# Gravitational lensing search for dark matter halos

Annual Scientific Meeting of the
Belgian Physical Society
May 13th 2015
Université de Liège

Judith Biernaux
Dépt. AGO
Groupe OrCA

# Around elliptical galaxies ?


NGC 4414


M87

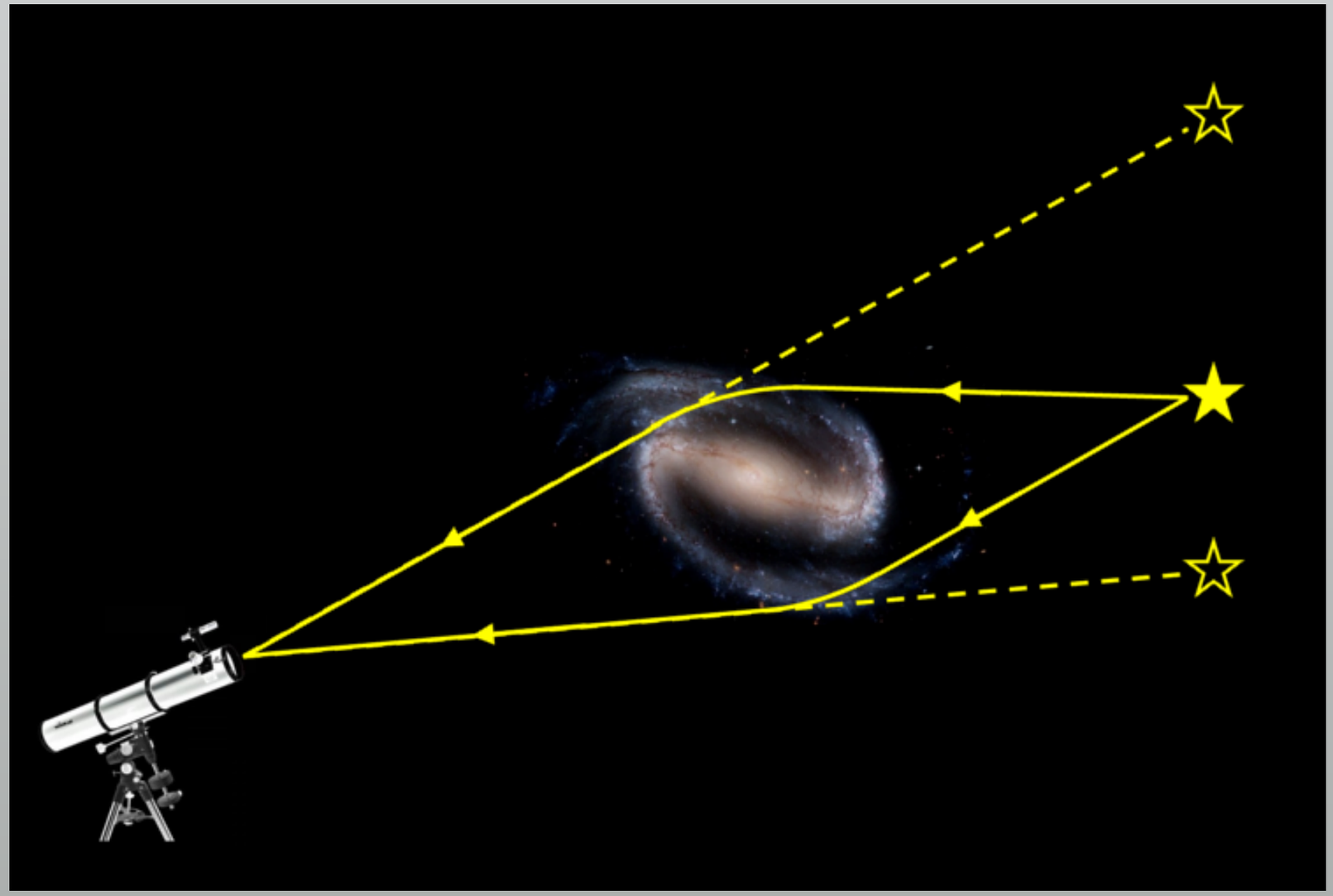
# Around elliptical galaxies ?

- Planetary nebulae (Romanowsky et al., 2003) → no haloes !
- Simulations of merging disk galaxies (Dekel et al., 2005) → haloes !
- X-ray emission (Memola et al., 2011) → haloes !
- Stellar kinematics (Cappellari et al., 2015) → no haloes !

➡ **Discrepant results…**

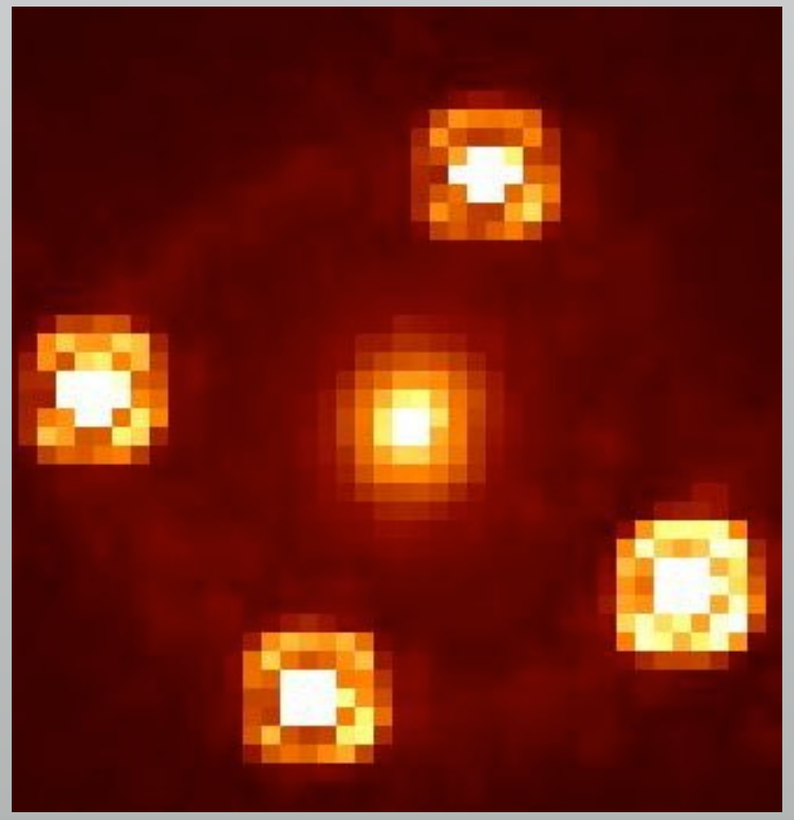
# Around elliptical galaxies ?

➡ **Gravitational lensing !**



# Around elliptical galaxies ?

➡ **Gravitational lensing !**



**HE0435-1223**

# Luminosity profile ?

$$I(r) = I_{eff}\ exp\{-k[\left(\frac{r}{r_{eff}}\right)^{1/4} - 1]\}$$

- Classical fit : minimizing a merit function in a p-dimensional space (p = # parameters)

