# Dynamical signatures of infall around galaxy clusters

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# Summary

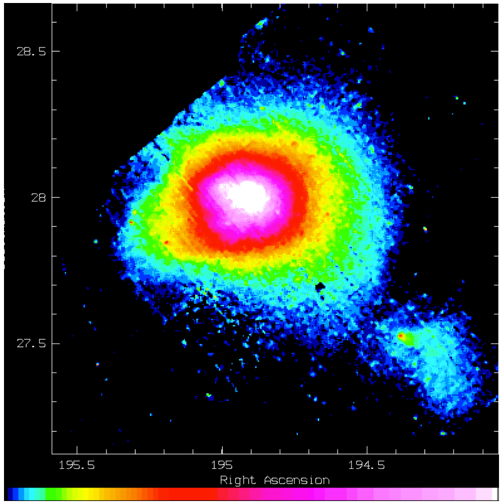
✧Dynamics of galaxy clusters beyond the sphere of virialization

✧Generalization of the Jeans formalism

✧Test on Cosmological Dark Matter simulations

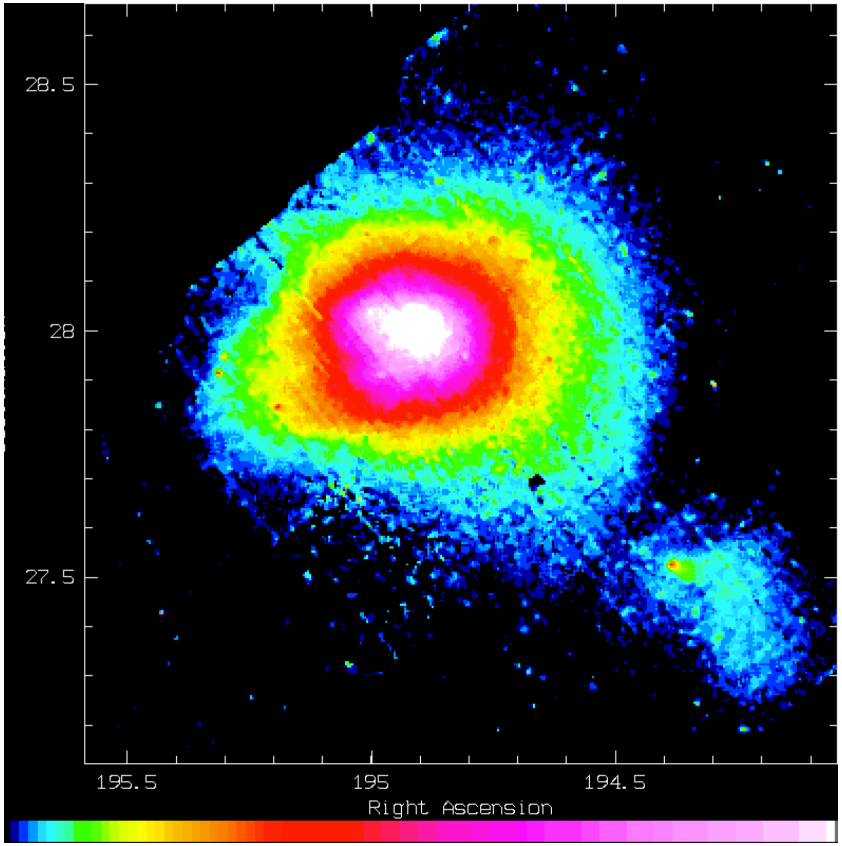
# Dynamics of galaxy clusters

In the inner region clusters are fully equilibrated → Jeans formalism




Central clusters are surrounded by infall zones where galaxies move into the relaxed cluster

