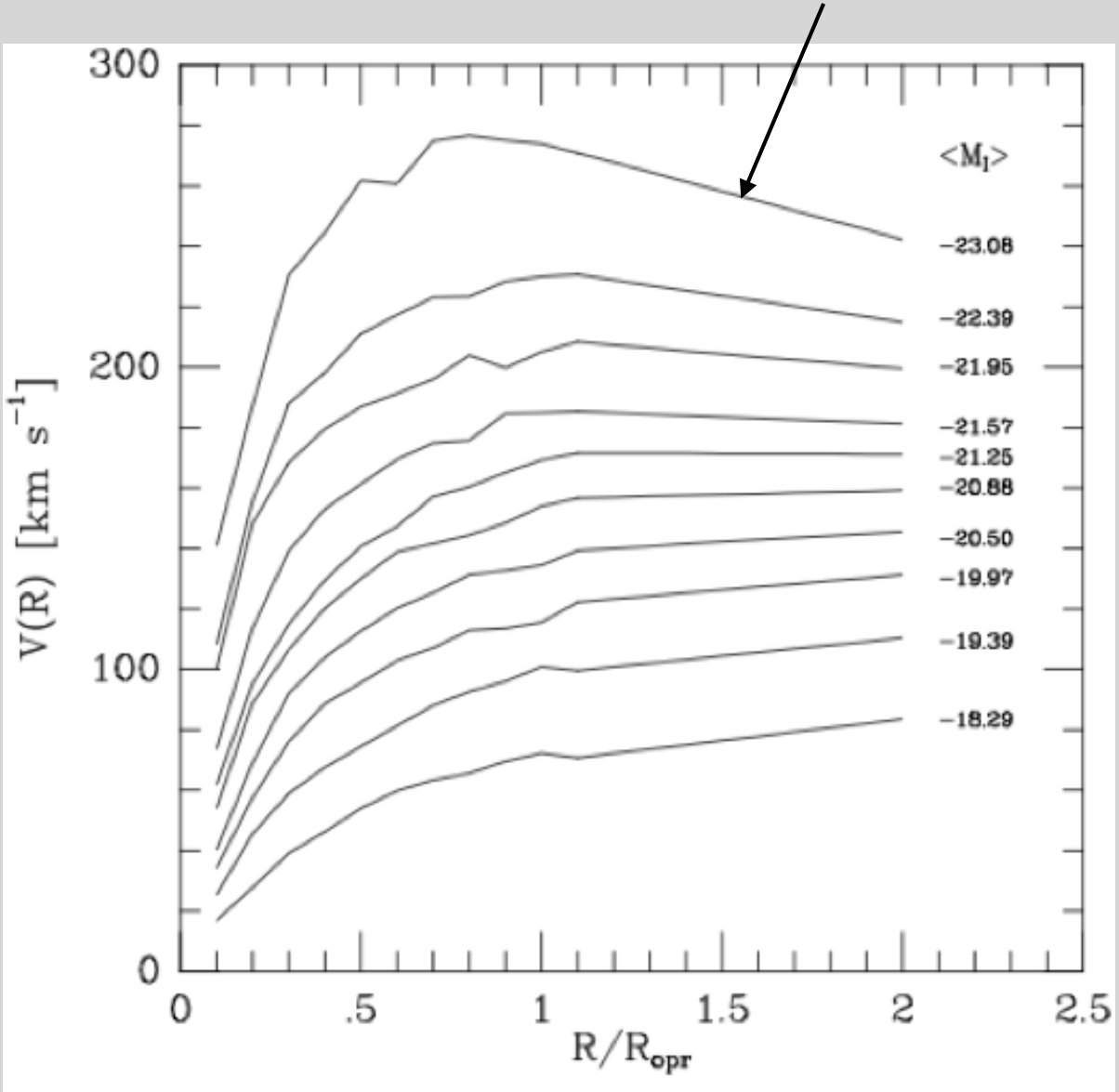
