Accounting For Non-circular Motion in Barred Spiral Galaxies

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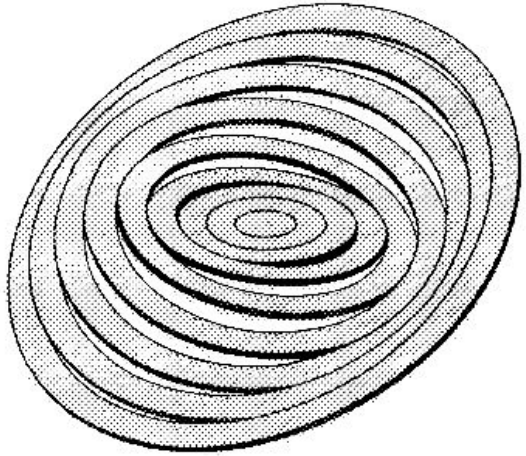
Outline

- Motivation
- Measuring non-circular motions using numerical simulation
- Case study: NGC 3319
- Ongoing work

Motivation

- More than two-third of spiral galaxies are barred
- Rotation curves are used as tools to study the mass distribution of galaxies
- The current method for correcting non-circular motion only works for specific bar orientation

Rotation curve

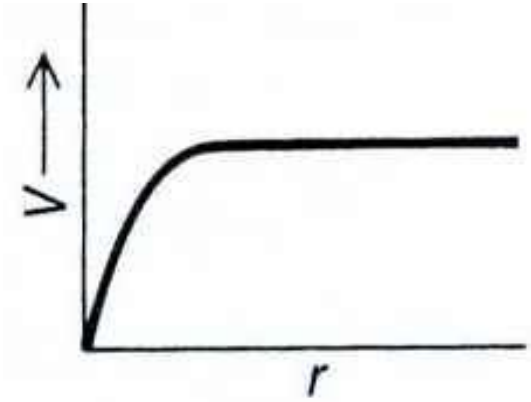


ROTCUR

- Uses the tilted-ring method
- circular motion only
- Excellent for warped disk

RESWIR

- performs harmonic decomposition of the residual velocity fields
- small scale non-circular motion see Oh et al 2008



Rogstad (1974)

DISKFIT (Spekkens *and* Sellwood 2007)

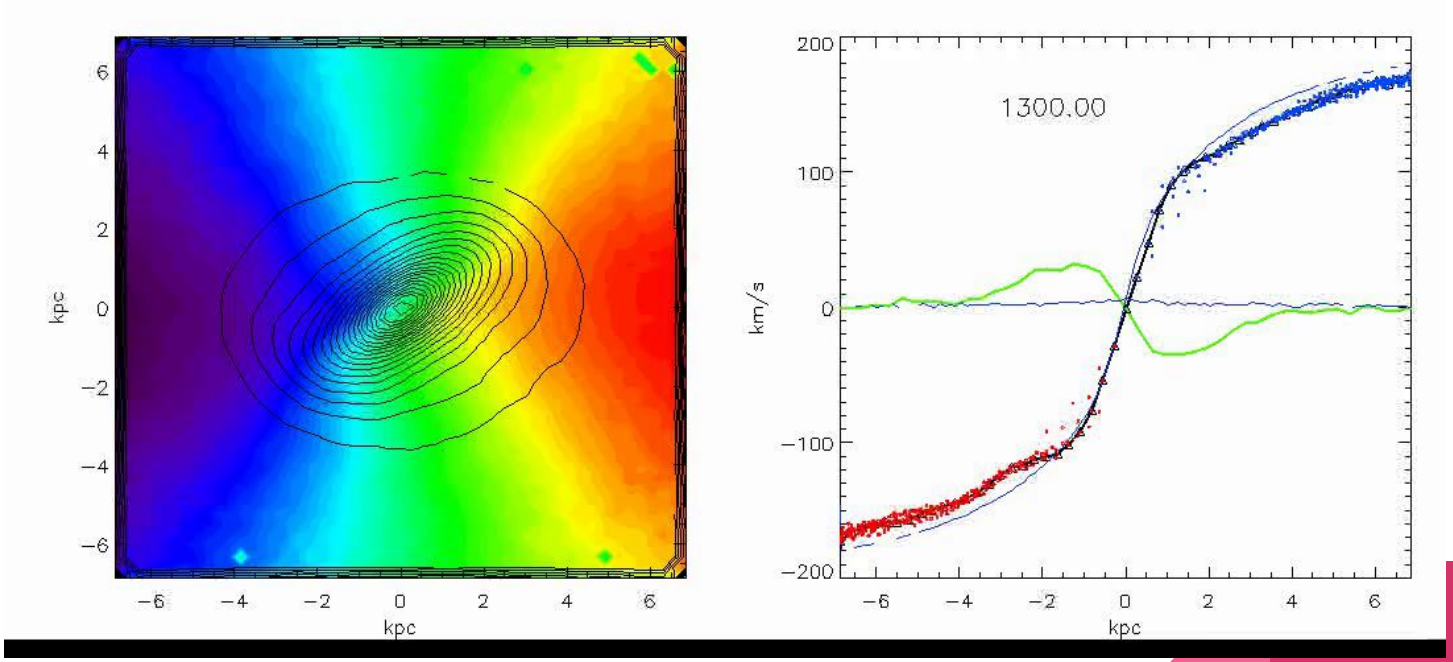
Pros:

- Based on chi-square minimization by Barnes & Sellwood 2003
- Nonparametric component to either photometric images or velocity fields
- More accurate rotation curves
- Allow the users to choose a physical model which best represent the data
- Use bootstrap method to estimate the uncertainty

Cons:

- Doesn’t work when the bar is parallel to either of the minor/major axis because of degeneracy (Sellwood & Sanchez 2010)

But ...



Dicaire et al. (2008)

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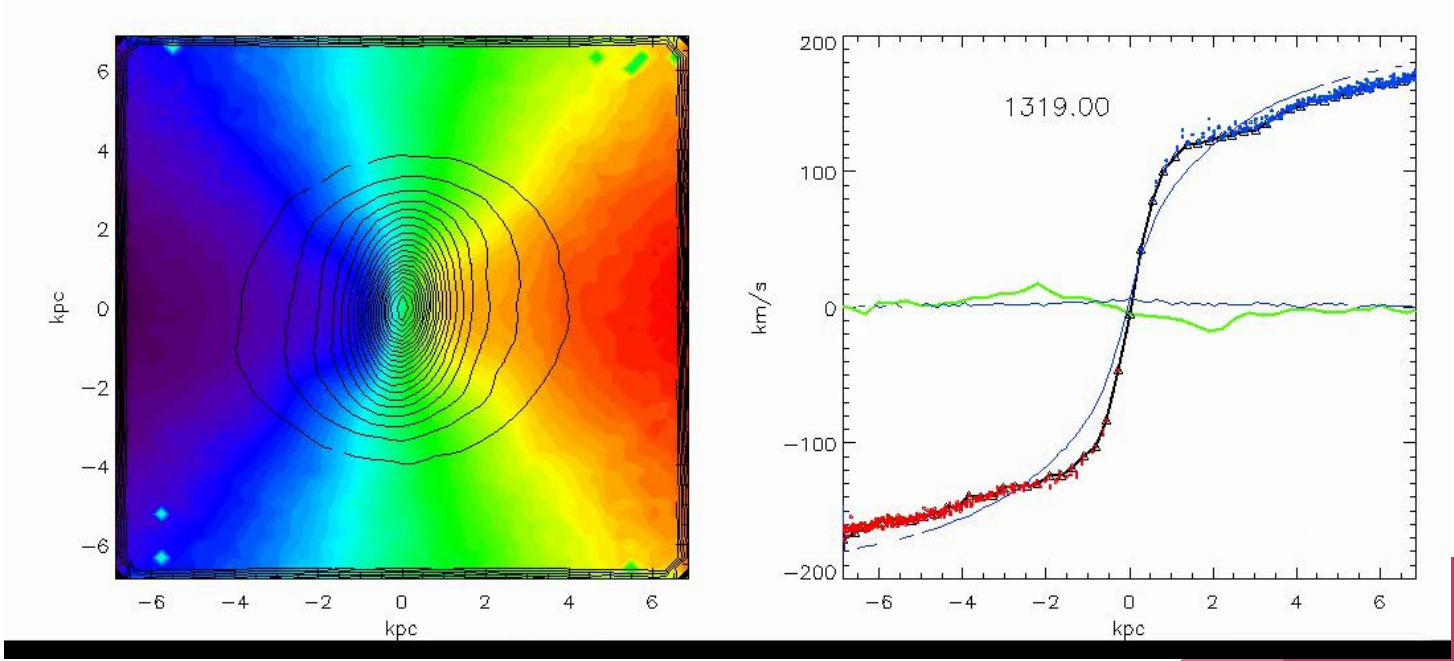