# Dynamics of galaxy clusters

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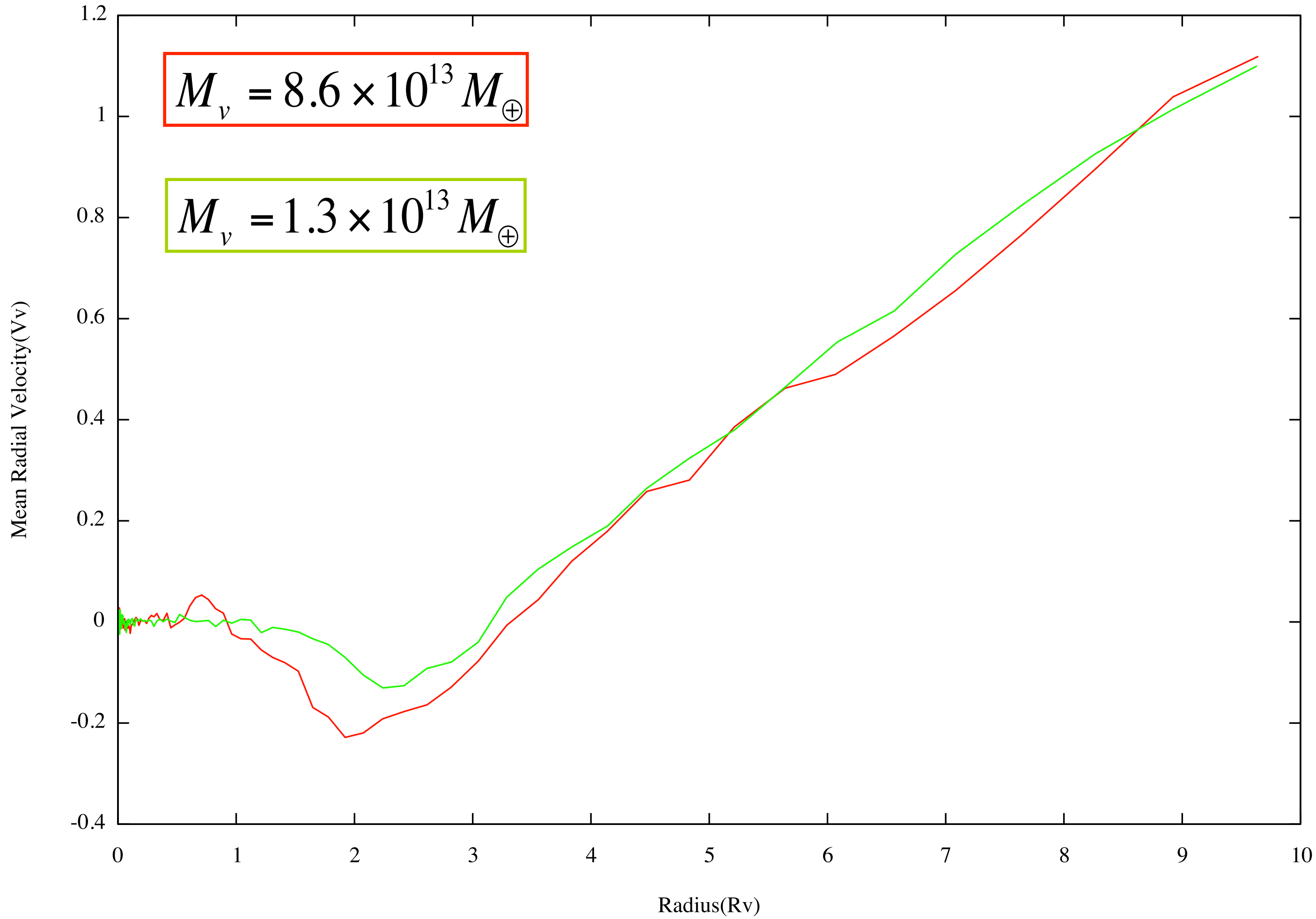
# Dynamics of galaxy clusters

Cosmological simulations show a non-zero mean radial velocity of halo members



# Dynamics of galaxy clusters

… multiple questions :

✧Does the infall affect the standard formalism?

✧Can we detect the effect of the infall?

✧Can we use this detection to constrain the cosmology?

# CLUSTER MASS ESTIMATION

## Equilibrium region

- Hydrostatic measure of X-ray emissivity and temperature of the hot cluster gas

- Jeans analysis of the dynamical state of clusters

## Non-Equilibrium region

- Distortion of background galaxies by gravitational lensing

- Caustic technique

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- Distortion of background galaxies by gravitational lensing
- Caustic technique
- (Appropriate) Jeans analysis of the dynamical state of clusters

# Standard Jeans Equation

$$-\frac{\partial\Phi(r)}{\partial r} = \frac{1}{\rho(r)}\frac{\partial\left(\rho(r)\cdot\sigma_r^2(r)\right)}{\partial r} + 2\beta(r)\frac{\sigma_r^2(r)}{r}$$

Gravitational potential

$$\Phi(r) = -\frac{G\cdot M(r)}{r}$$

Dynamical properties of the galaxies

- ⊖ Spherical system
- ⊜ Identical and collisionless particles
- ⊛ Steady-state system