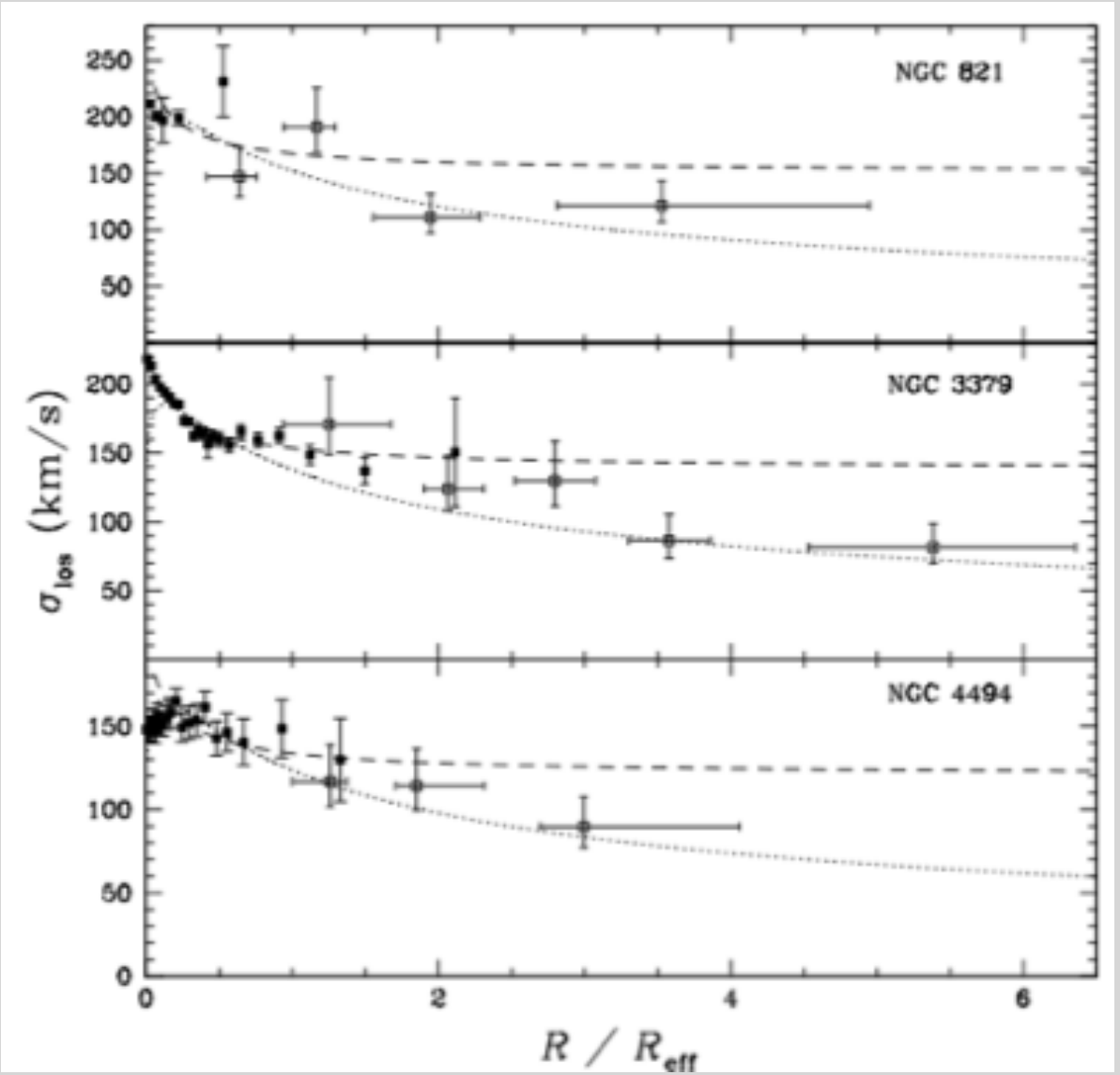


