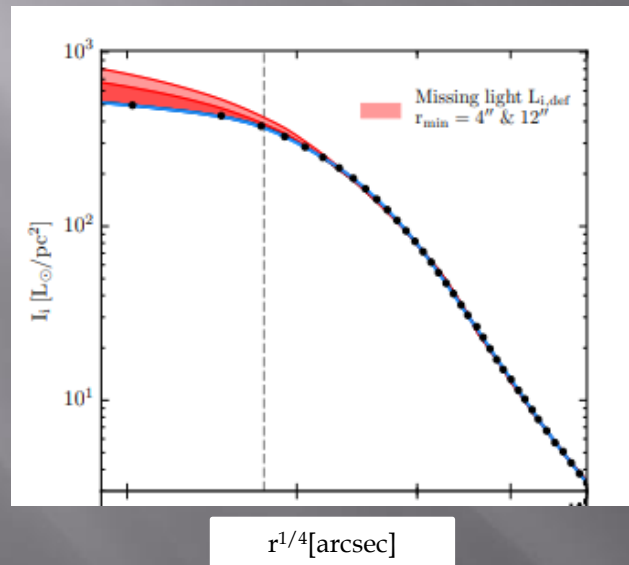
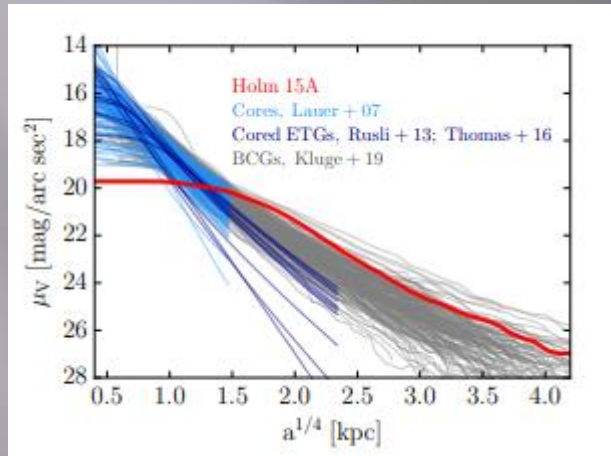


# A 40-Billion solar mass black hole in the extreme core of Holm 15A, the central galaxy of Abell 85

- ▣ Holm 15A is the brightest cluster galaxy of Abell 85 with  $\sim 2$  mag fainter central region
- ▣ SuperMassive Black Hole(SMBH) of  $4.0 \pm 0.8 \times 10^{10}$  solar masses in the center of the galaxy
- ▣ Seeking confirmation that cores are generated from SMBH binaries

# What do we mean by “cored” galaxy? How are they created?



- Believed to be formed by black hole binaries
- Black hole binaries eject stars by gravitational slingshots
- Black hole in the center

