Disc and Extinction map Working Group

Daisuke Kawata
(MSSL, University College London)

Challenges 2015

- Local Dark Matter Density
  Silverwood, Sivertsson, Read

- Pattern speed of the arm and spiral Arm
  (Pfenniger, Chemin), Romero-Gomez, Hunt, Kawata

- New! Solar peculiar motion
  Spagna, Hunt?

- Tutorial
  Eugene Vasilieve: ABGal
  Jason Hunt: SNAPDORAGONS
  Robin, Marshall: 3D extinction map, current status (several public data, but not all sky)

- Collaborations:
  Eugene Vasiliev + UB, UNAM team
    Motion of particles from reconstructed potential
  Upgrade of Besancon model, Fernádez- Trincado, Robin, Pichardo

Hunt & Kawata challenges for 2015

Can you recover V_LSR=218.4 km/s and (U,V,W)=(11,12,7) km/s from M0III tracers from:

1. A featureless axisymmetric disc galaxy without extinction or error?
2. The same galaxy with dust extinction added? - Cut at V<20.2714 mag (~G=20 mag)
3. The same galaxy with dust extinction and Gaia like errors added?

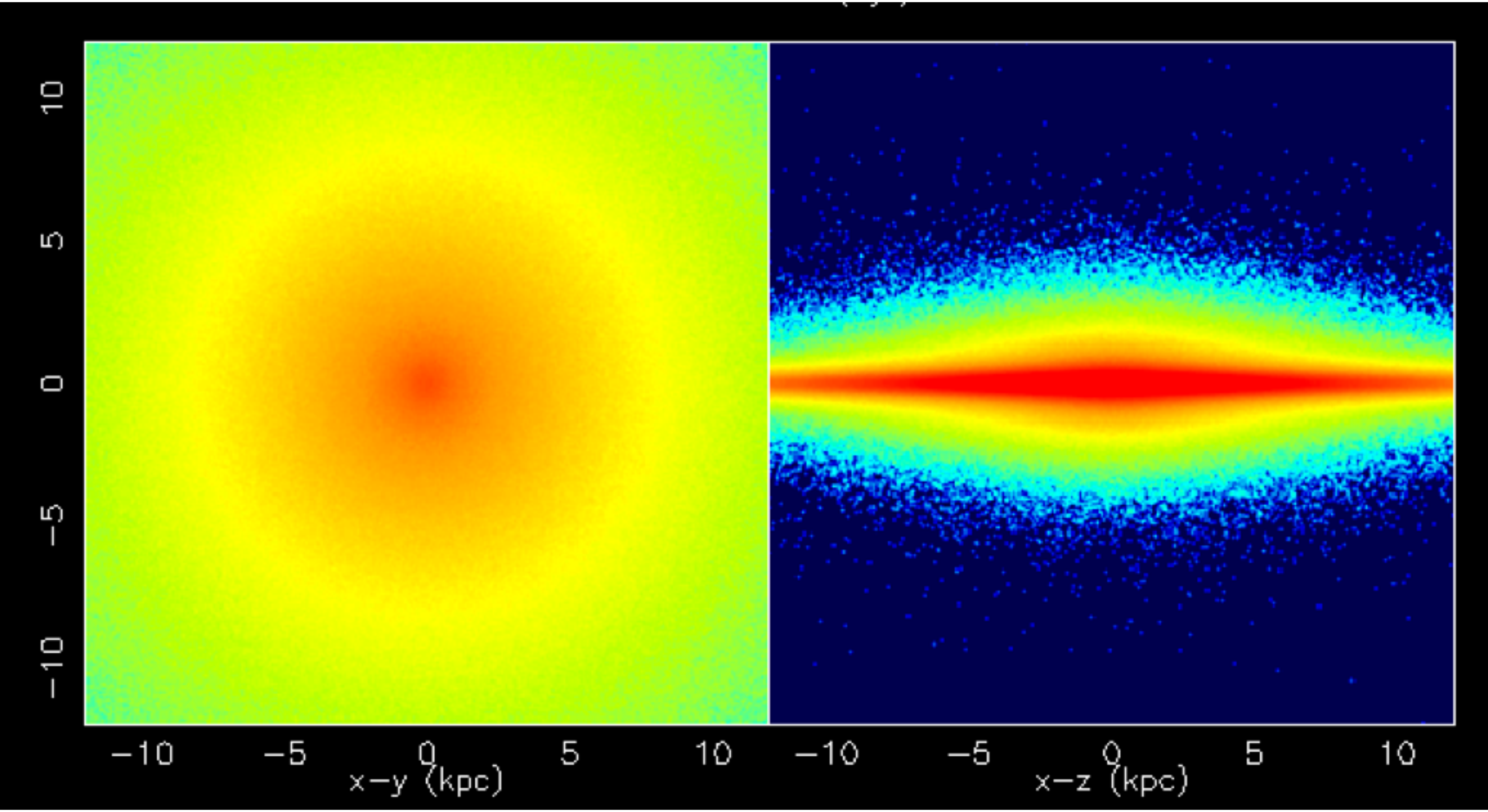
Model	N	Data file
Full data	5,999,999	1.dat.gz
With extinction	2,372,335	2.dat.gz
With extinction & error	2,372,335	3.dat.gz

All in the format: alpha (radians), delta (radians), parallax (arc second), mu-alpha (as/yr), mu-delta (as/yr), radial velocity (km/s), x (kpc), y (kpc), z (kpc), vx (km/s), vy (km/s), vz (km/s), mass (10^12 solar masses), V, V-I.

(x,y,z,vx,vy,vz galactocentric, for checking purposes only!)

The observer is assumed at (-8,0) kpc

Thin+Thick disk model: no bar or spiral arm



Local Dark Matter Density
Silverwood, Sivertsson, Read

- Applying the method published
  Silverwood et al. arXiv: 1507.08581
  to Jason Hunt's axisymmetric disk, and other global disk mock data
- work in progress

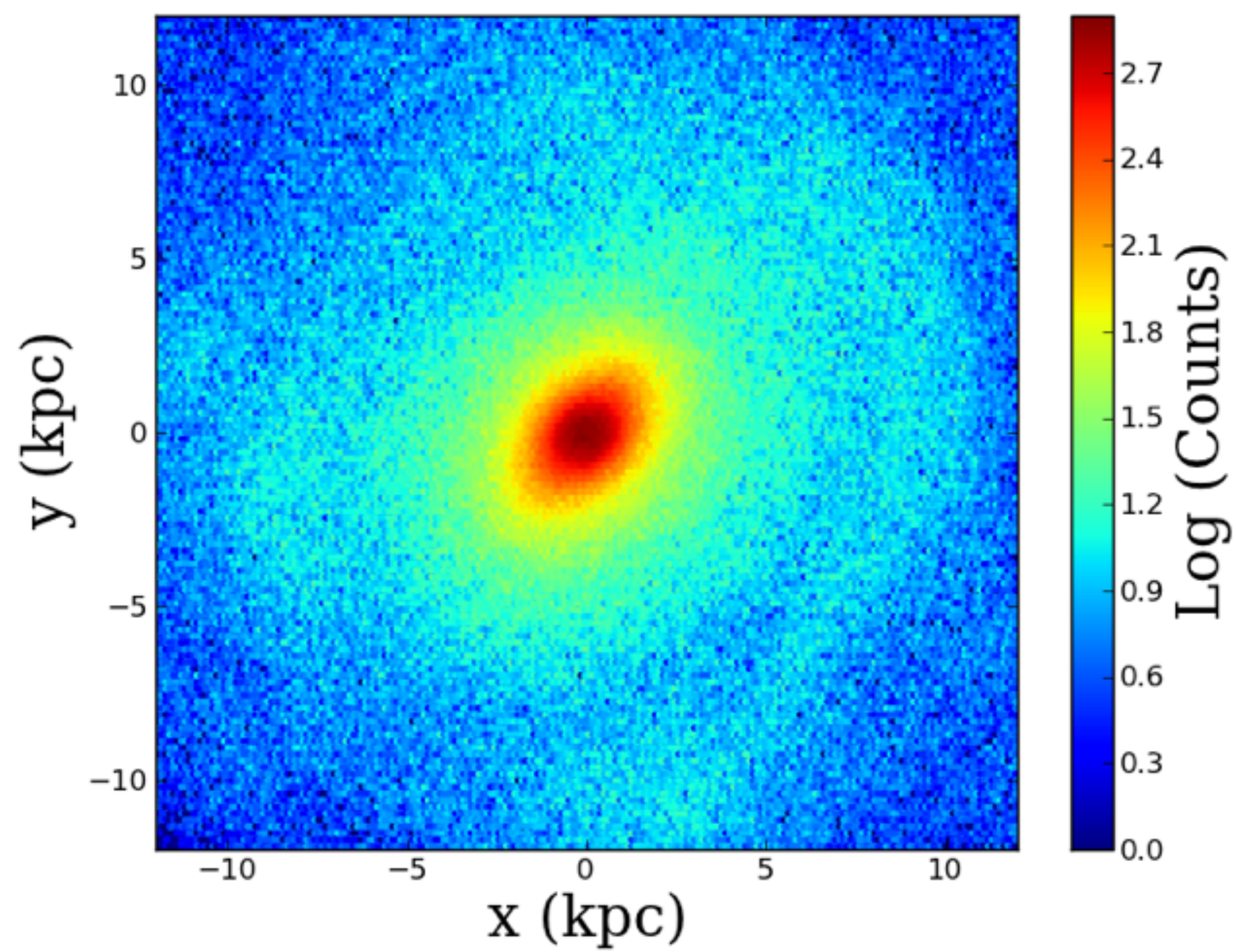
Pattern Speed of the Bar (and Spiral Arms)

