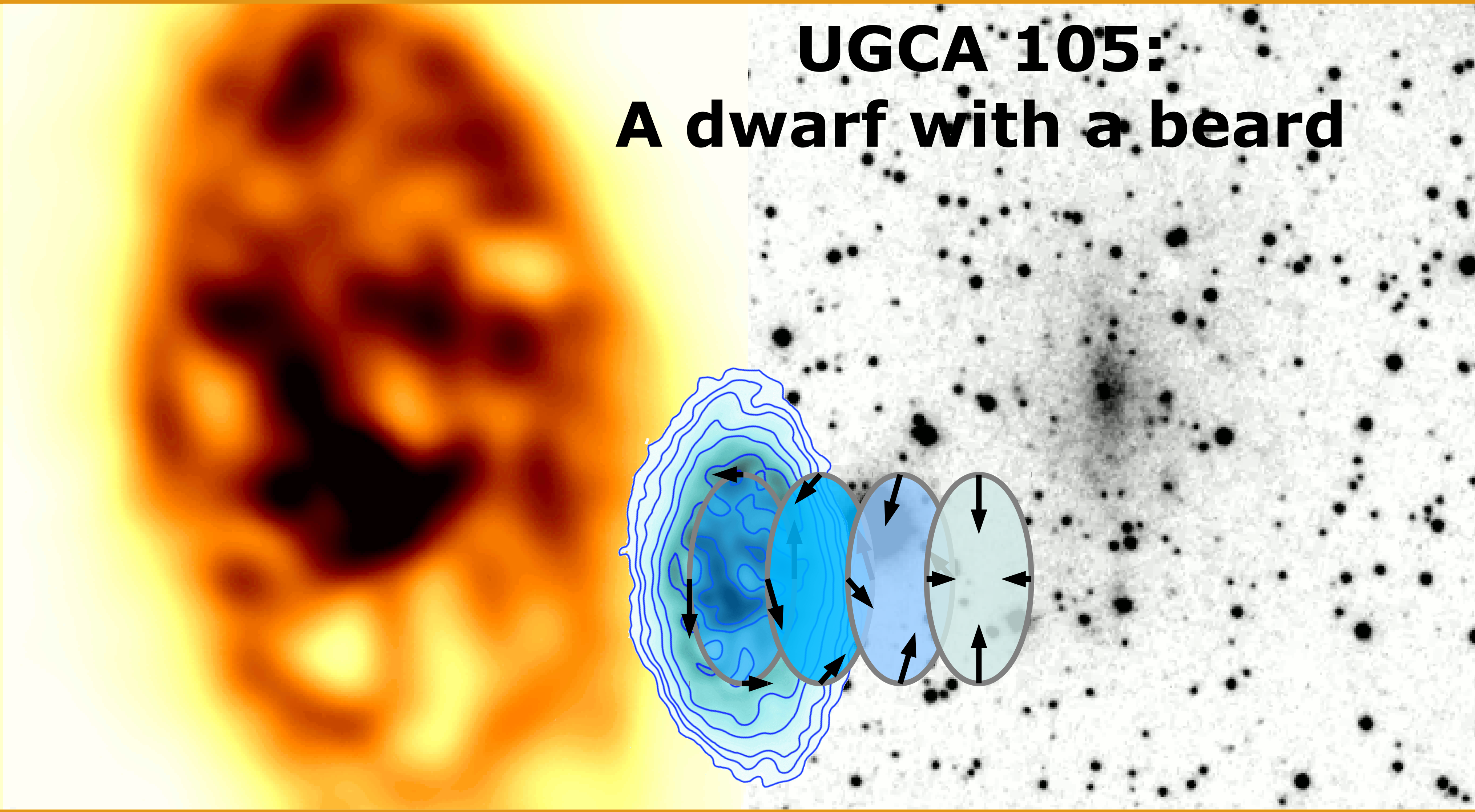
UGCA 105: A dwarf with a beard



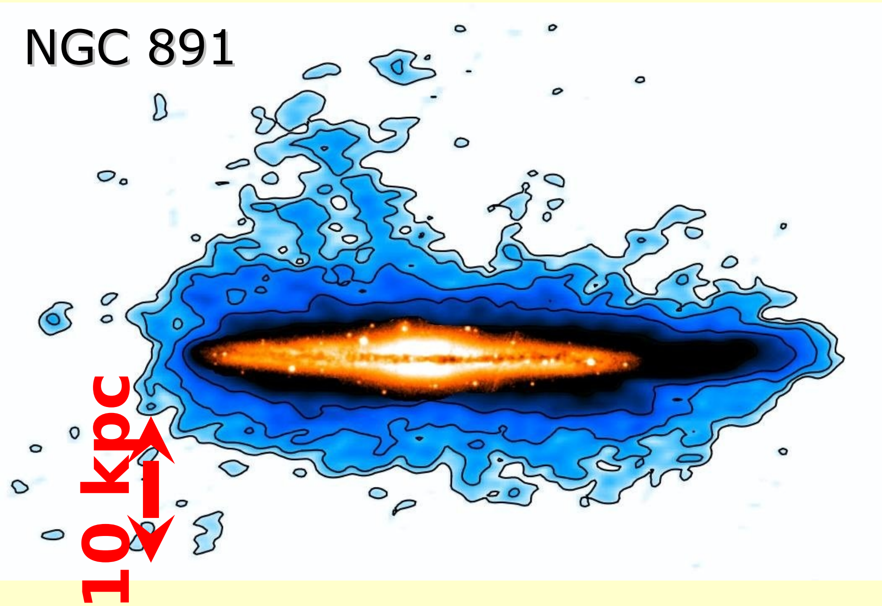
Gyula I. G. Józsa

SKA AFRICA SQUARE KILOMETRE ARRAY

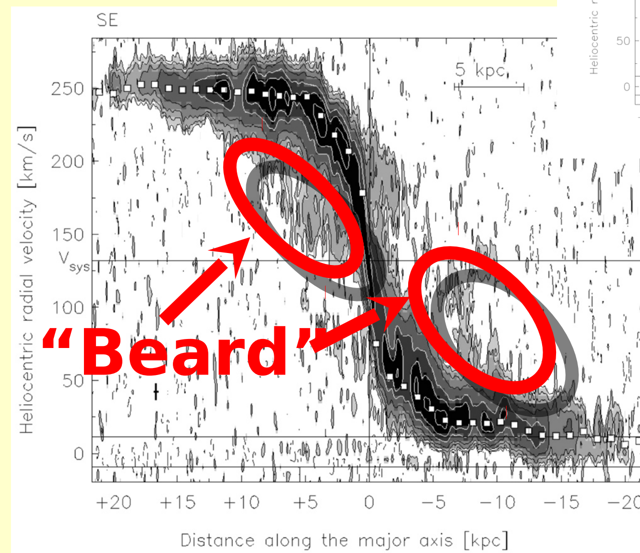
RHODES UNIVERSITY Where leaders learn

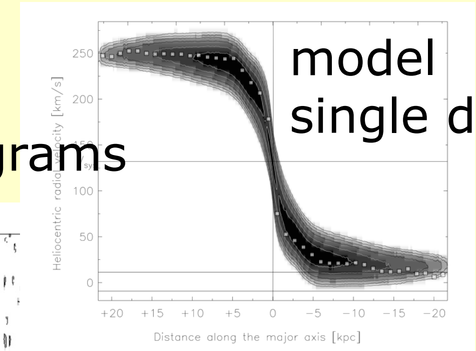
Faint neutral gas

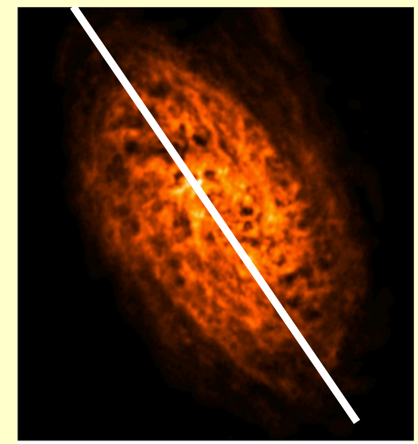
- Thick H I disks

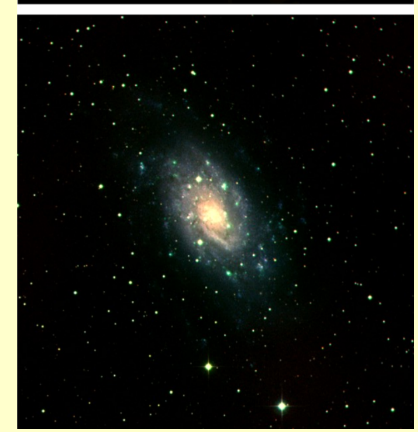


NGC 2403
position-velocity diagrams









- NGC 891 (Oosterloo et al. 2007):
30% (~1.2 x 10^9 $M_\odot$) of the gas in extraplanar halo component

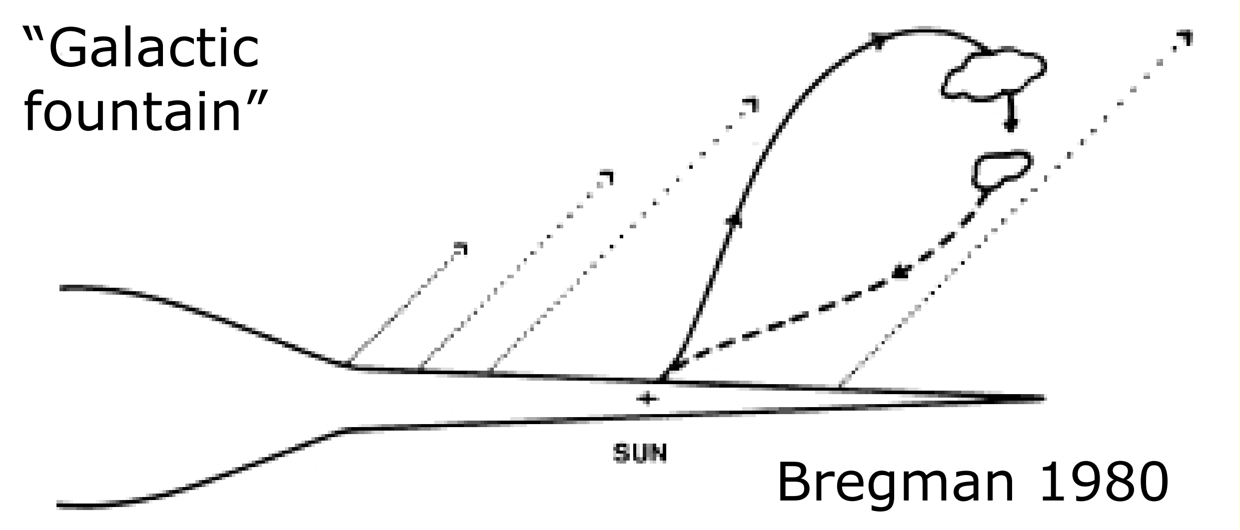
- NGC 2403 (Fraternali et al. 2002):
10% (~3 x 10^8 $M_\odot$) of the gas in extraplanar component