$\sigma_r^2(r)$ Radial velocity dispersion

$\beta(r) = 1 - \frac{\langle\sigma_\vartheta^2\rangle}{\langle\sigma_r^2\rangle}$ Velocity anisotropy

$\rho(r)$ Galaxy density distribution

# Generalized Jeans Equation

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ii. Cosmological constant

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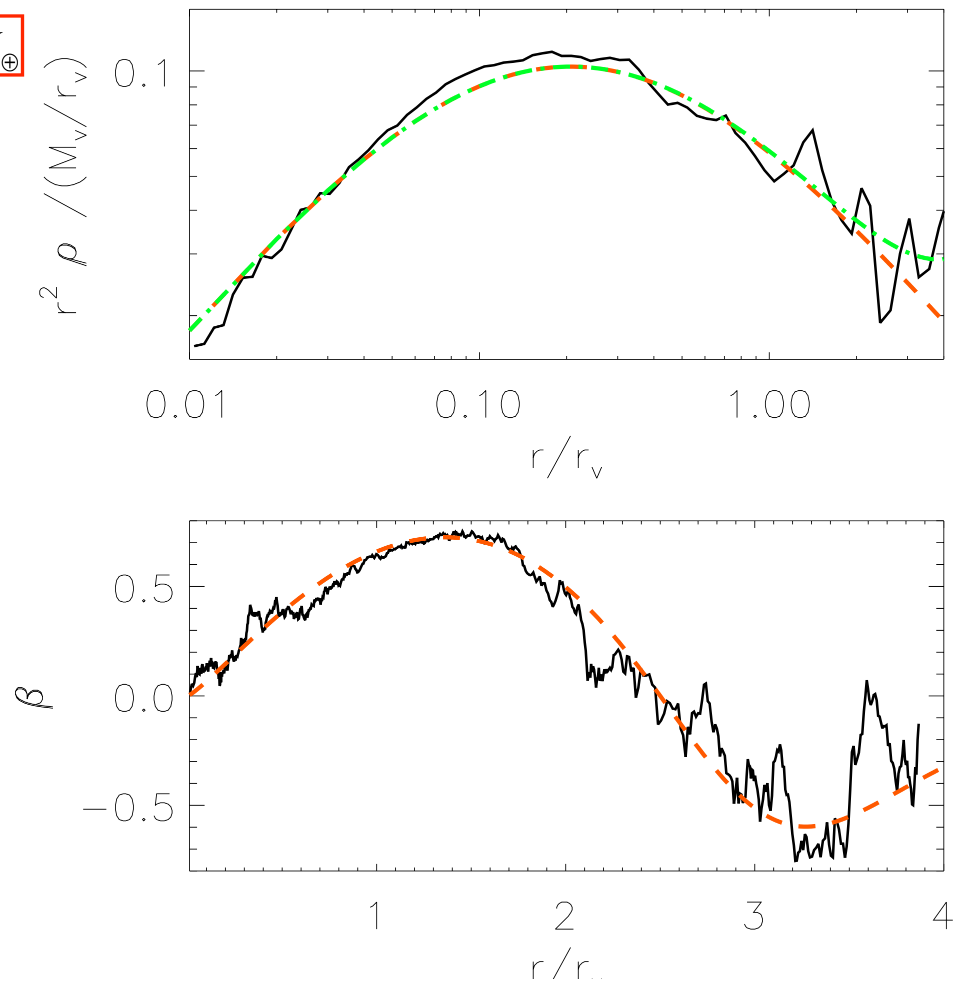
# Test on simulations

Single massive halo :