Laurent Chemin, Daniel Pfenniger, Merce Romero-Gomez,
Jason Hunt, Daisuke Kawata

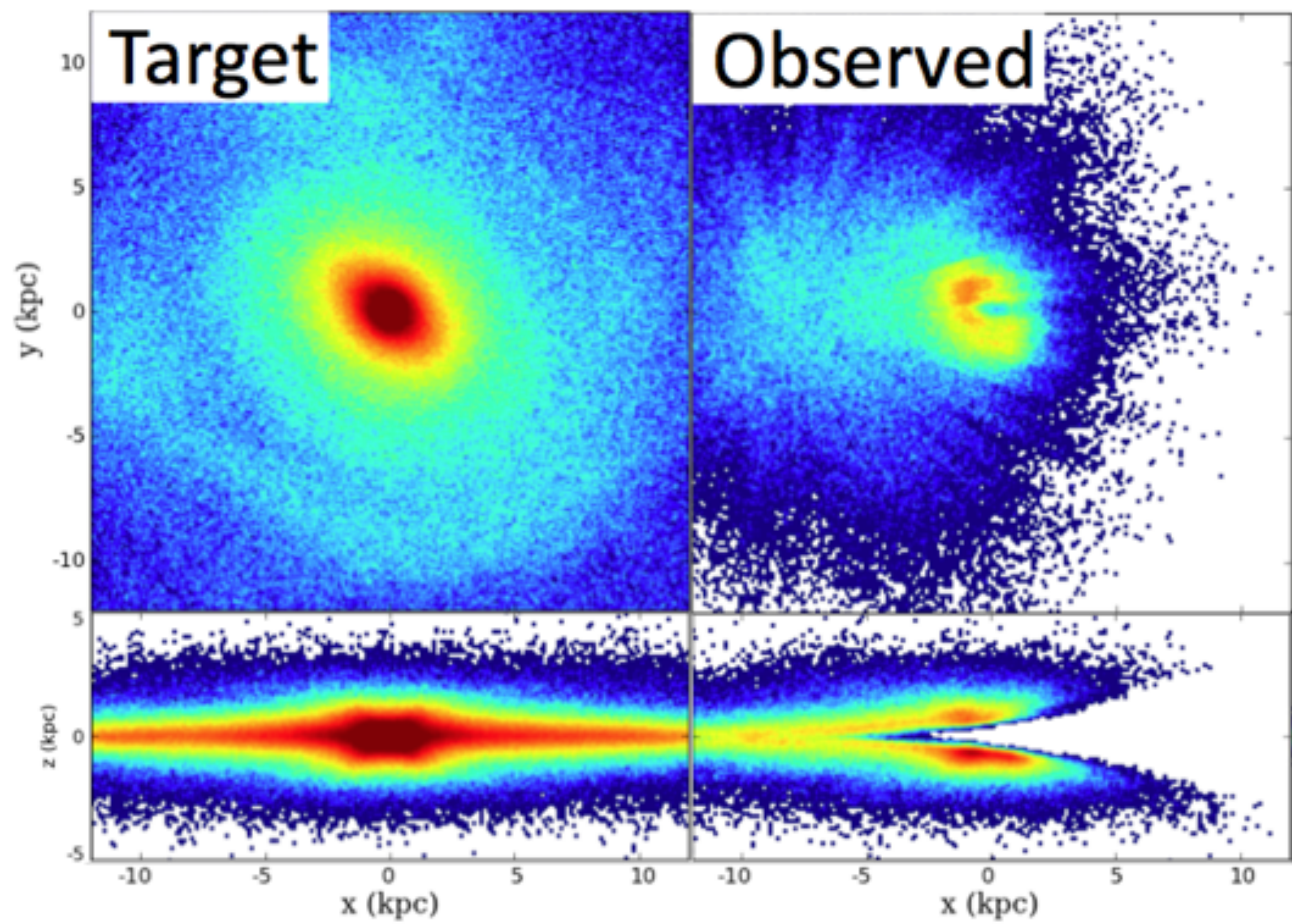
- Objective
  Recovering Bar and Pattern speed from Mock data

- Method
  Local Tremaine-Weinberg method: using grid and SPH derivatives
  M2M: PRIMAL

Mock data: GD3 (Jason Hunt)
N-body barred disc spapshot
pattern speed 28.9 km/s/kpc



Testing with mock target disc
created with N-body simulations
a star particle = M0 giant star
+3D extinction and Gaia errors



Target data (V<16.5 mag)
created from N-body simulations

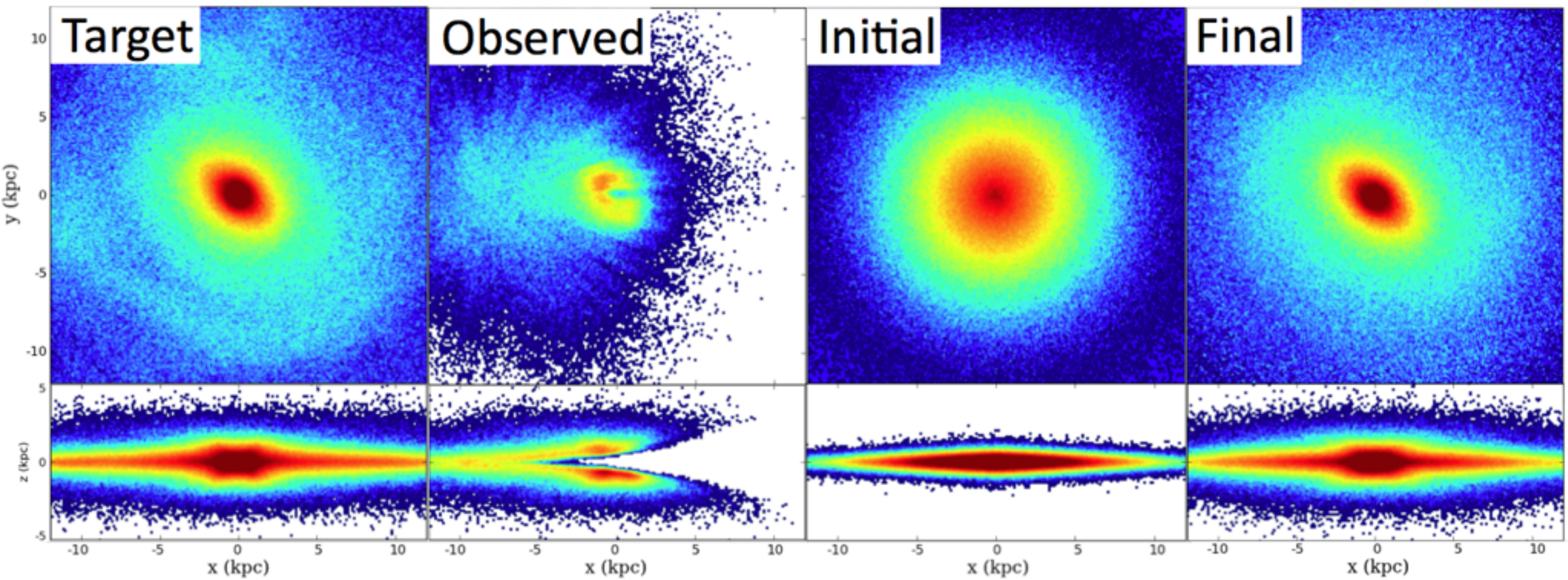
M2M modelling

pattern speed = 29.7 km/s/kpc ($\Omega_{p,t}$=28.9 km/s/kpc)

Mock data with extinction and Gaia error

Note: DM potential is known

Hunt & Kawata (2014)



