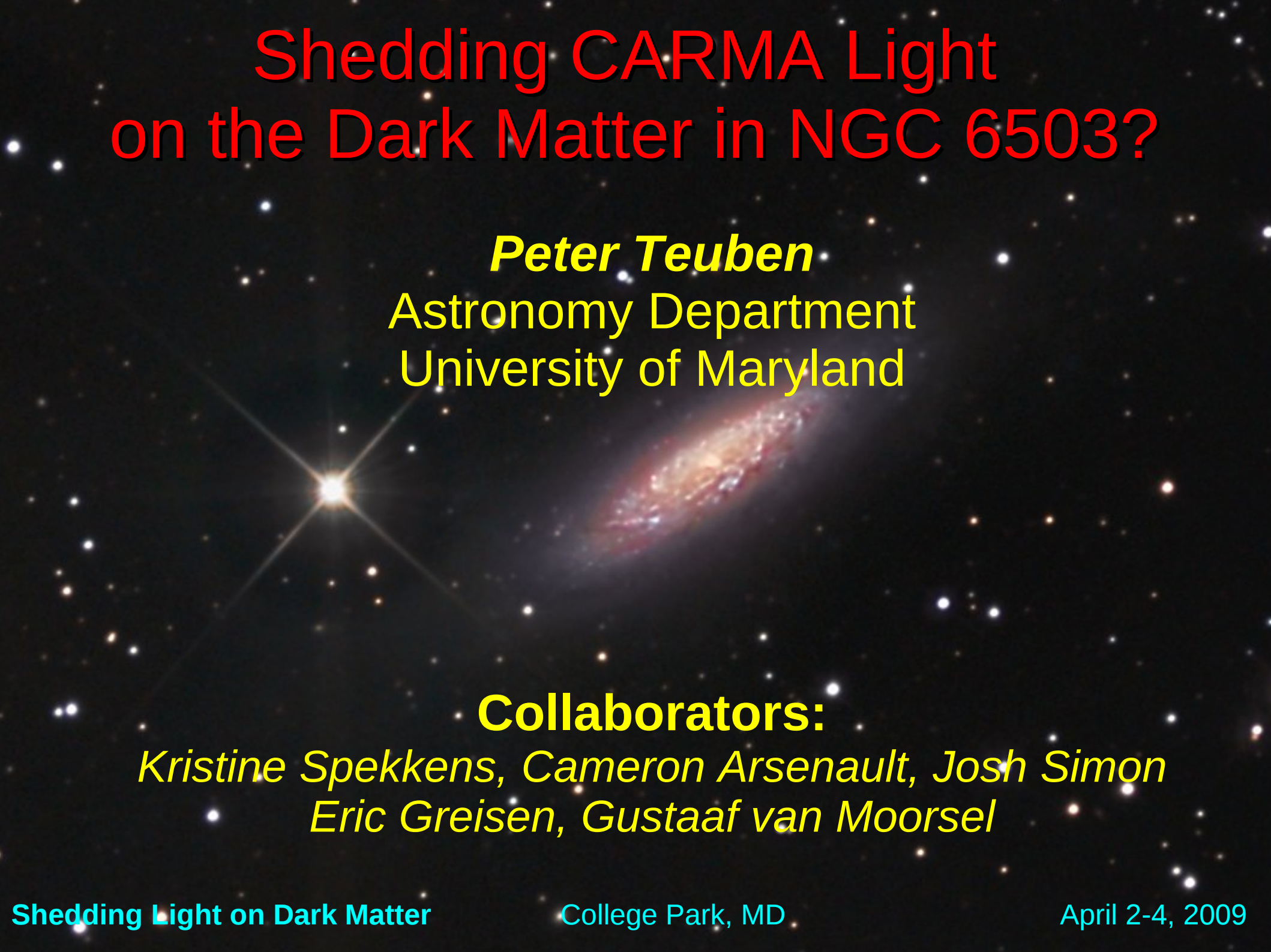
Shedding CARMA Light on the Dark Matter in NGC 6503?



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Collaborators:

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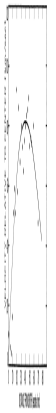
Eric Greisen, Gustaaf van Moorsel

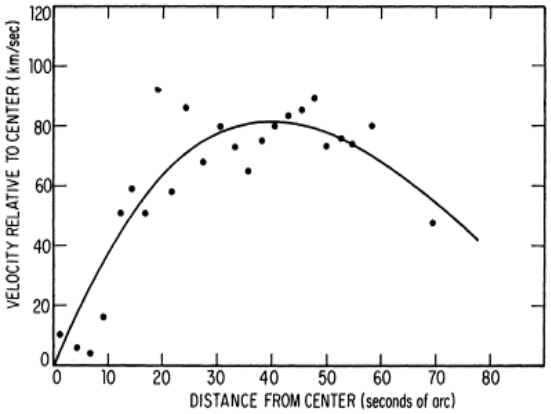
NGC 6503

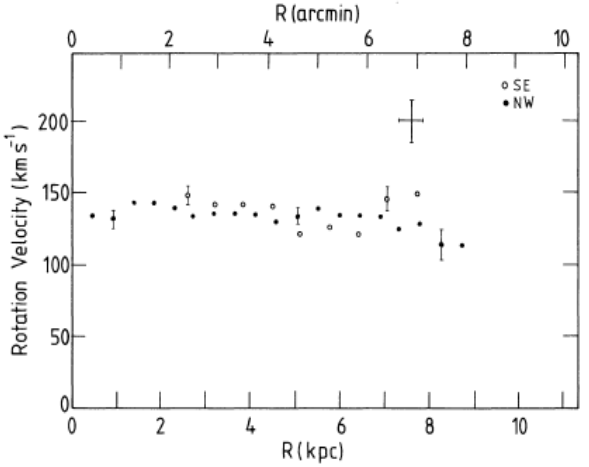
- Type: SA(s)cd
- RA/DEC: 17^h49^m $+70^d09^m$
- VSYS: 28 km/s (HEL) 40 km/s (LSR)
- Distance: 5.2 Mpc or 6 Mpc (old: 3.7 Mpc)
- Scale: 1” ≈ 18 pc, 1' ≈ 1 kpc
- Size: 5.4 kpc (Optical) 9.0 kpc (HI)
- Shape: 74^o (incl) 121^o (position angle)
- Luminosity: -17.68 or $1.5\ 10^9\ L_\odot$ (in B band)
- Mass: $1.6\ 10^9\ M_\odot$ (in HI)