$M_v = 1.0 \times 10^{15} M_{\oplus}$



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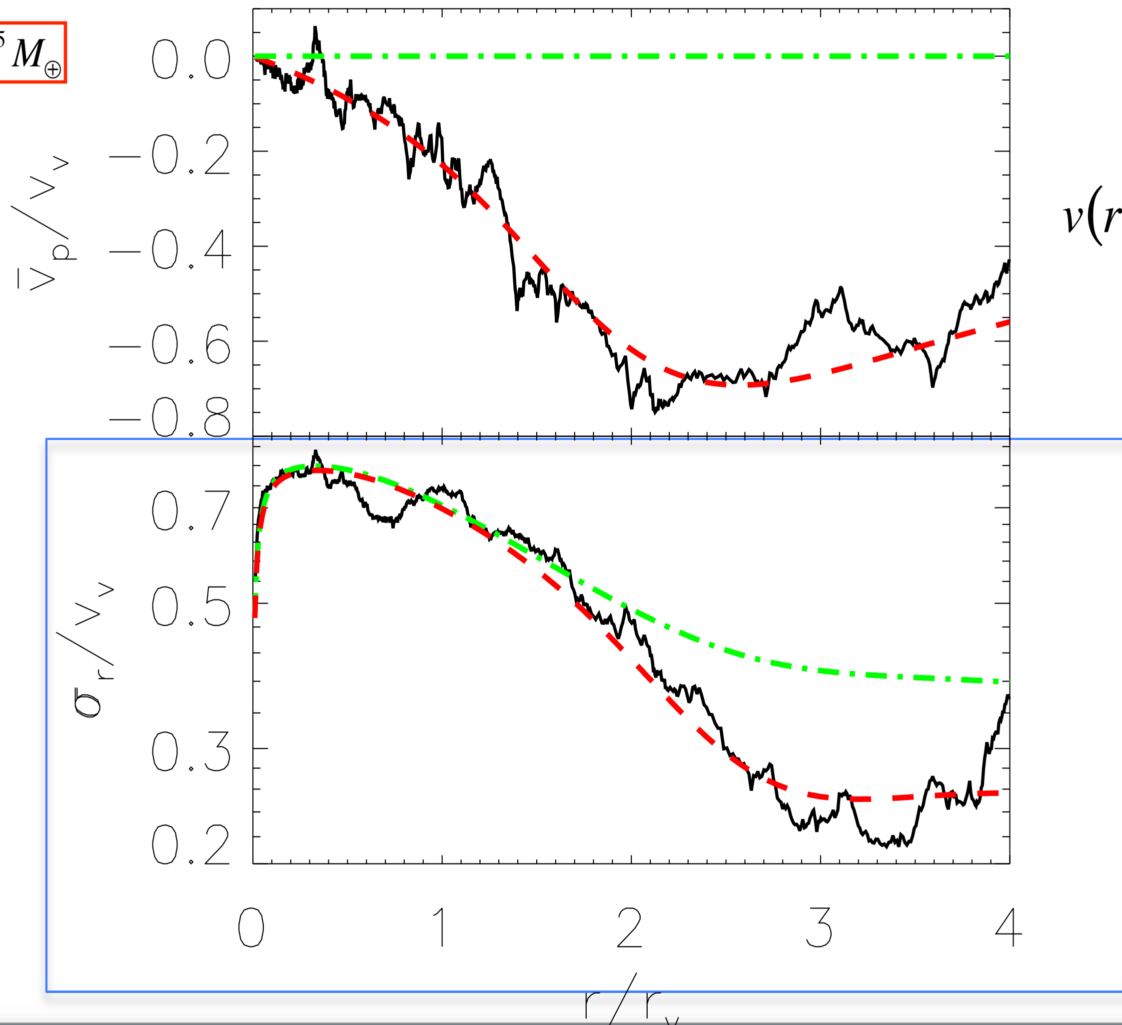
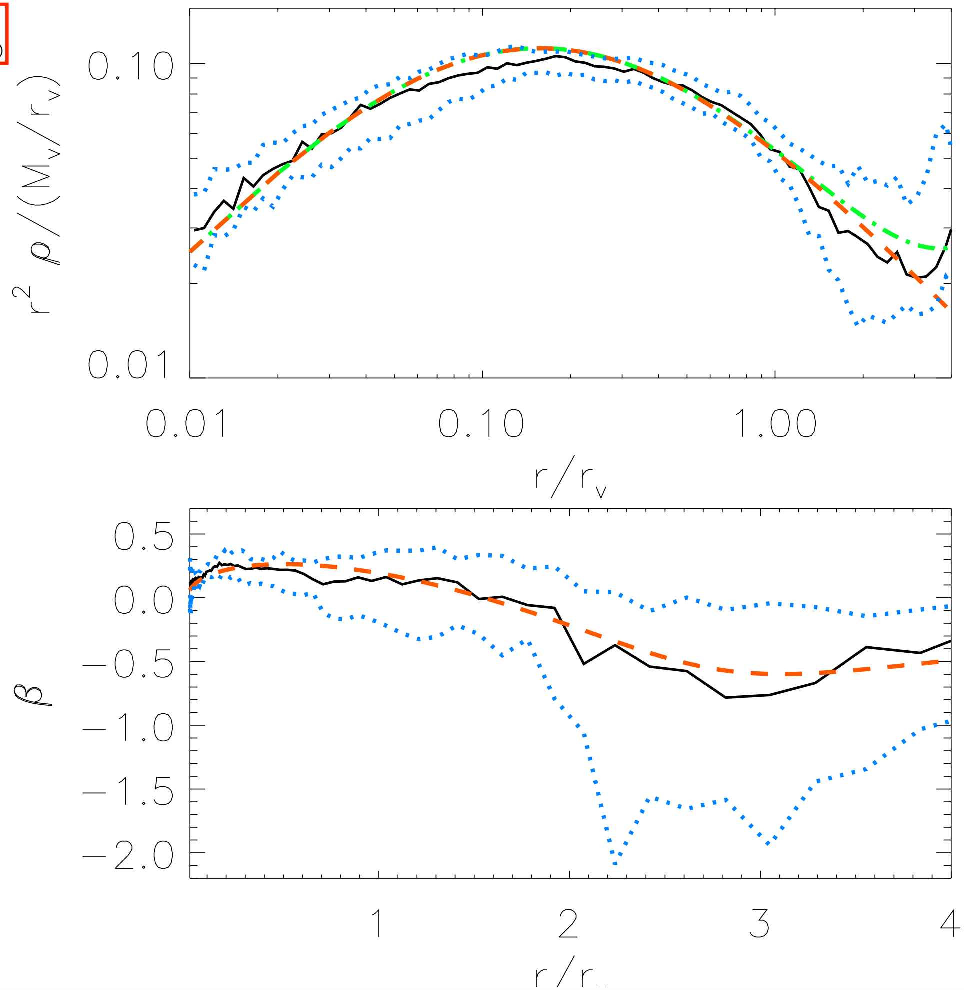