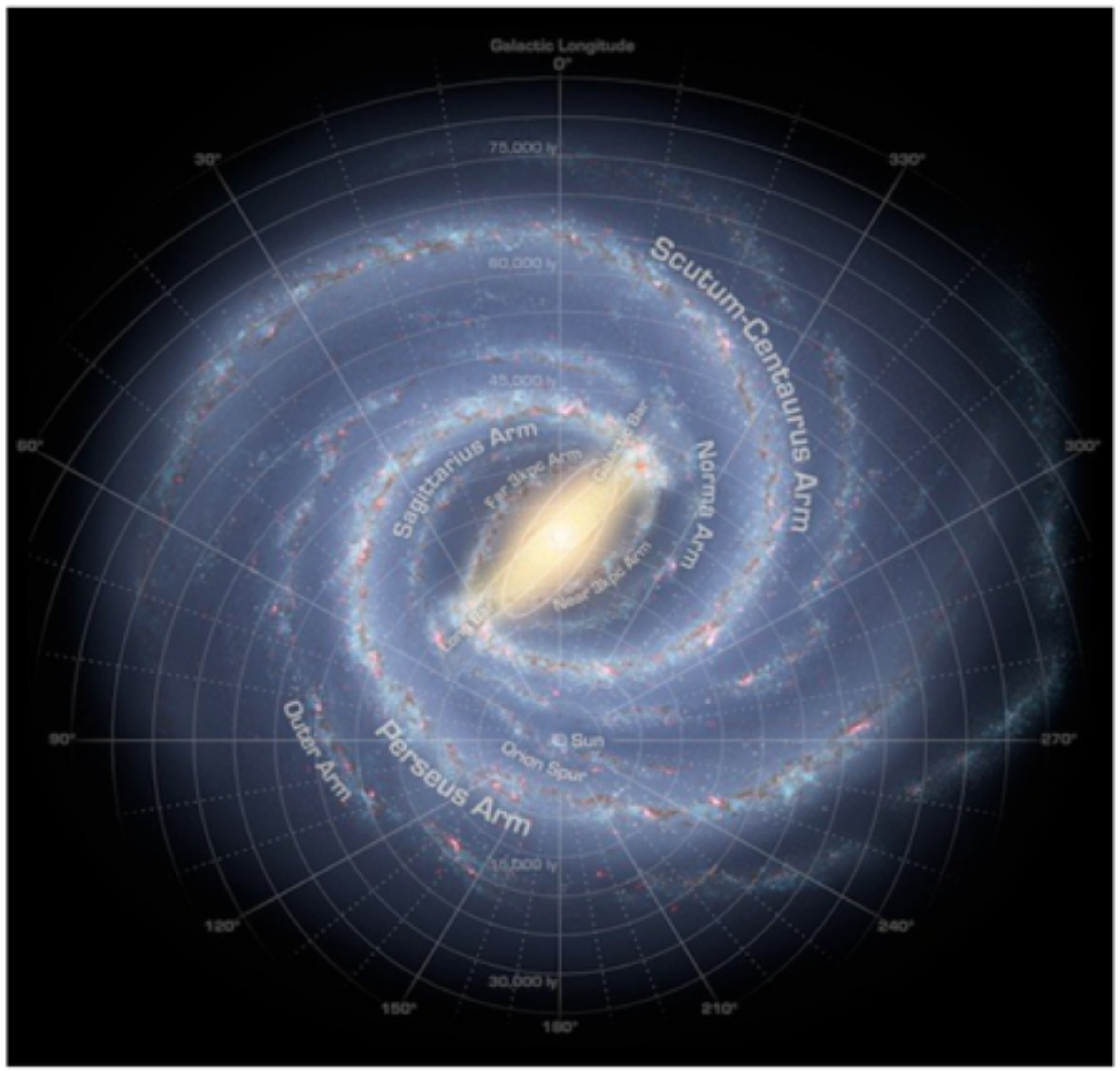
Target data (V<16 mag) created from N-body simulations

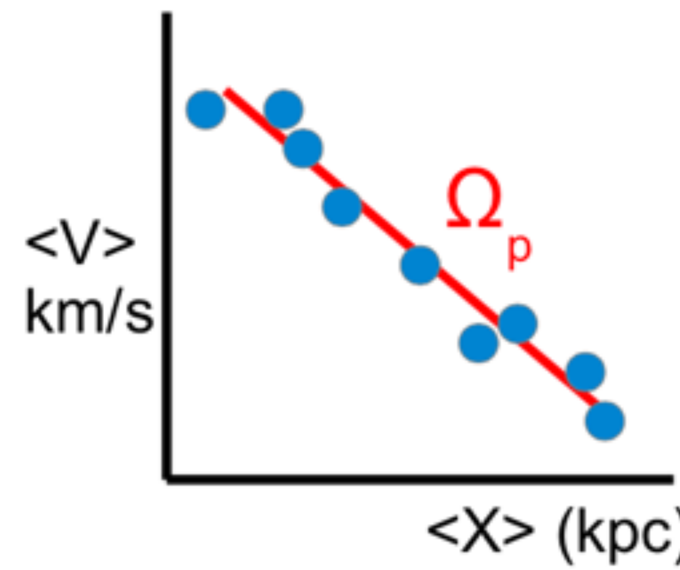
PRIMAL modelling

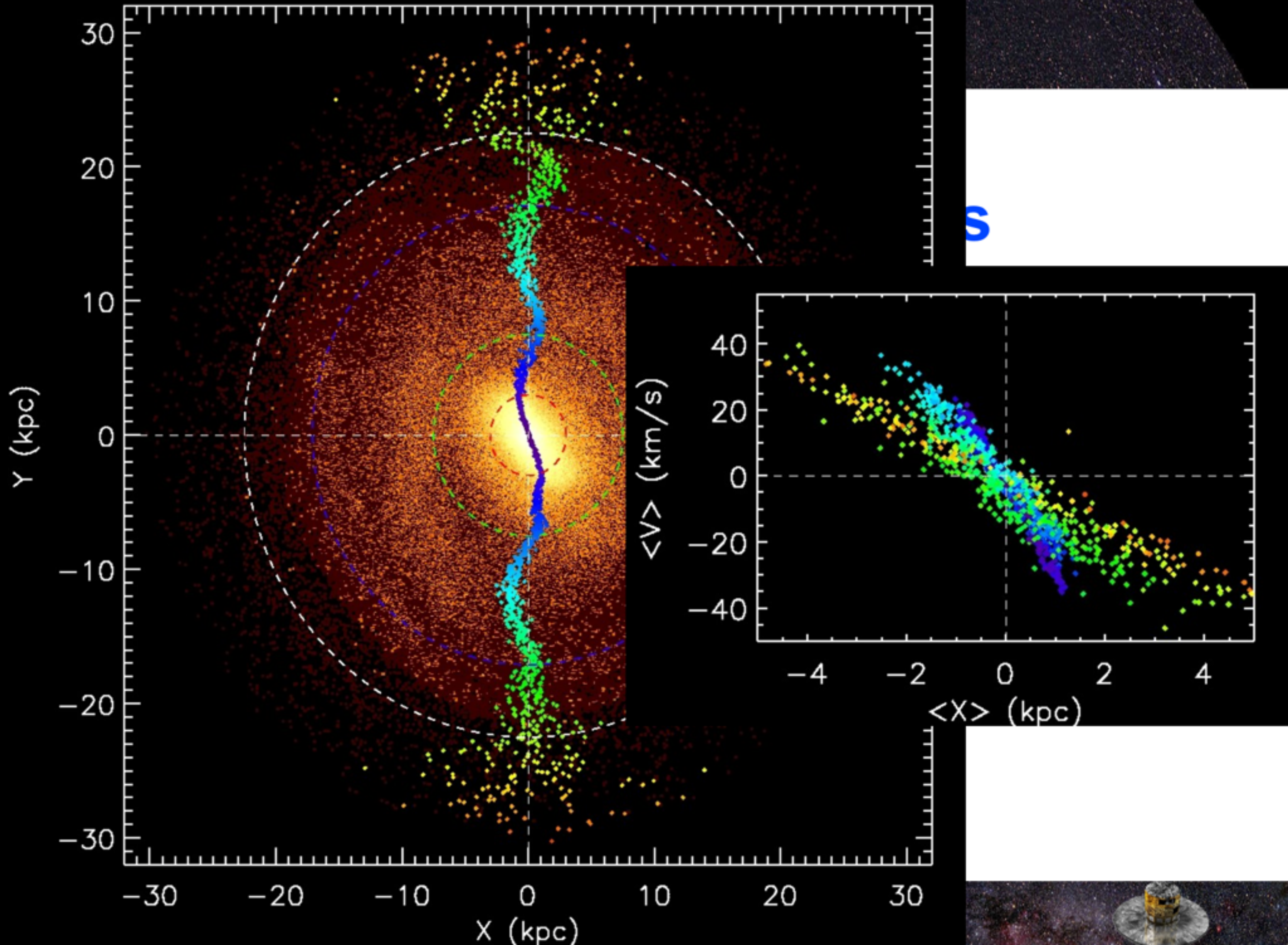
Density waves pattern speeds

Tremaine-Weinberg method (Tremaine & Weinberg 1984)

$$\Omega_p \int_{-\infty}^{\infty} \Sigma(x,y,t)\, x\, dx = \int_{-\infty}^{\infty} \Sigma(x,y,t)\, v_y(x,y,t)\, dx$$