- Few cases studied well enough to establish presence of gaseous halo (HALOGAS)

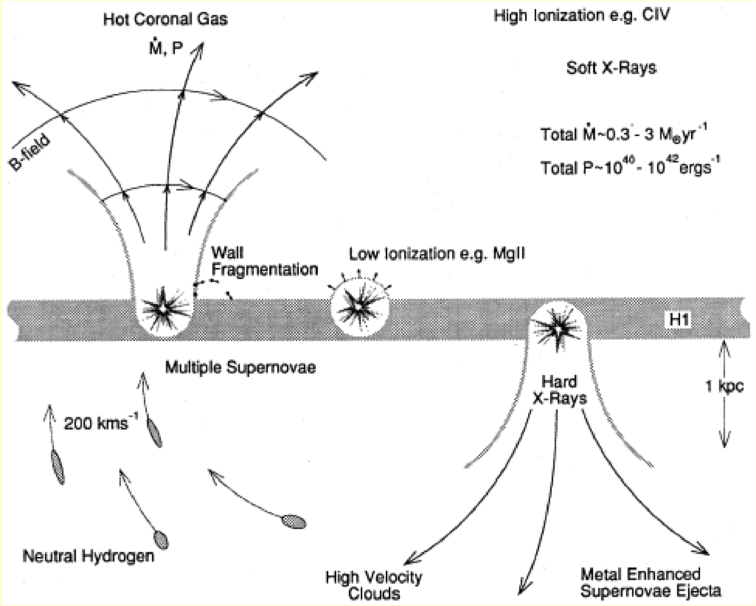
Galactic fountain

- Neutral extraplanar gas is expected

“Galactic fountain”



Bregman 1980



Norman & Ikeuchi (1989)

Signatures for (neutral) gas accretion

- Extraplanar gas traces (partly) accretion

- Accretion of cold material needed to replenish star forming material: 1-3 $M_\odot$/yr (e.g. Bothwell et al. 2011)

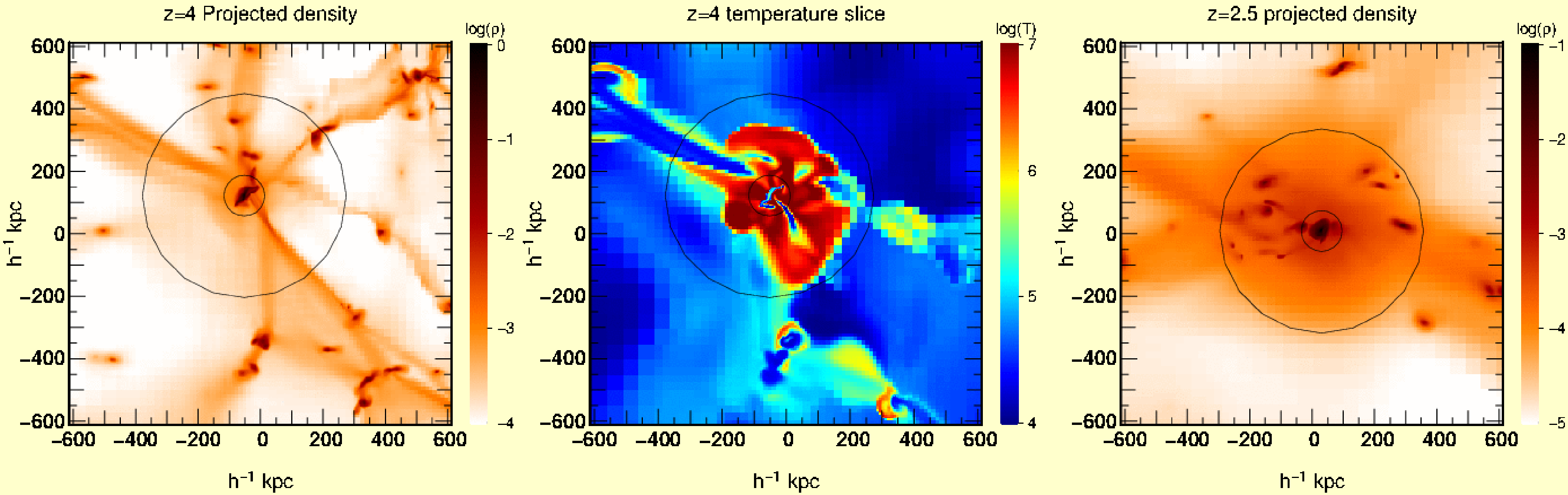
- Infall of low-metallicity gas (0.1 solar) needed to explain stellar metallicity abundances (e.g. "G-dwarf problem", Wakker et al. 1999)

- Observed: < 0.23 $M_\odot$/yr (HVCs, minor mergers, Sancisi et al. 2008, di Teodoro & Fraternali)

- Could be much more if an unseen, cold accretion takes place (Birnboim & Dekel 2003, Kereš et al. 2005)

- In some cases, the extraplanar gas is rotating too slow (Sancisi et al. 2008, Fraternali & Binney 2008)

- Fraternali & Binney 2008 infer 10-20% contribution of external low-angular-momentum gas for the gas kinematics in the halos of NGC 891 and NGC 2403



Ocvirk et al. 2008, for $2\cdot10^{12}M_\odot$ DM halo

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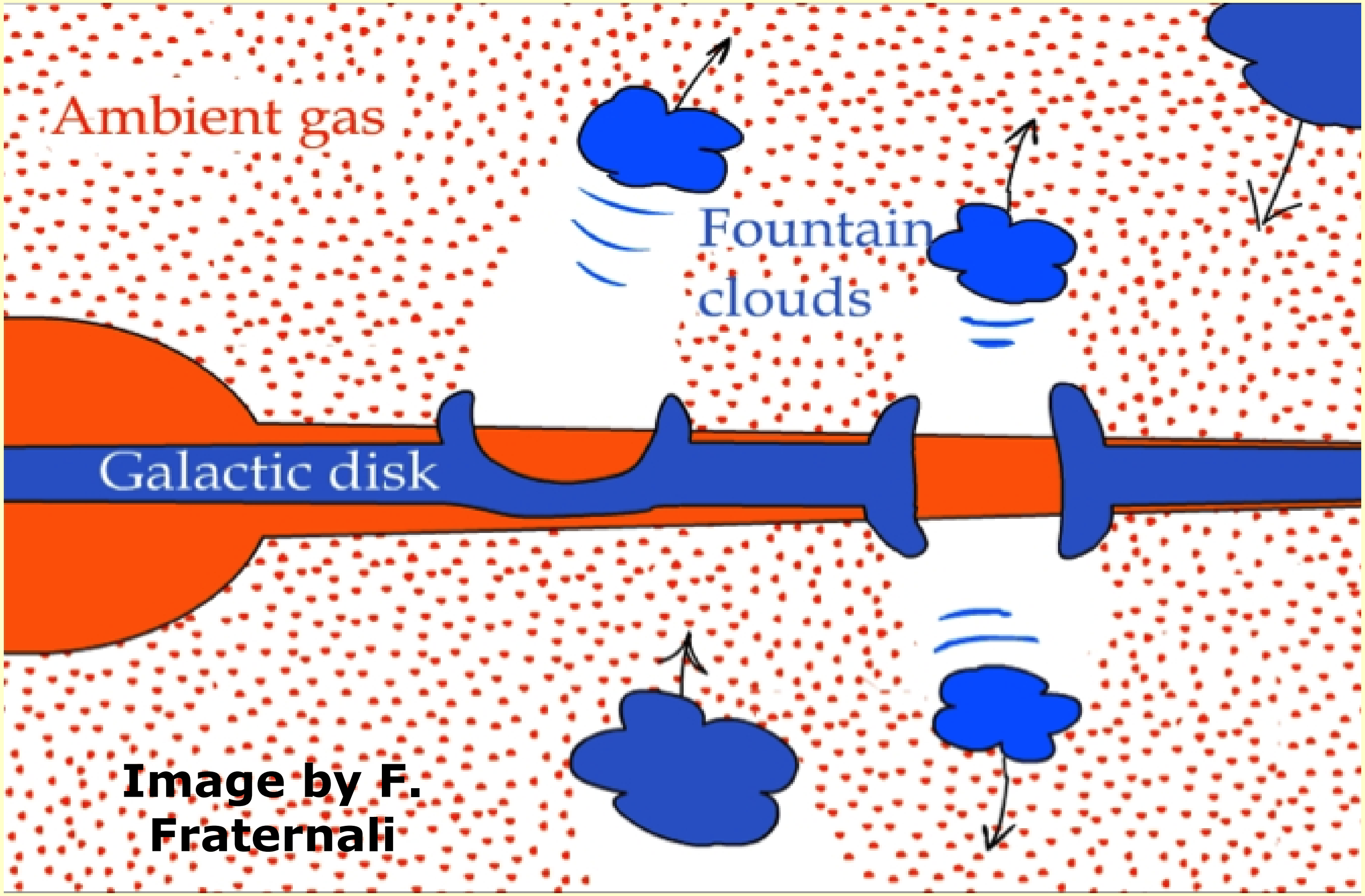
Galactic fountain

- Neutral extraplanar gas is expected, but ambient, low-angular momentum gas is required