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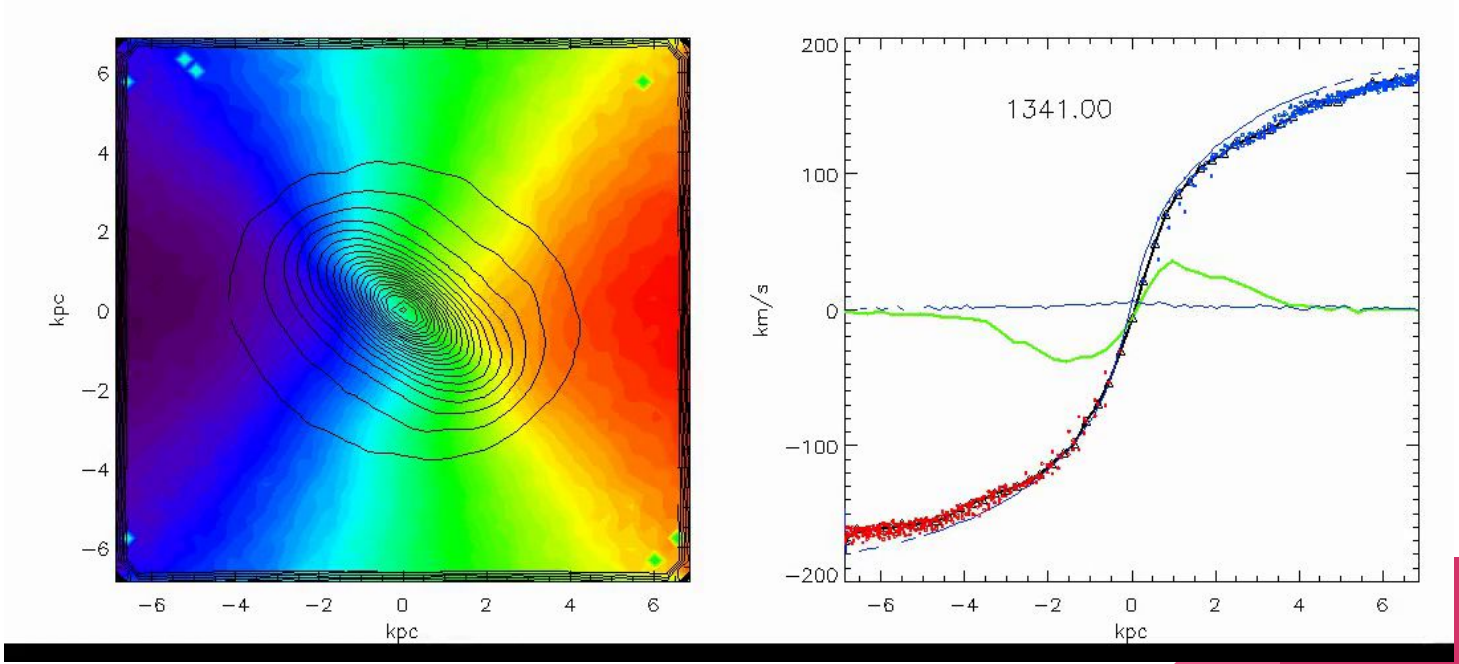