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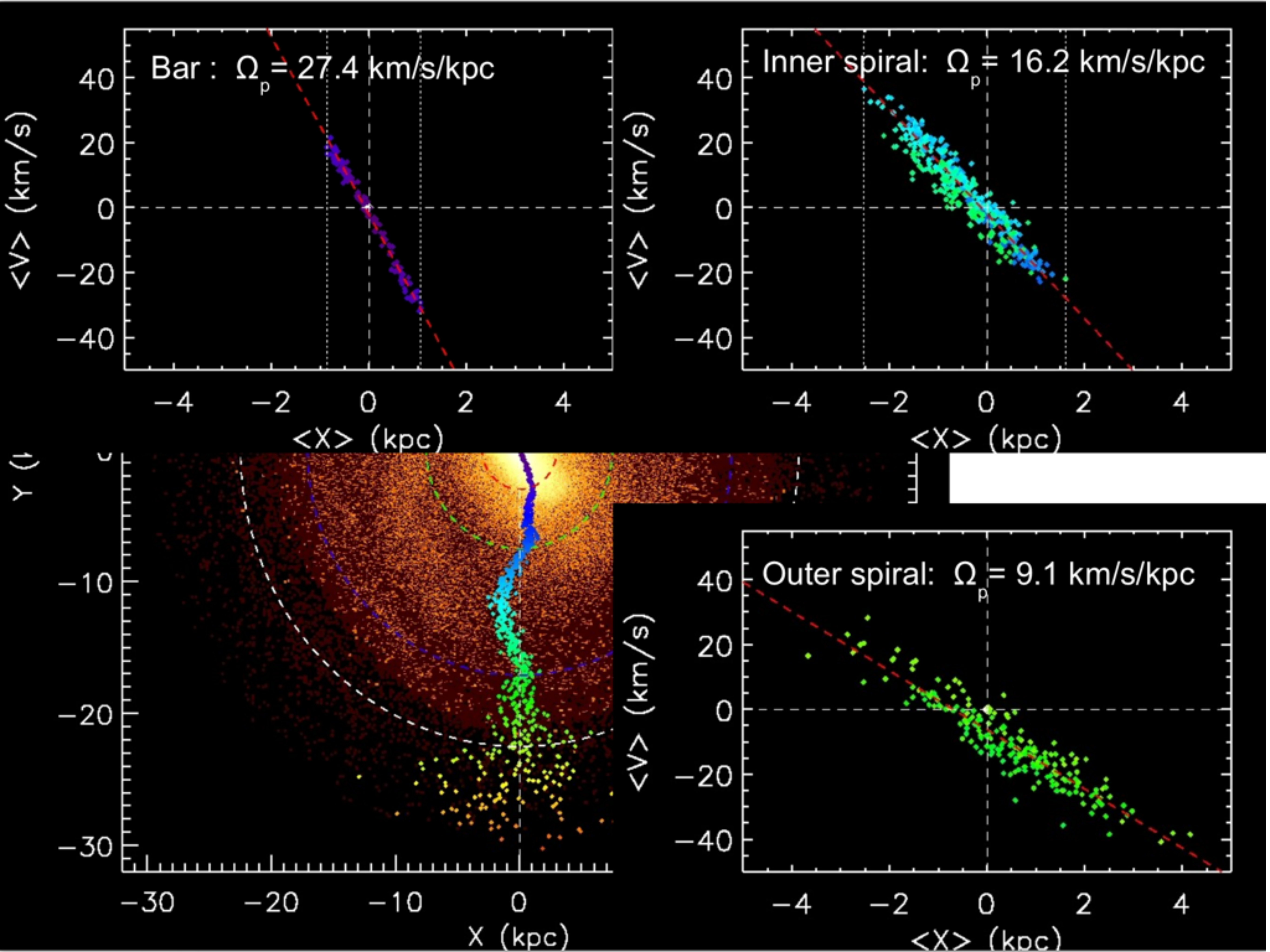
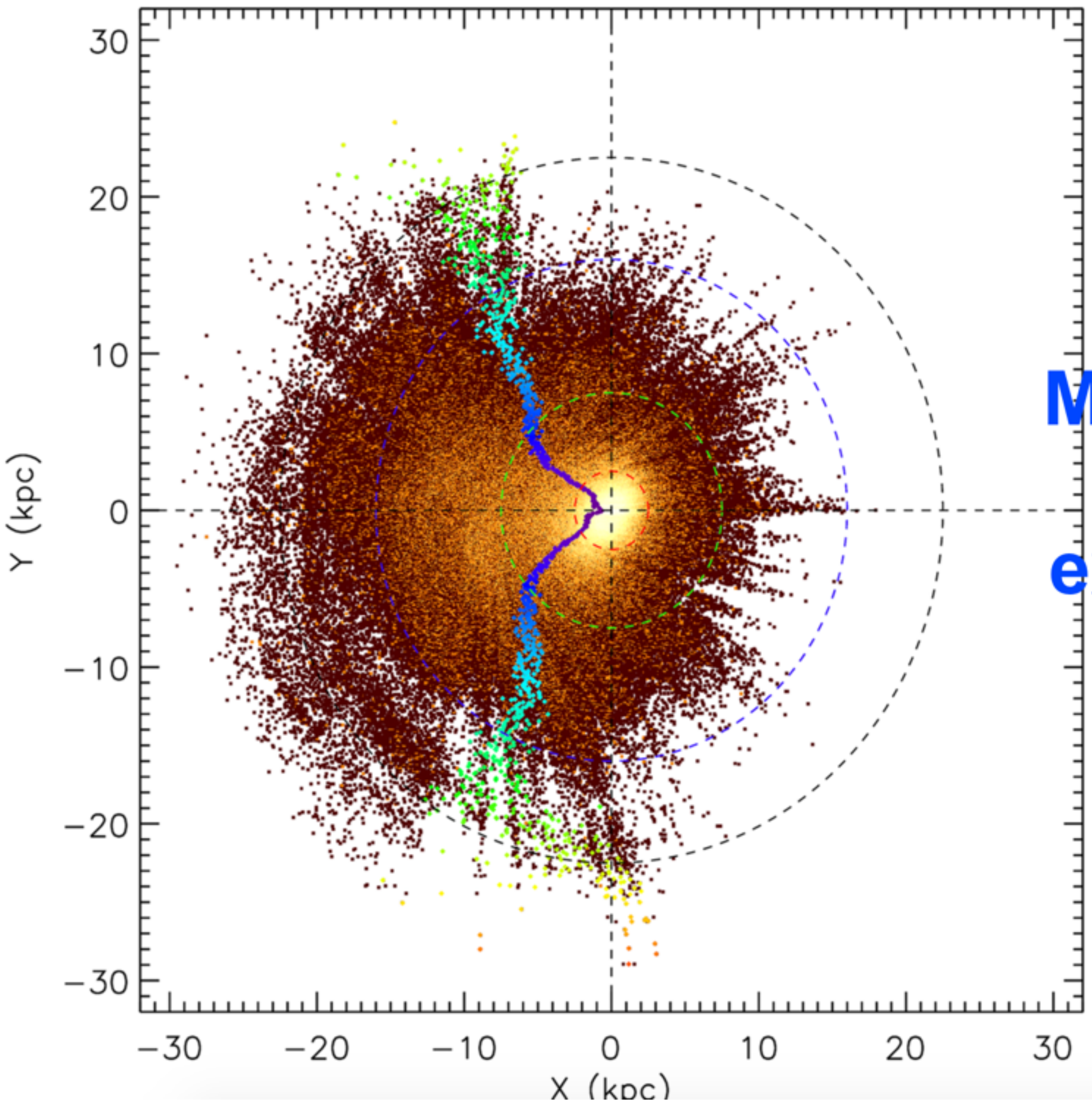
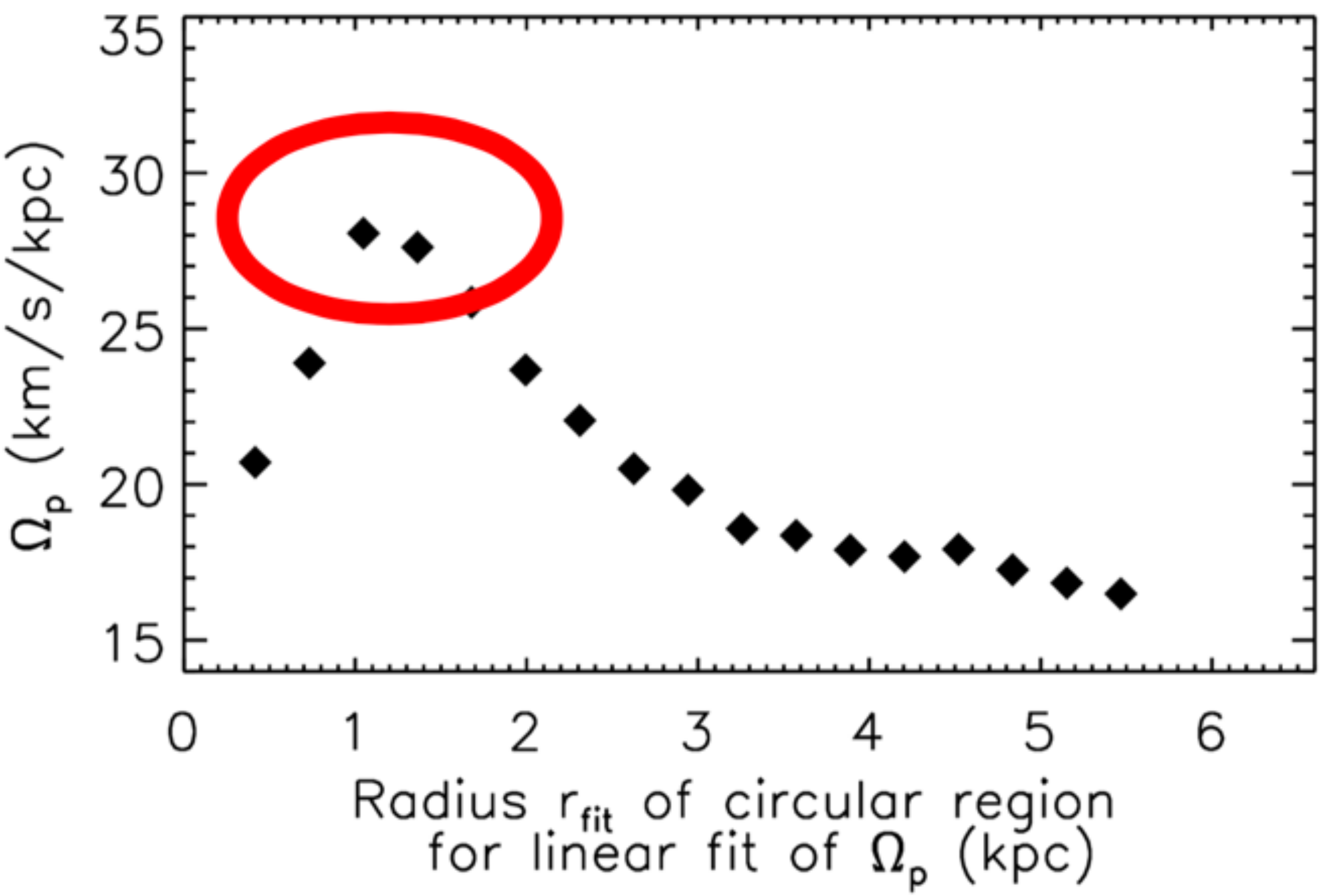