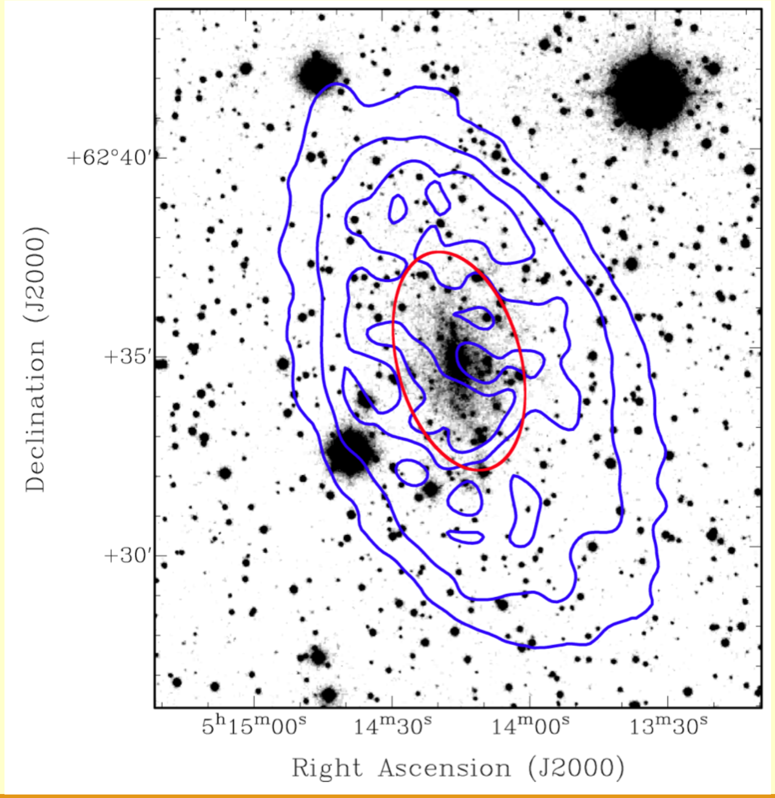


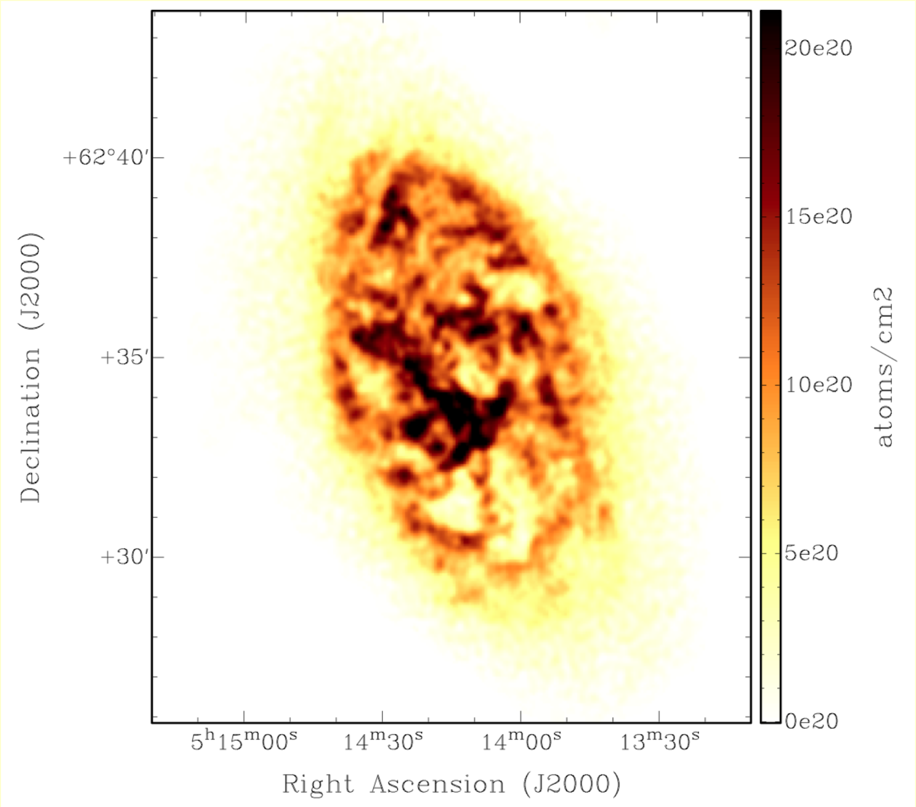
- Cold, accreted gas (Birnboim & Dekel 2003, Kereš et al. 2005)

- Hot corona (Marinacci et al. 2010, 2011)

UGCA 105

- SABm -> hot corona from accretion?
- M_B = -14.7
- D_{25} = 5.8 kpc
- D_{HI} = 16 kpc
- $M_{HI} = 6.4 \cdot 10^8\ M_\odot$
- v_{max} = 80 km s^{-1}
- $SFR = 0.07\ M_\odot y^{-1}$





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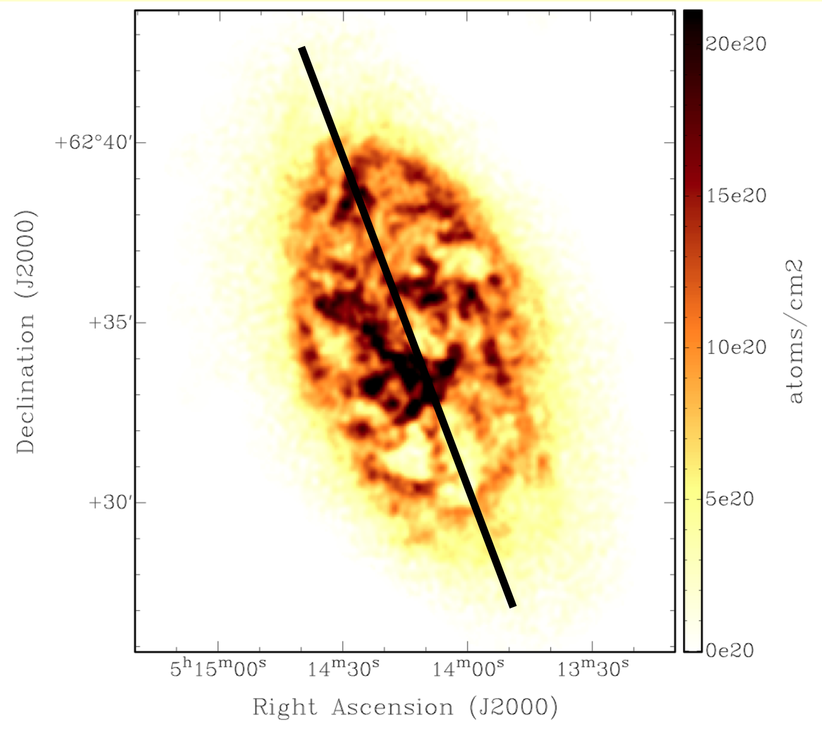