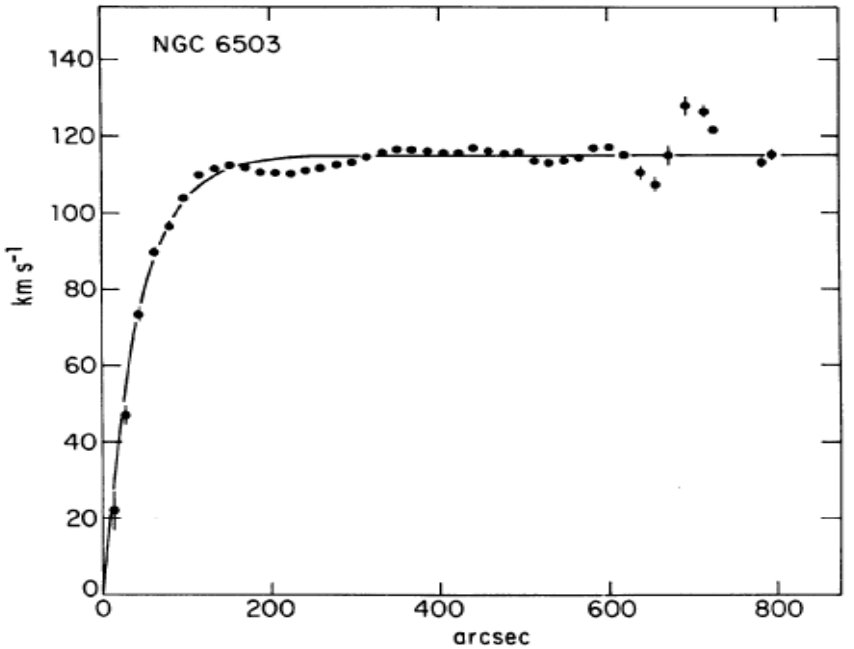
Old Data Sets

- Long slit spectra (Burbidge et al. 1964), out to 60”
- HI synthesis WSRT (Shostak et al. 1981), out to 500”, 50” resolution
- HI synthesis VLA (v.Moorsel & Wells 1985), out to 800” 15x31” resolution



