

Speaker: Mattia Sirressi

Master thesis project at INAF-Osservatorio Astronomico di Brera



Supervisors: Claudia Cicone, Paola Severgnini, Massimo Dotti

In collaboration with:

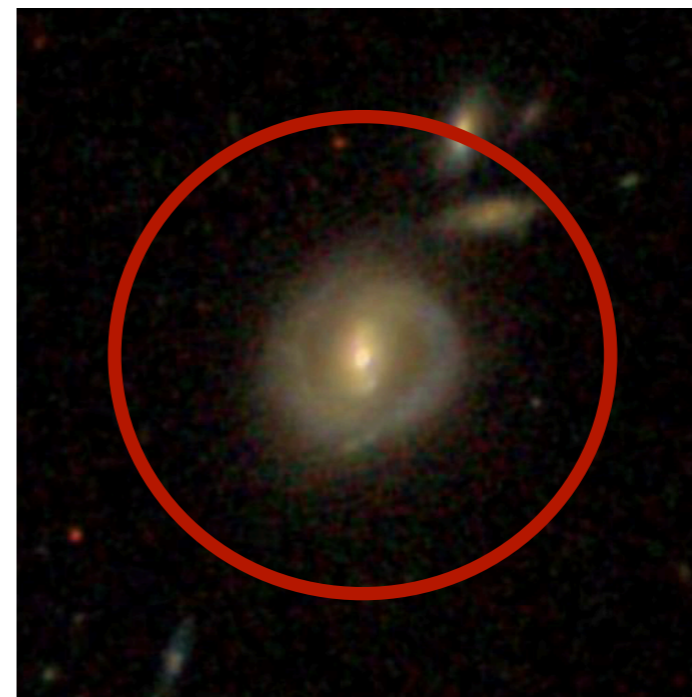
V. Braitto, R. Della Ceca, C. Vignali, J. Reeves, G. Matzeu,

L. Ballo, A. Caccianiga, S. Campana, A. Moretti

Testing the blast-wave feedback scenario in a local AGN with ALMA

Content

- Target source - MCG-03-58-007:
local ($z = 0.03$) AGN with X-ray **wind**
- Blast-wave **feedback** scenario
- **ALMA** CO(1-0) observations
to trace H₂ gas kinematics
- Rotating **disk** emission fit and study of the residuals
- Results and discussion:
low- v **outflow** or compact rotating structure?



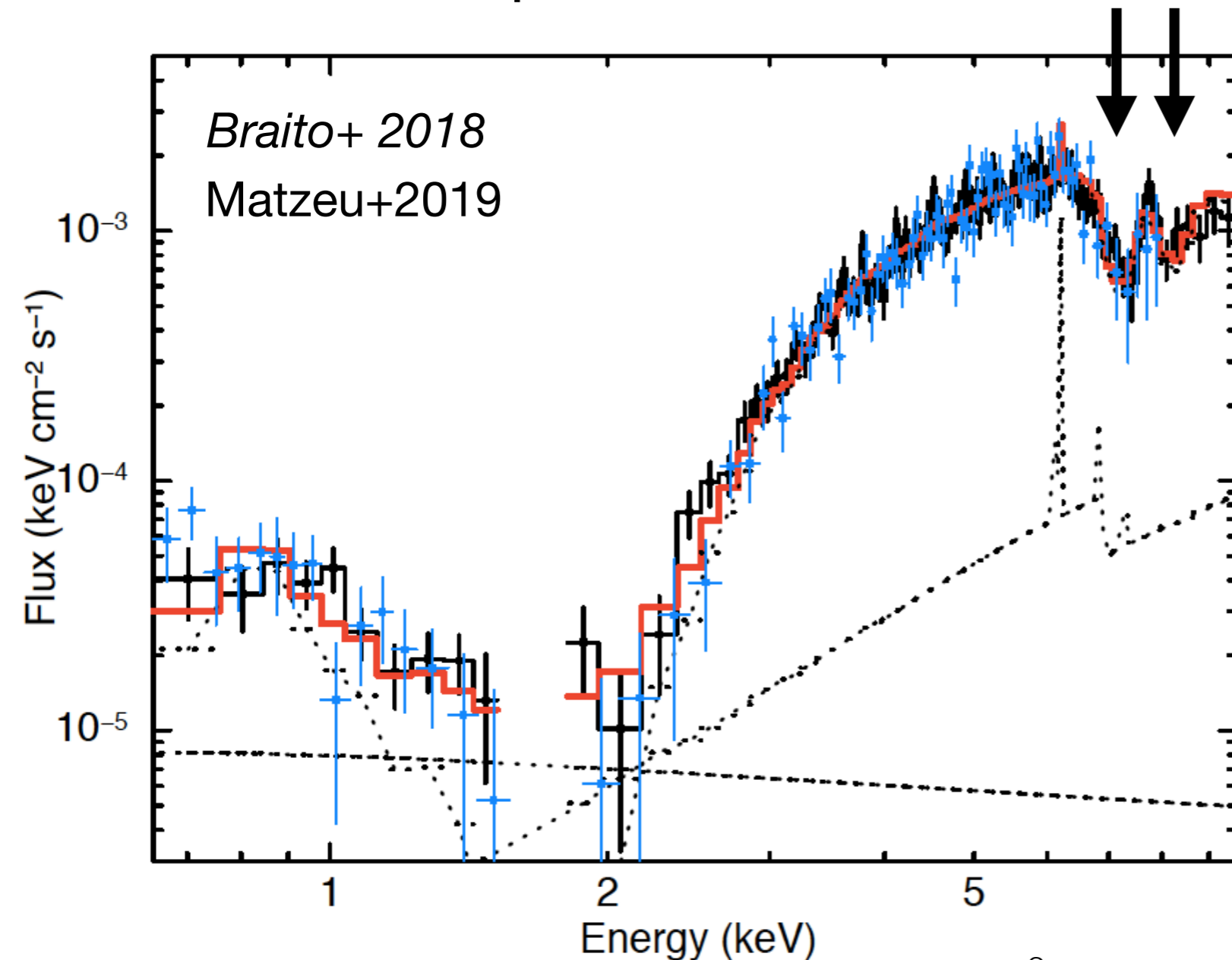
Aladin Lite (SDSS)