Bar : Ω_p = 27.4 km/s/kpc
Inner spiral: Ω_p = 16.2 km/s/kpc
Outer spiral: Ω_p = 9.1 km/s/kpc
<V> (km/s)
<X> (kpc)
X (kpc)

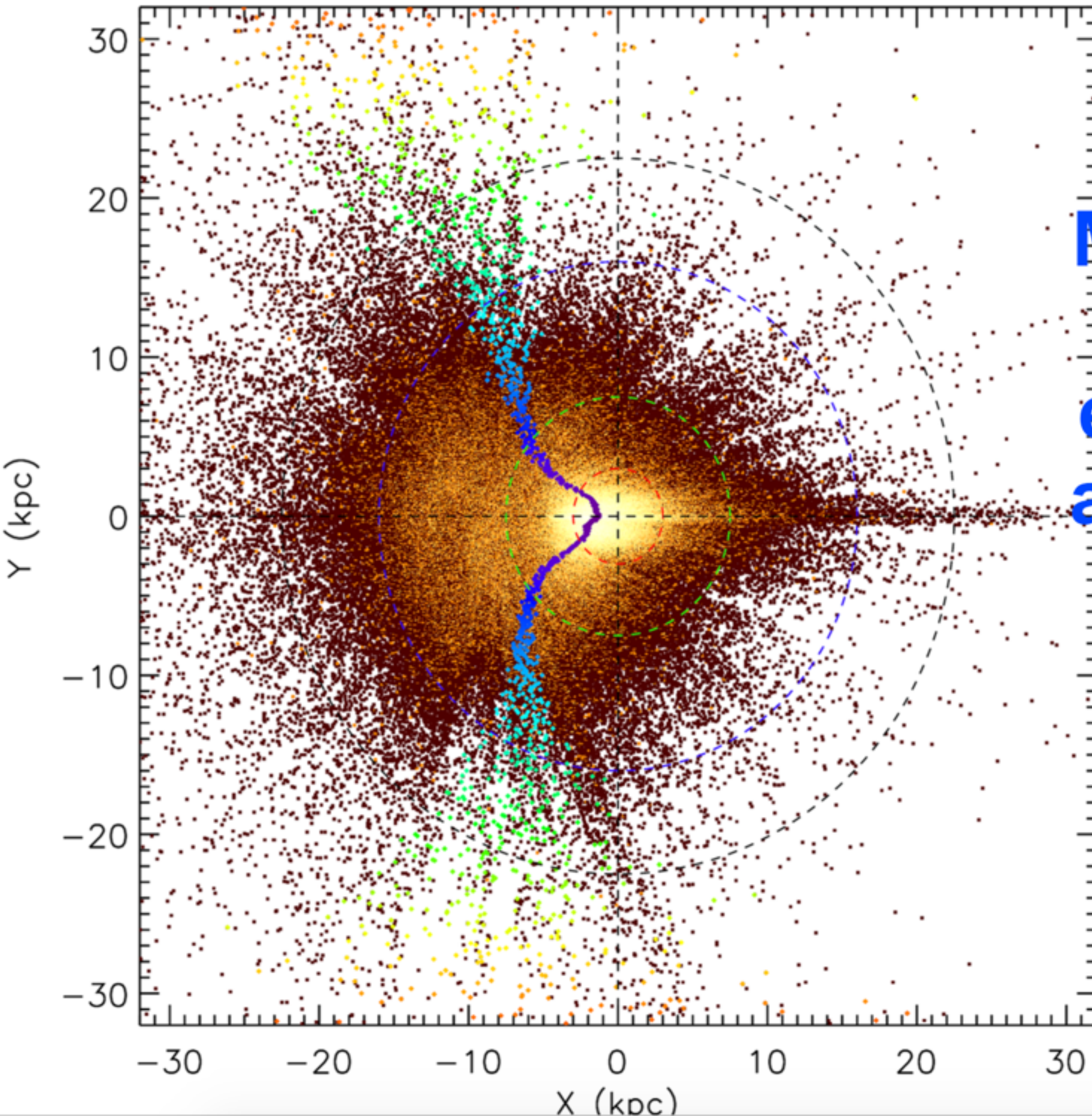


Mock data with extinction

Angular speed maximum in the bar ~ 28 km/s/kpc

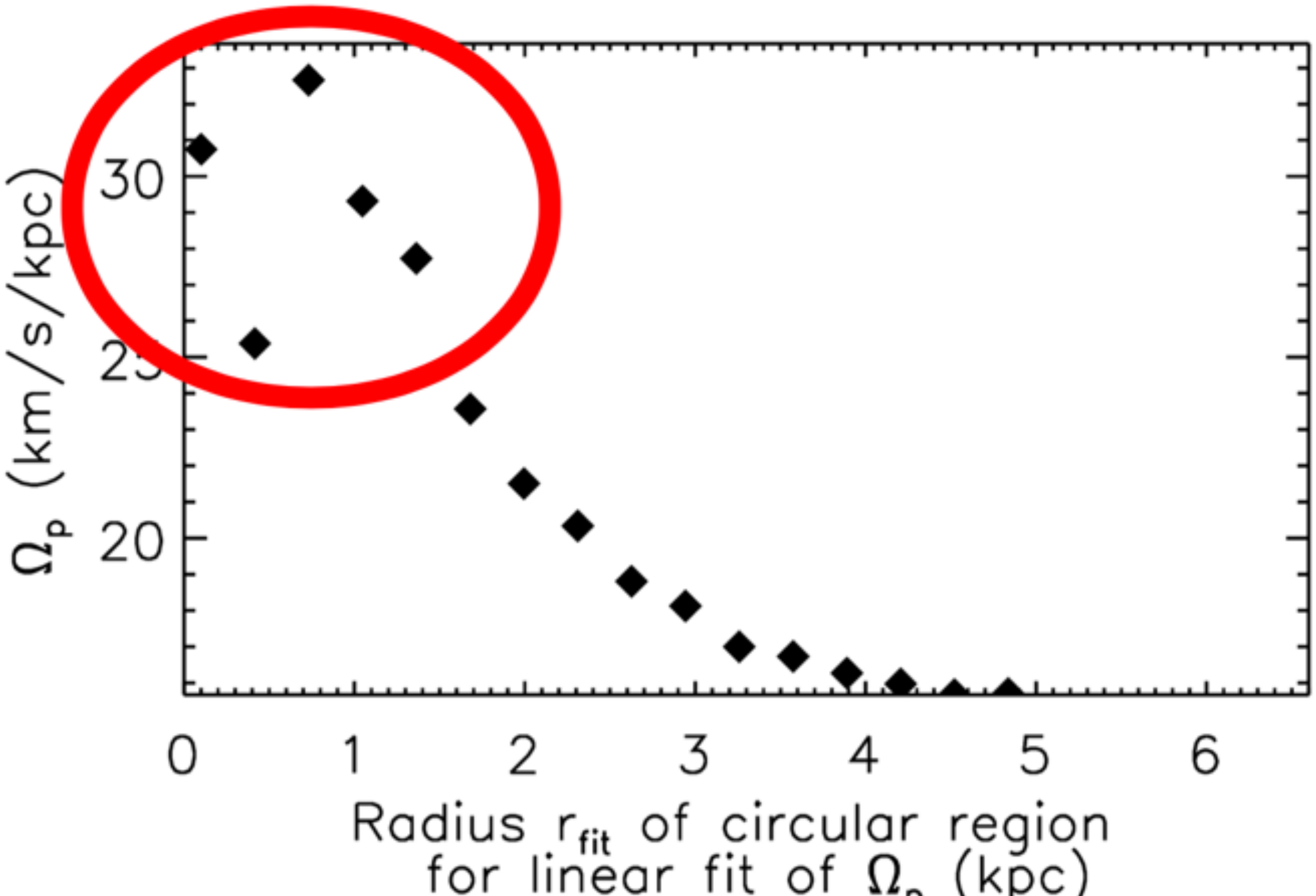


Mock data with extinction



Mock data with extinction and errors

Mock data with extinction and errors



Angular speed more scattered in the bar region

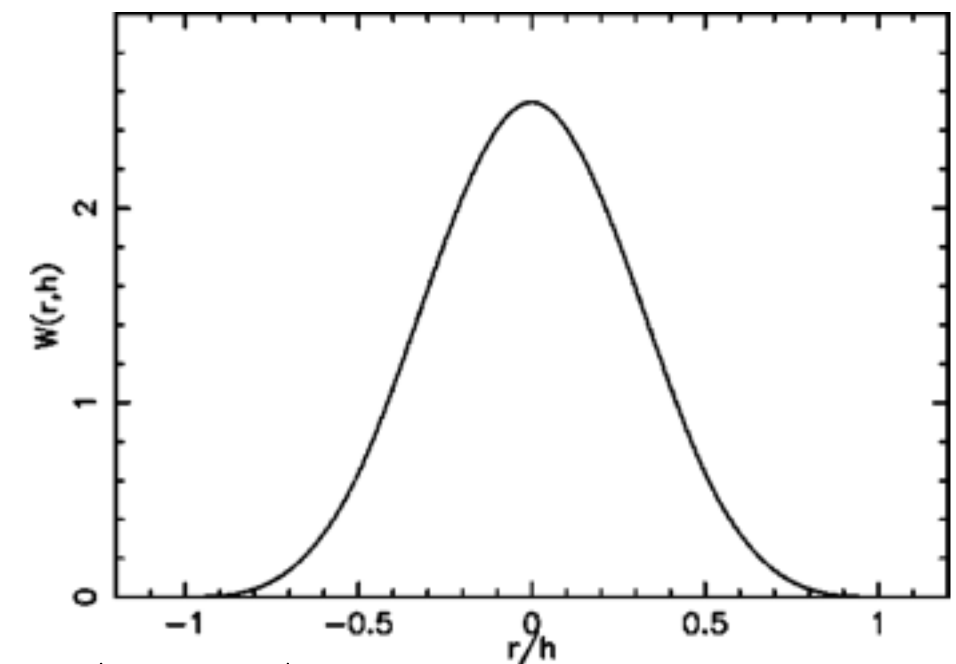
Still consistent with input value

Smoothed Particle
Local Tremaine-Weinberg method

smoothed physical value at **x**

$$< f(\mathbf{x}) >= \int f(\mathbf{x}')W(\mathbf{x}-\mathbf{x}', h)d\mathbf{x}'$$