➡ Local minima

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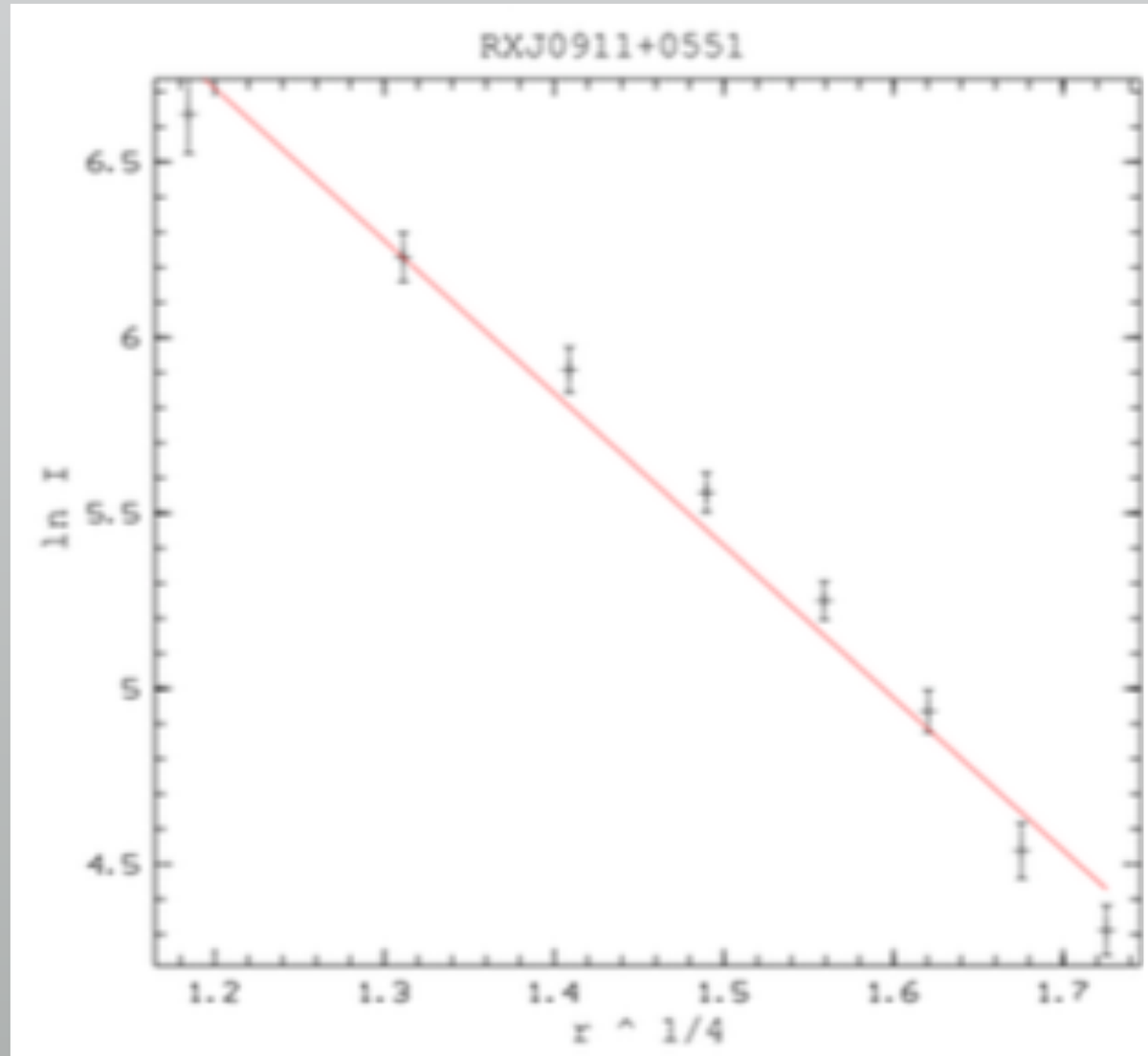
**Independent measurement of each parameter is needed (ellipticity, PA, effective (half-light) radius)**

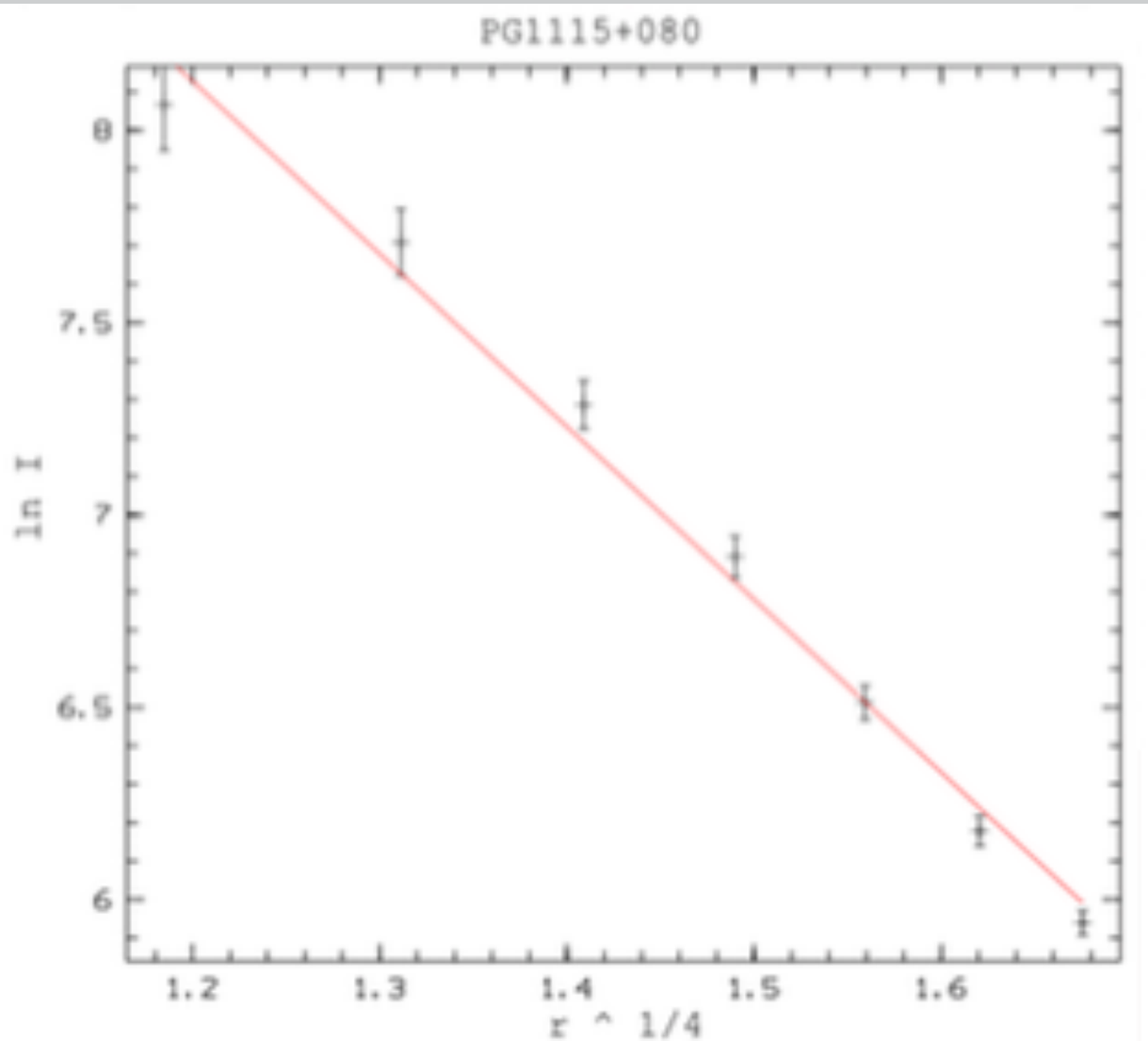
Effective (half-light) radius : **linear regression**