○ *ALMA FoV: 72 arcsec = 45 kpc*

AGN with fast nuclear wind

two X-ray **outflowing** absorbers at $v = 0.1c$ and $0.2c$

@ sub-pc scales



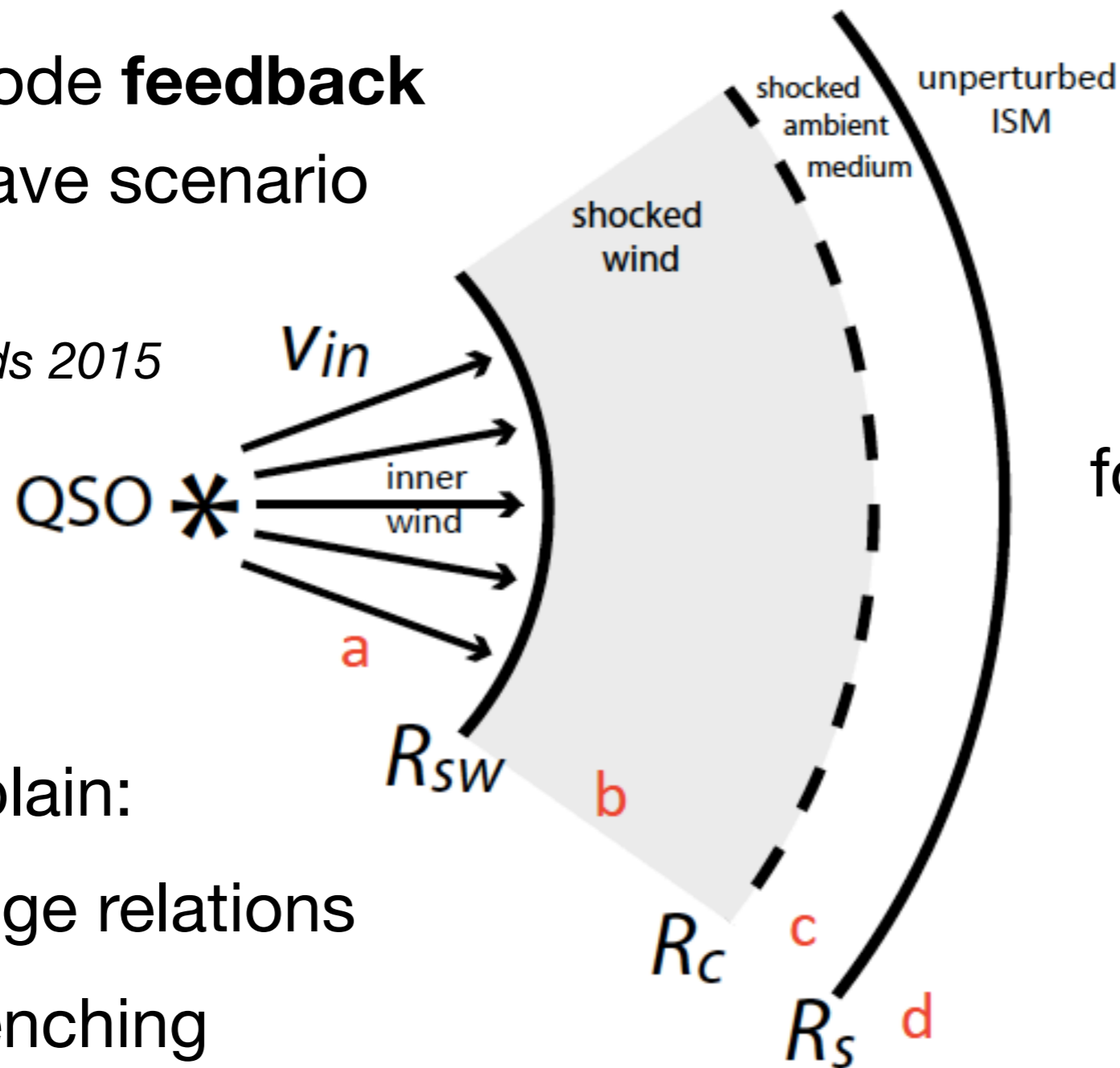
MCG-03-58-007

- Seyfert 2 at $z = 0.03$
- $L_{IR} = 1.7 \cdot 10^{11} L_{\odot}$
- $SFR \sim 10 M_{\odot} yr^{-1}$