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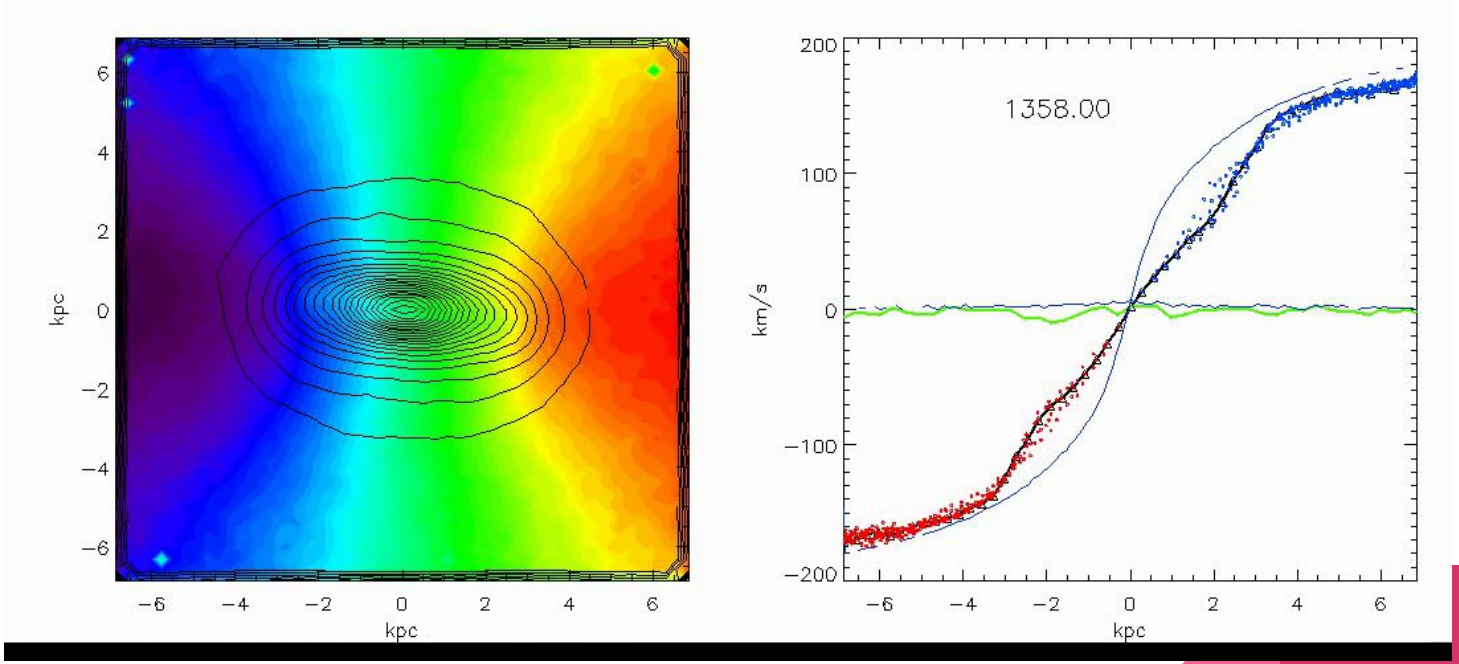

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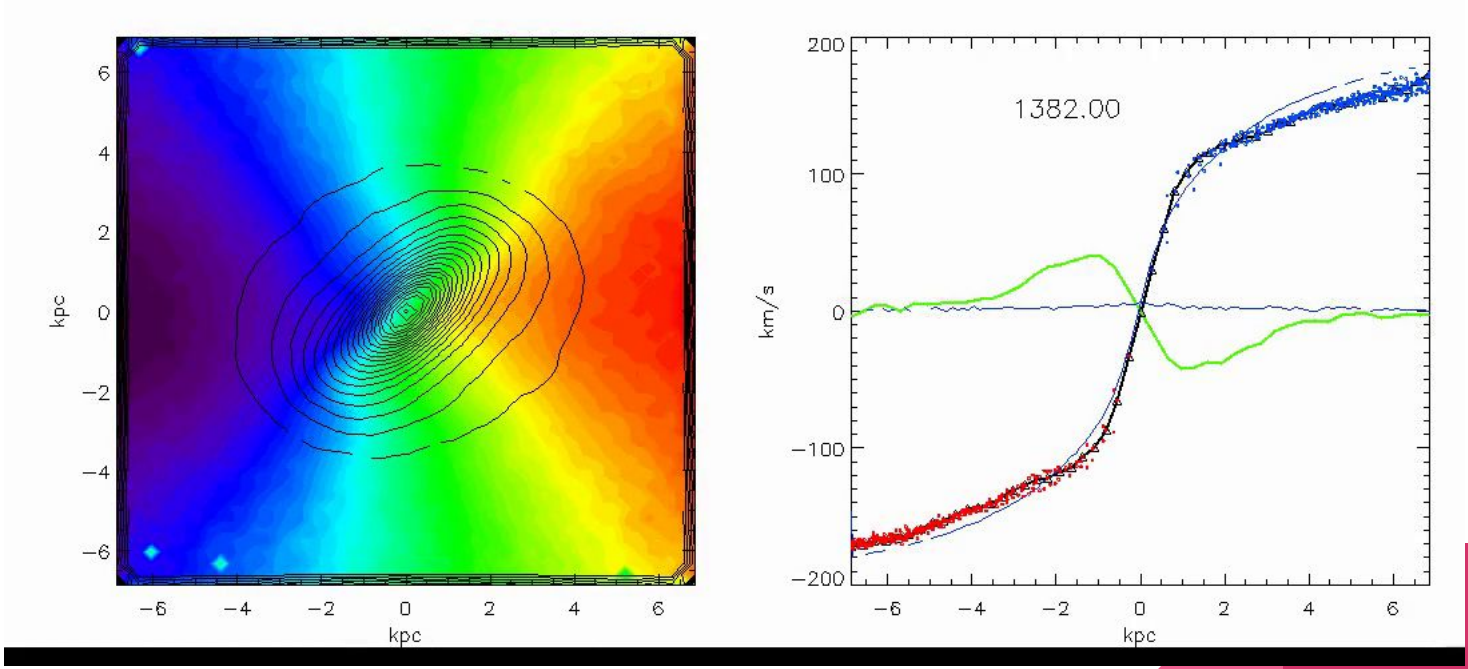