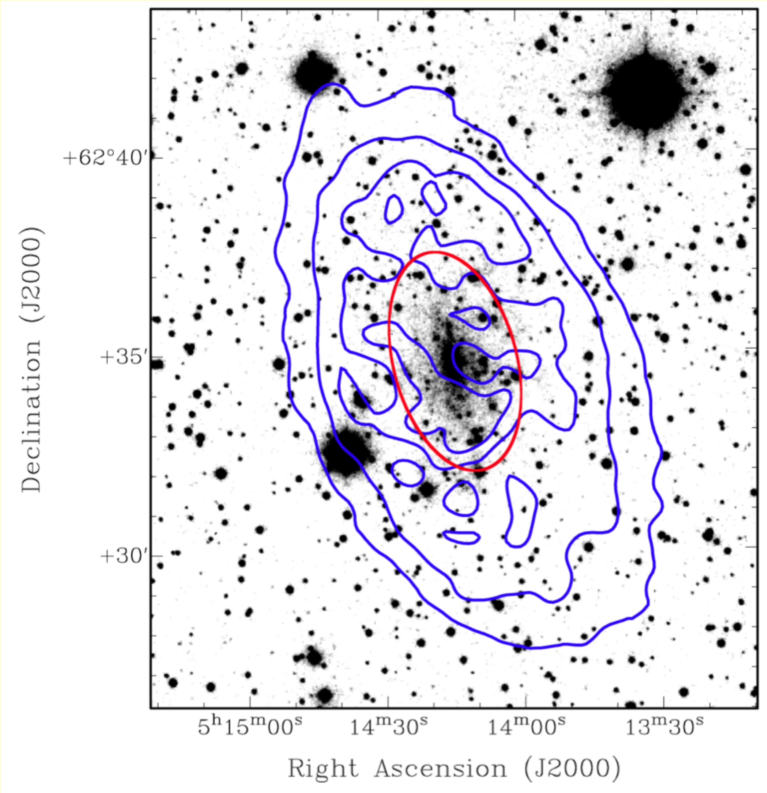

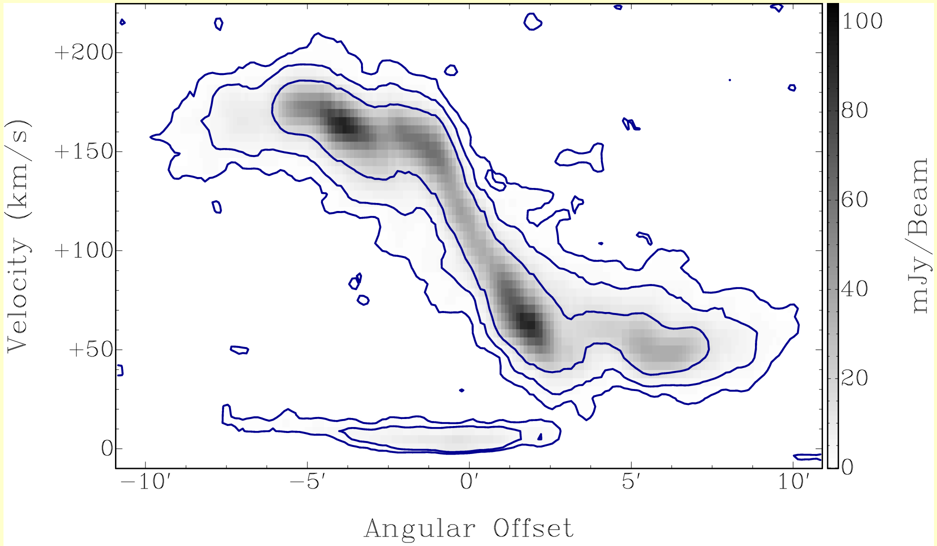

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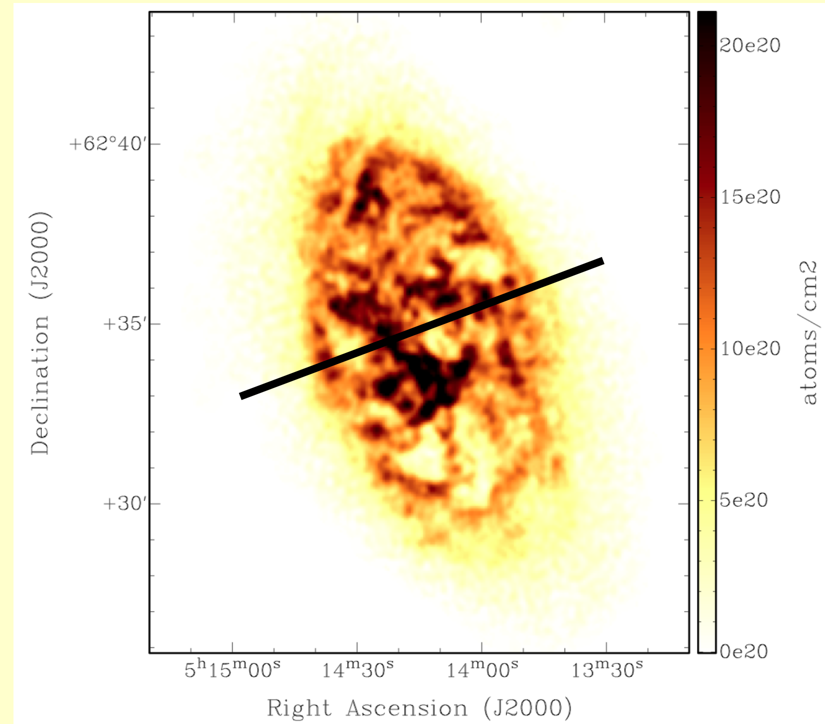
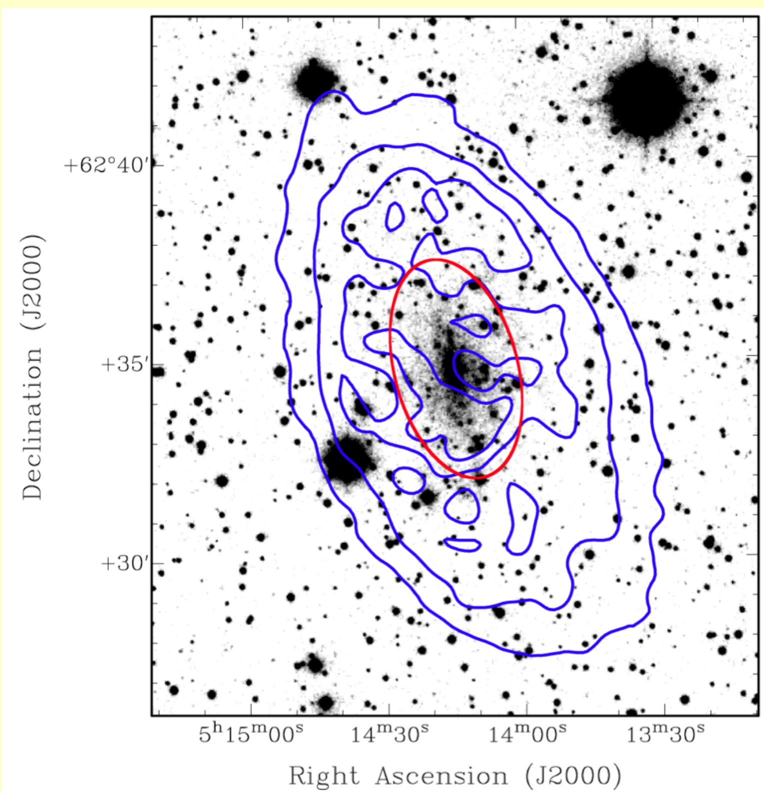
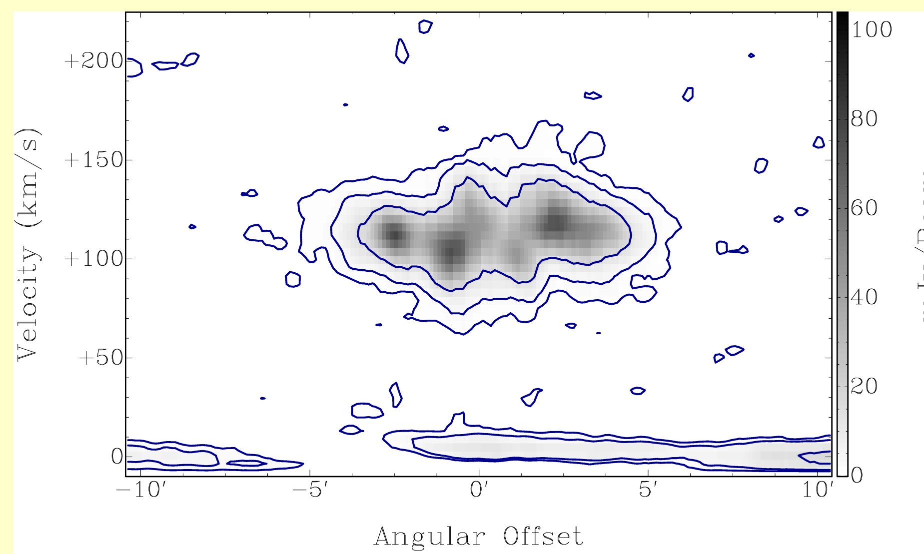
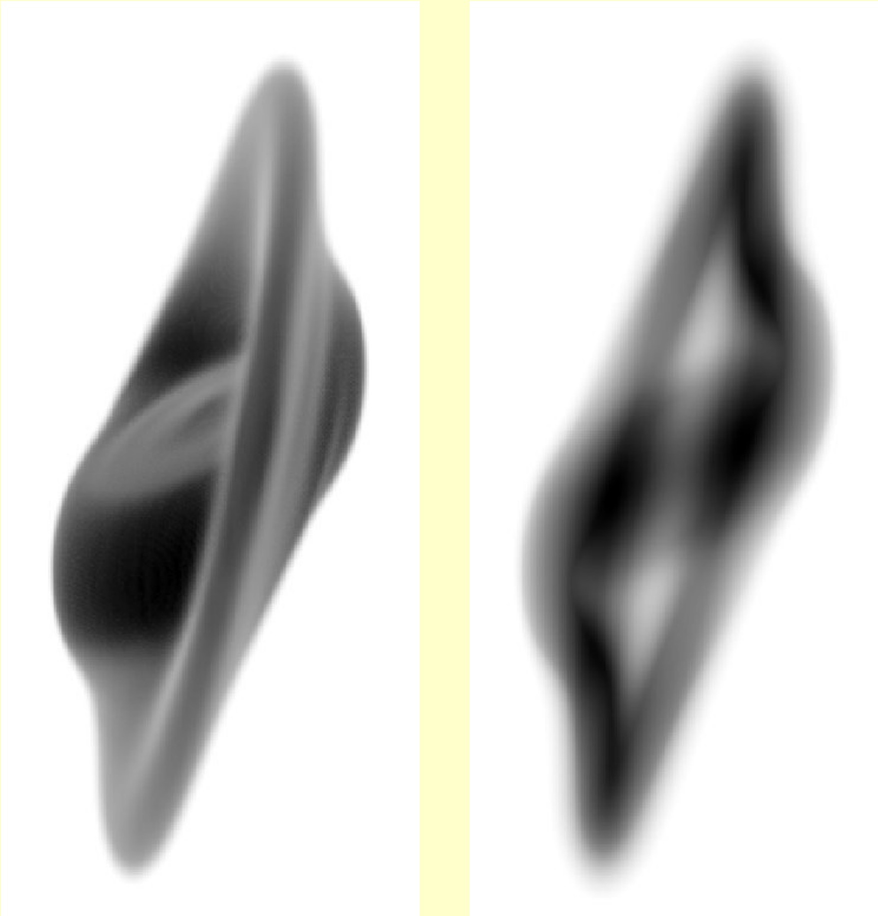






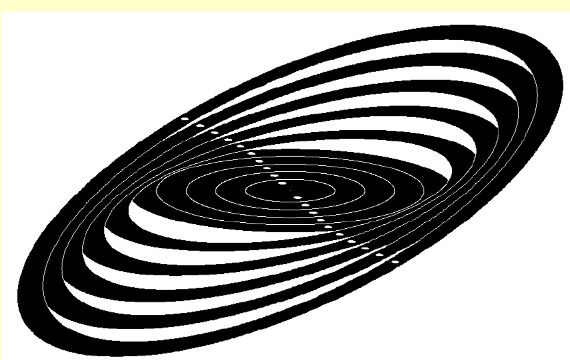
The tilted-ring model



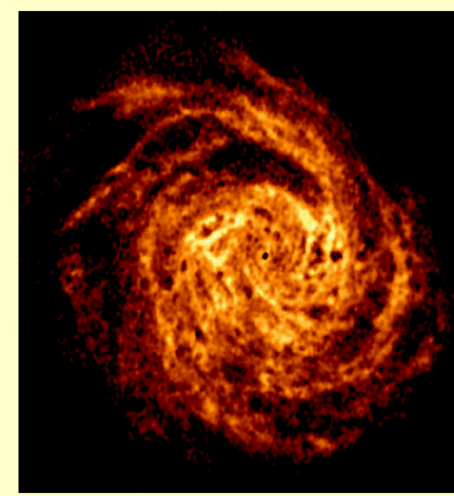
Tilted-Ring-Model
(Rogstad et al. 1974):

parametrise rings at different radii by

- two orientation parameters (inclination, position angle)
- central position
- surface brightness (thickness)
- rotation velocity



García-Ruiz 2001



Boomsma et al. 2008

Extending the tilted-ring model

Basic TRM
- Surface brightness SBR
- Rotation velocity VROT
- Position angle PA
- Inclination INCL
- Scale height Z0
- Dispersion SDIS
- Ring centre RA XPOS
- Ring centre Dec YPOS
- Systemic velocity VSYS

Global symmetric motion and gradients
- **Radial motion VRAD**
- **Vertical motion VVER**
- **Vertical gradients DVRO (VROT)**
  DVRA (VRAD)
  DVVE (VVER)

Higher-order warp harmonics
- Azimuthal change of height above symmetry plane (order i = 0, ... , 4)

WMiA (amplitude)
WMiP (phase)

Global shifts along projected axes
- Minor axis LS0
- Major axis LC0
- Velocity (VM0A)

Global surface brightness harmonics
- Azimuthal change of surface brightness (order i = 1, ... , 4)

SMiA (amplitude)
SMiP (phase)

Local (bar- spiral arm) distortions
- Adding Gaussian components (i ≤ 4)

GAiA (amplitude)
GAiP (phase)
GAiW (width)

Global (LOS-) velocity harmonics
- Azimuthal change of LOS velocity (order i = 1, ... , 4)

VMiA (amplitude)
VMiP (phase)

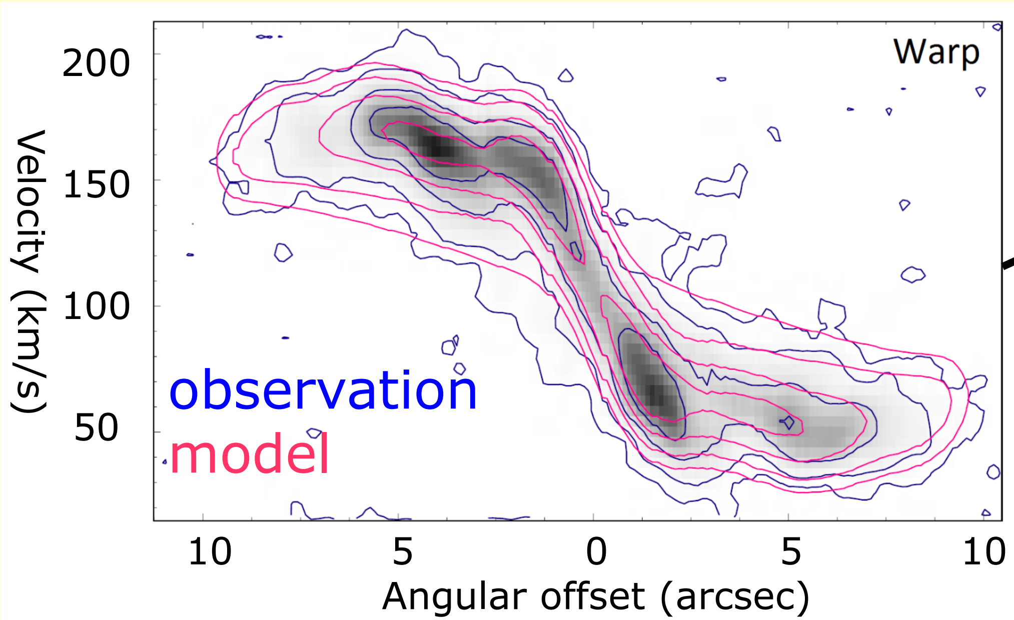
Modelling only parts of the disk
- Selection of azimuthal regions (i ≤ 2)