Elliptical galaxies

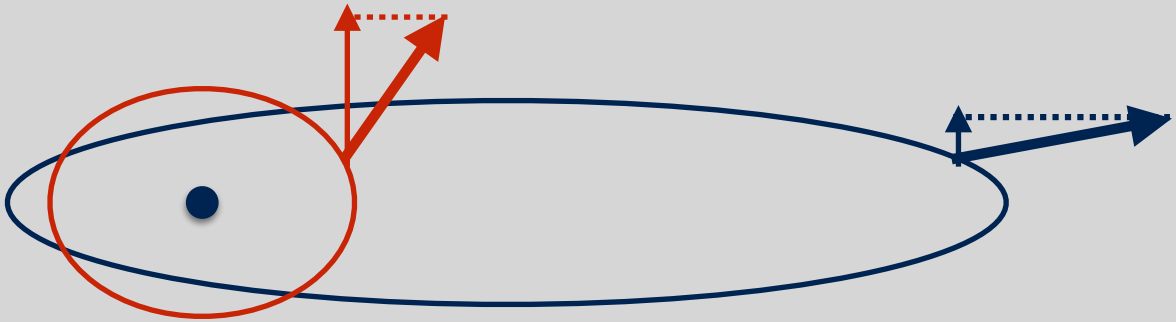
Elliptical galaxies

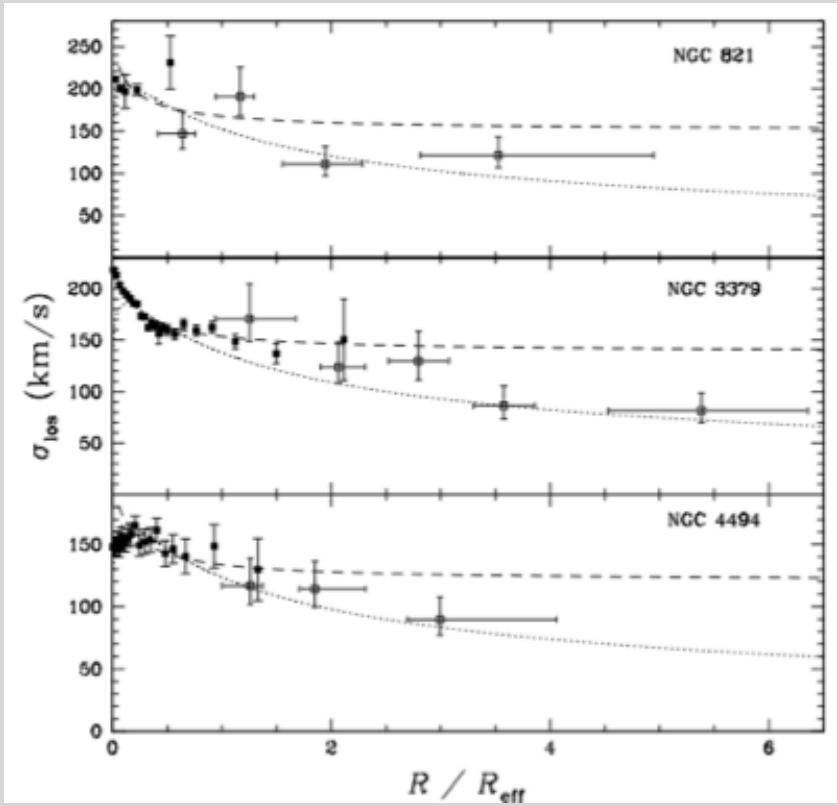
- Romanowsky et al., 2003



Elliptical galaxies

- Romanowsky et al., 2003
- Dekel et al., 2005

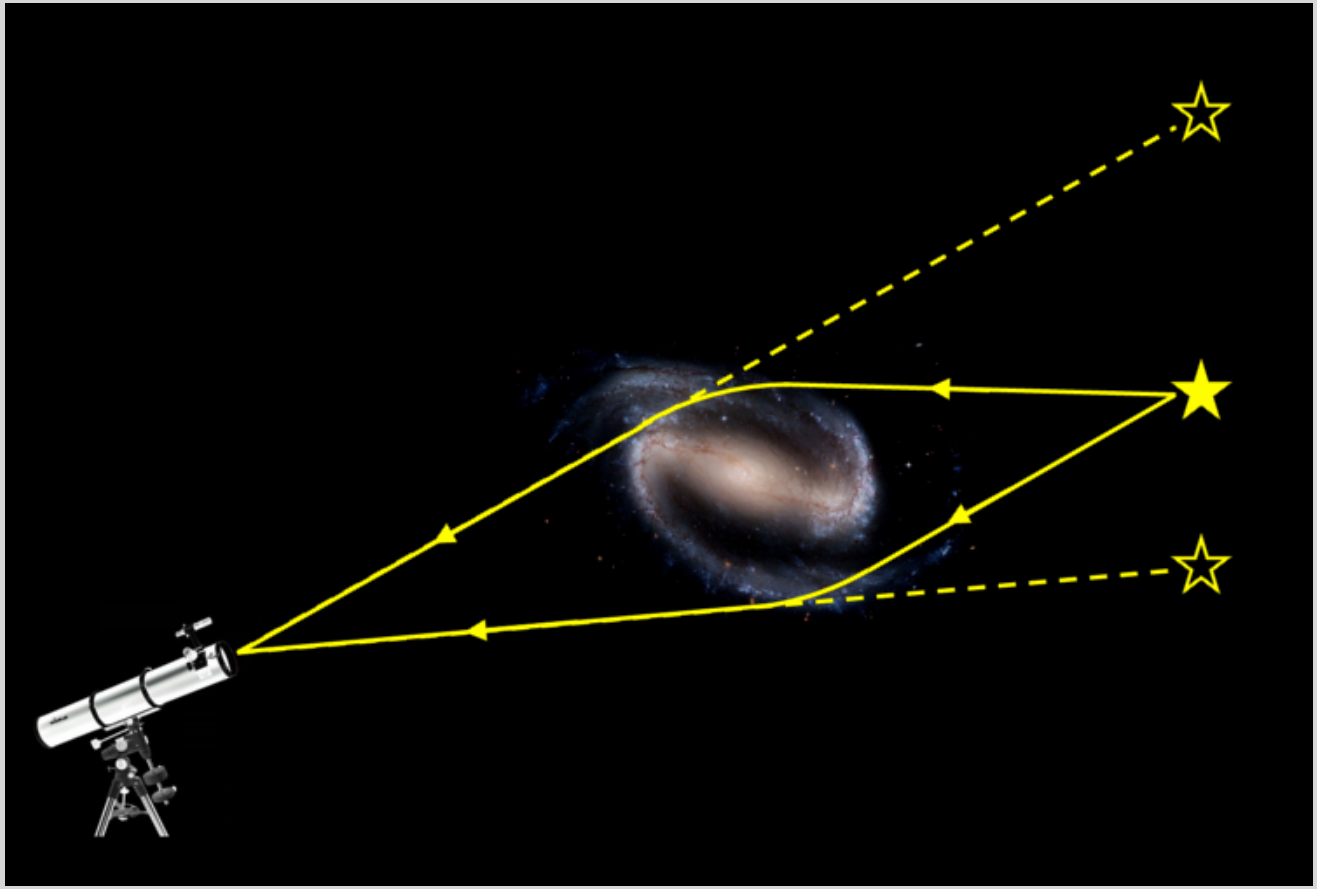