Dicaire et al. (2008)

N-Body/Hydrodynamic simulations

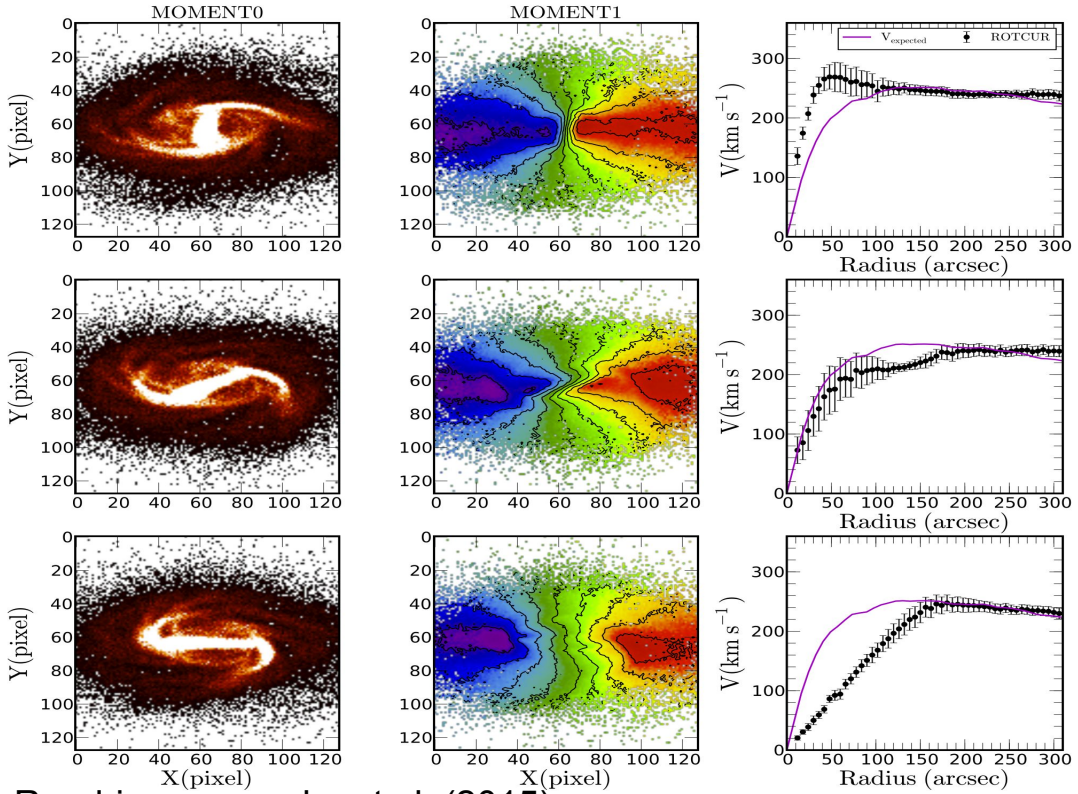
✤ The simulations are from the GalMer project (Chilingarian et al. 2010)