Combining insights from X-ray and mm observations

quasar mode **feedback**
blast-wave scenario

King & Pounds 2015



ALMA proposal
for studying molecular
gas kinematics

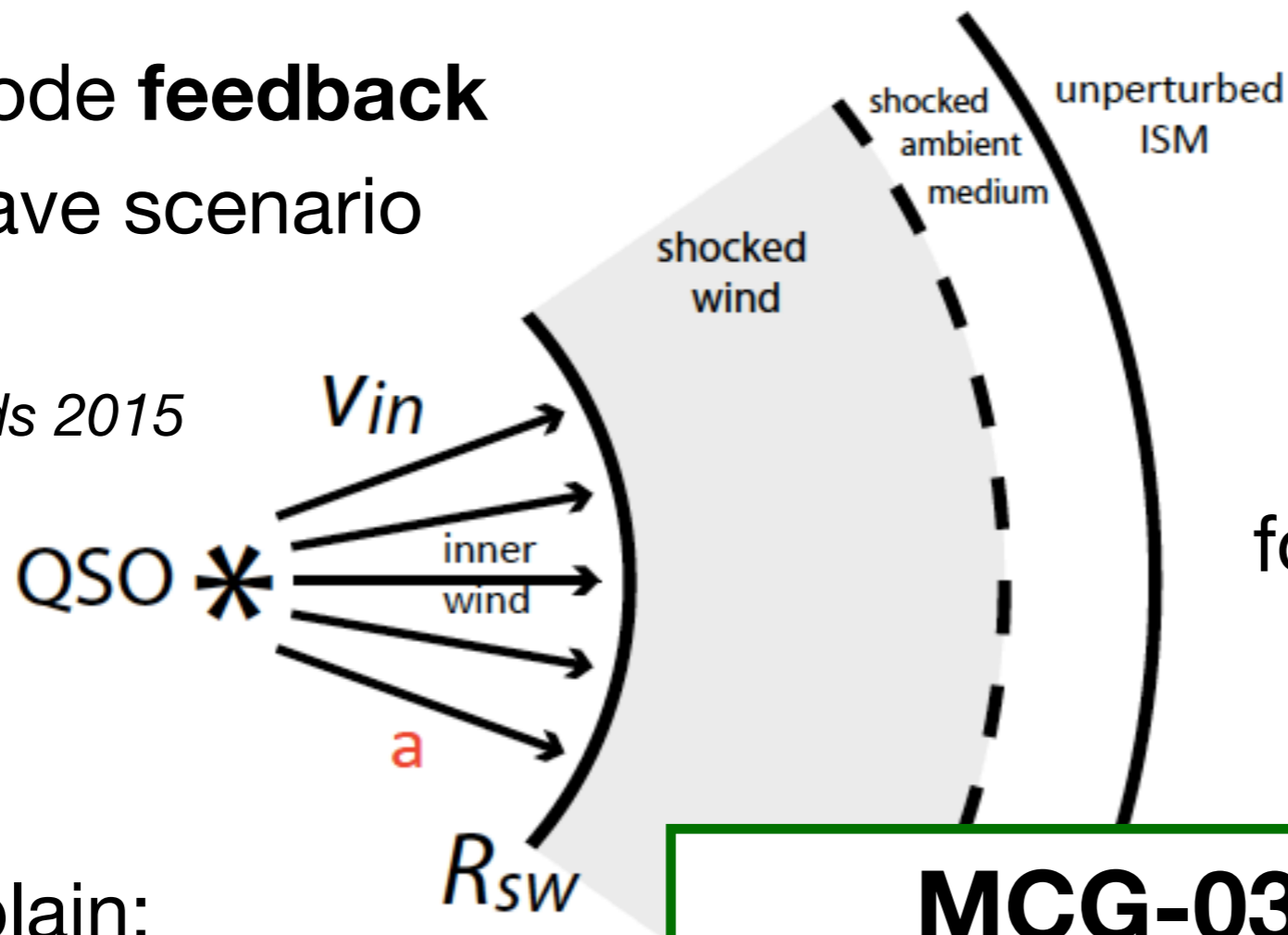
it can explain:

- BH-bulge relations
- SF quenching

Combining insights from X-ray and mm observations

quasar mode **feedback**
blast-wave scenario

King & Pounds 2015



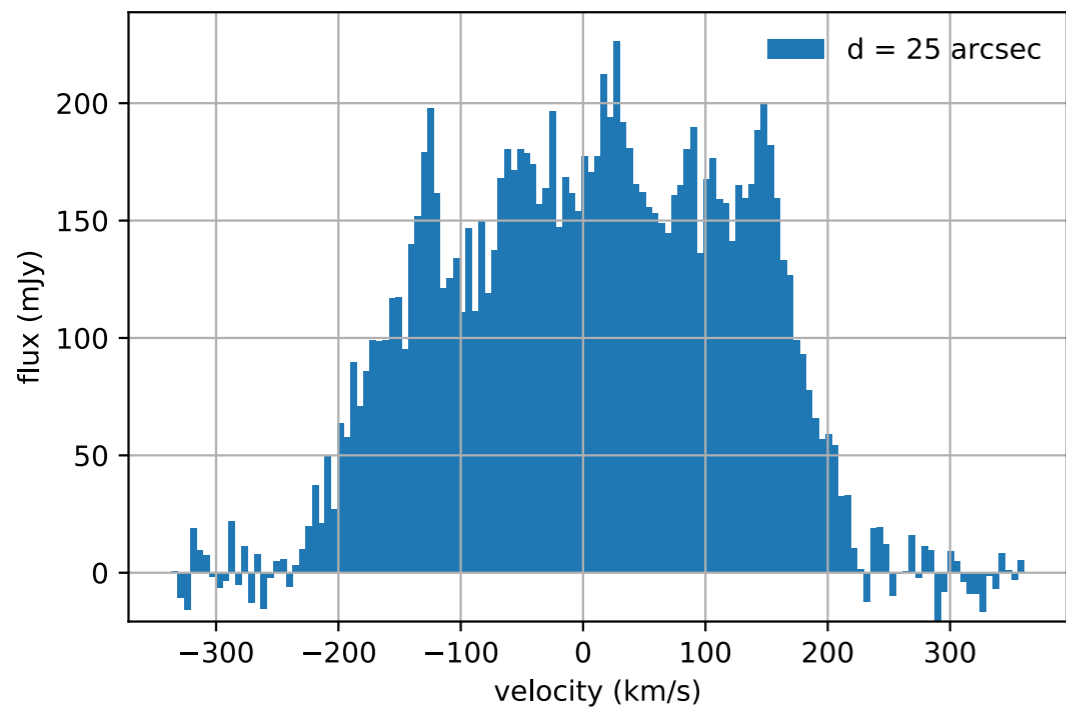
ALMA proposal
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it can explain:

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MCG-03-58-007
low SFR: best candidate
for studying AGN feedback