Line of sight

Elliptical galaxies

Gravitational lensing

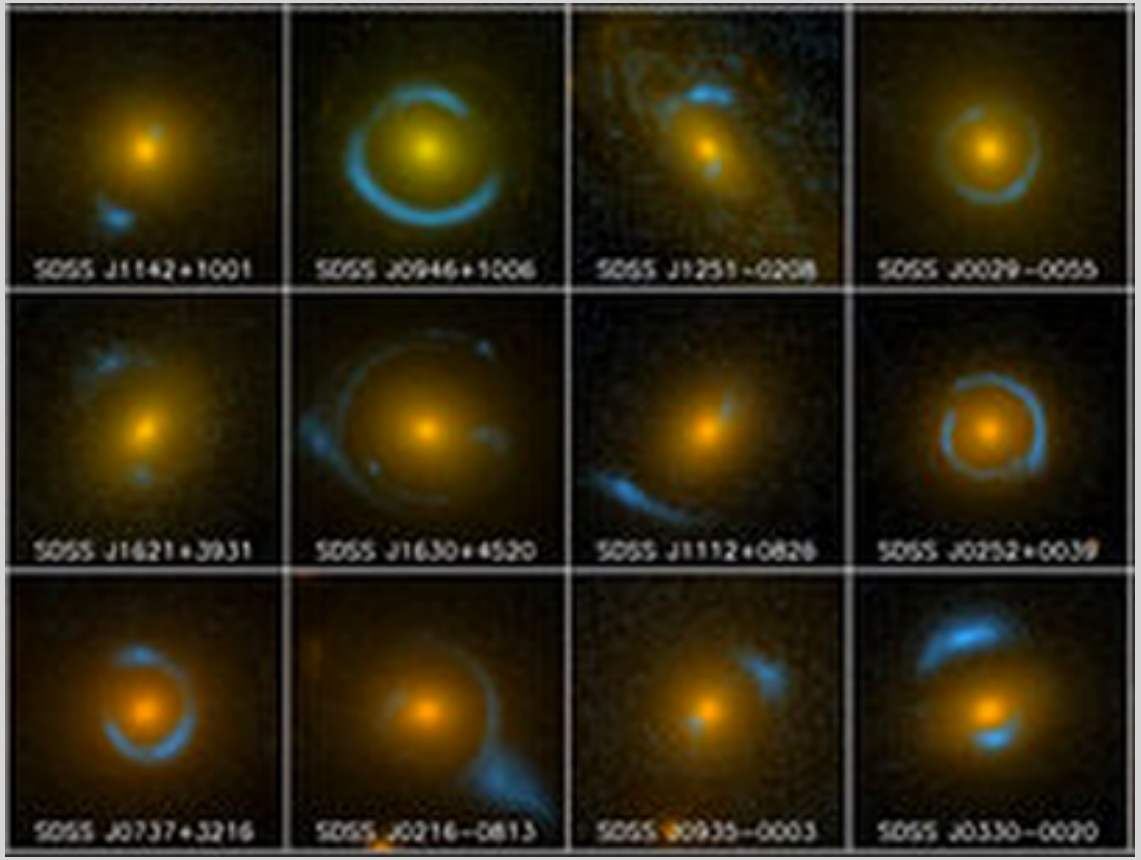


Elliptical galaxies

Gravitational lensing

- SLACS (HST)

  Galaxy - Galaxy



Elliptical galaxies

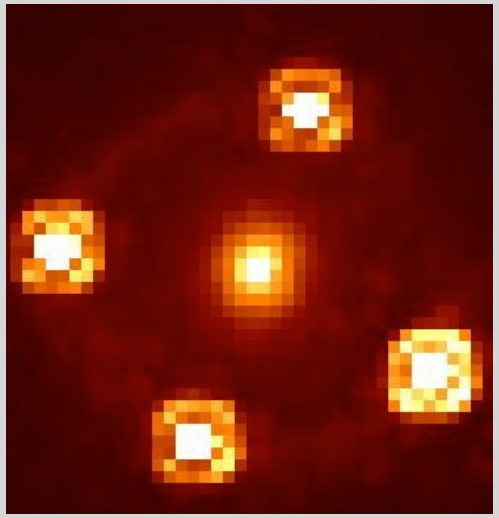