$$\ln I = \ln I_{eff} - k\left(\frac{r}{r_{eff}}\right)^{1/4} - k$$

$$s = -\frac{k}{r_{eff}^{1/4}}$$

# Luminosity profile ?



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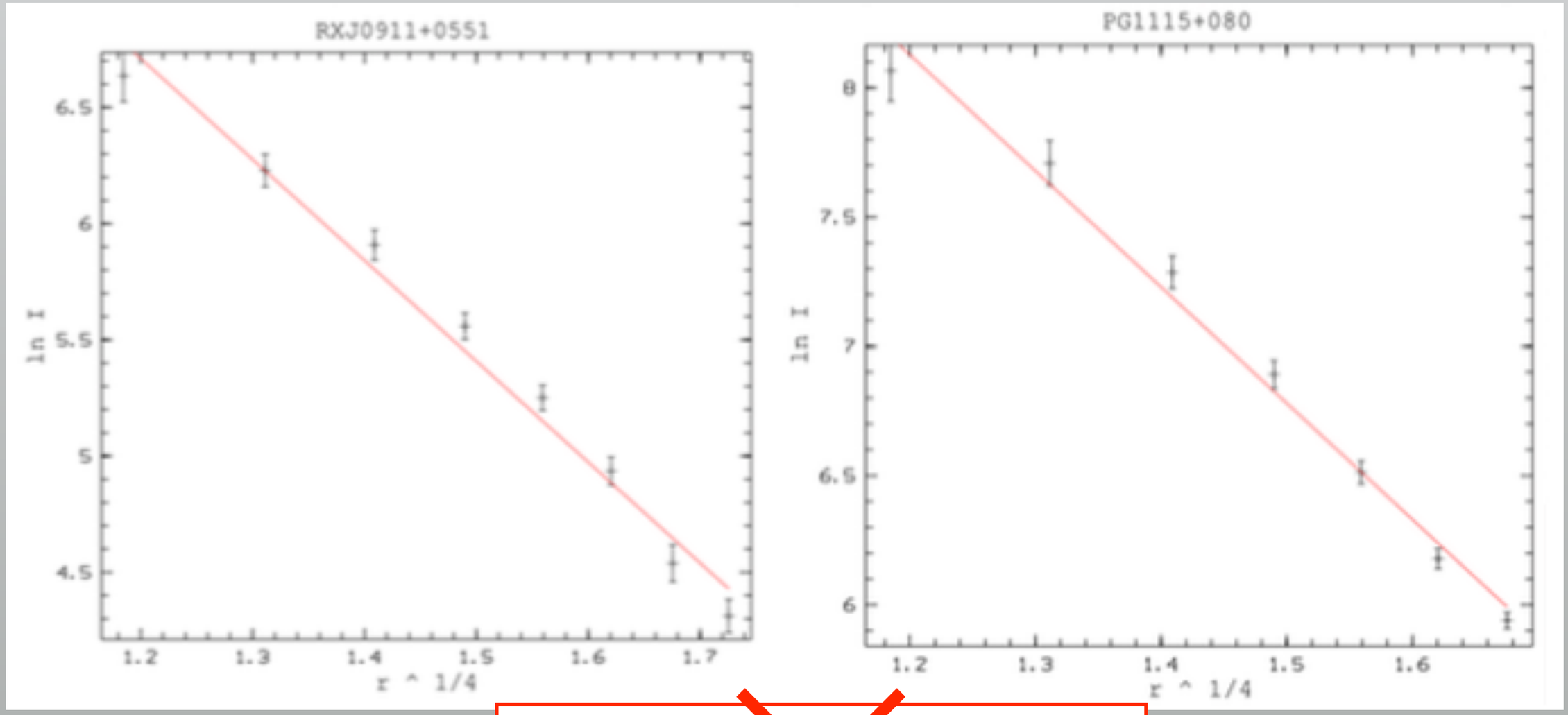
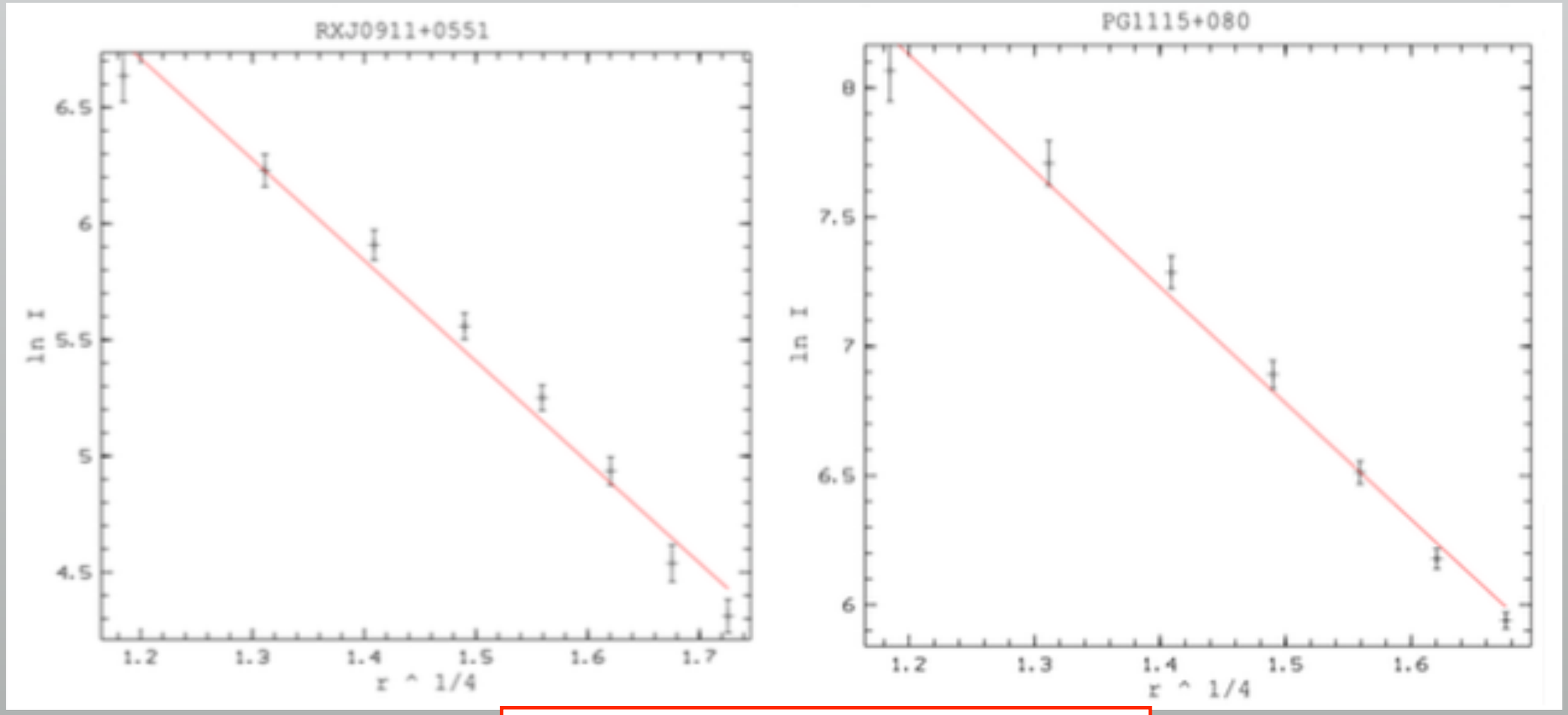