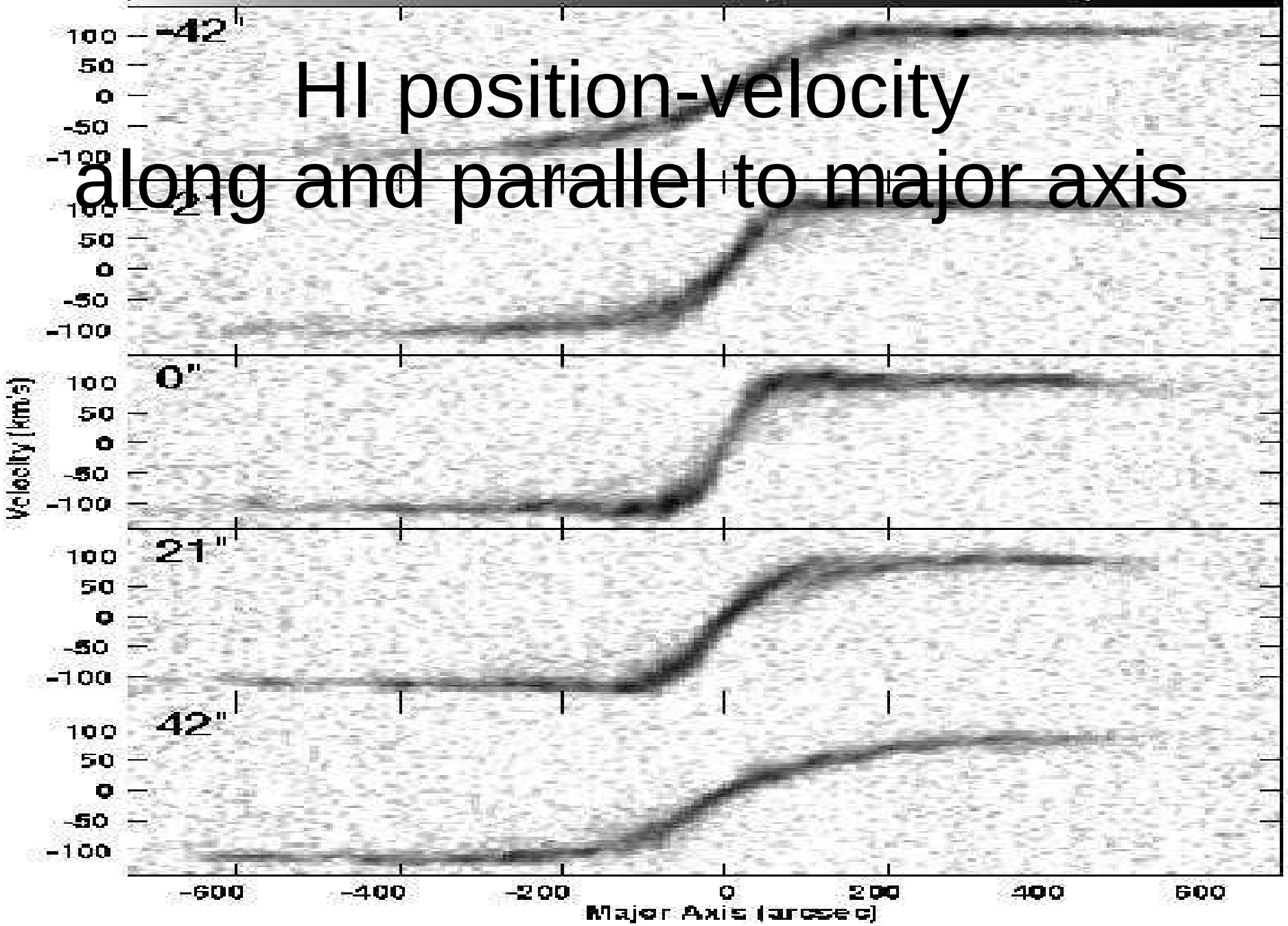




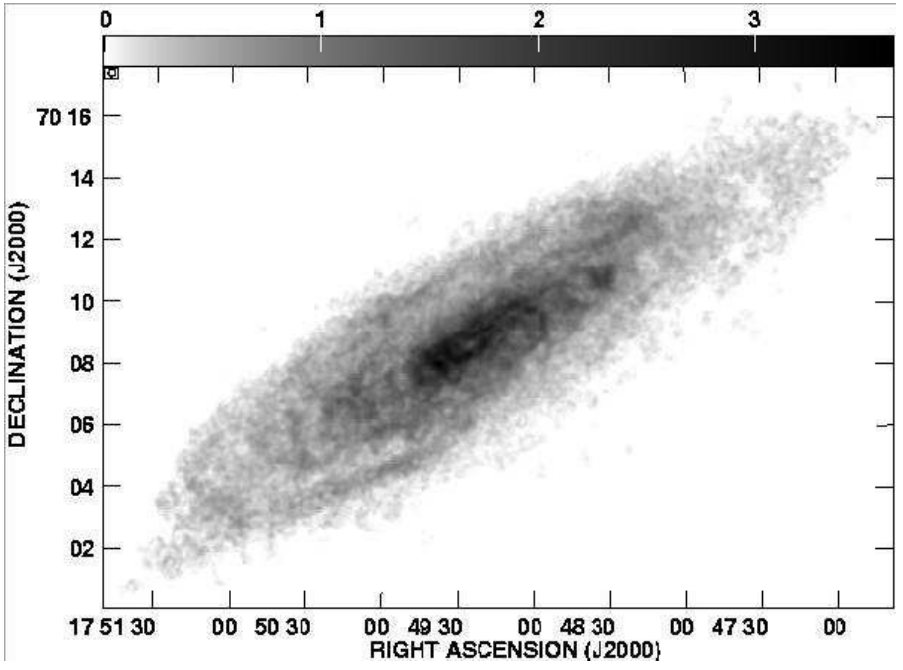


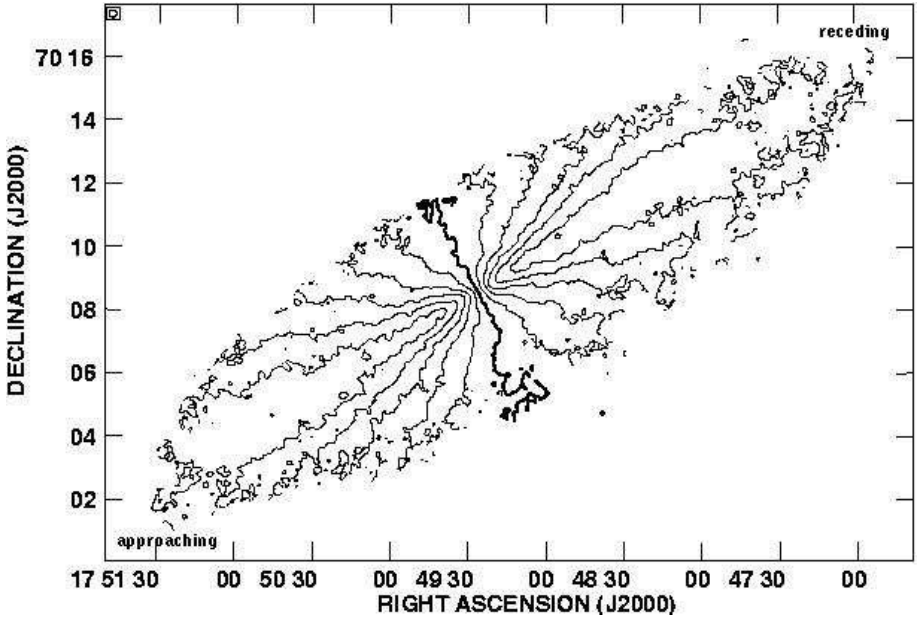
New Data Sets

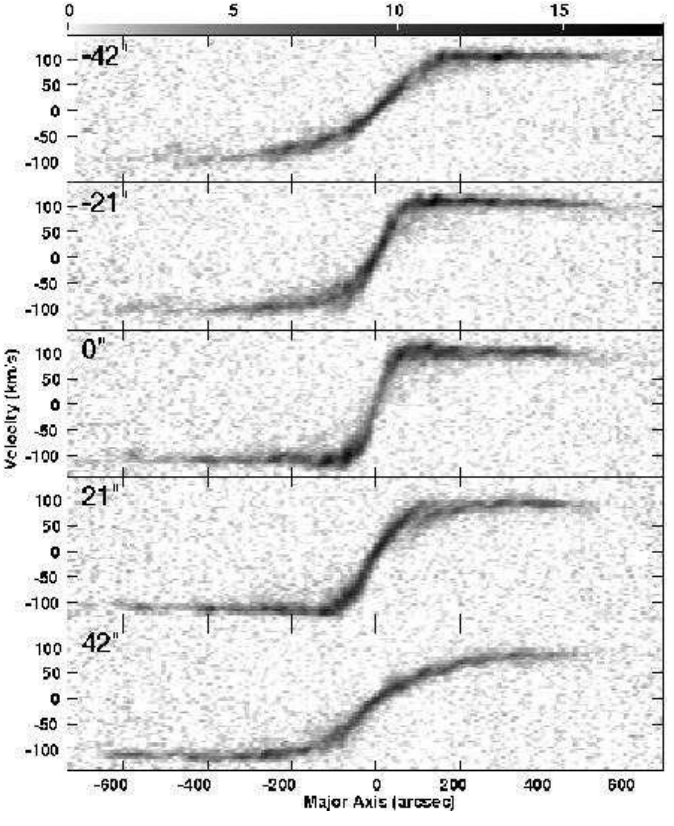
- HI synthesis VLA (1996/2009), out to 900”, 14” resolution
- Hα, DensePak, central 120”, 4”
- CO (1-0), central 100” CARMA synthesis, 5”