# Photometry

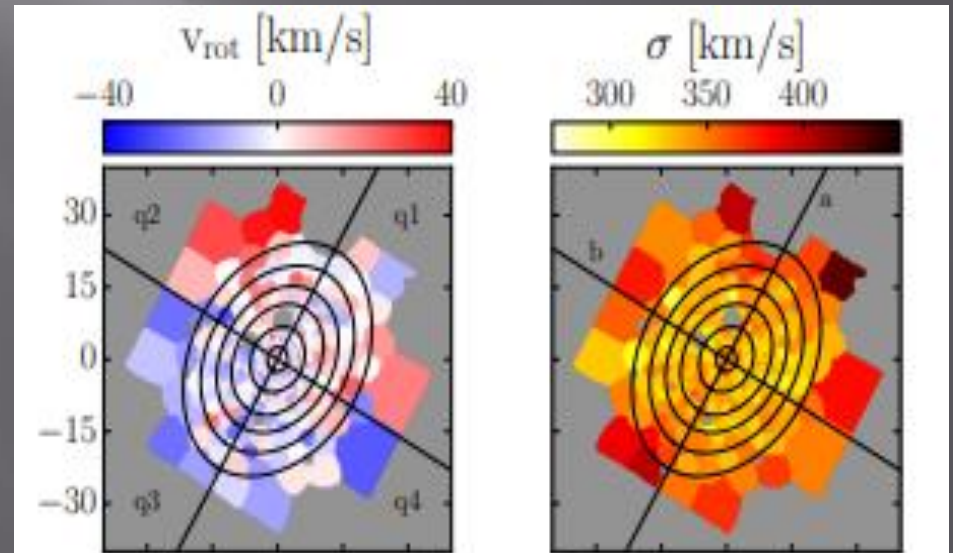
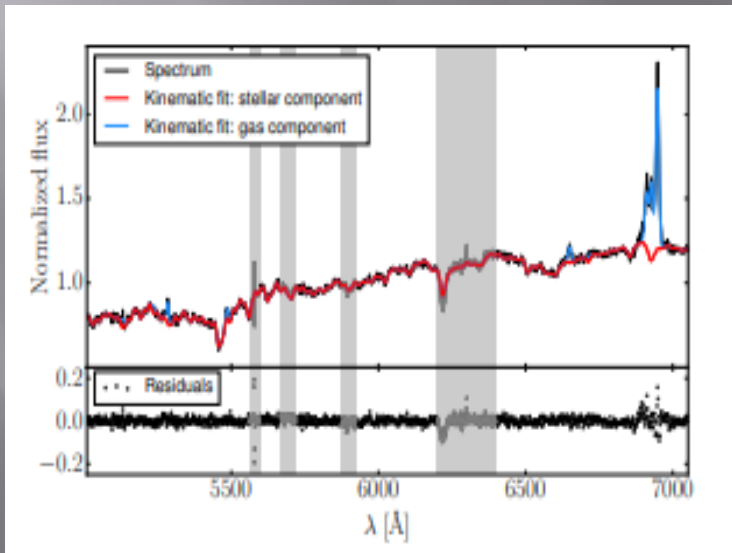
- ▣ Fraunhofer Telescope(i-band image)
- ▣ MUSE from VLT

Used Sersic/core-Sersic models to get the best-fit parameters

Checked if dust or color gradients is what causes the deficit of light in the center and excluded it.

# Spectroscopy

- Used MUSE absorption spectra to define kinematics ( $v_{\text{rot}}$  and  $\sigma$ )



r[arcsec]

# Modelling

Schwarzschild dynamical modeling

$$\rho(r,\theta) = \rho_*(r,\theta) + M_{\text{BH}}\delta(r) + \rho_{\text{DM}}(r)$$