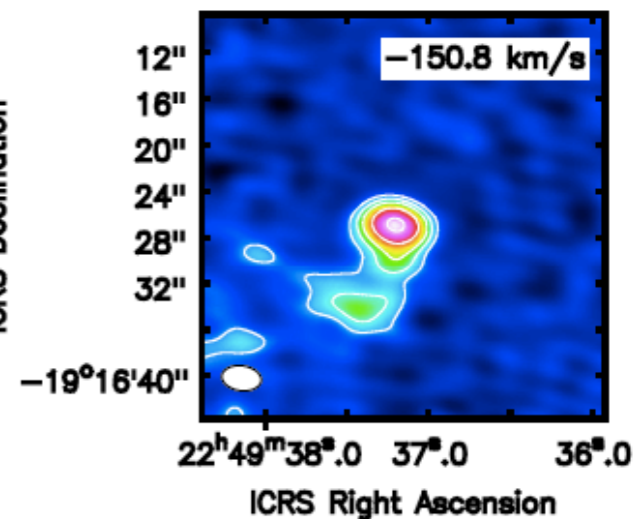
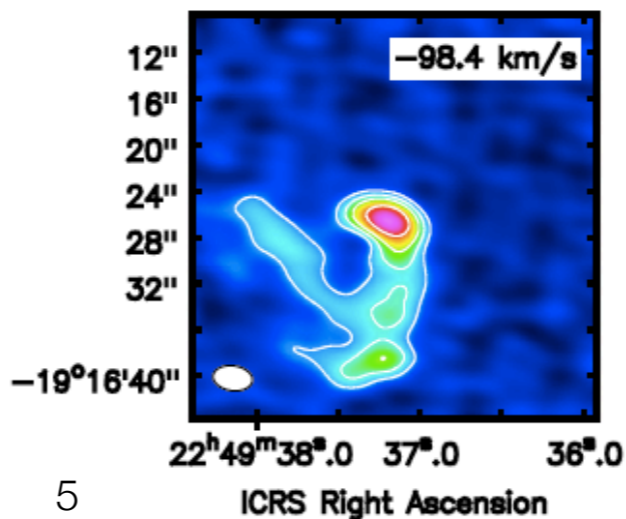
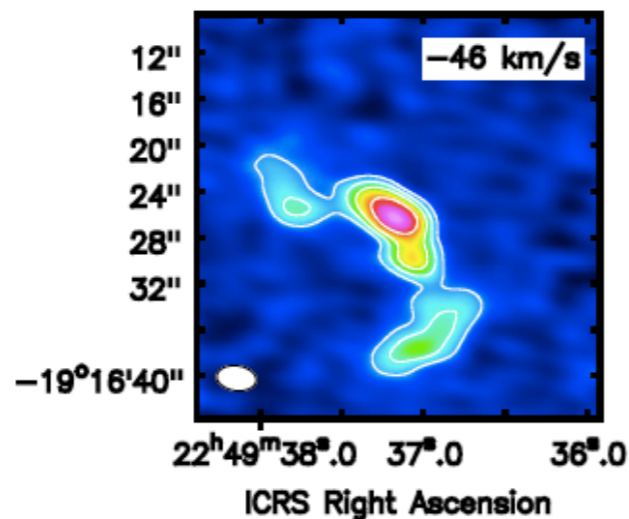
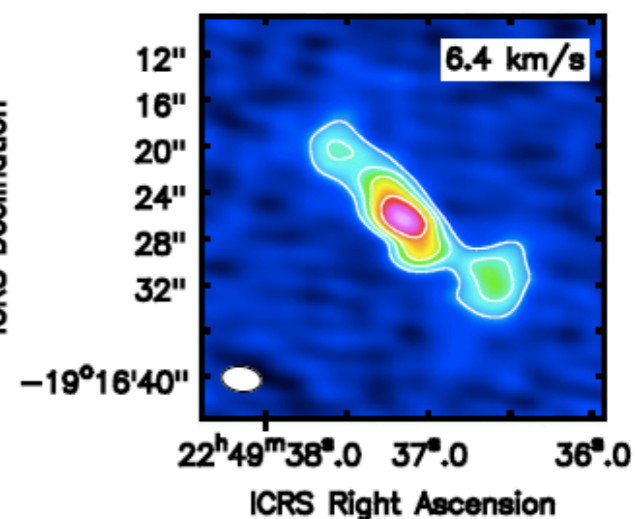
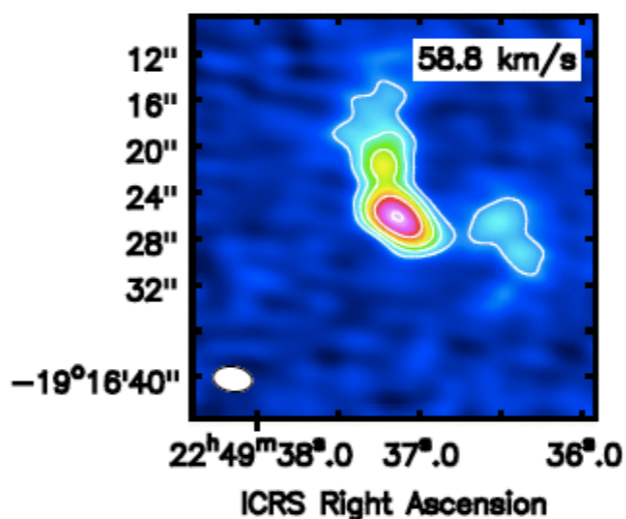
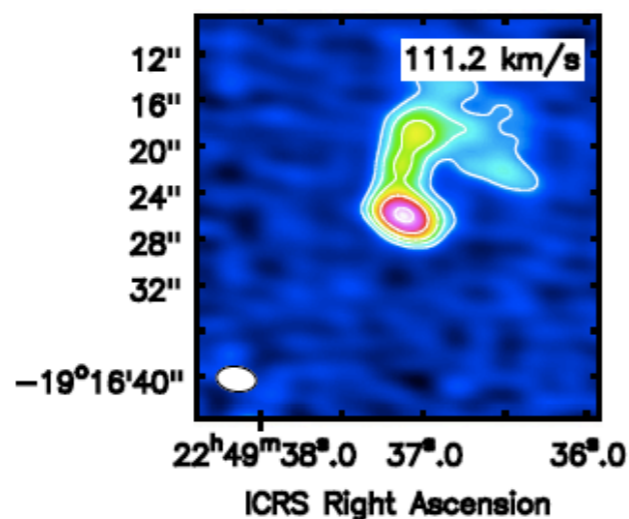
CO(1-0) line