HI position-velocity
along and parallel to major axis
-42"
-21"
0"
21"
42"
Velocity (km/s)
Major Axis (arcsec)

VLA HI at 14”

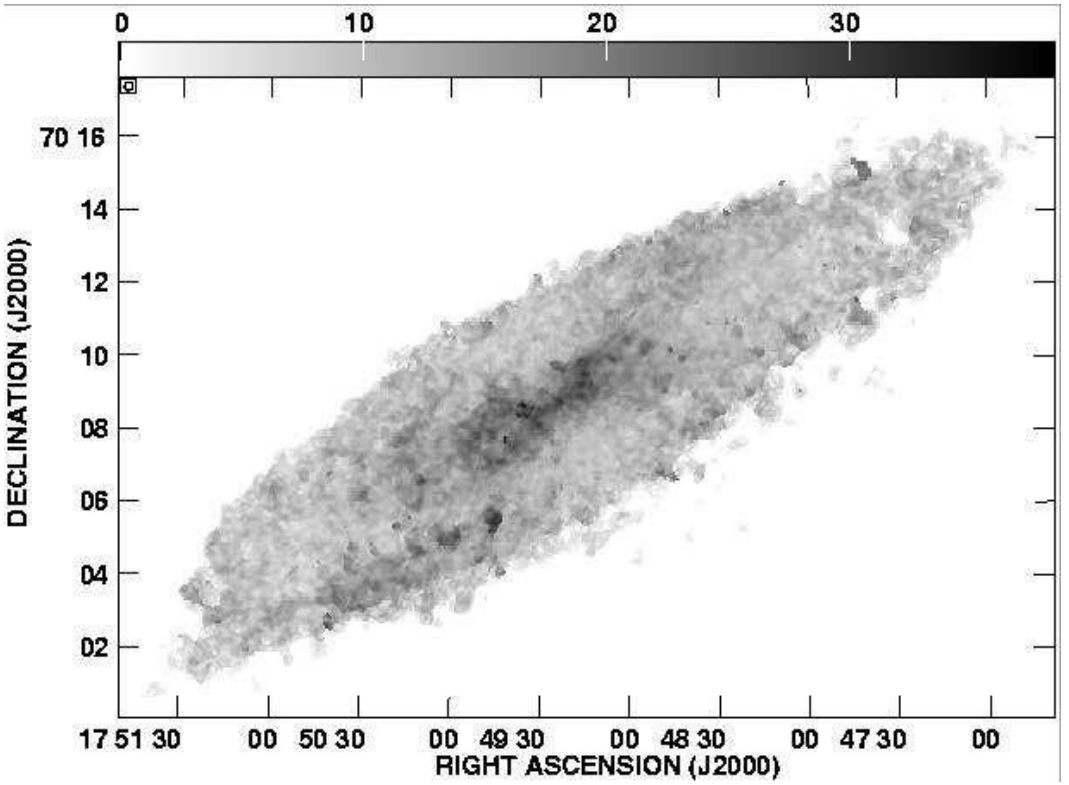

0
1
2
3
70 16
14
12
10
08
06
04
02
DECLINATION (J2000)
17 51 30
00 50 30
00 49 30
00 48 30
00 47 30
00
RIGHT ASCENSION (J2000)

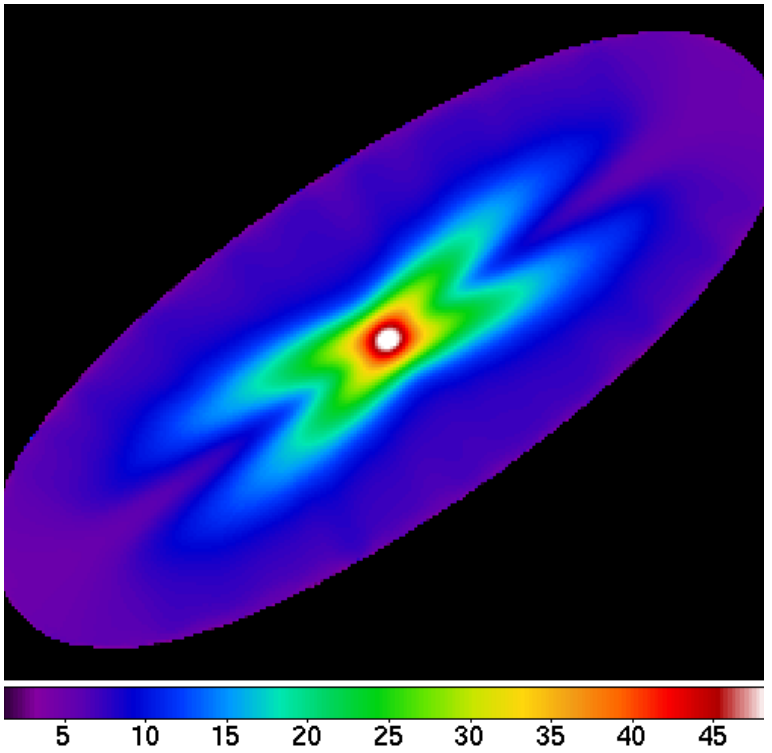

receding
approaching
70 16
14
12
10
08
06
04
02
DECLINATION (J2000)
17 51 30
00 50 30
00 49 30
00 48 30
00 47 30
00
RIGHT ASCENSION (J2000)