✤ The mass of the disk, bulge and dark matter halo are known for each snapshot

✤ Make snapshot observation inside the simulation and derive the rotation curve

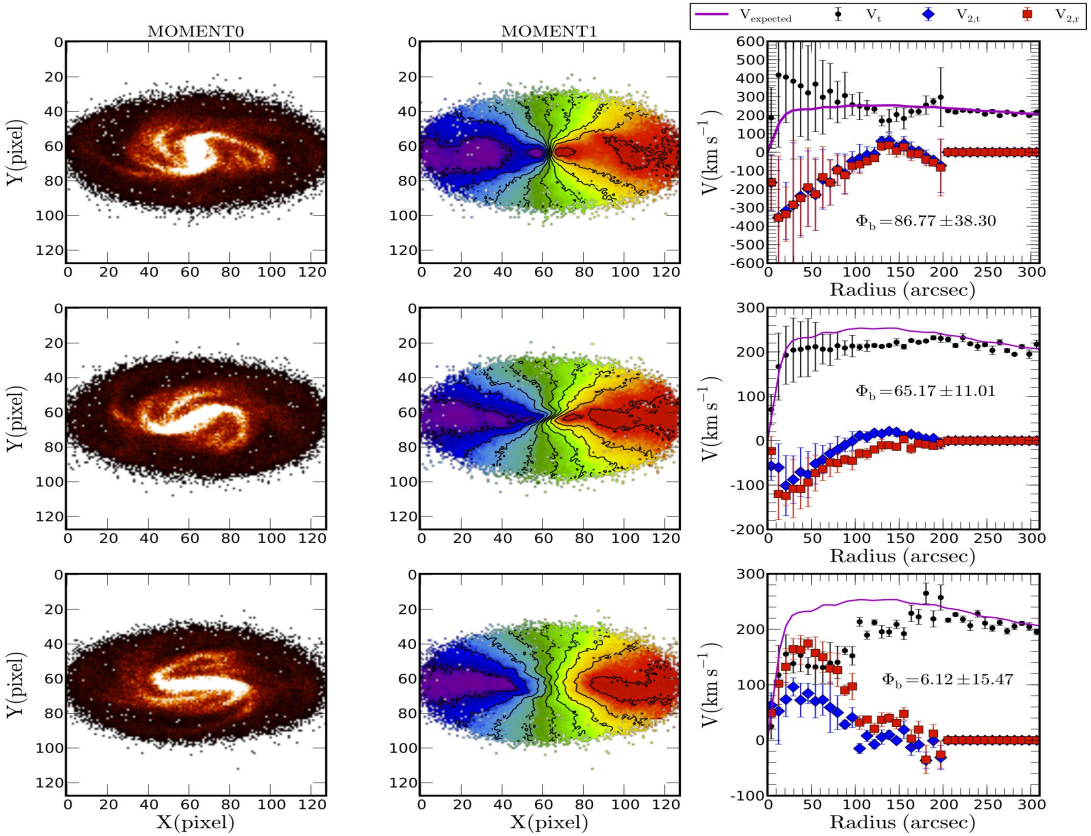
✤ The expected rotation curves were calculated from the gravitational potential and its derivatives

ROTCUR result



T. Randriamampandry et al. (2015)

DISKFIT result



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Measuring non-circular motions using numerical simulation

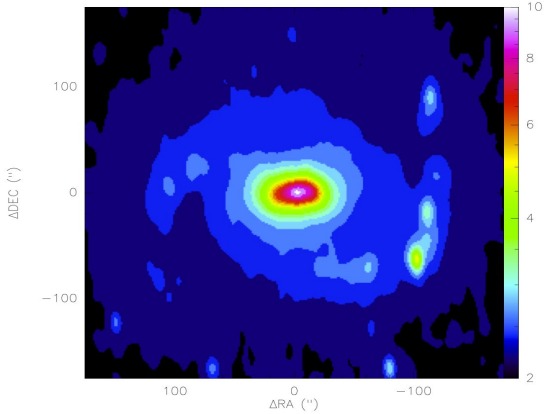
✤ The correction is obtained by comparing the measured velocities (ROTCUR) with those expected from the gravitational potential

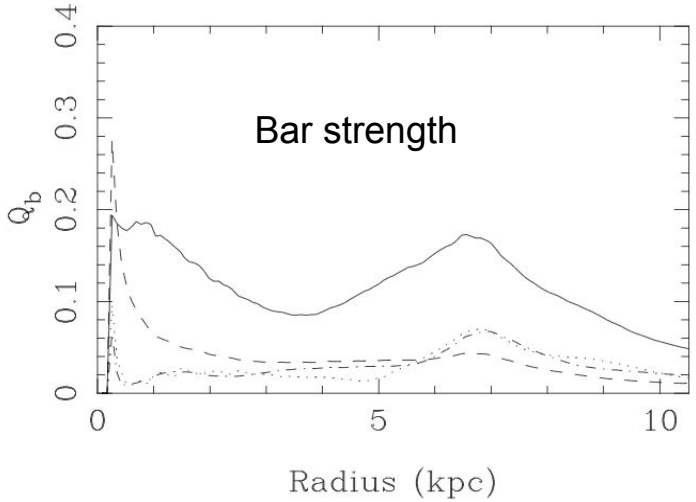
✤ We choose snapshot that have the same bar properties as the observed galaxy: bar strength and orientation