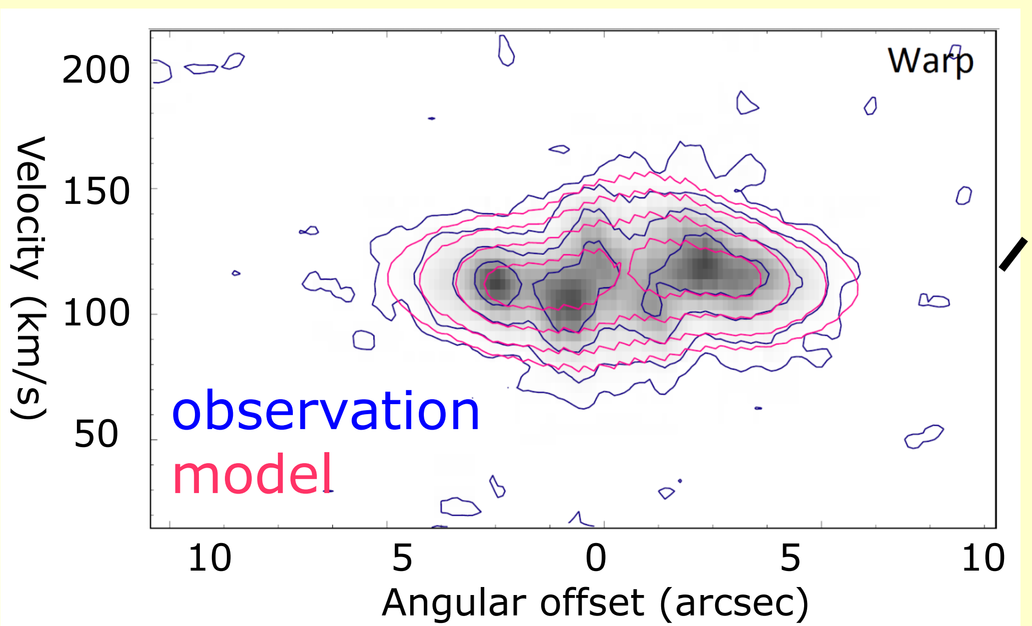
AZiP (azimuth)
AZiW (width)

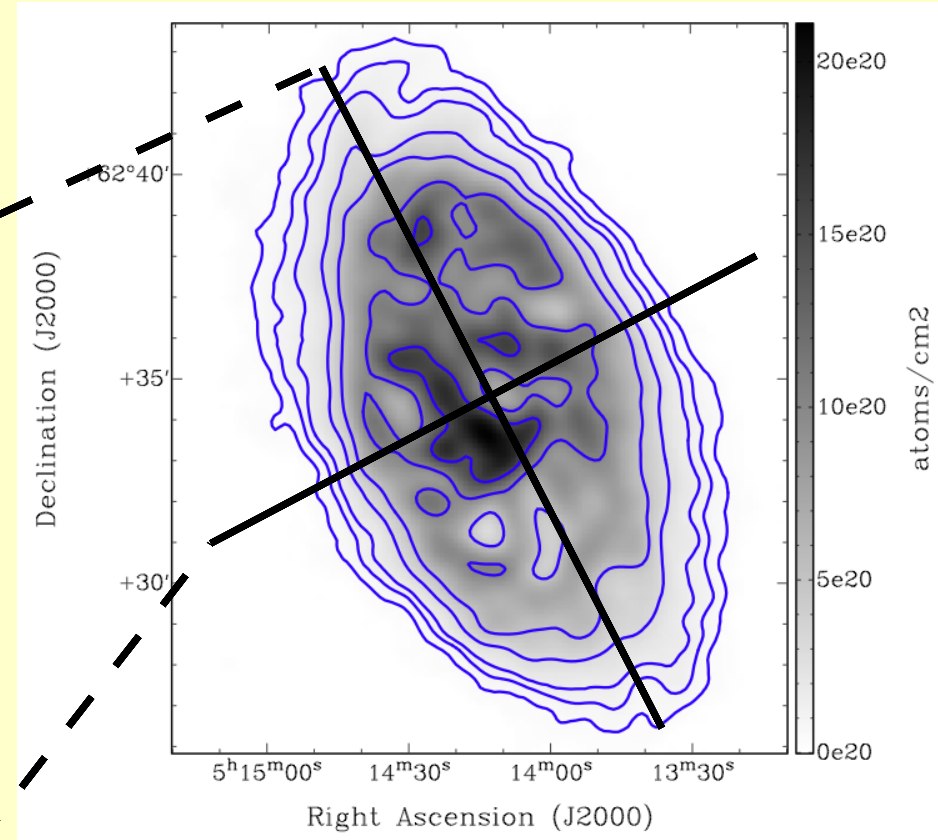
Sub-cloud concept
- Number of sub-clouds CLNR

Global parameters
- Global dispersion DISP

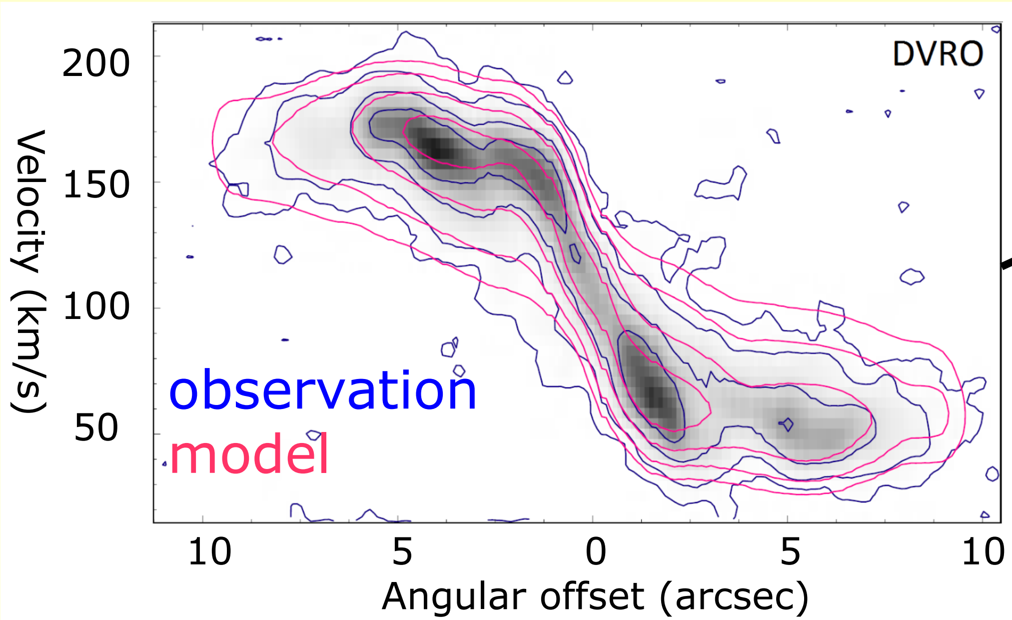
UGCA 105: warping?