0
5
10
15
-42"
-21"
0"
21"
42"
100
50
0
-50
-100
Velocity (km/s)
-600
-400
-200
0
200
400
600
Major Axis (arcsec)

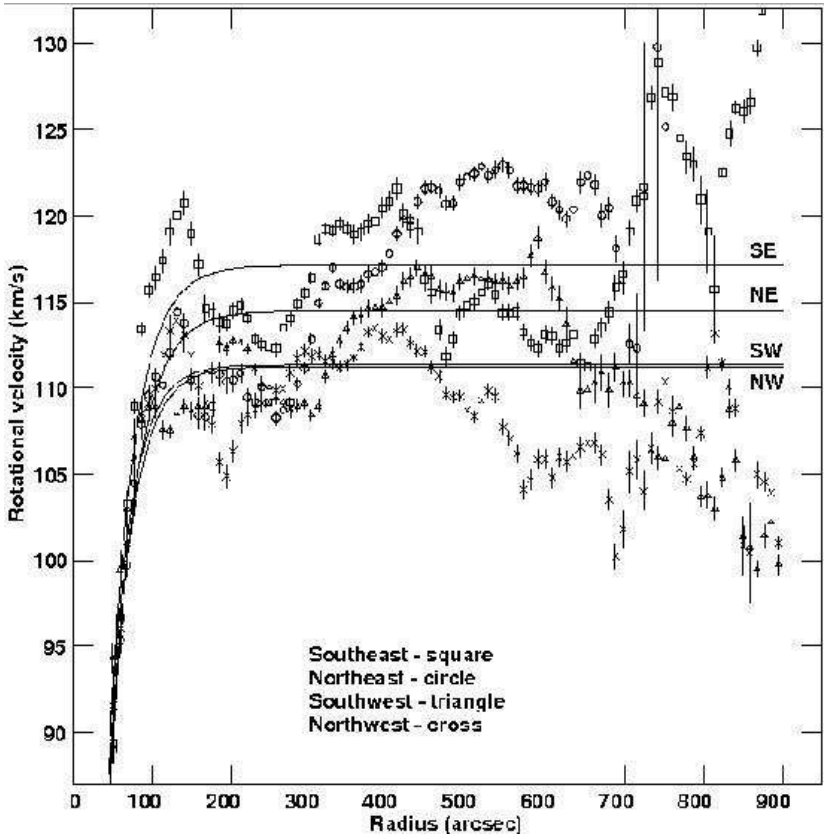
HI – velocity dispersion (σ)

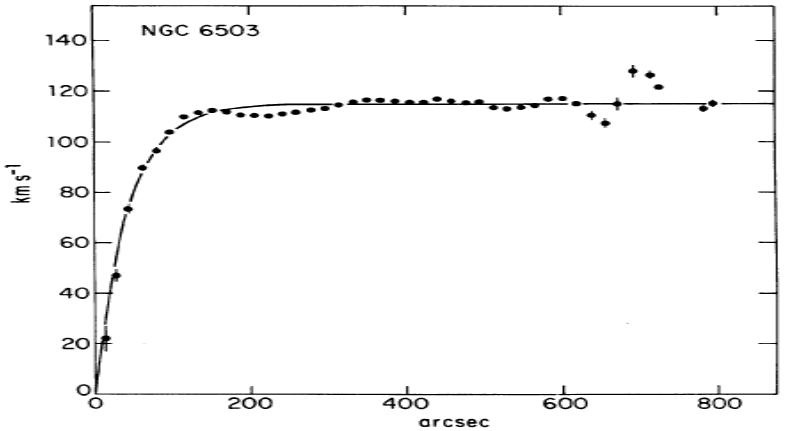
- Observations
- Model w/ constant σ



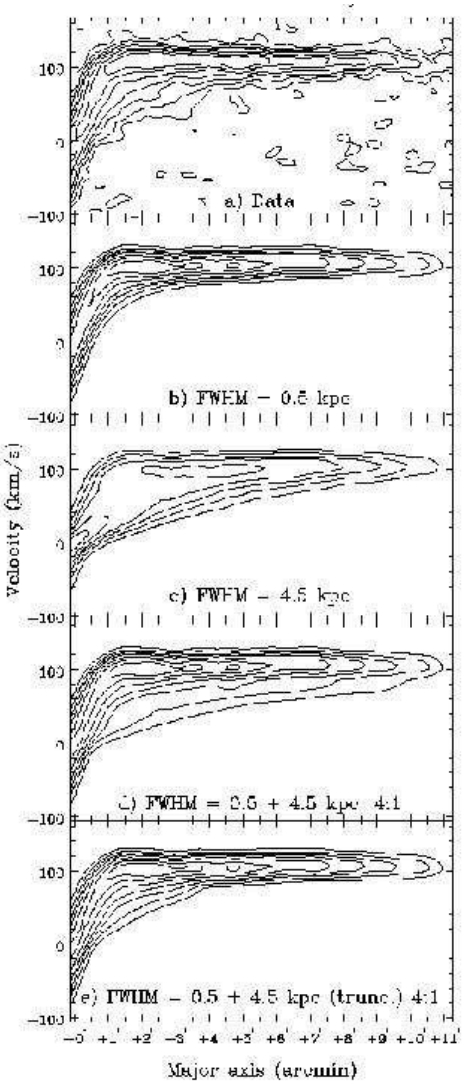


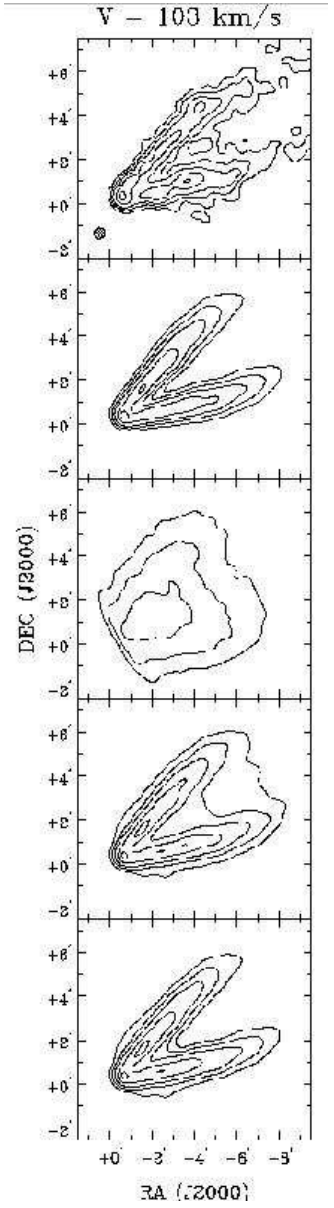
“Rotation Curve”