$$I(r) = I_{eff}\ exp\{-\kappa[\left(\frac{r}{r_{eff}}\right)^{1/4} - 1]\}$$

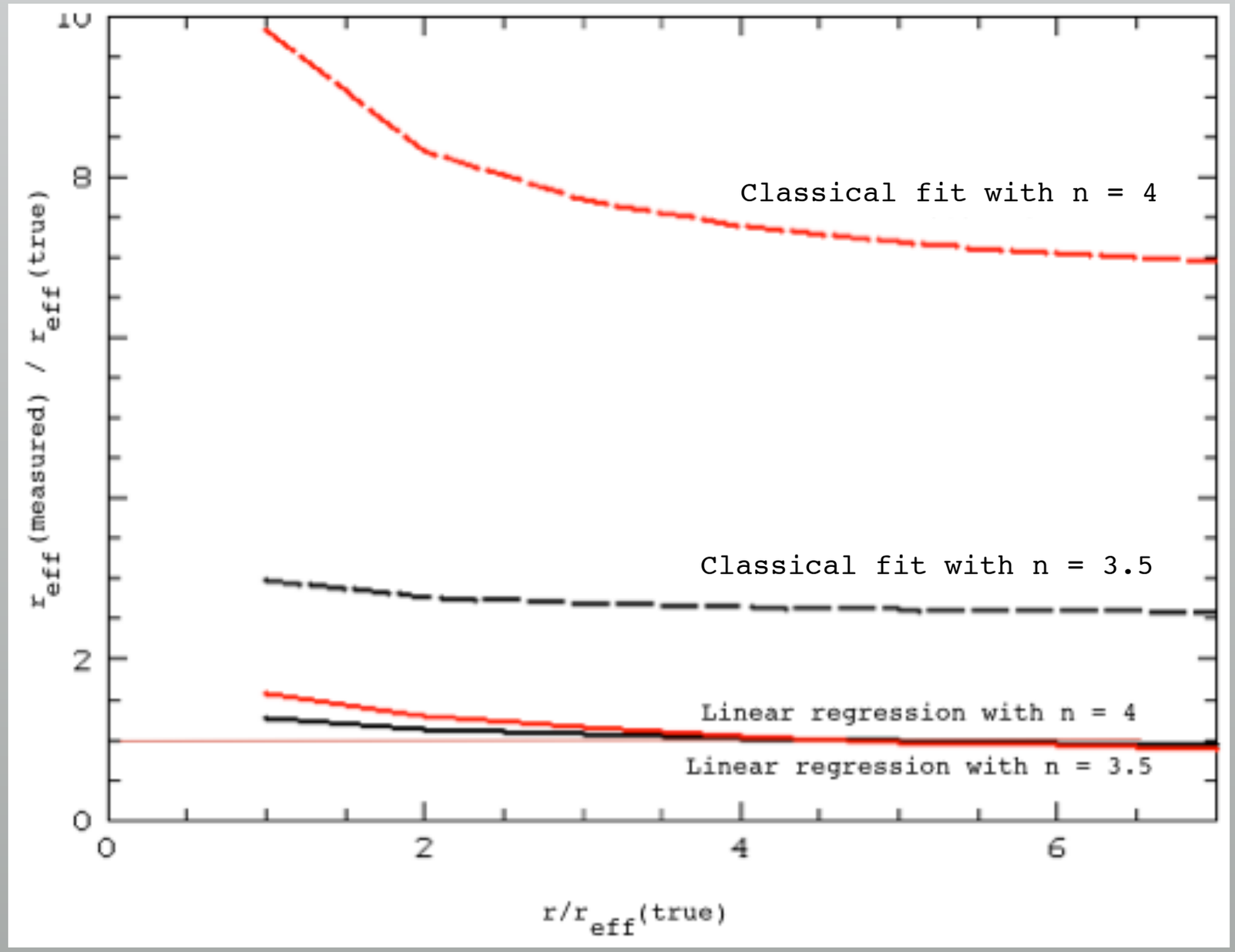
# Luminosity profile ?




$$I(r,n) = A\exp\left(-k\left(\frac{r}{r_{eff}}\right)^{1/n}\right)$$

# Luminosity profile ?

Comparison of fitting methods on a fake galaxy (n = 3)



# What is up next ?

- Need of a method to measure n
- Need to compare the luminosity profiles to the mass profiles and search for haloes

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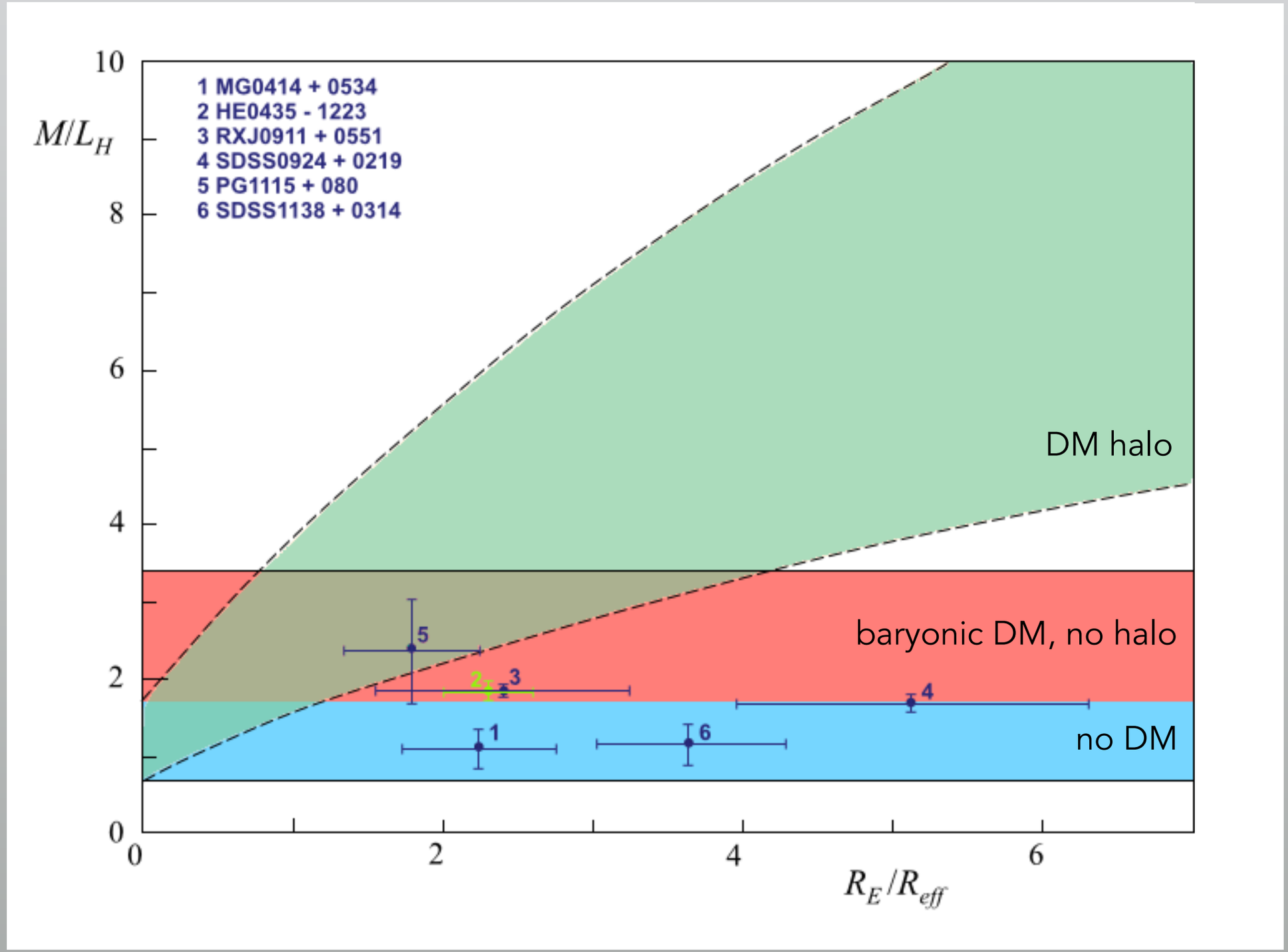
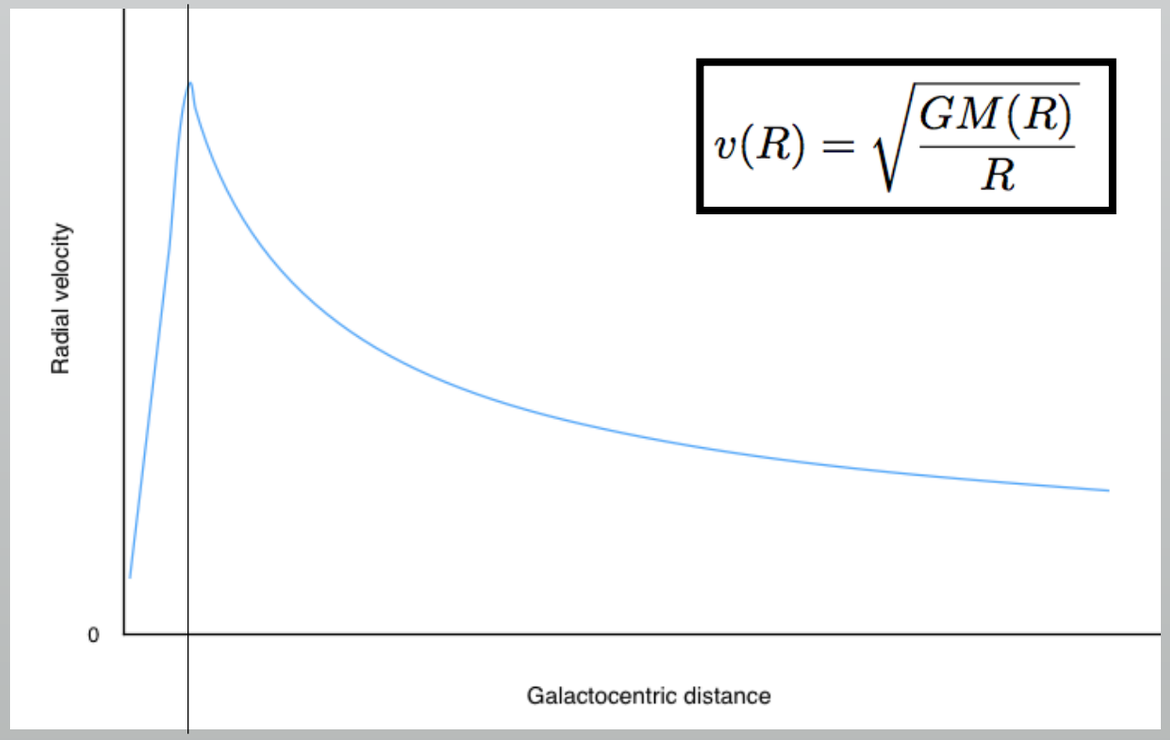