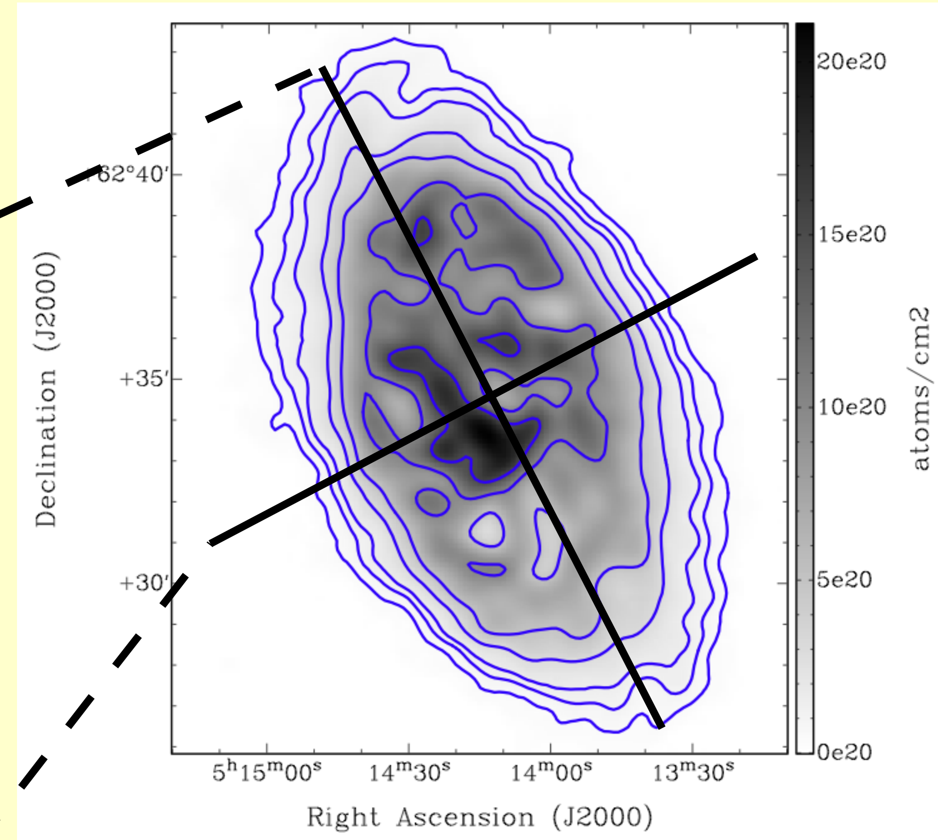


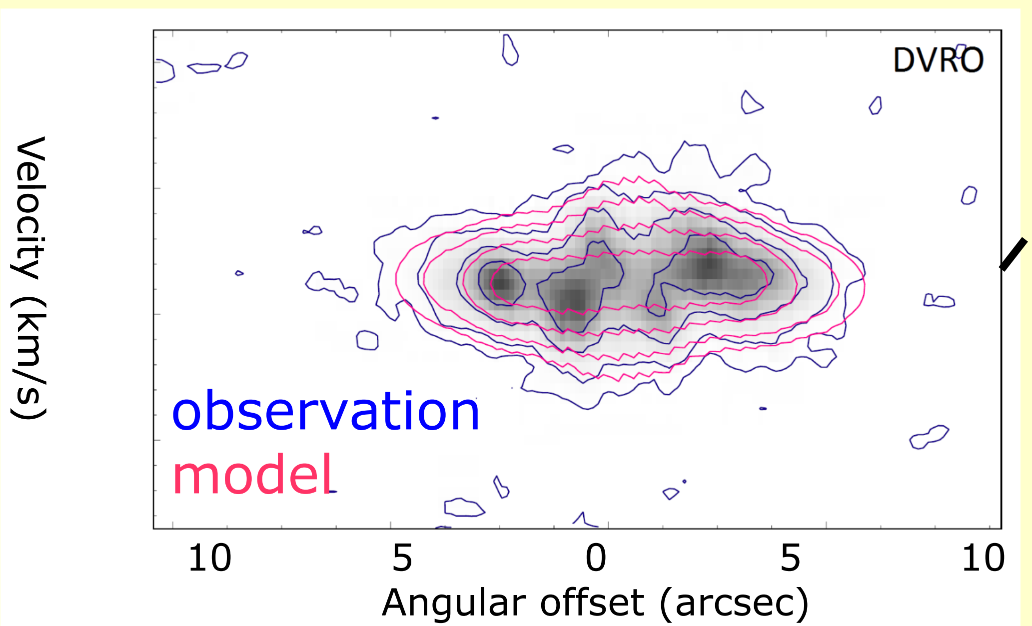




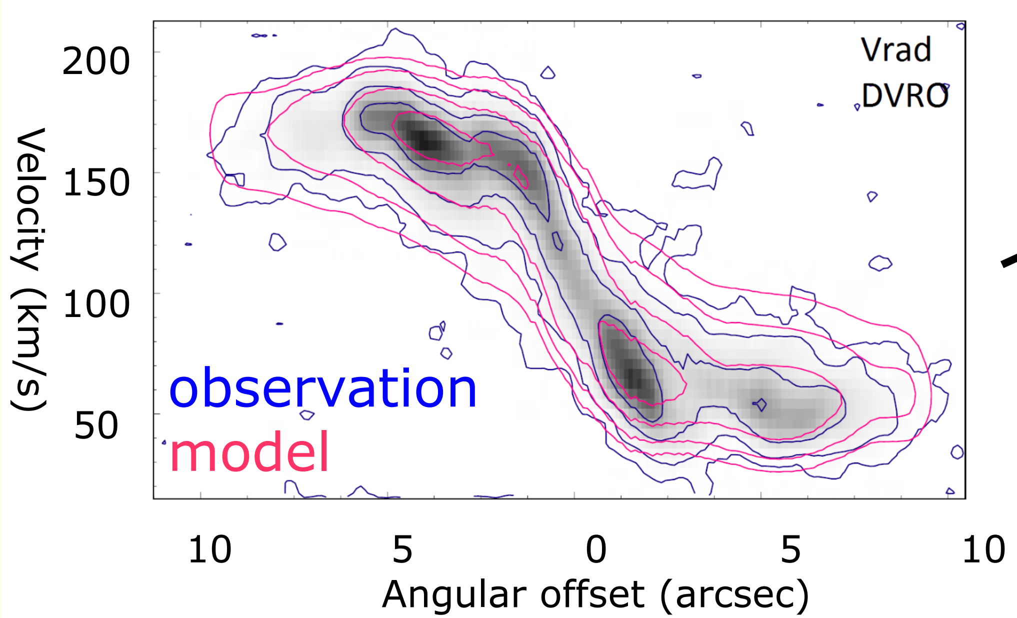
UGCA 105: lag

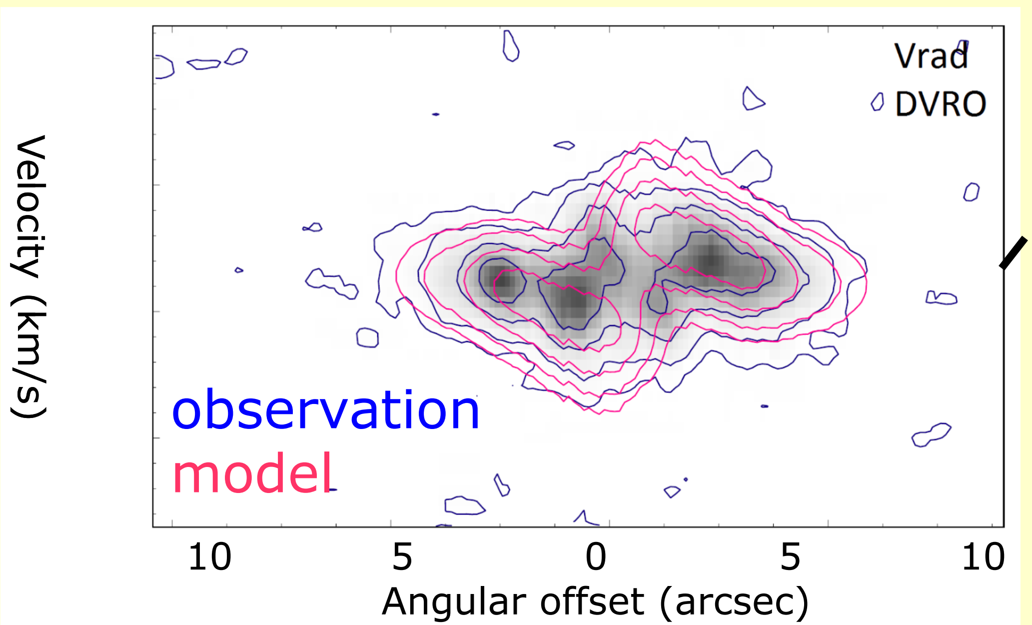


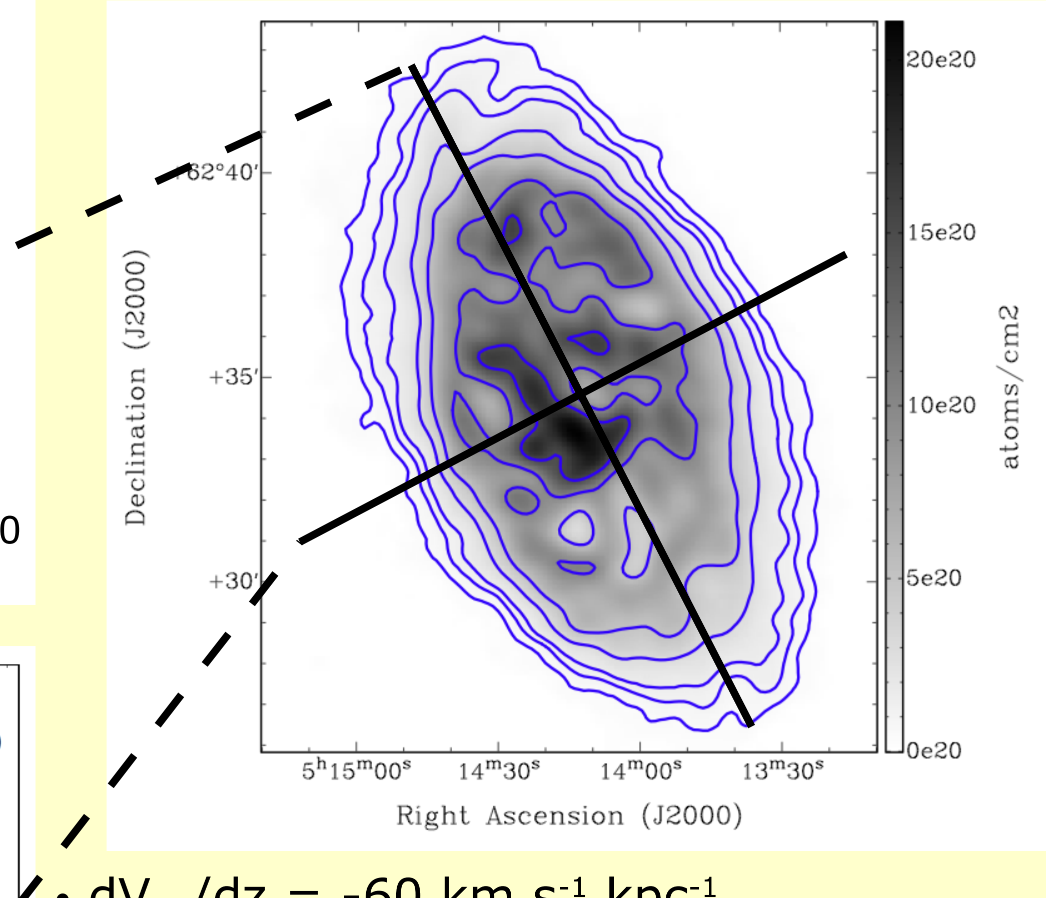




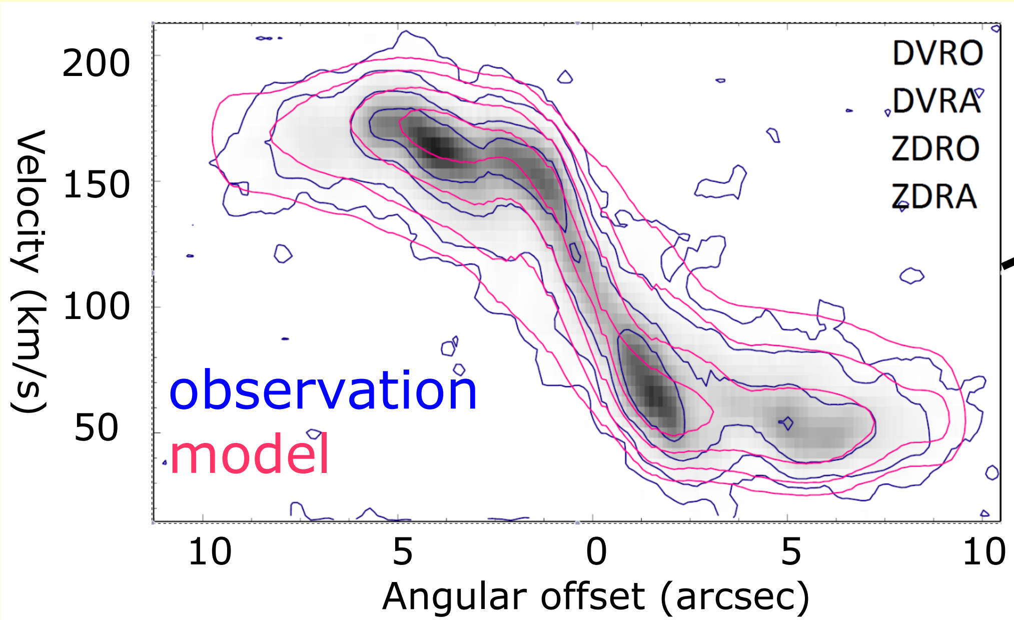
- $dV_{rot}/dz = -60\ \mathrm{km\ s^{-1}\ kpc^{-1}}$