W(r,h): smoothing kernel,
h: smoothing length



spline kernel r=|**x**-**x'**|,

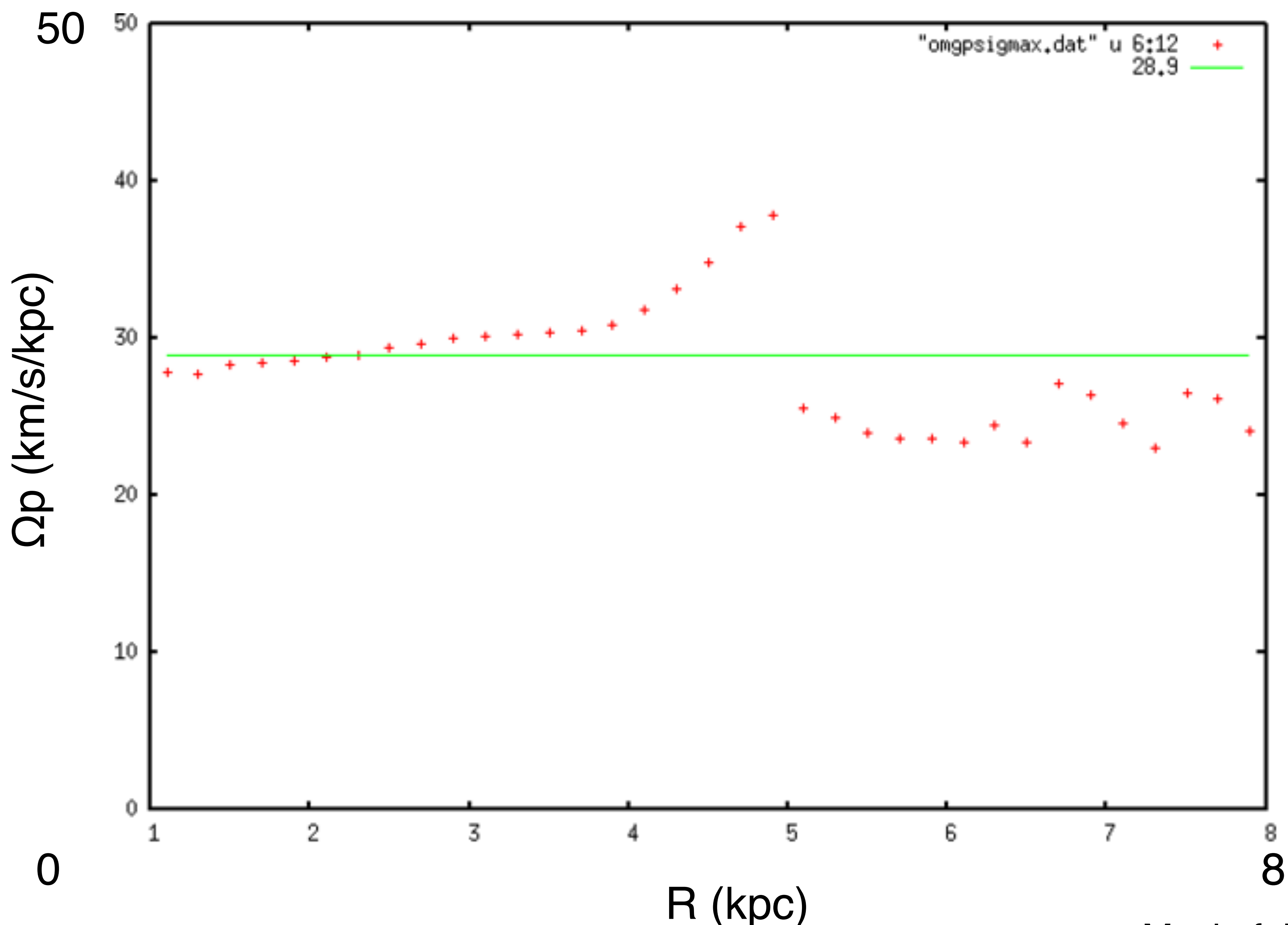
$$W(r,h) = \frac{8}{\pi h^3} \begin{cases} 1-6(r/h)^2+6(r/h)^3 & \text{if } 0 \le r/h \le 1/2, \\ 2[1-(r/h)]^3 & \text{if } 1/2 \le r/h \le 1, \\ 0 & \text{otherwise.} \end{cases}$$

derivatives

$$< \nabla f(\mathbf{x}) >= \sum_j \frac{m_j}{\rho_j} f(\mathbf{x}_j) \nabla_i W(\mathbf{x}-\mathbf{x}_j, h)$$

$$\frac{\partial}{\partial x}\left[\Sigma(x,y,t)v_x(x,y,t)\right] + \frac{\partial}{\partial y}\left[\Sigma(x,y,t)v_y(x,y,t)\right] = \Omega_p\left(y\frac{\partial \Sigma}{\partial x} - x\frac{\partial \Sigma}{\partial y}\right)$$