# What is up next ?

- Galactic evolution
- Cosmology

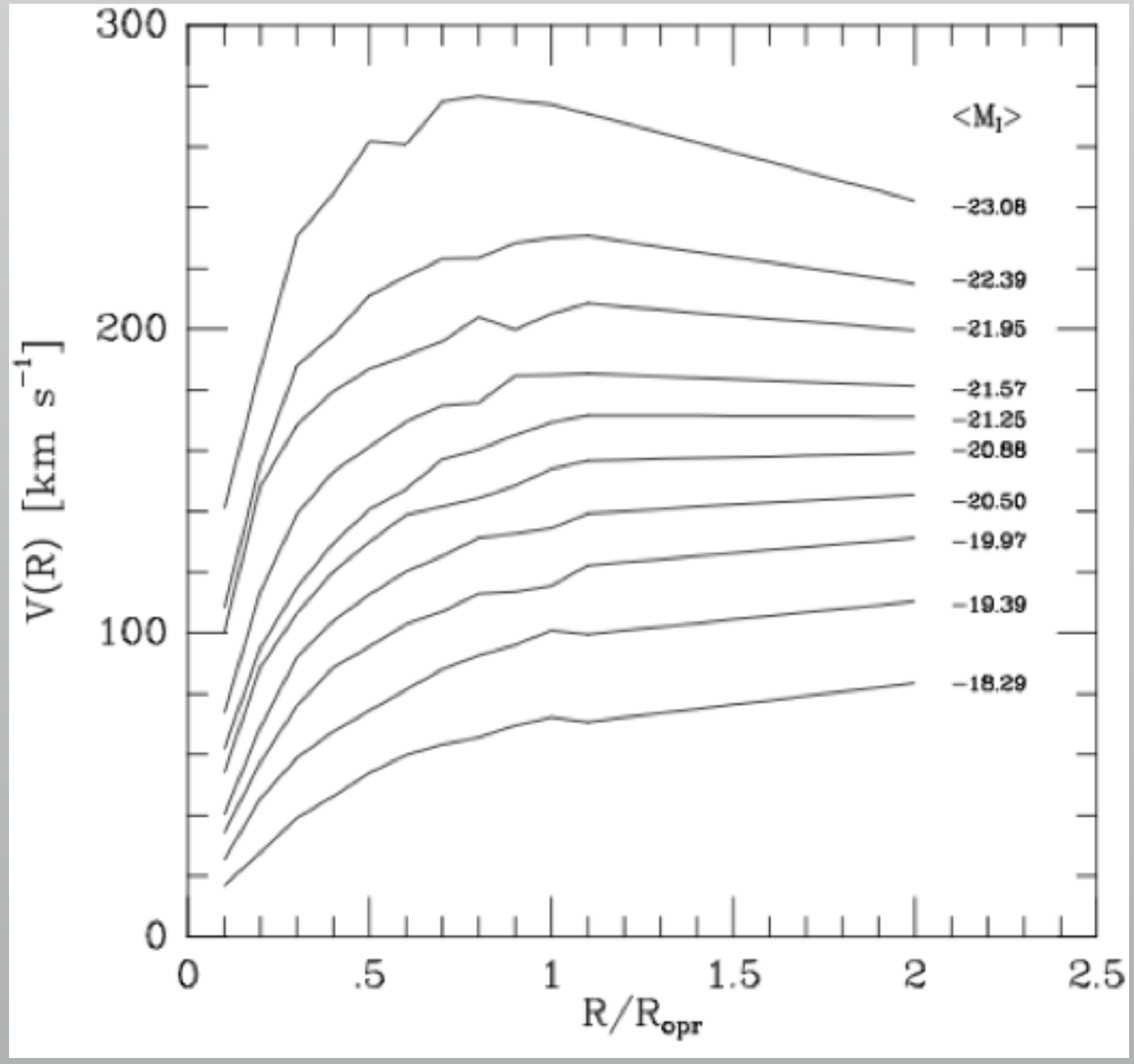
# Thank you

# Dark matter halos ?




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

→ **Dark matter halo around spirals**




*Persic, Salucci and Stel, 1995*

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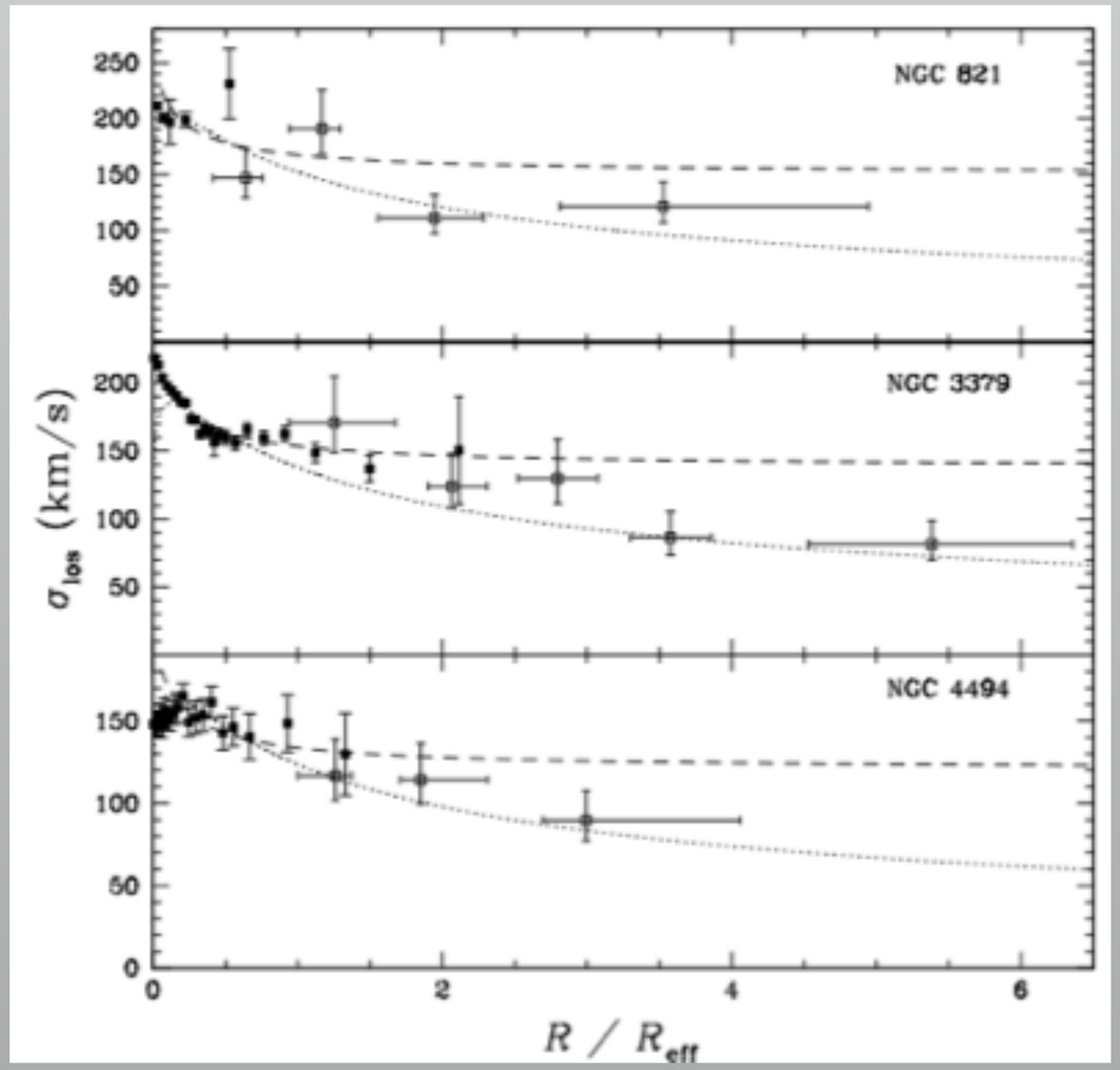