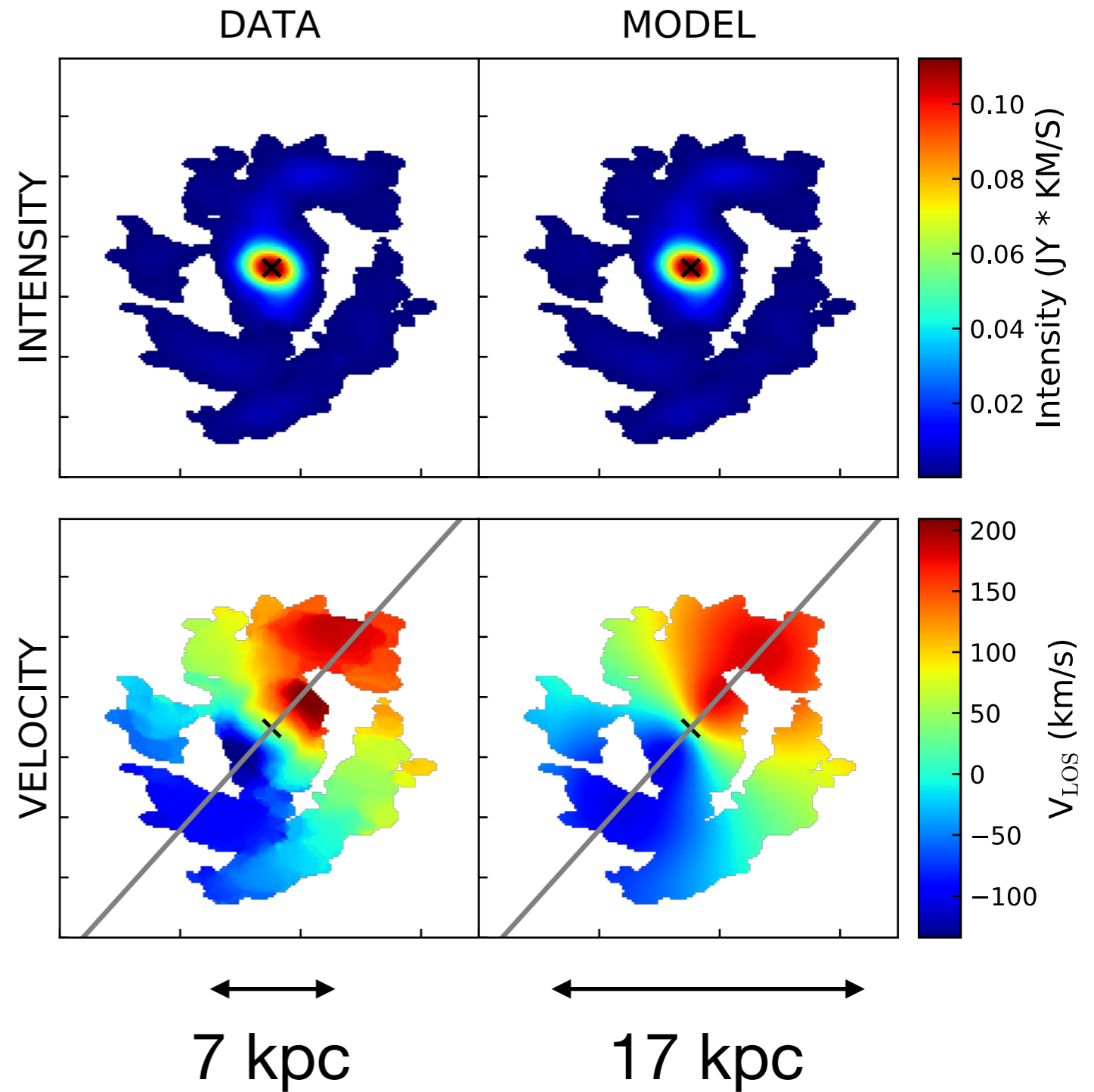
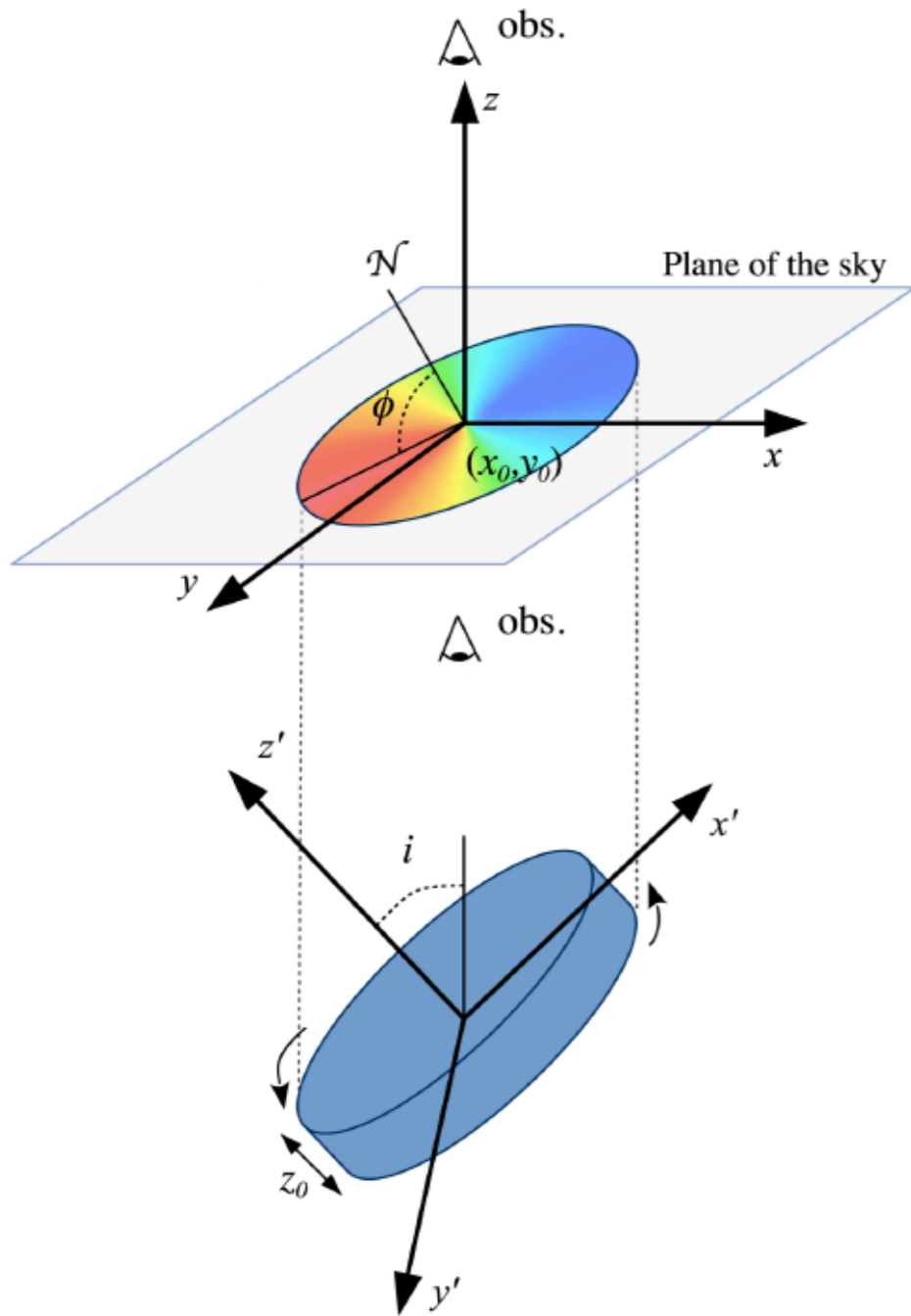
CO(1-0) emission dominated by rotation on a disk