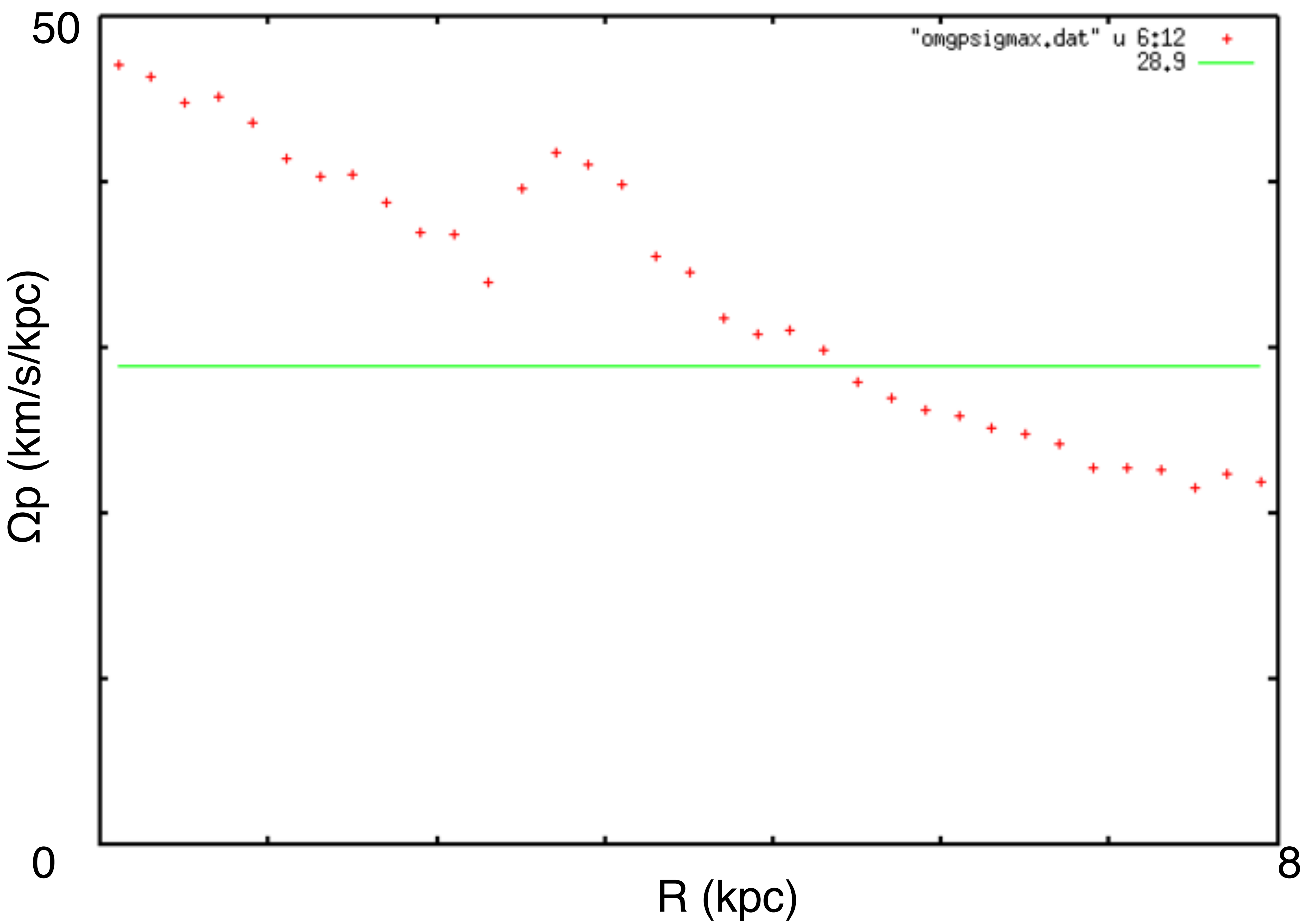
Smoothed Particle
Local Tremaine-Weinberg method: all data



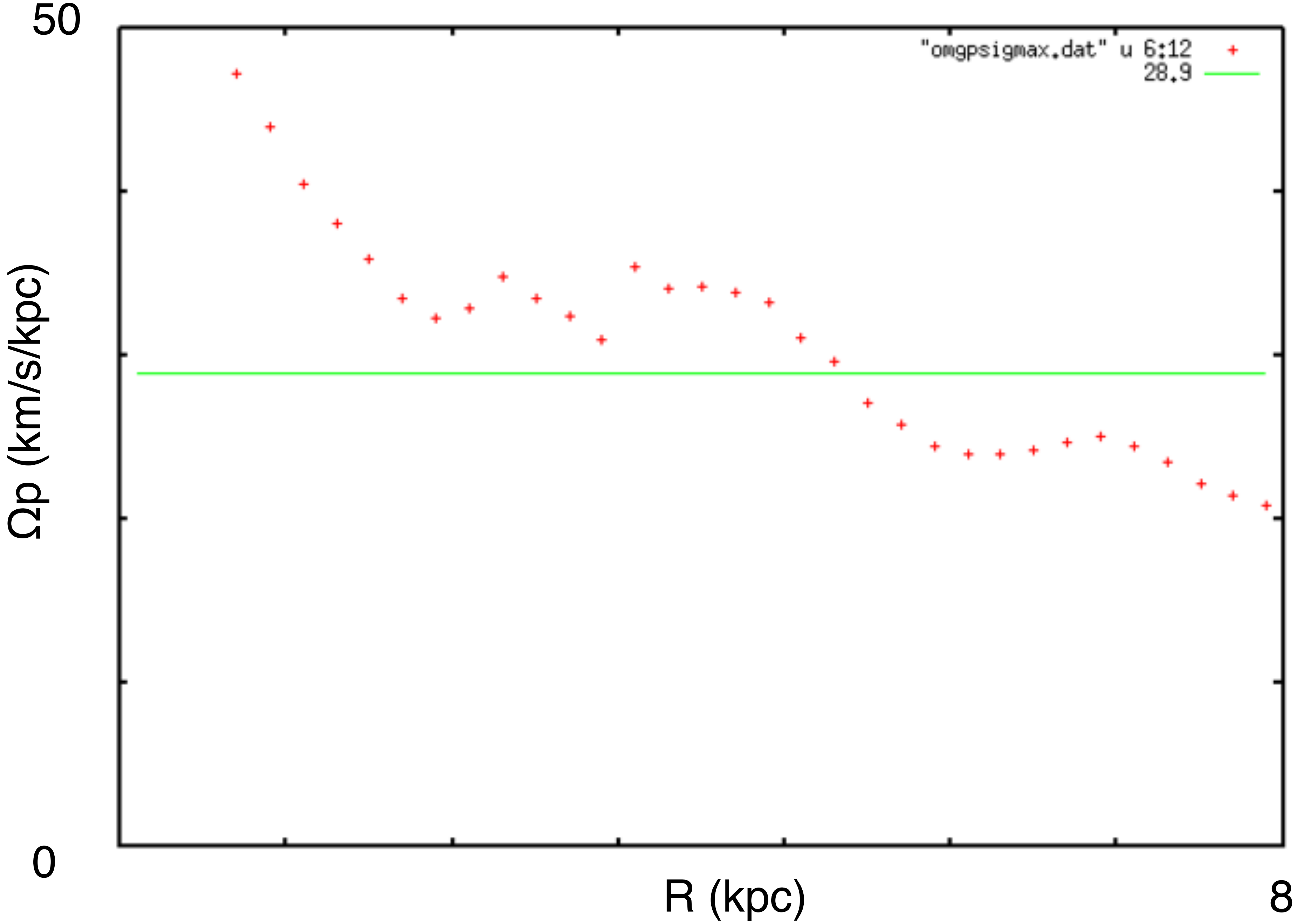
Maxi of this value

$$\frac{\partial}{\partial x}\left[\Sigma(x,y,t)v_x(x,y,t)\right] + \frac{\partial}{\partial y}\left[\Sigma(x,y,t)v_y(x,y,t)\right] = \Omega_p\left(y\frac{\partial\Sigma}{\partial x} - x\frac{\partial\Sigma}{\partial y}\right)$$