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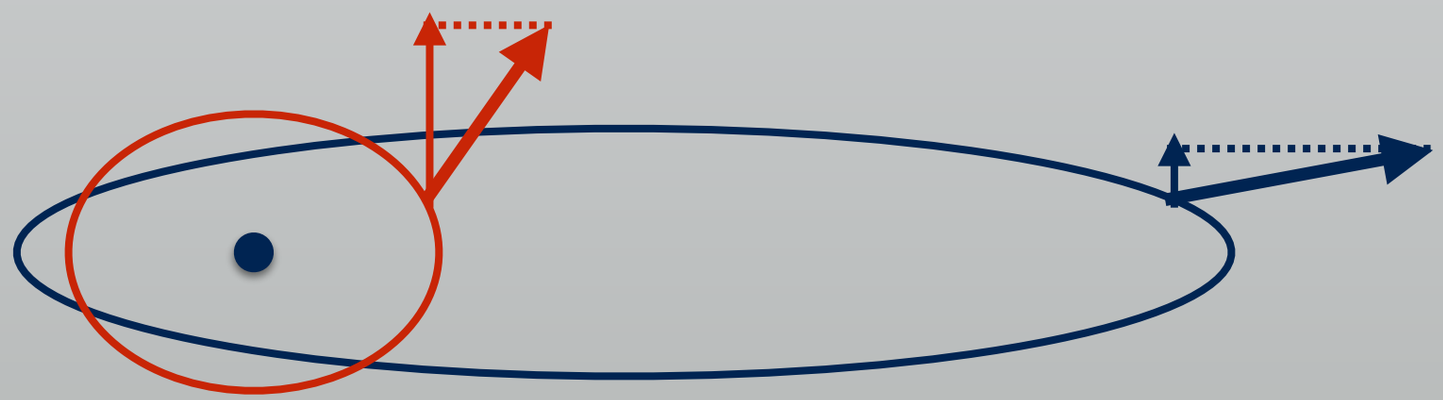