$$v(r) = v_p(r) + H \cdot r$$

# Test on simulations

Stacked halo :

$M_v = 8.6 \times 10^{13} M_\oplus$



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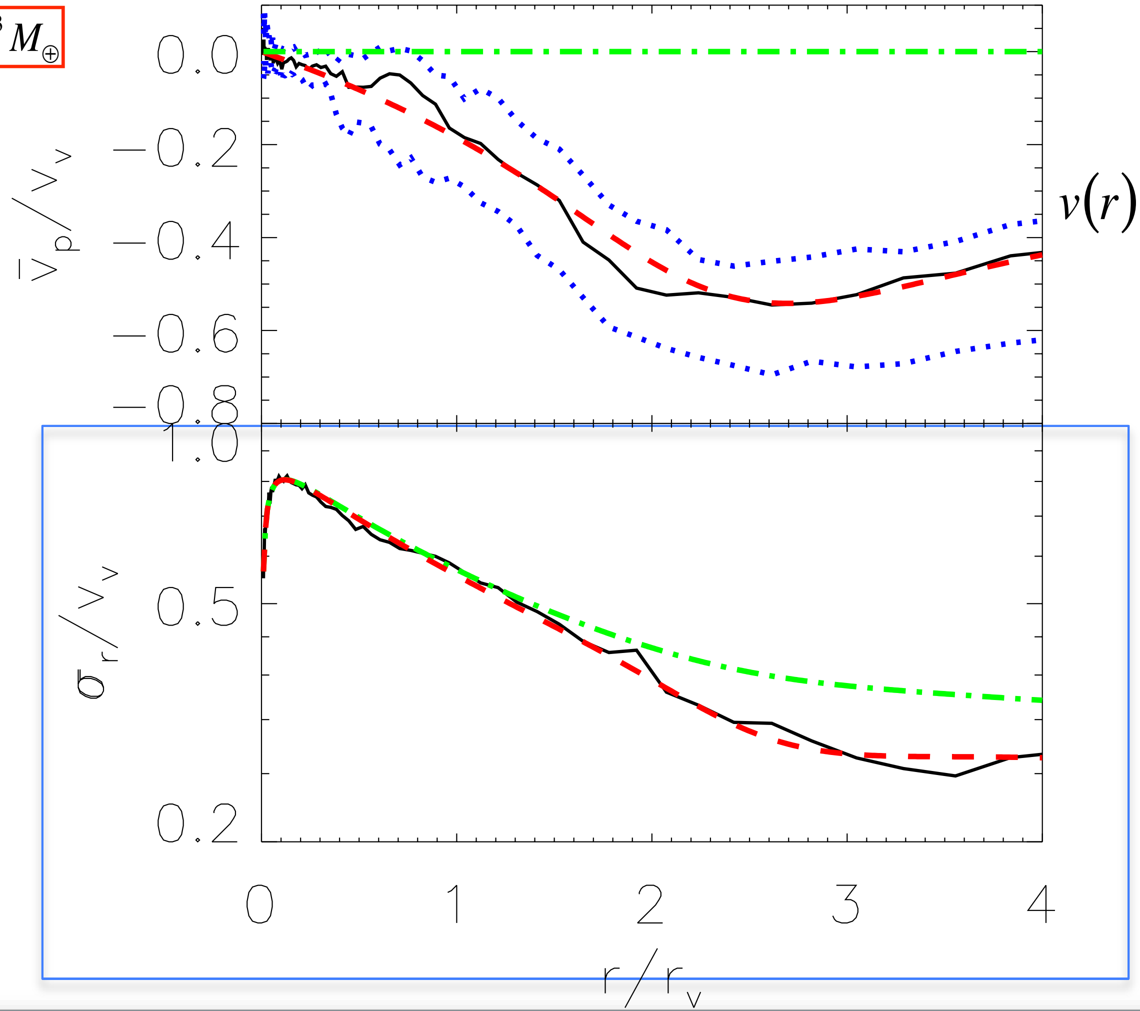