Modeling

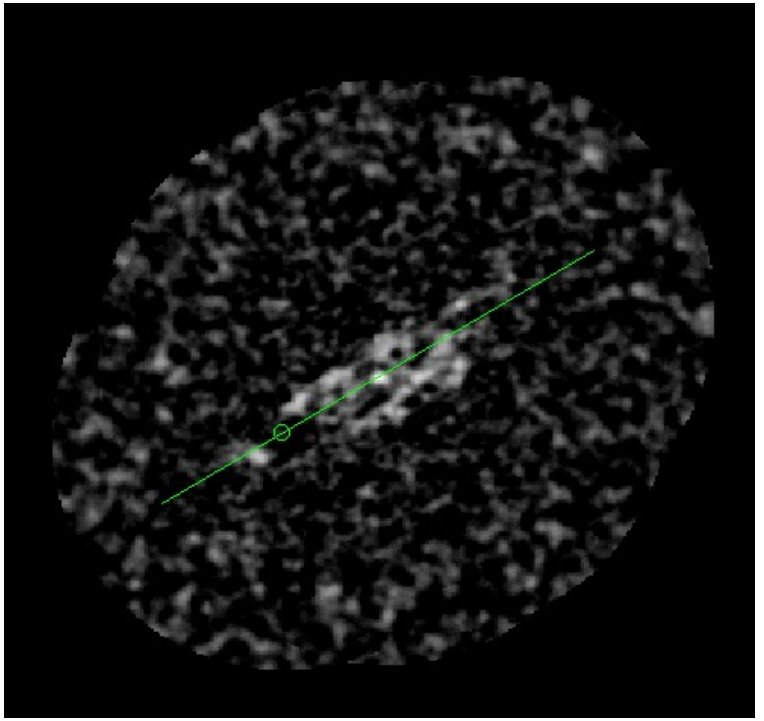

a) Data
b) FWHM = 0.5 kpc
c) FWHM = 4.5 kpc
d) FWHM = 0.5 + 4.5 kpc 4:1
e) FWHM = 0.5 + 4.5 kpc (trunc.) 4:1
Velocity (km/s)
Major axis (arcmin)

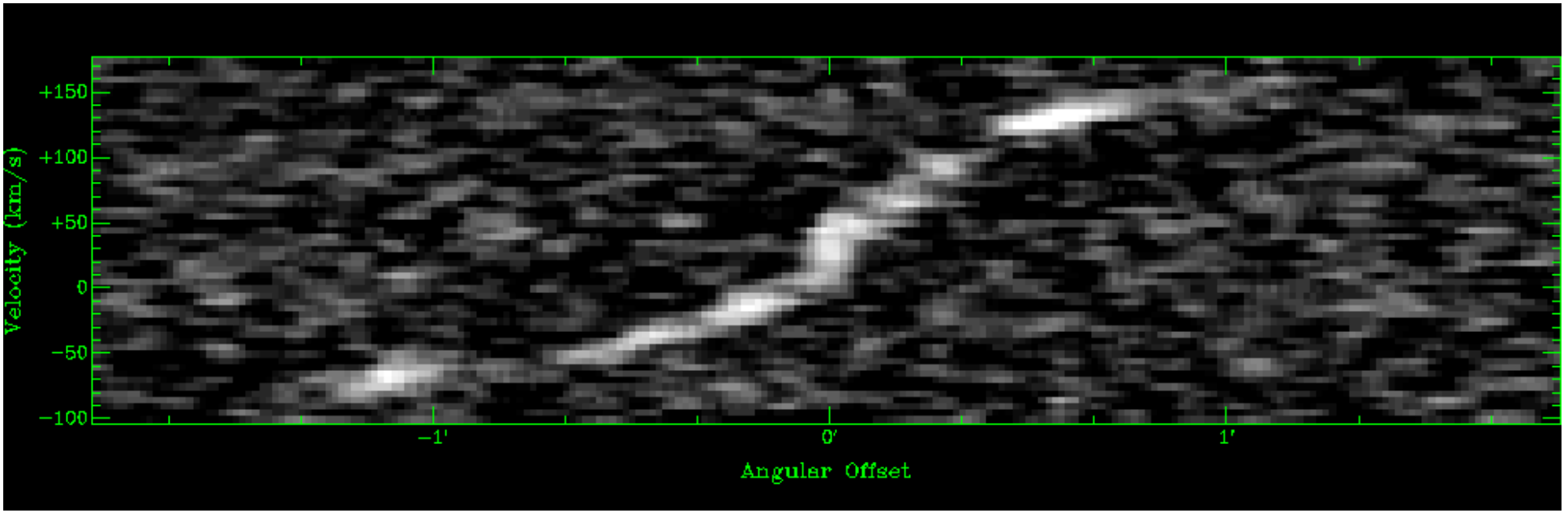

V = 103 km/s
DEC (J2000)
RA (J2000)