Gravitational lensing

- SLACS (HST)

  Galaxy - Galaxy

- CASTLES (HST)

  Quasar - Galaxy



HE0435-1223

Elliptical galaxies

Gravitational lensing

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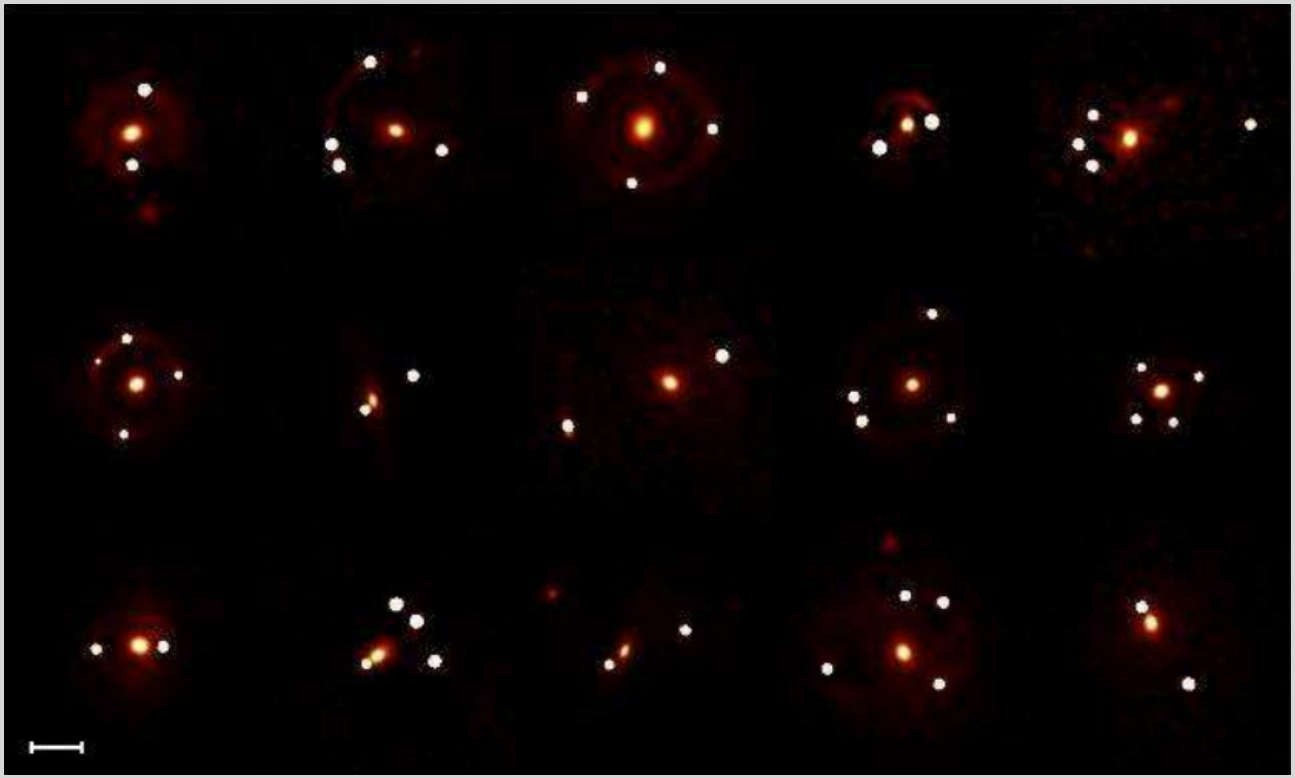
  Quasar - Galaxy