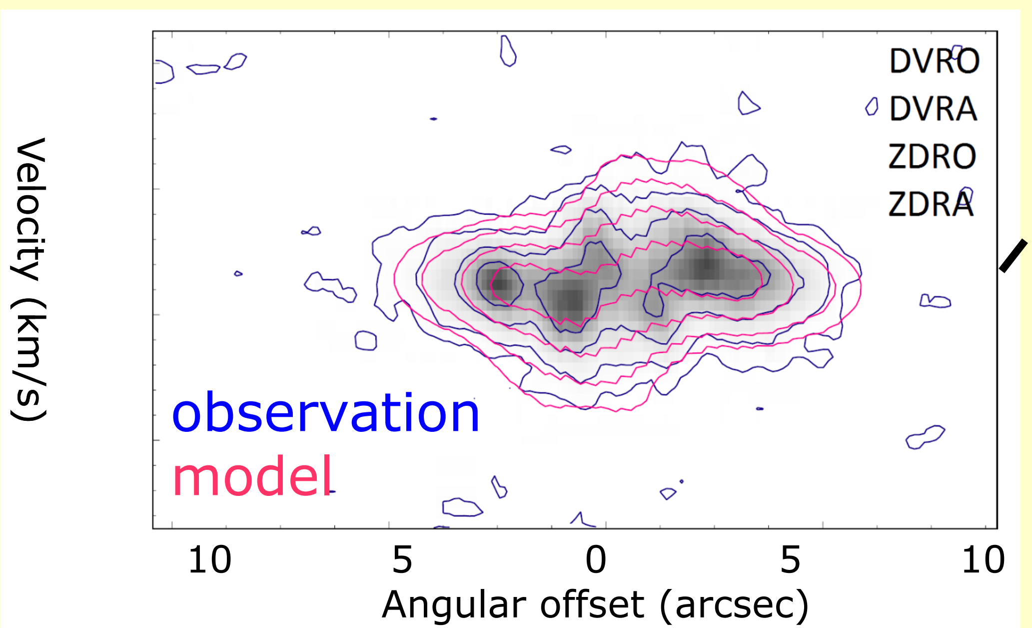


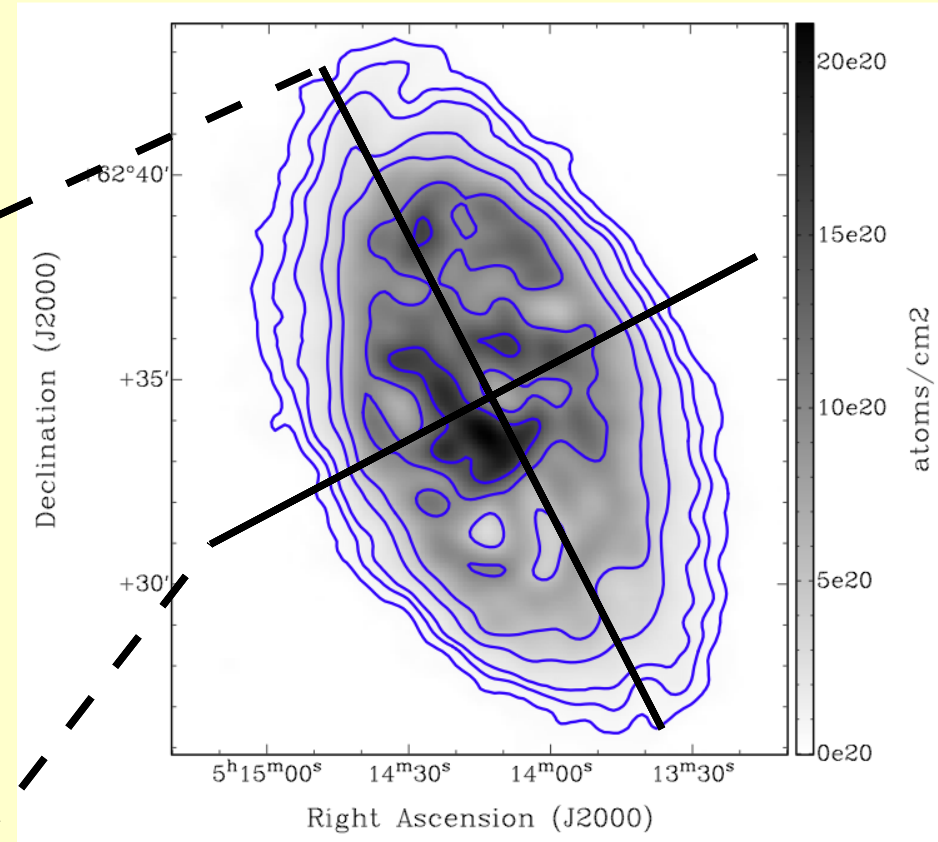




- $dV_{rot}/dz = -60\ km\ s^{-1}\ kpc^{-1}$
- No radial motion in central plane

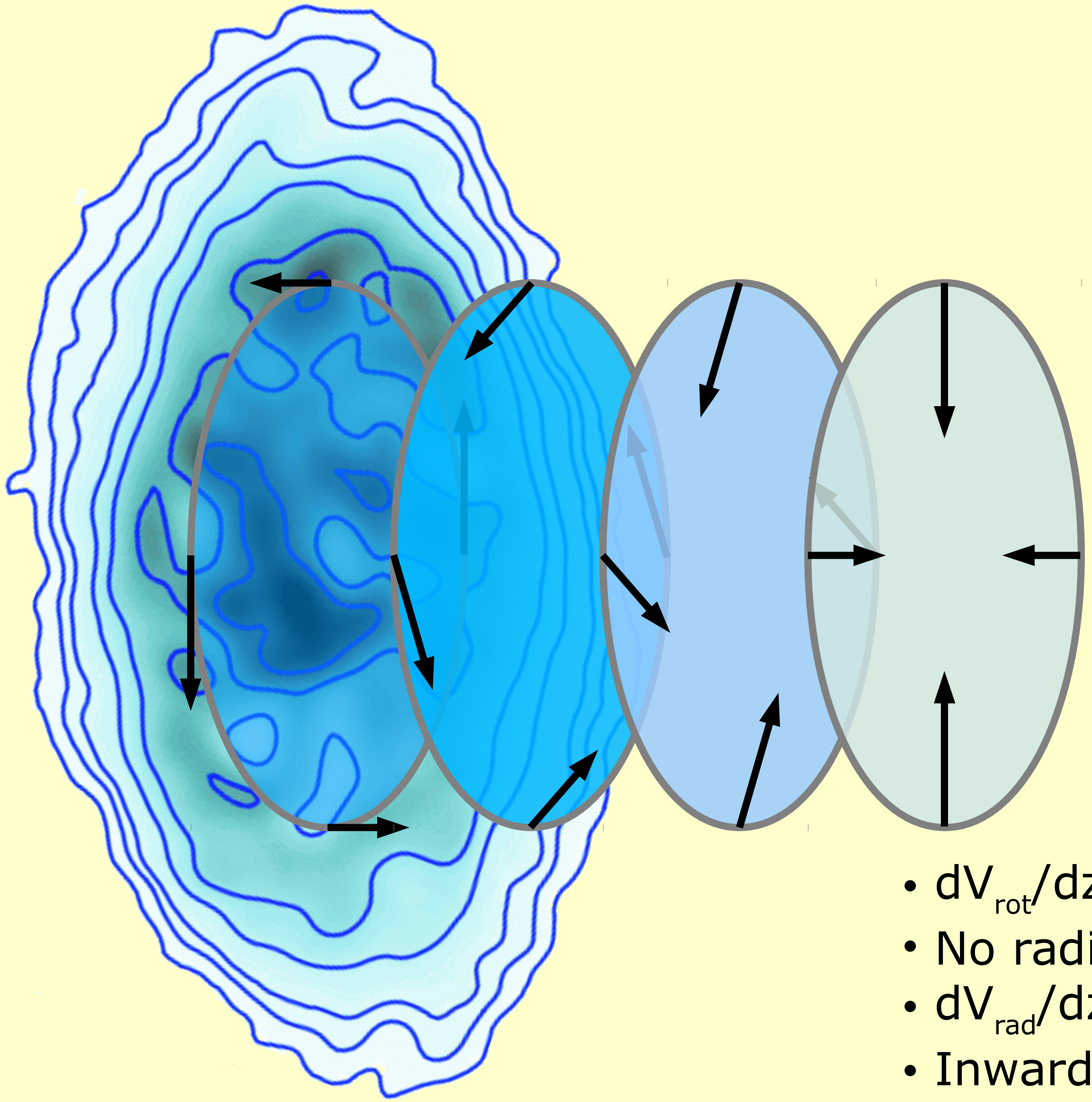


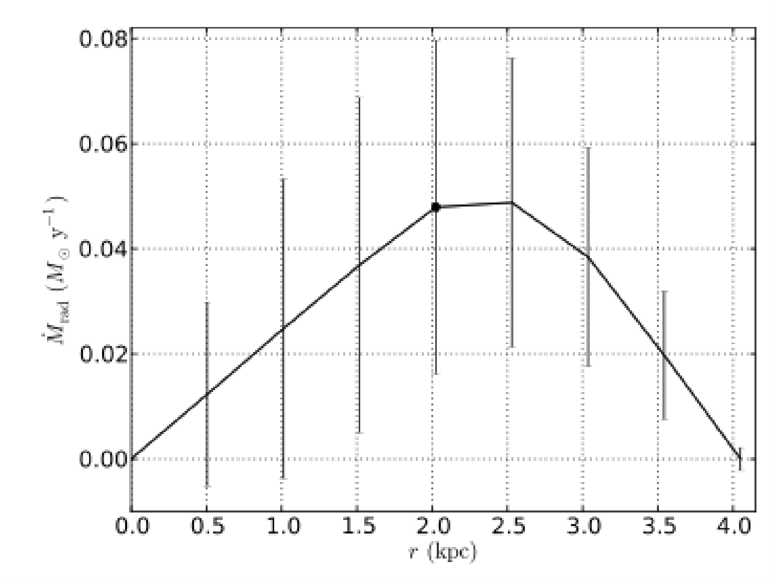




- $dV_{rot}/dz = -60\ \mathrm{km\ s^{-1}\ kpc^{-1}}$
- No radial motion in central plane
- $dV_{rad}/dz = -70\ \mathrm{km\ s^{-1}\ kpc^{-1}}$
- Inwards transport 0.05 $M_\odot\ y^{-1}$
- 40% of gas mass in thick disk