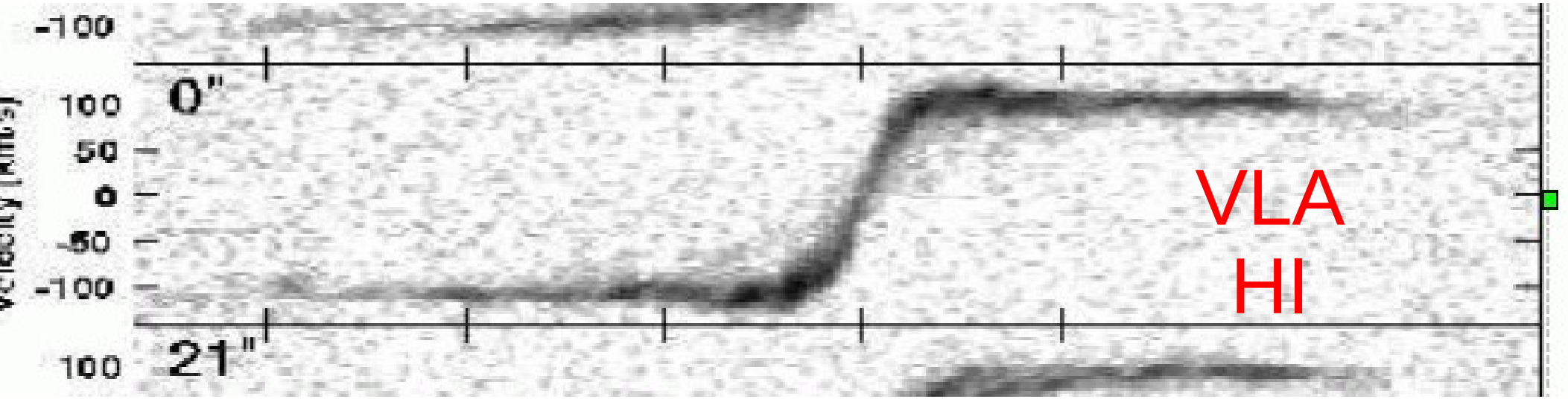
CARMA

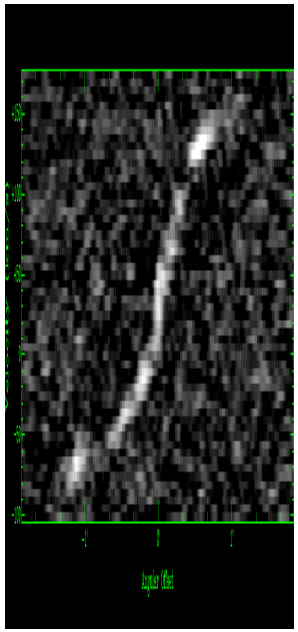
- 23 antenna: 6 OVRO + 9 BIMA + 8 SZA (new!)
- Synthesis array, up to 2 km baselines
  - Resolution 0.3” ... 10” (at 3 mm)
- Frequency bands:
  - 26-36 GHz (1 cm)
  - 80-115 Ghz (3mm) e.g. CO (1-0)
  - 215-270 GHz (1mm) e.g. CO (2-1)