  Magain and Chantry



Elliptical galaxies

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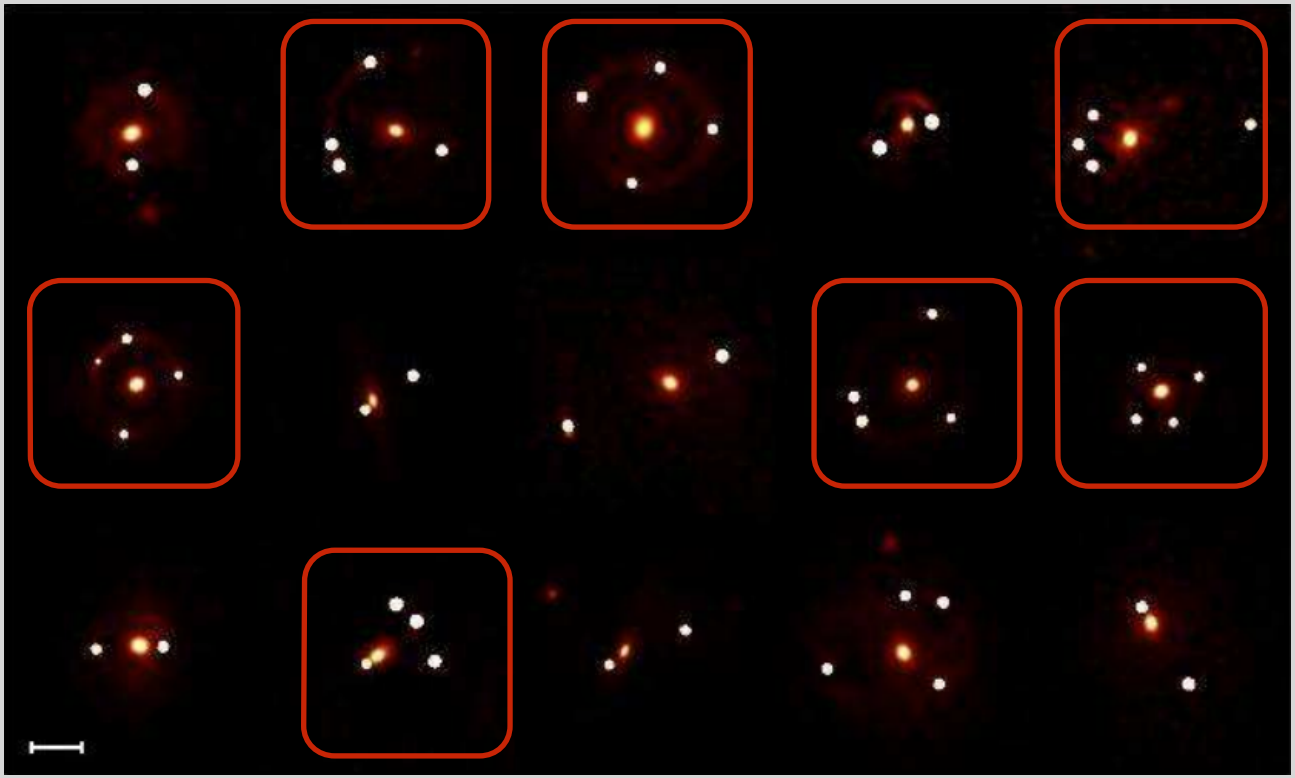