$$\rho_*(r,\theta) = Y_* v(r,\theta)$$

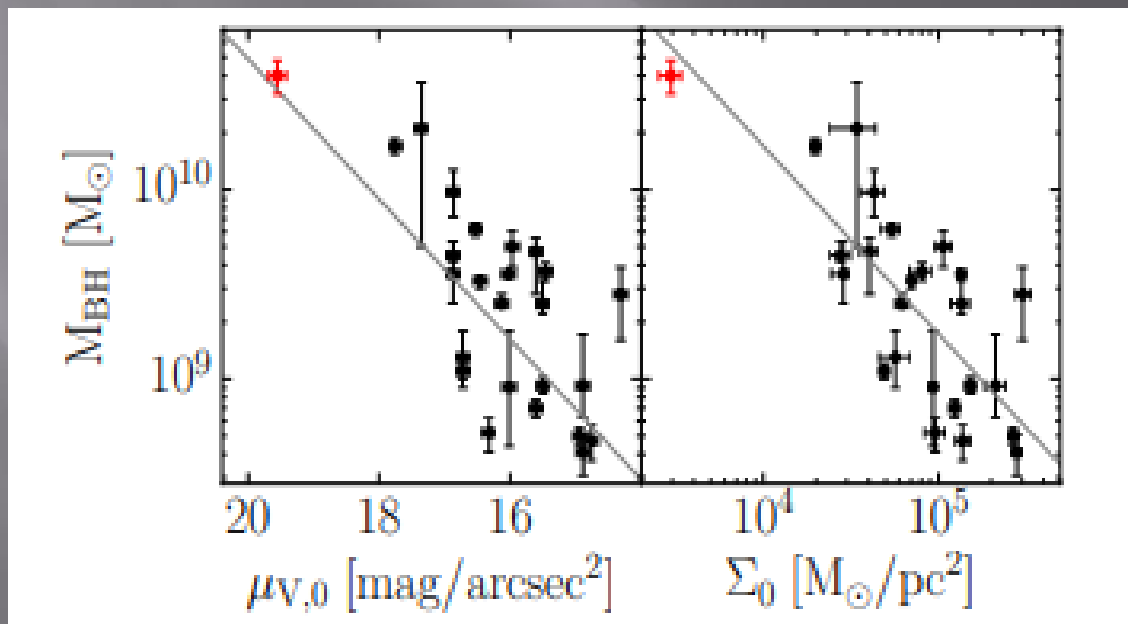
$\rho_{\text{DM}}$ : Navarro model

From this density( $\rho$ ) we can derive a potential  $\Phi$   
and from  $\Phi$  we sample orbits

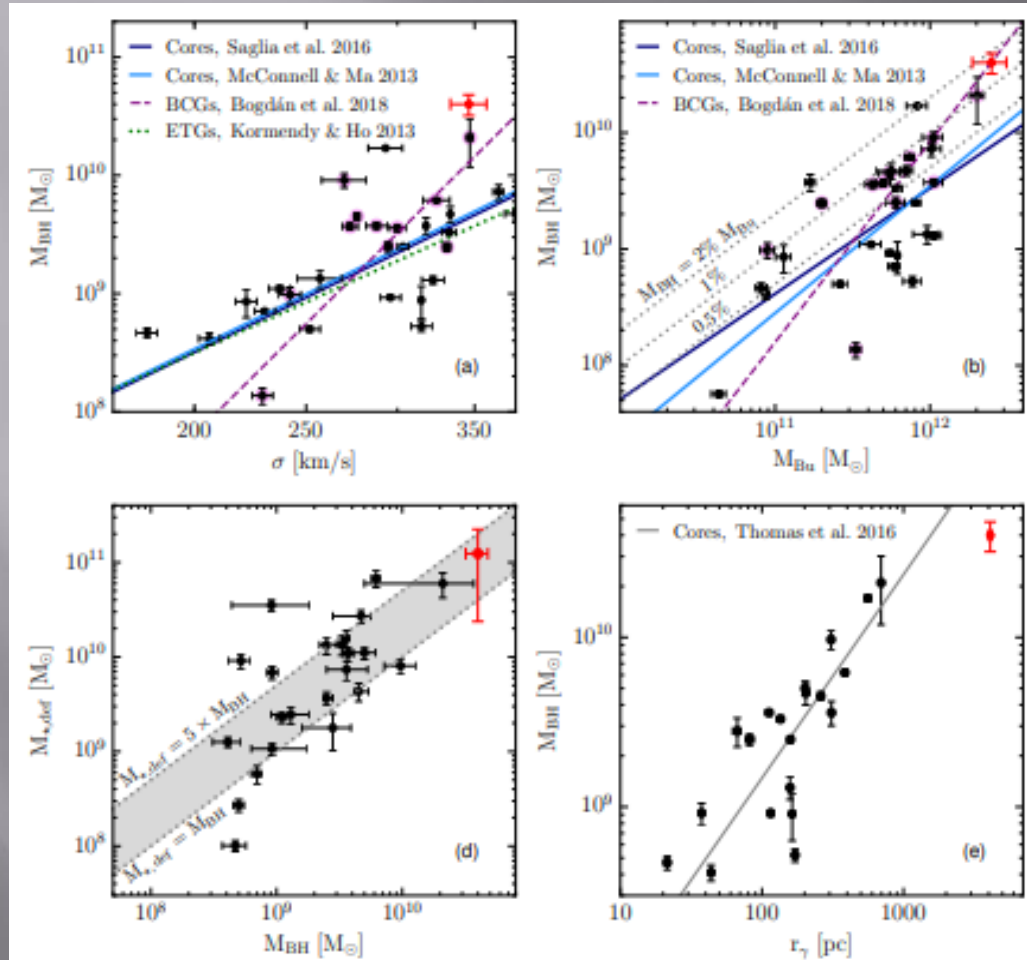
This modeling allows to find the best-fit  
parameters for  $M_{\text{BH}}, Y_*$