UGCA 105: kinematic structure





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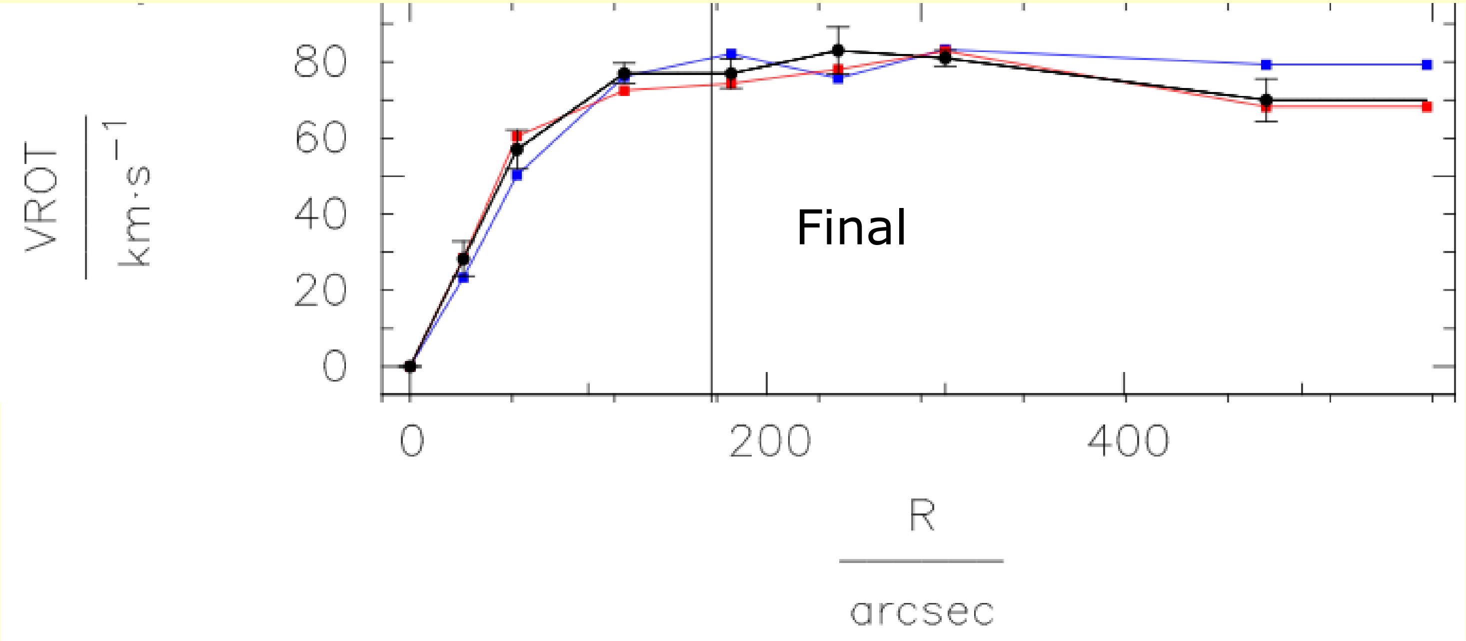
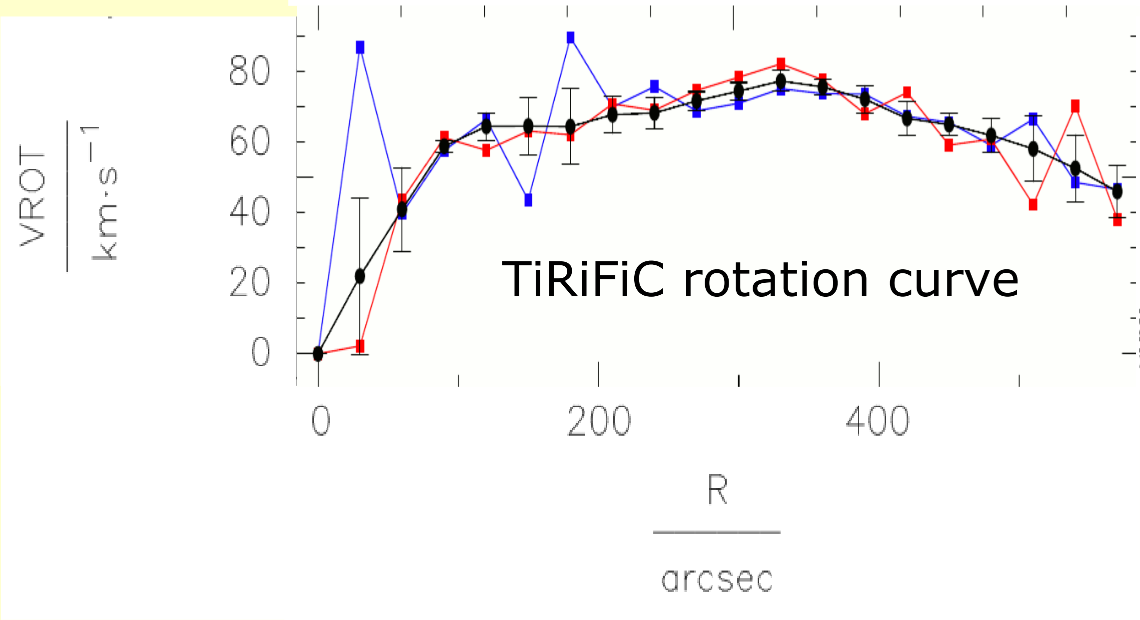
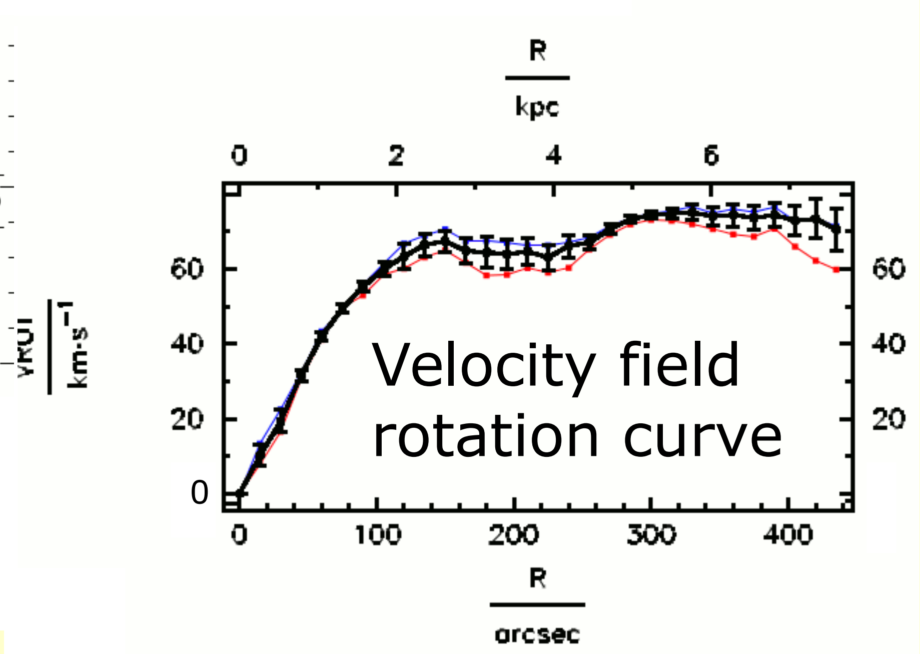
- 40% of gas mass in thick disk
- Dedicated modelling required

Corrolary: rotation curve



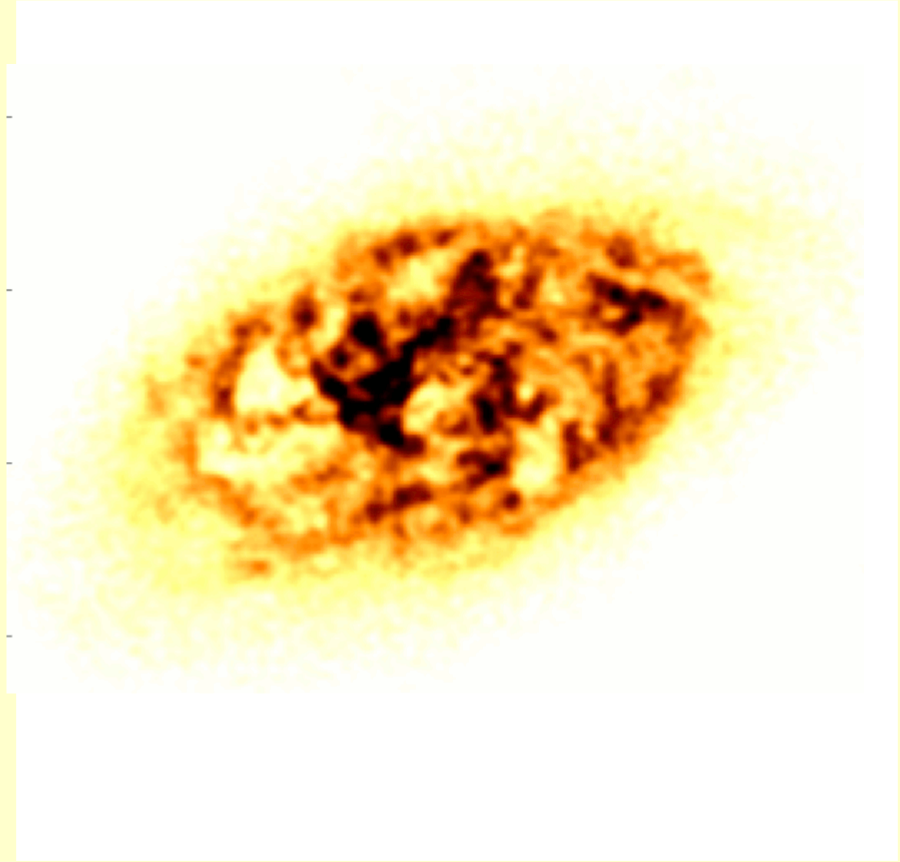




Summary and Outlook

- UGCA 105 might currently accrete (neutral) gas at a rate comparable to its star formation rate

- Corrolary: galaxy rotation curves (especially within dwarf mass range) depend on the appropriate acquisition of the galaxy's vertical (kinematical) structure



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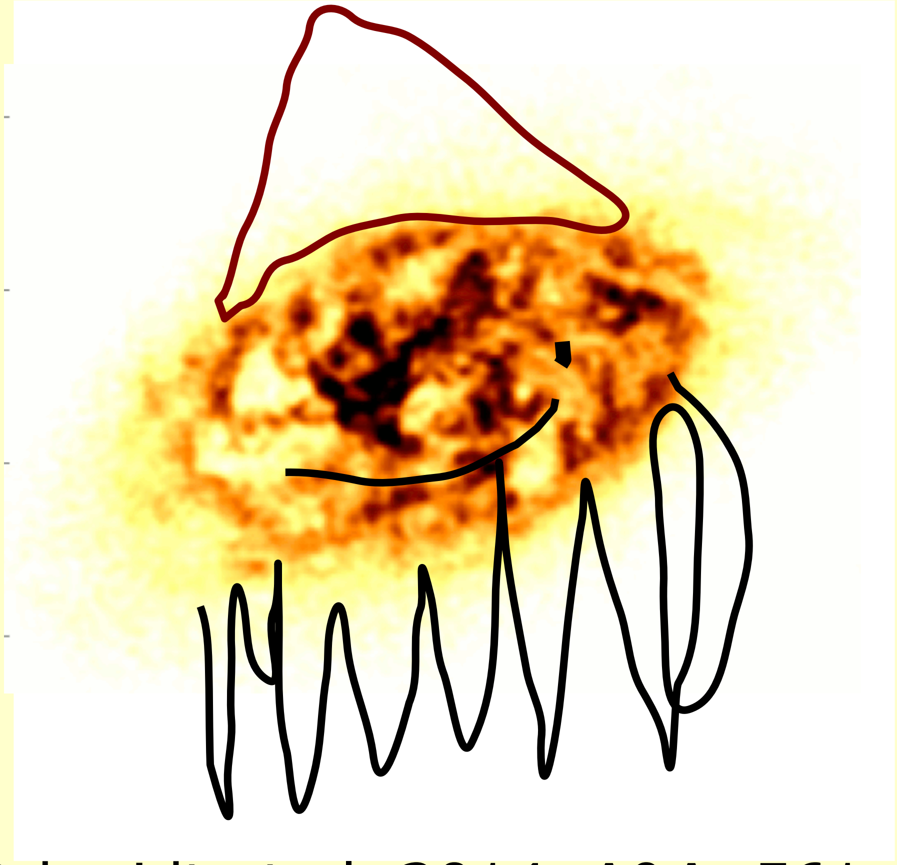

Schmidt et al. 2014, A&A, 561, 28