CARMA CO(1-0): Position-Velocity along major axis







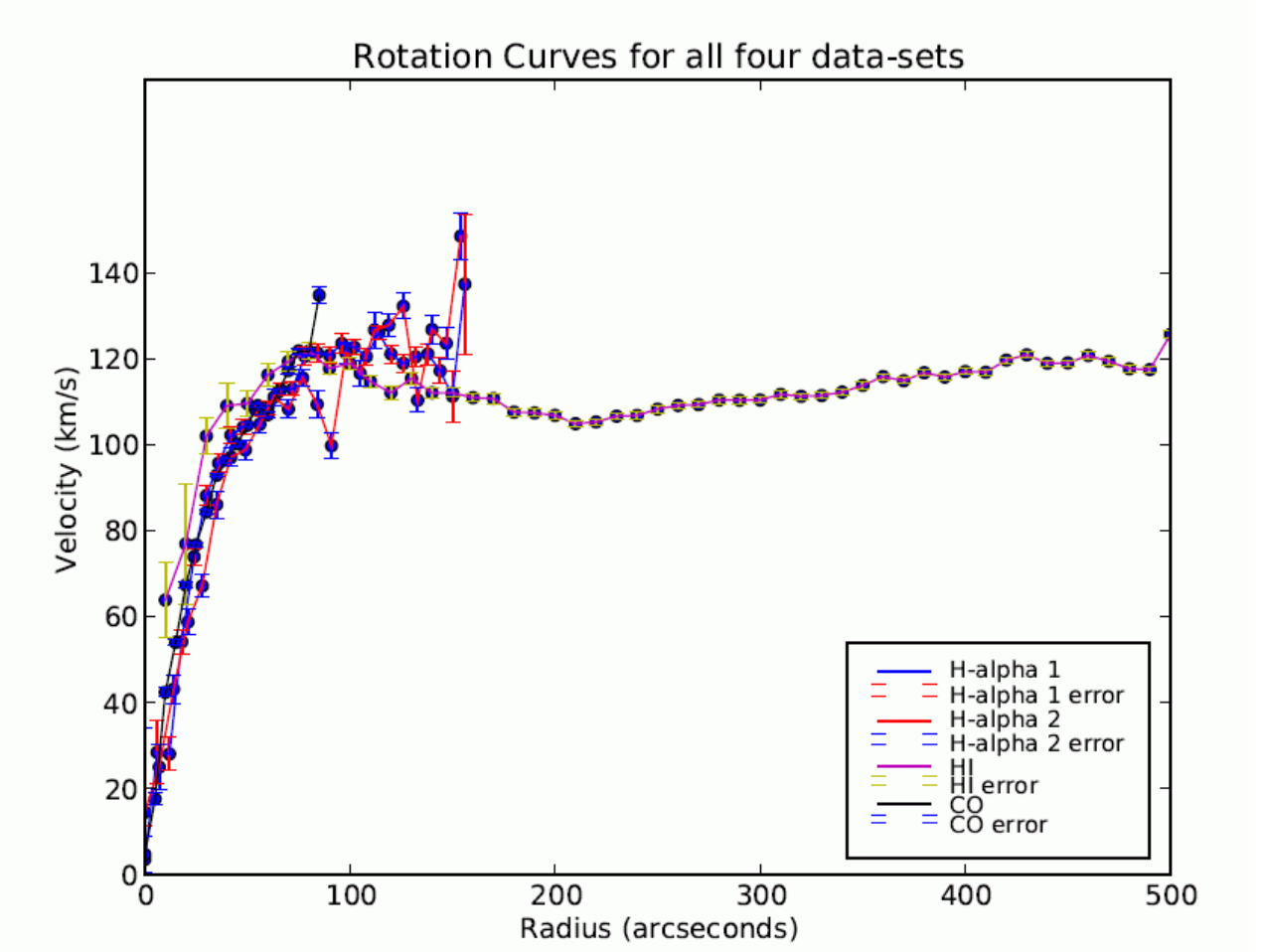


CARMA
CO (1-0)

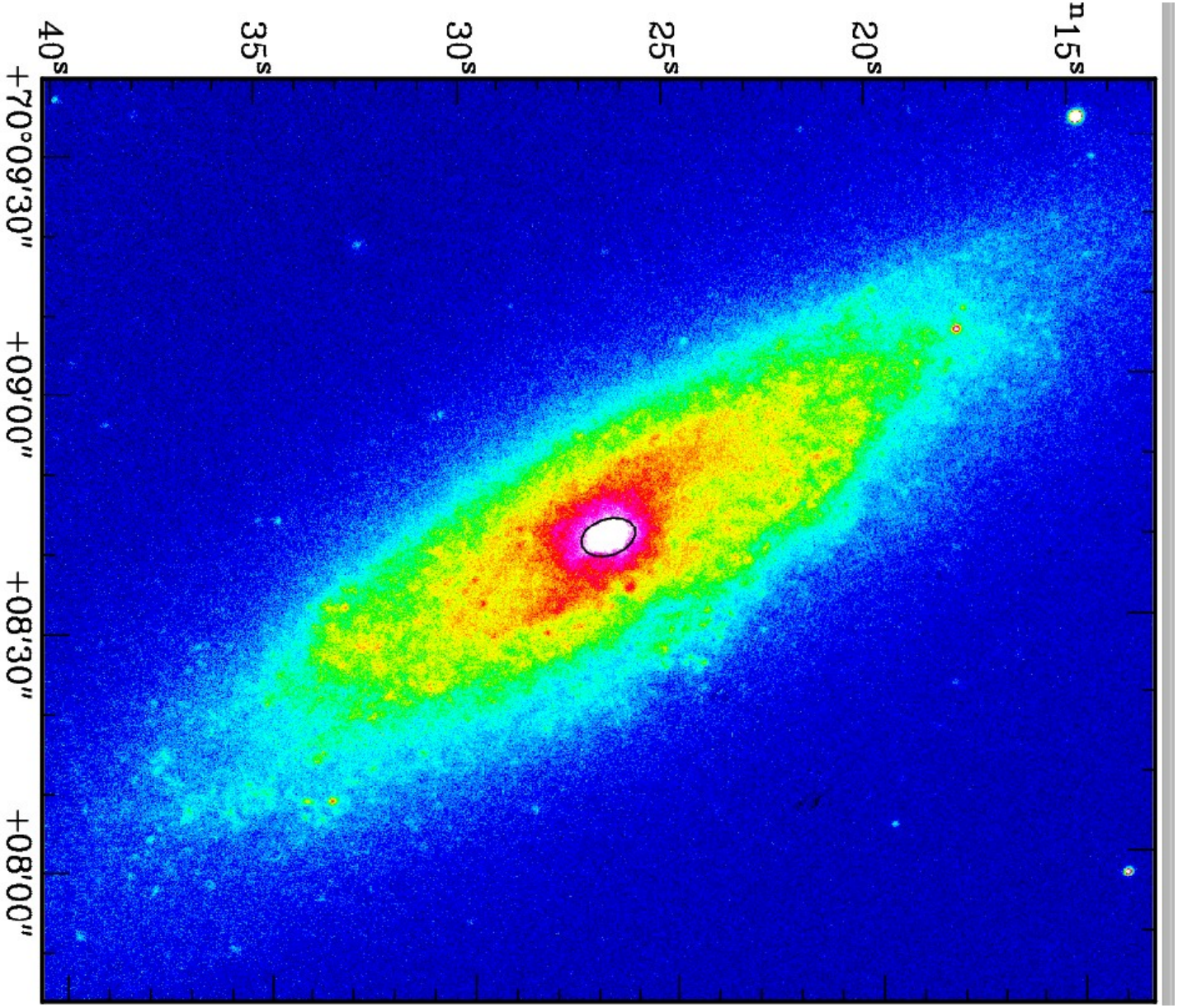
Data Cube to Rotation Curve

- Moment analysis
  - Classically: $I(x,y,vz) \rightarrow V_z(x,y) \rightarrow V_{rot}(r)$
  - Lots of issues at each step:
    - Moments vs. profile fitting vs. edge-trace
    - Beam smearing: spatial and velocity
    - Optically thin or thick tracer + coverage
- Full 3D modeling
  - Fairly new, and expensive; iterative (e.g. Swaters)

Rotation Curve comparison



H-band: a nuclear bar? (Freeland et al. 2009 submitted)



Unresolved (5”) high velocity gradient in the central 100 pc

- Bar at favorable viewing angle?
  - Strong bars don't form in hot stellar systems?
  - Unusually small bar (but bars can be nested)
- DM Cusp?
- DM around SMBH?
  - But very small bulge, so very small central BH?
- Star Formation?
- Something else?

Future Work

- High res (1.5” or 0.3”) of nuclear region
  - CARMA C-array starts April 6th !
- Full modeling, perhaps with a nuclear bar