# What does $M_{\text{BH}}$ tell us?

- ▣ Black hole holds  $\sim 2\%$  of total stellar mass
- ▣ Very rare and visible only in BCGs
- ▣  $M_{\text{BH}}$  still one order of magnitude offset from previous  $M_{\text{BH}}-\sigma$  relations



# Comparison with previous relations



□ Far off from previous relations of ETGs

□ Compatible with BCGs

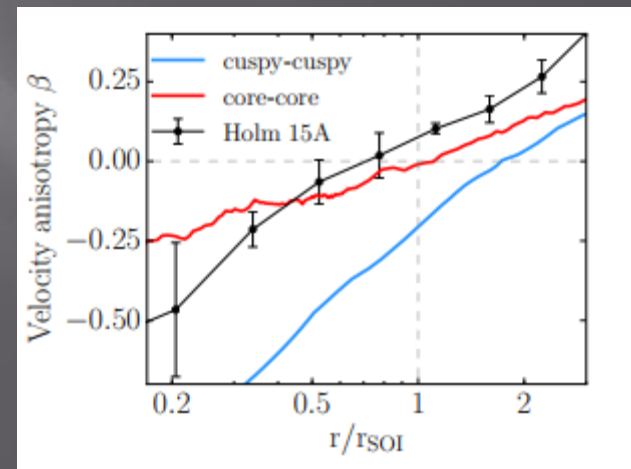
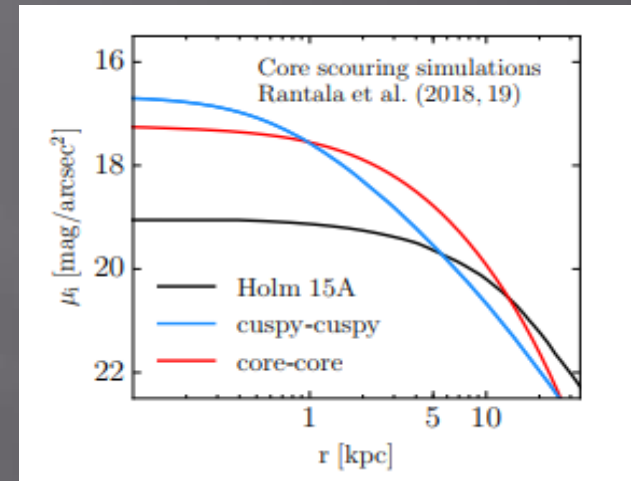
# Merger origin

N-body simulations give the outcome of gas-free merger of cored galaxies

Progenitors formation estimated in  $z \geq 1$  or 2

Other galaxies tend to have velocity anisotropy parameter closer to cuspy-cuspy relation

$$\beta = 1 - (\sigma_t^2 / \sigma_r^2)$$





# Conclusions

- ▣ Holm 15A has one of the biggest black holes in known universe ( $4.0 \times 10^{10}$  solar masses) and core
- ▣ The data for Holm 15A are compatible with previous relations for BCGs
- ▣ The study manages to show that core galaxies can come from core-core mergers