↑
no high velocity components



3D - Barolo: disk model fit



Di Teodoro & Fraternali 2015

Data

Model

Residuals

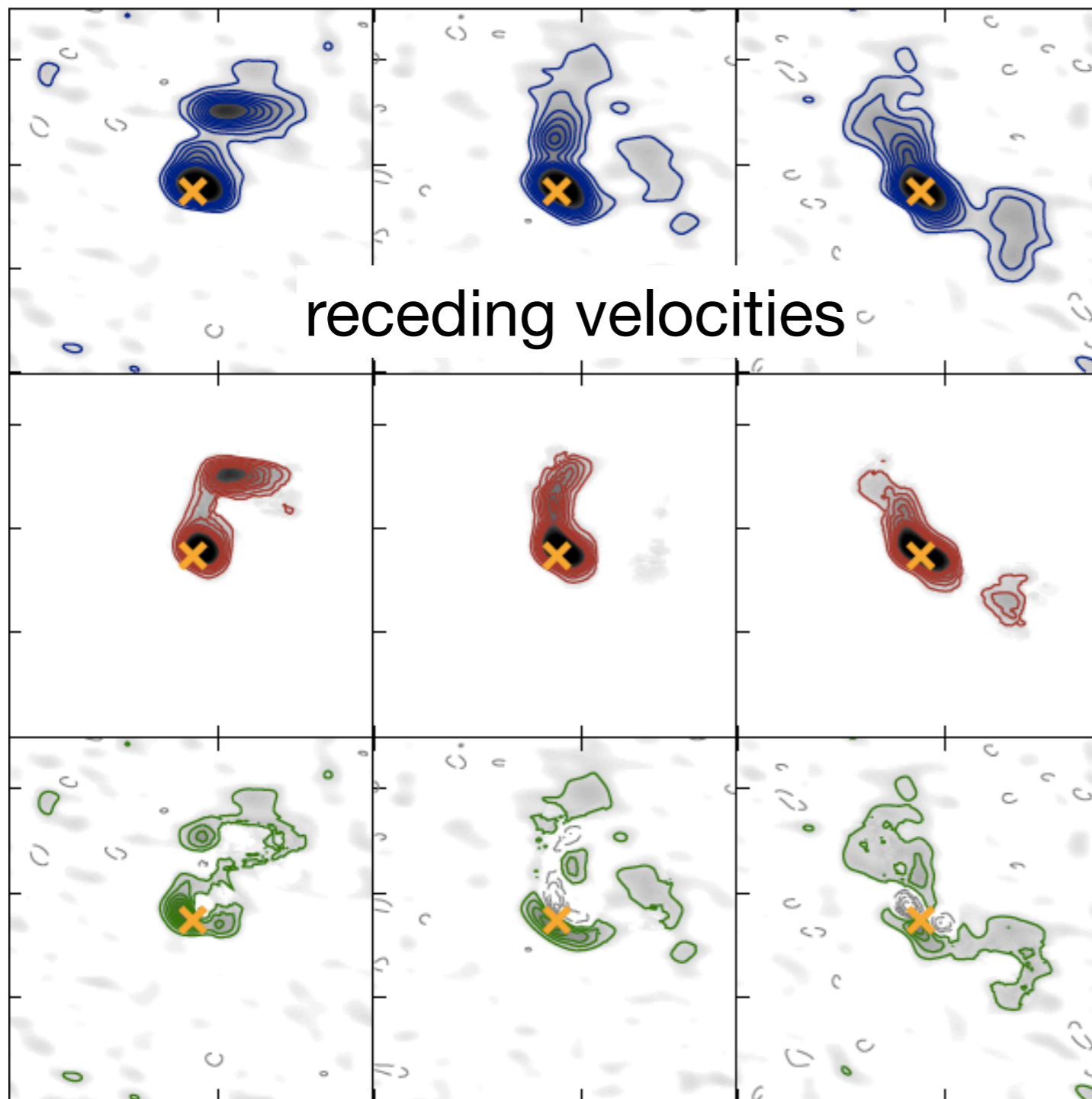
1x1.5 kpc

● Beam

$v = 141 \text{ km/s}$

$v = 88 \text{ km/s}$

$v = 36 \text{ km/s}$