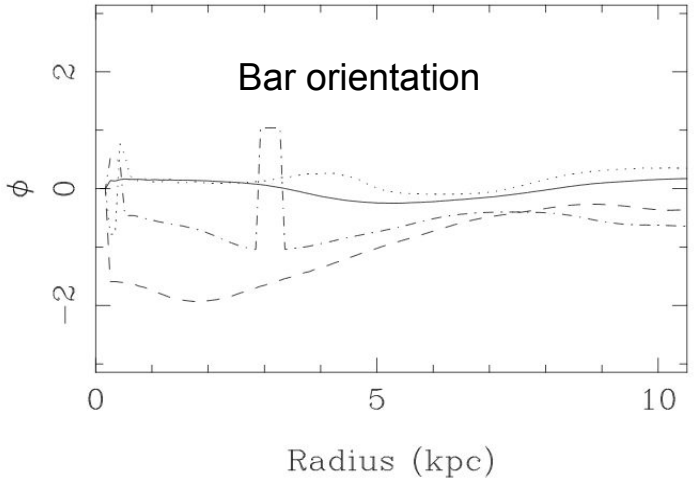
✤ Other parameter such as B/D ratio also needs to be taken into account

Test case : NGC 3319

PAb = 2 deg. (bar orientation)
Qb = 0.24 (bar strength)







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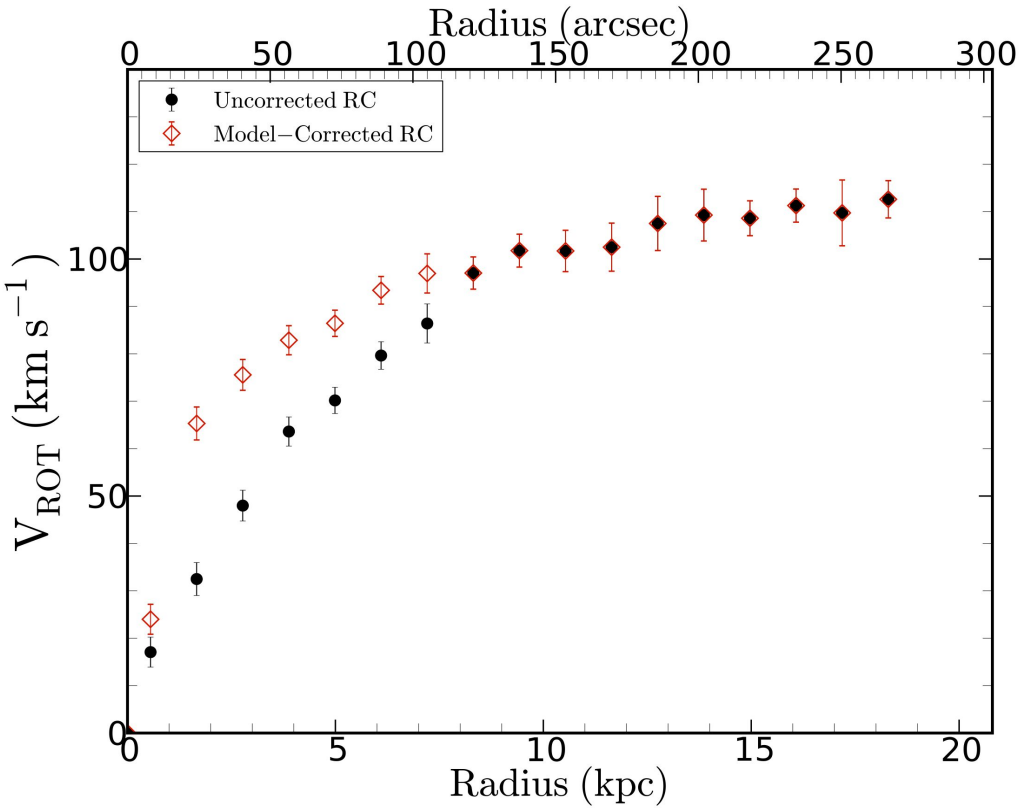