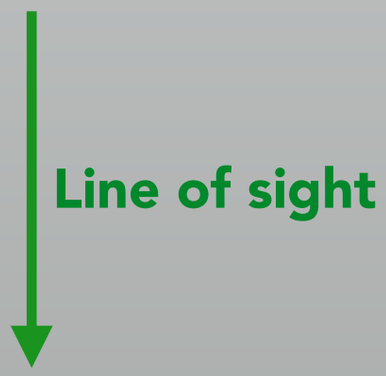

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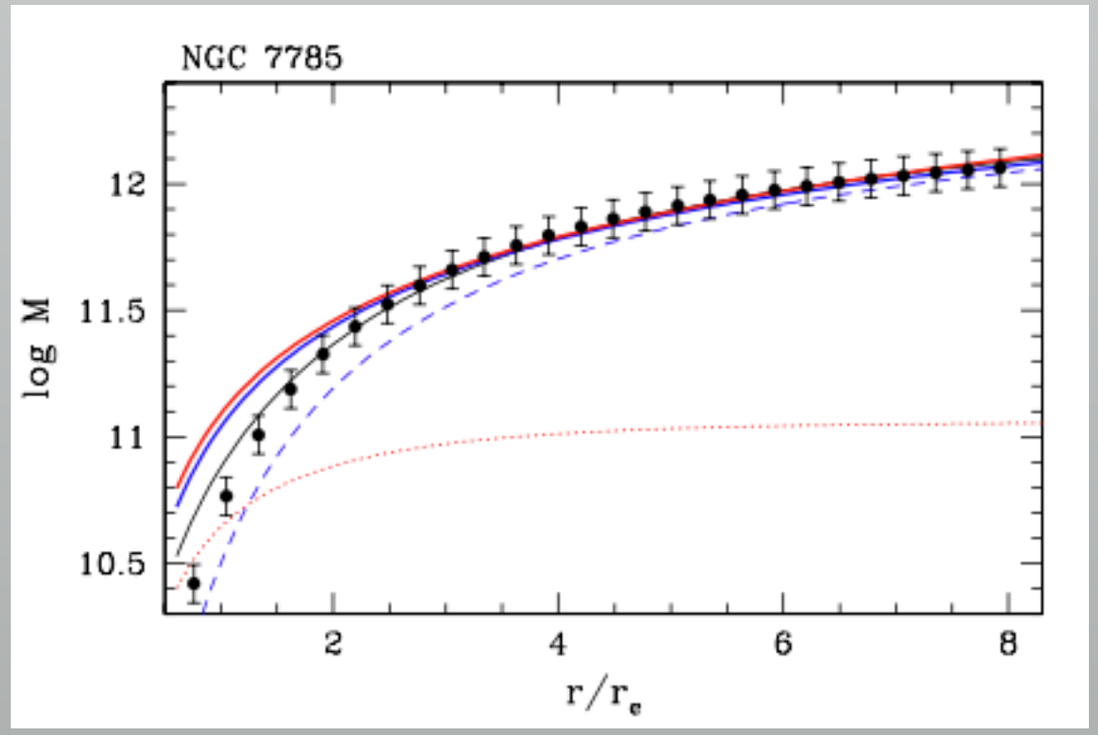
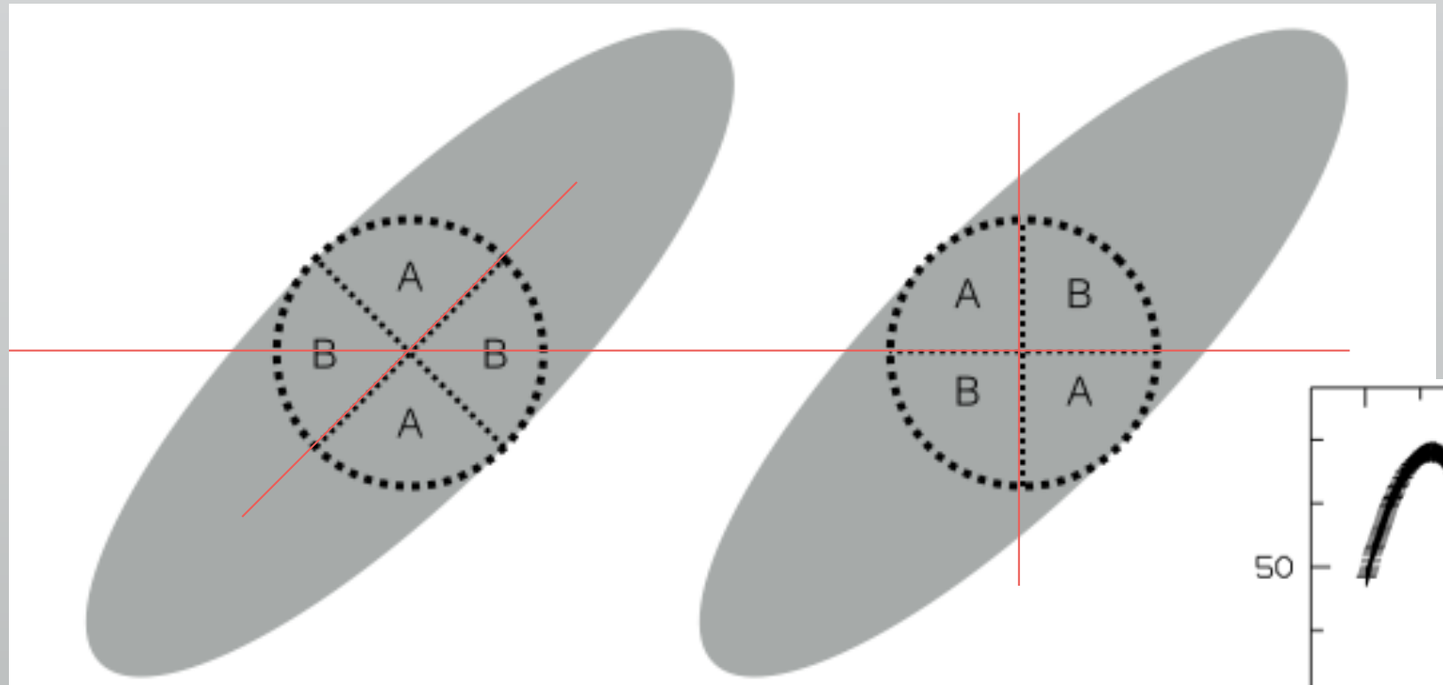
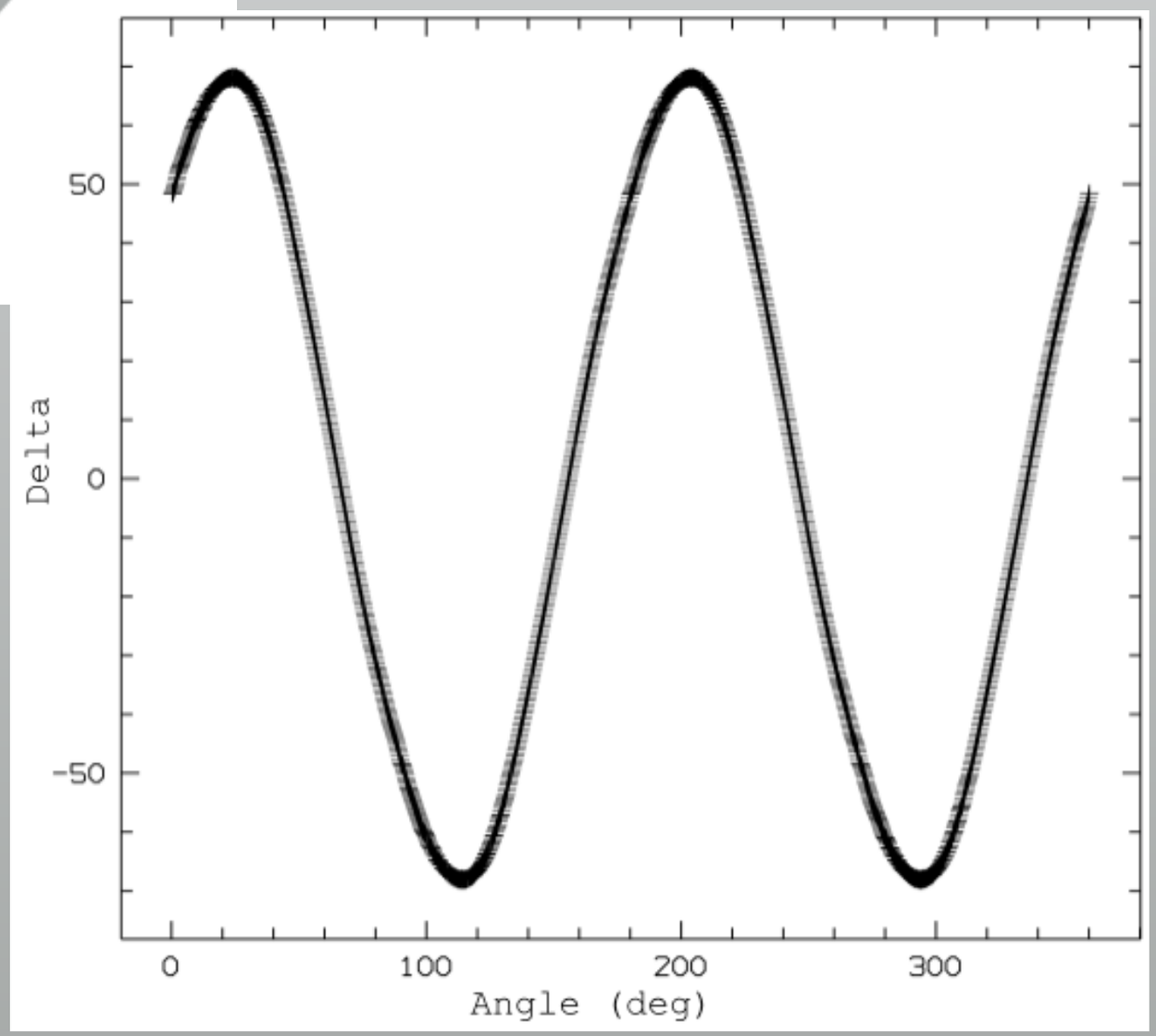


# Around elliptical galaxies ?

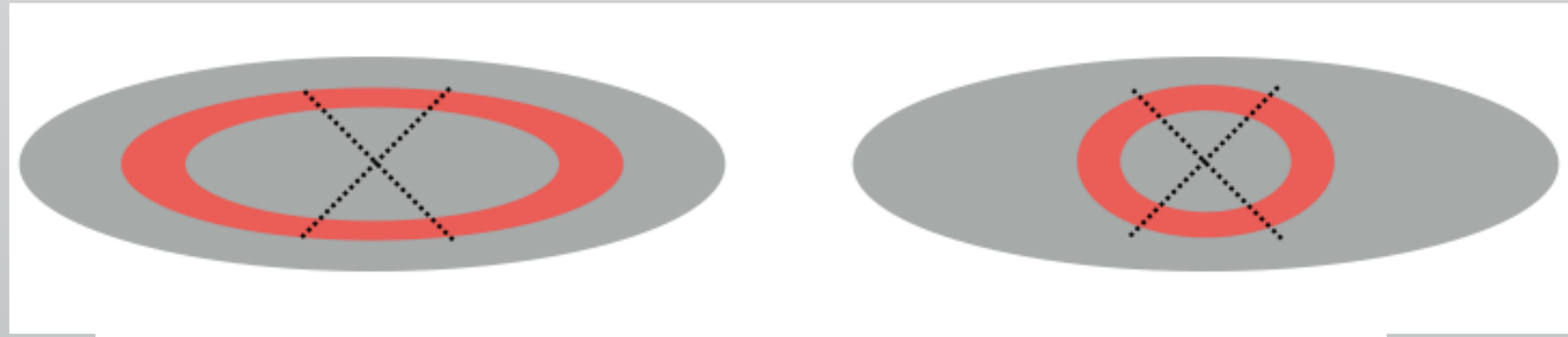
| System (galaxy) | With halo (SIE) | Without halo (constant M/L) |
|---|---|---|
| MG0414+0534 | 33 | 30 |
| HE0435-1223 | 2.6 | 2.9 |
| RXJ0911+0551 | 200 | 186 |
| SDSS0924+0219 | 5 | 6 |
| PG1115+080 | 20 | 6 |
| SDSS1138+0314 | 1.2 | 0.7 |
| B1422+231 | 7 | 43 |