Elliptical galaxies

Gravitational lensing

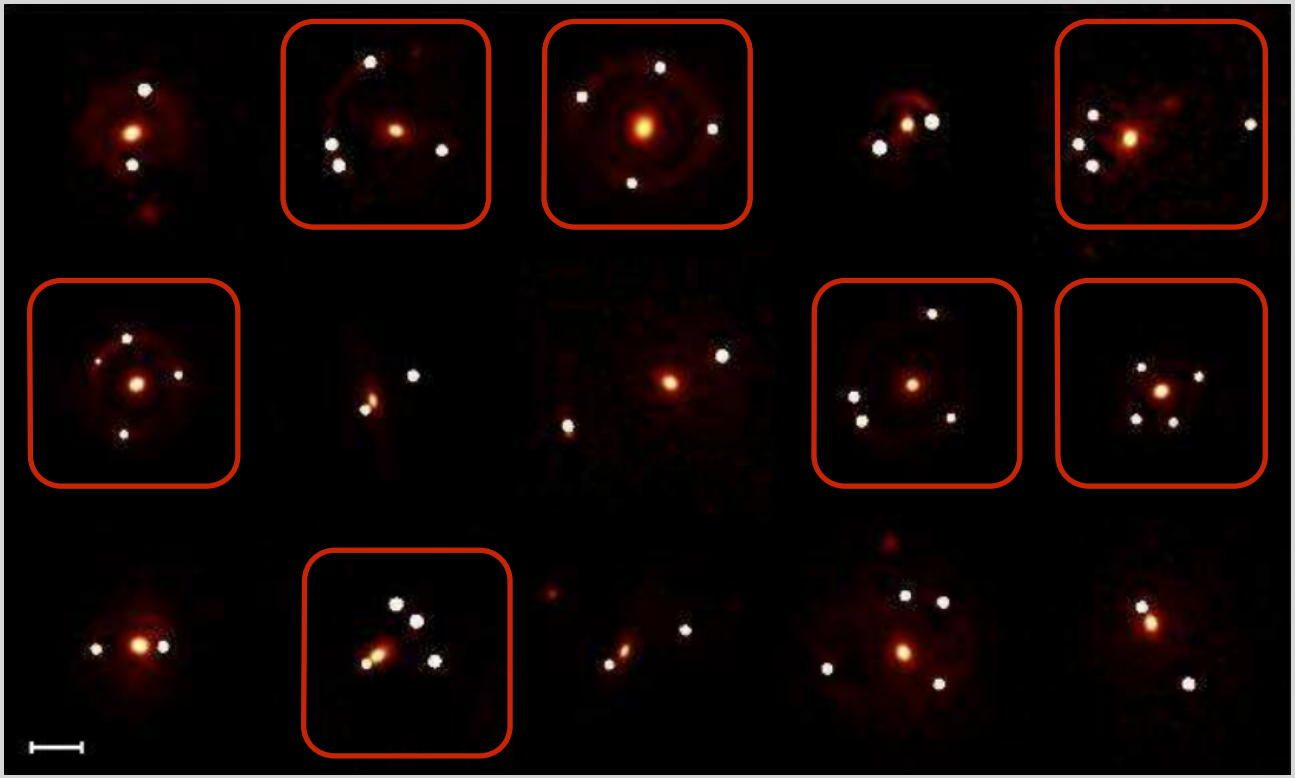
- Luminosity profiles (MCS)

  Magain, Courbin &

  Sohy, 1998

- Mass profiles (LENSMODEL)

