UGCA 105: A dwarf with a beard
Faint neutral gas

- Thick H I disks

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

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

- Few cases studied well enough to establish presence of gaseous halo (HALOGAS)
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
Signatures for (neutral) gas accretion

Ocvirk et al. 2008, for $2 \cdot 10^{12} M_\odot$ DM halo

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

- Could be much more if an unseen, smooth accretion takes place (Birnboim & Dekel 2003, Kereš et al. 2005)
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)
• SABm -> hot corona from accretion?
• $M_B = -14.7$
• $D_{25} = 5.8$ kpc
• $D_{HI} = 16$ kpc
• $M_{HI} = 6.4 \cdot 10^8$ $M_\odot$
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UGCA 105

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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)

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)

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)

Sub-cloud concept
• Number of sub-clouds CLNR

Global parameters
• Global dispersion  DISP
UGCA 105: warping?

Observation model

Observation model
G.I.G. Józsa, UGCA 105

\[ \frac{dV_{rot}}{dz} = -60 \text{ km s}^{-1} \text{ kpc}^{-1} \]
• \( \frac{dV_{\text{rot}}}{dz} = -60 \text{ km s}^{-1} \text{ kpc}^{-1} \)
• No radial motion in central plane
UGCA 105: inwards motion

- $dV_{\text{rot}}/dz = -60 \text{ km s}^{-1} \text{ kpc}^{-1}$
- No radial motion in central plane
- $dV_{\text{rad}}/dz = -70 \text{ km s}^{-1} \text{ kpc}^{-1}$
- Inwards transport $0.05 \, M_\odot \, \text{y}^{-1}$
- 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

![Graph showing rotation curve with data points and error bars. The x-axis represents radius in arcsec, and the y-axis represents velocity in km/s. The graph is labeled as Final, TiRiFiC rotation curve, and Velocity field 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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