Smoothed Particle
Local Tremaine-Weinberg method: 0.5<|z|<1 kpc
with extinction selection



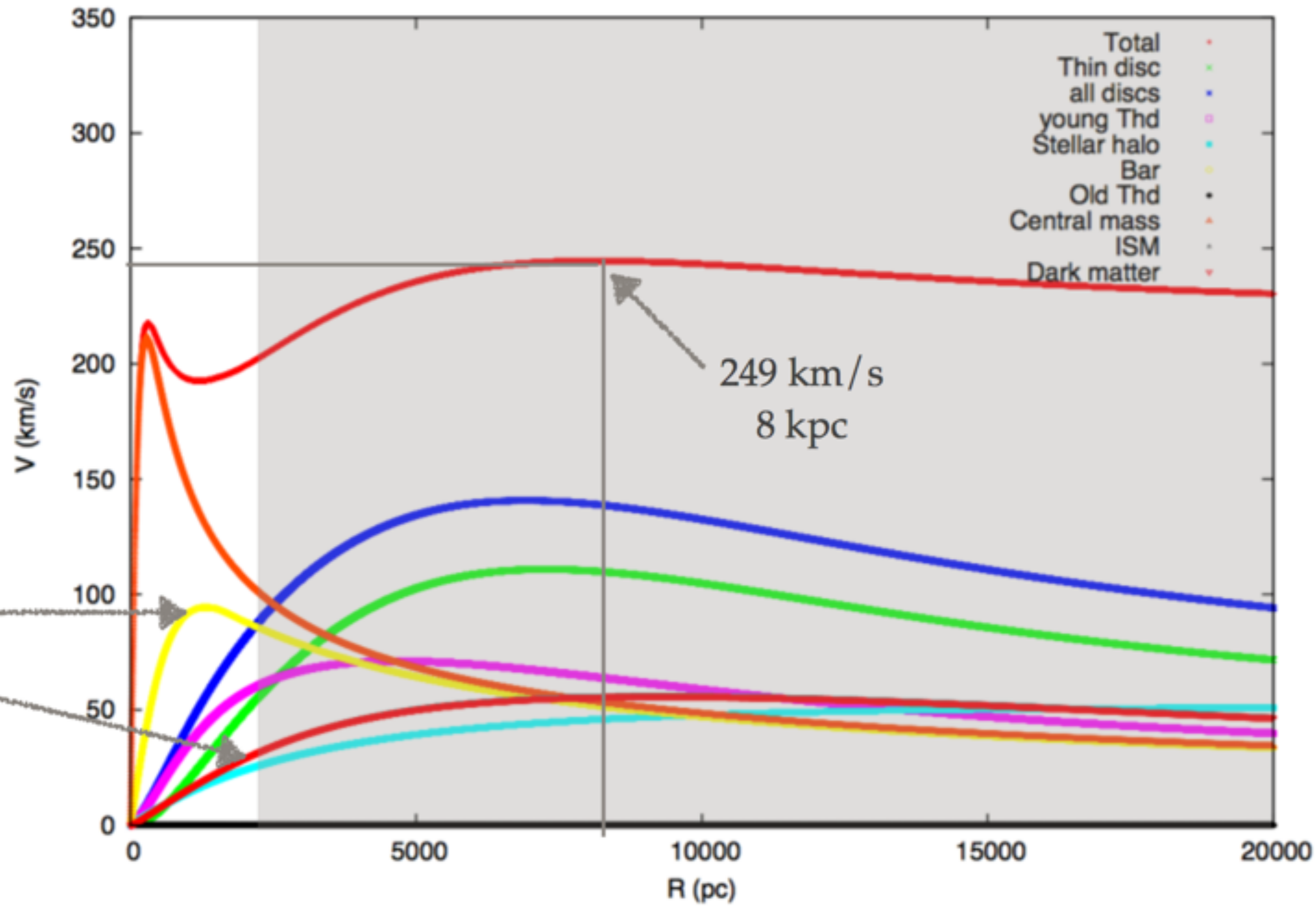
Smoothed Particle
Local Tremaine-Weinberg method: 0.5<|z|<1 kpc
with extinction selection with error



New dynamical update - BGM2015

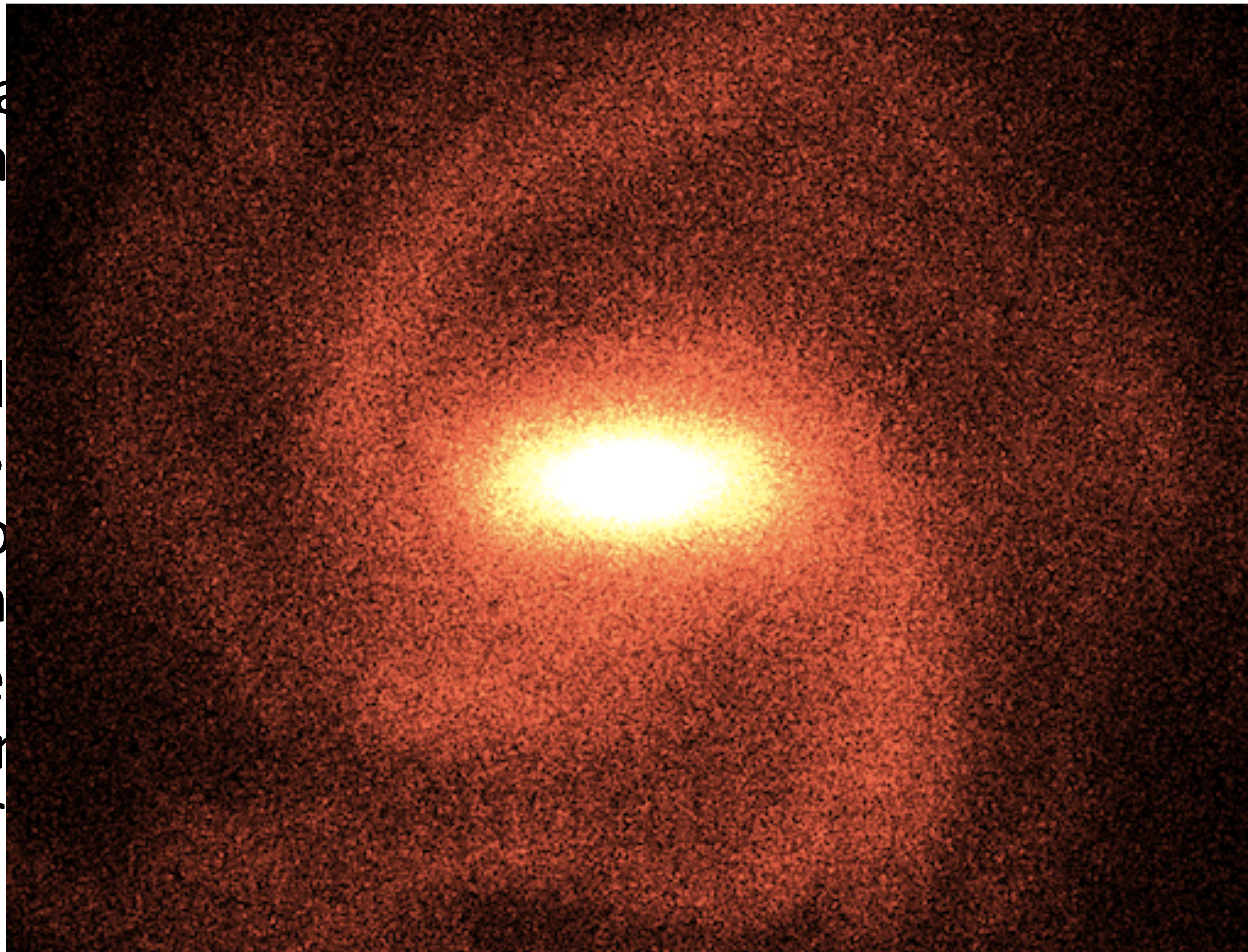
Pichardo method.
Pichardo et al. (2004)

[1] Triaxial bar
[2] Stellar halo



BGM model: Fernández-Trincado et al. (2015, in prep.)

Challenge: Motion of particles from a reconstructed potential



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Preliminary results