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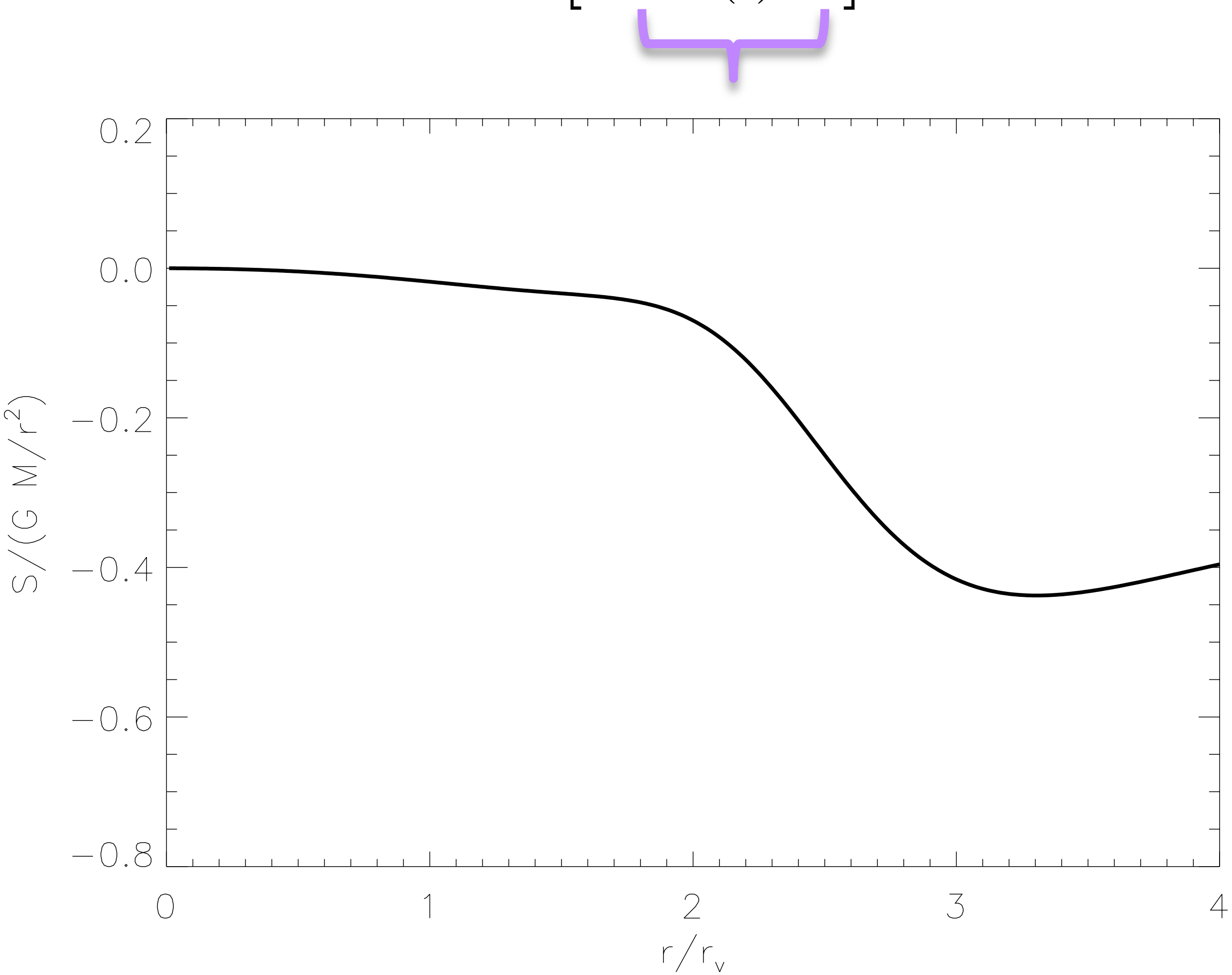
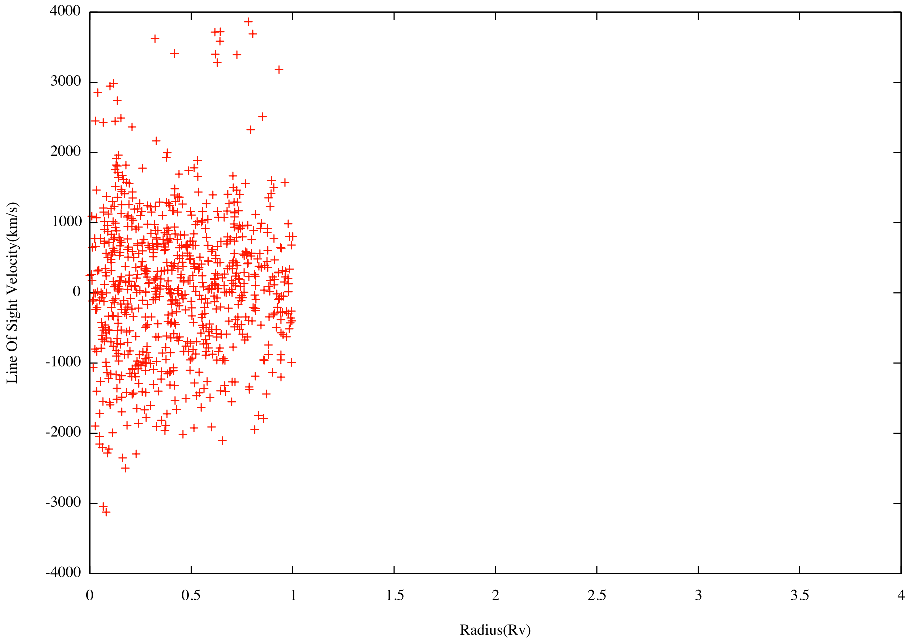
# Test on simulations