  Keeton, 2001



Elliptical galaxies

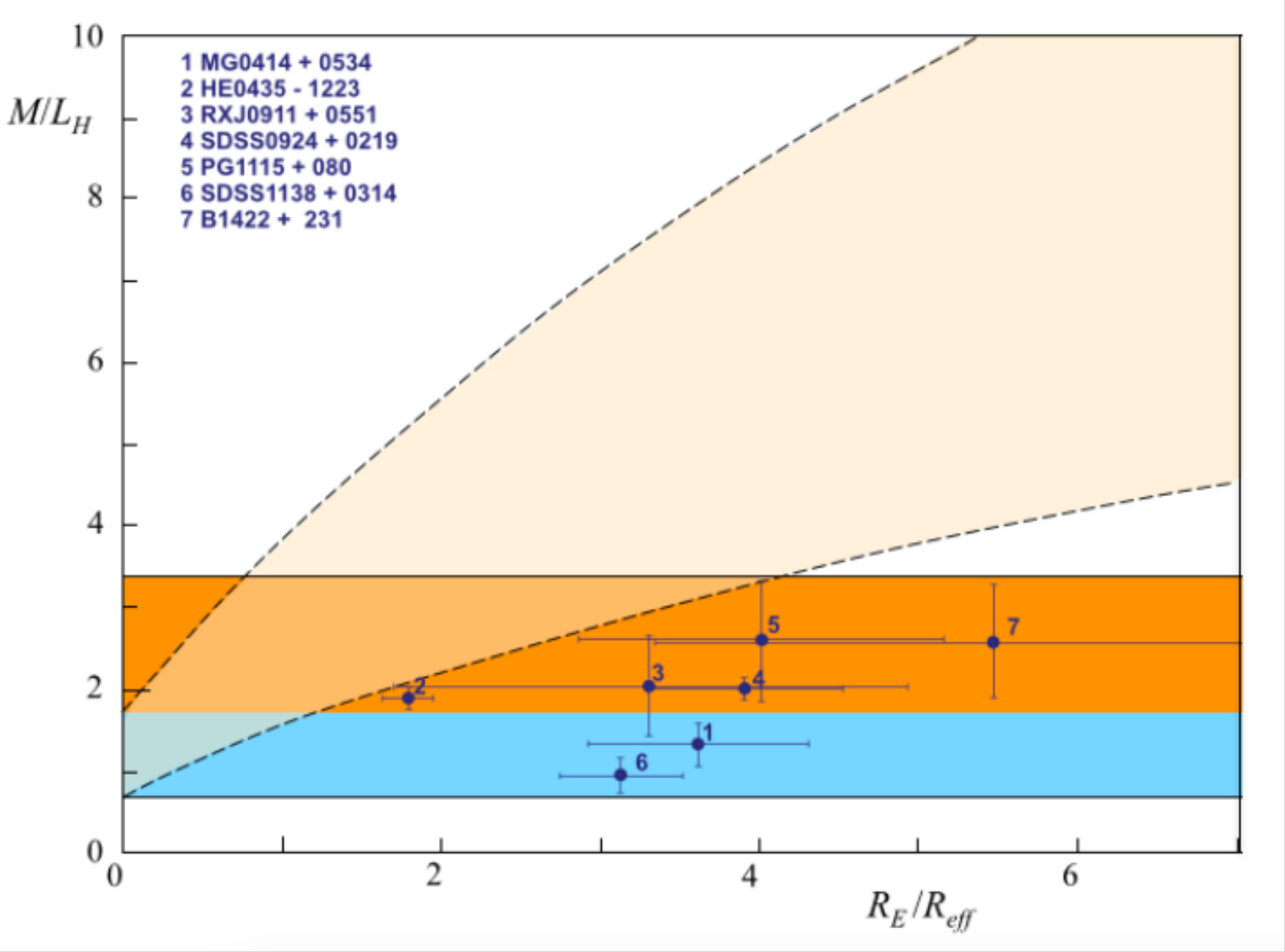
RESULT #1 : constant M/L vs SIE mass model : the χ^2 test

System	SIE	constant M/L
MG0414+0534	33	30
HE0435-1223	2.6	2.9
RXJ0911+0551	200	186
SDSS0924+0219	5	6
PG1115+080	20	6
SDSS1138+0314	1.2	0.7
B1422+231	7	43

Elliptical galaxies

RESULT #2

Biernaux et al. (in preparation)



Dark matter halos ?

?

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Pfenniger et al., 1994

- Cold gas clouds (H + H_2 + He)

Dark matter halos ?

?

Pfenniger et al., 1994

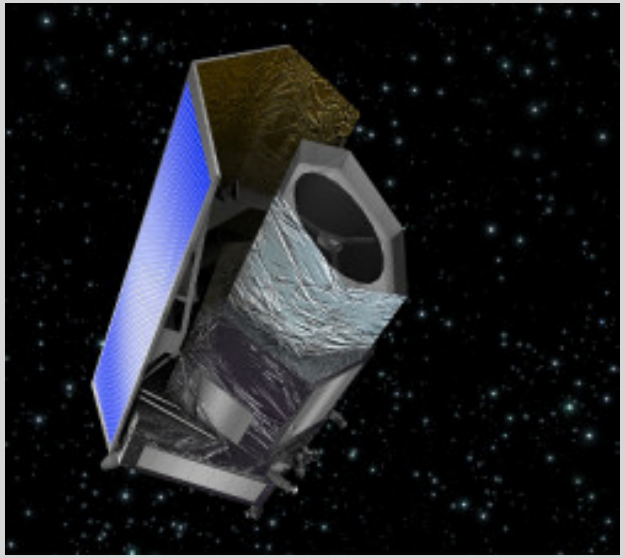
- Cold gas clouds (H + H_2 + He)
- Merging OK

Further research

HST

Further research

HST



Euclid

Thank you !