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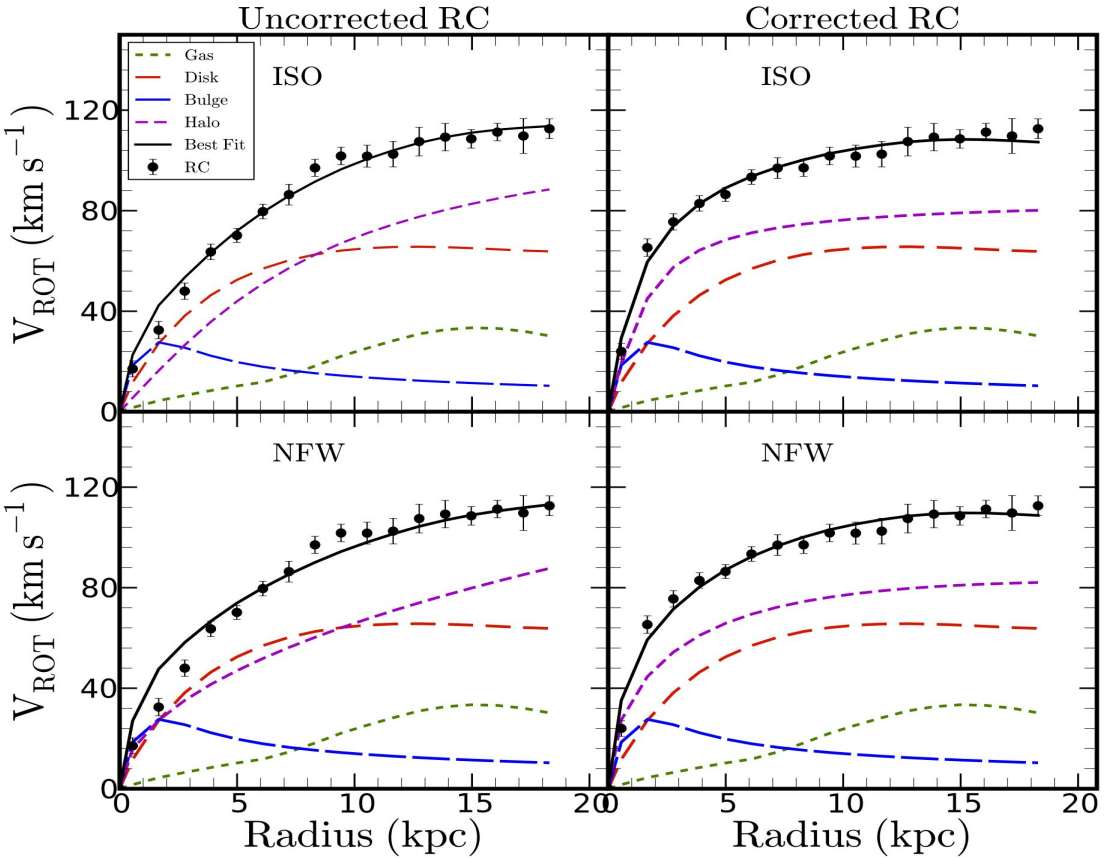

Test case : NGC 3319

Halo Model	Params	Uncorrected RC	Corrected RC
ISO	ρ_0	5.55±0.99	74.08±15.15
	R_c	6.91±1.11	1.34±0.16
	Υ_d	0.25	0.25
	Υ_b	0.40	0.40
	χ^2_r	1.35	0.75
NFW	c	0.43±0.01	5.18±0.73
	R_{200}	147.25±11.00	56.46±3.44
	Υ_d	0.25	0.25
	Υ_b	0.40	0.40
	χ^2_r	3.24	1.44

Notes: Υ_d is the mass-to-light ratio for the stellar disk and Υ_b for the bulge. The central DM density ρ_0 is given in units of 10^{-3} $M_\odot$ pc^{-3}; R_c and R_{200} are in kpc.

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Ongoing work

✤ Characterize and quantify the non-circular for galaxies with different bar strength and orientation using the GALMER simulations

✤ look for any correction between the non-circular motion and the

strength/orientation of the bar and other properties (B/T, D/B, L/DM etc ...)

✤ Make new models of a sample barred galaxies to study the dynamics of the gas in the bar region (GalactICs+GADGET2)

✤ Create a grid of correction for galaxies with different bar strength and orientation

THANK YOU