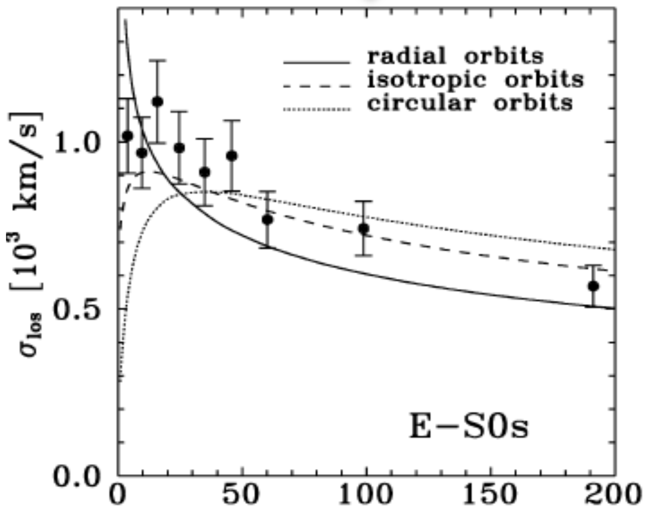
$$M_{std-Jeans}(r) = \left[1 + \frac{S(r)}{GM(r)/r^2}\right] M(r)$$



# Dynamical mass estimation

① Line of sight velocity dispersion from data




② Solution of the Jeans equation

$$\sigma_{los}^2(R) = f(\beta, M)$$

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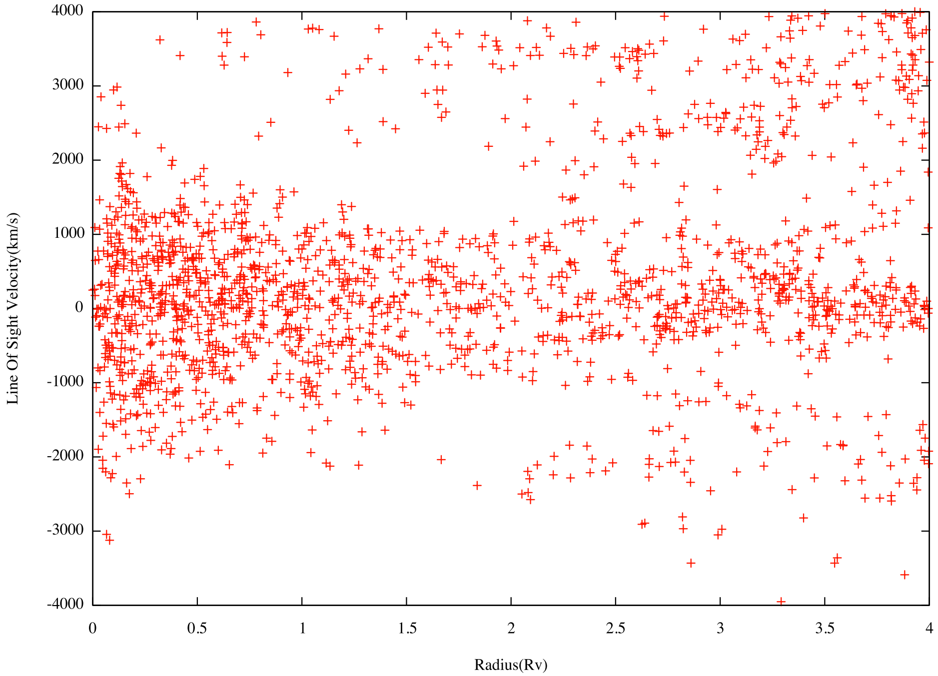


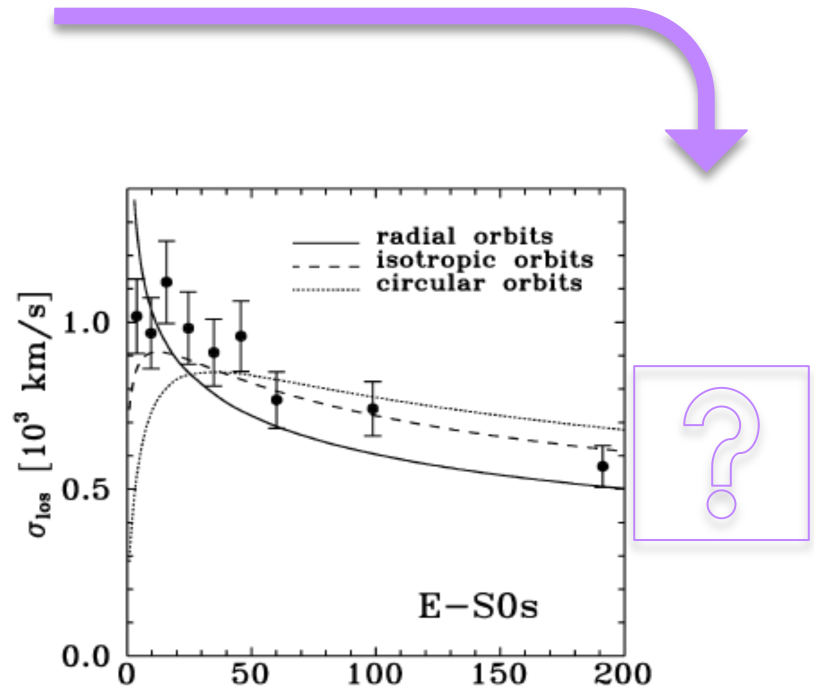


② Solution of the generalized Jeans equation

$$\sigma_{los}^2(R) = f(\beta, M, v_r)$$

# Conclusion

Future application :

measurement of the mass distribution in the region outside the relaxed cluster

- ✧Generalized Jeans equation
- ✧Jeans analysis out to several virial radii
- ✧Contraining the mass,anisotropy and infall profiles