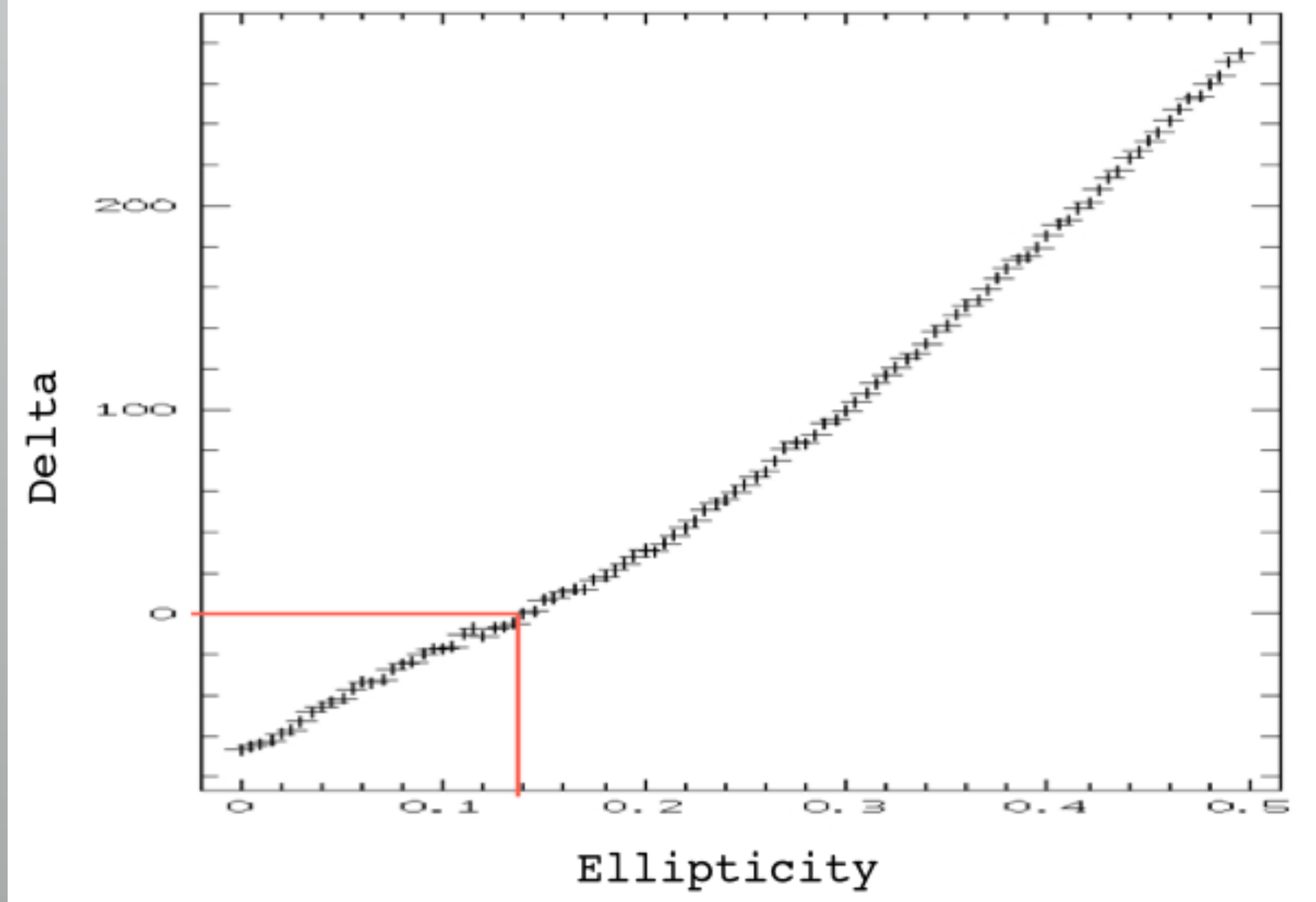
# Measurement of position angle



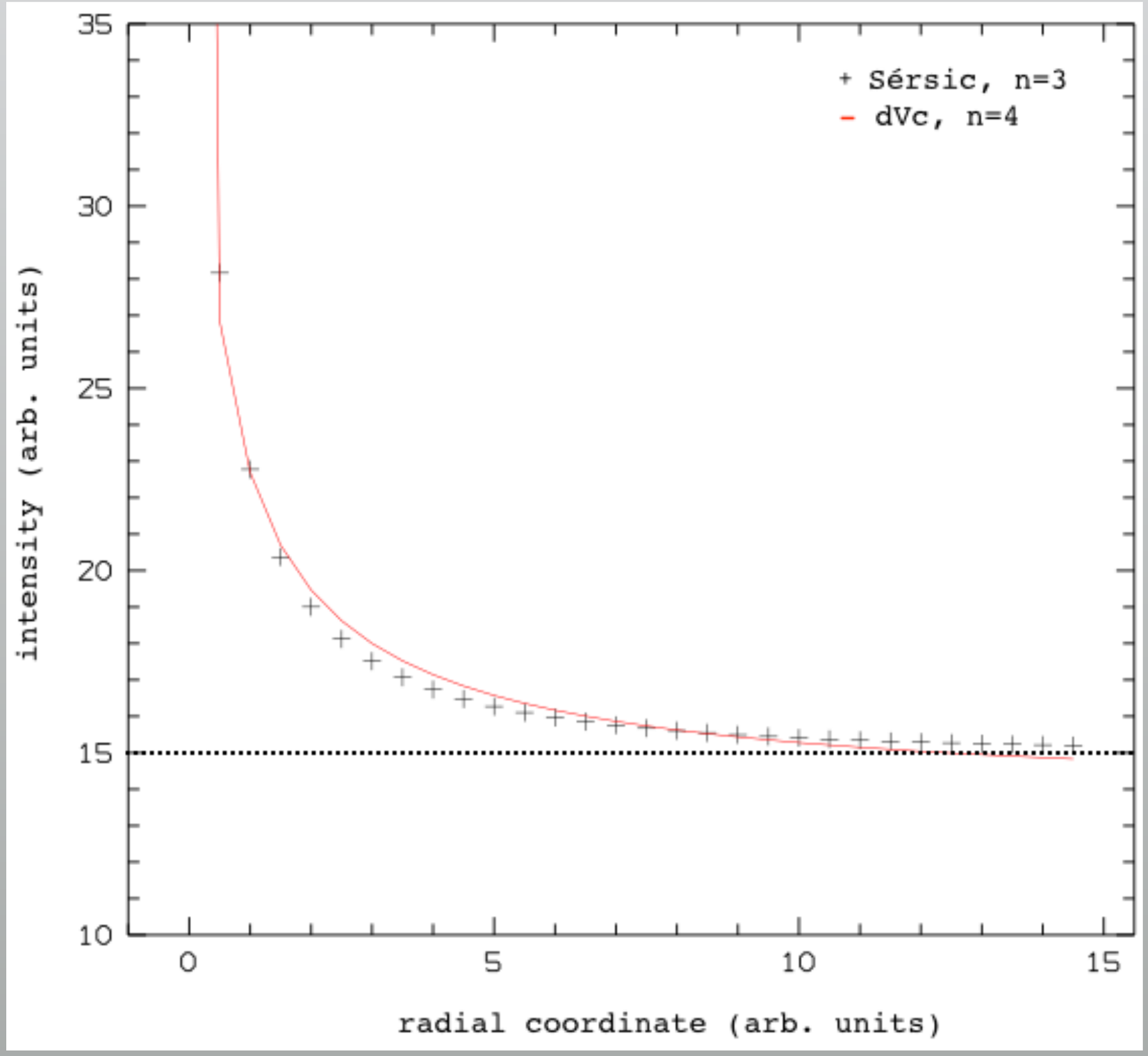



# Measurement of ellipticity





# Mesure de n


+ Sérsic, n=3
- dVc, n=4
intensity (arb. units)
radial coordinate (arb. units)
35
30
25
20
15
10
0
5
10
15

# Mesure de n