Data

Model

Residuals

1x1.5 kpc

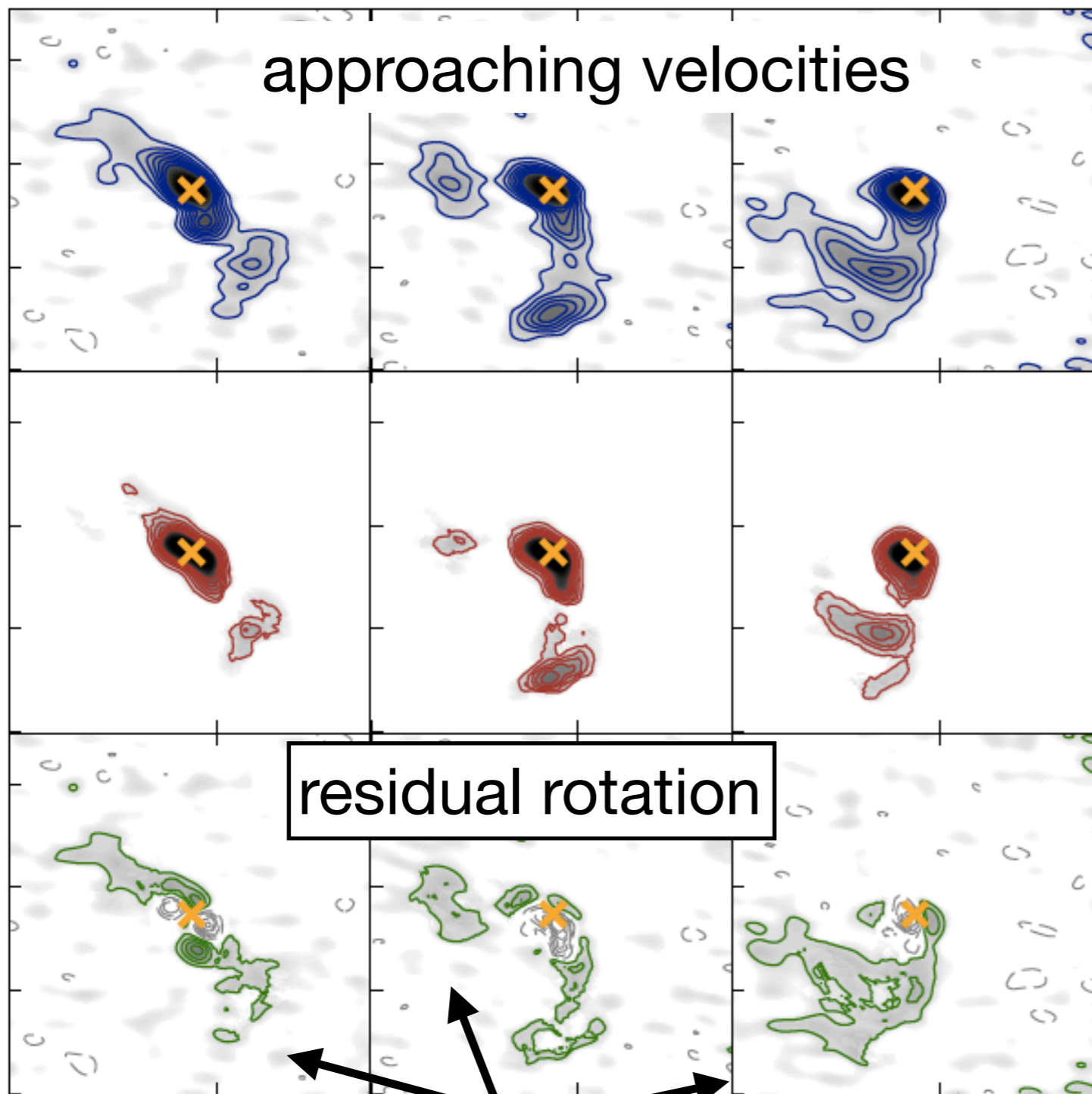
● Beam

$v = -16$ km/s

$v = -68$ km/s

$v = -121$ km/s

approaching velocities



residual rotation

$3 \sigma_{rms}$

Data

Model

Residuals

1x1.5 kpc

● Beam

$v = -16$ km/s

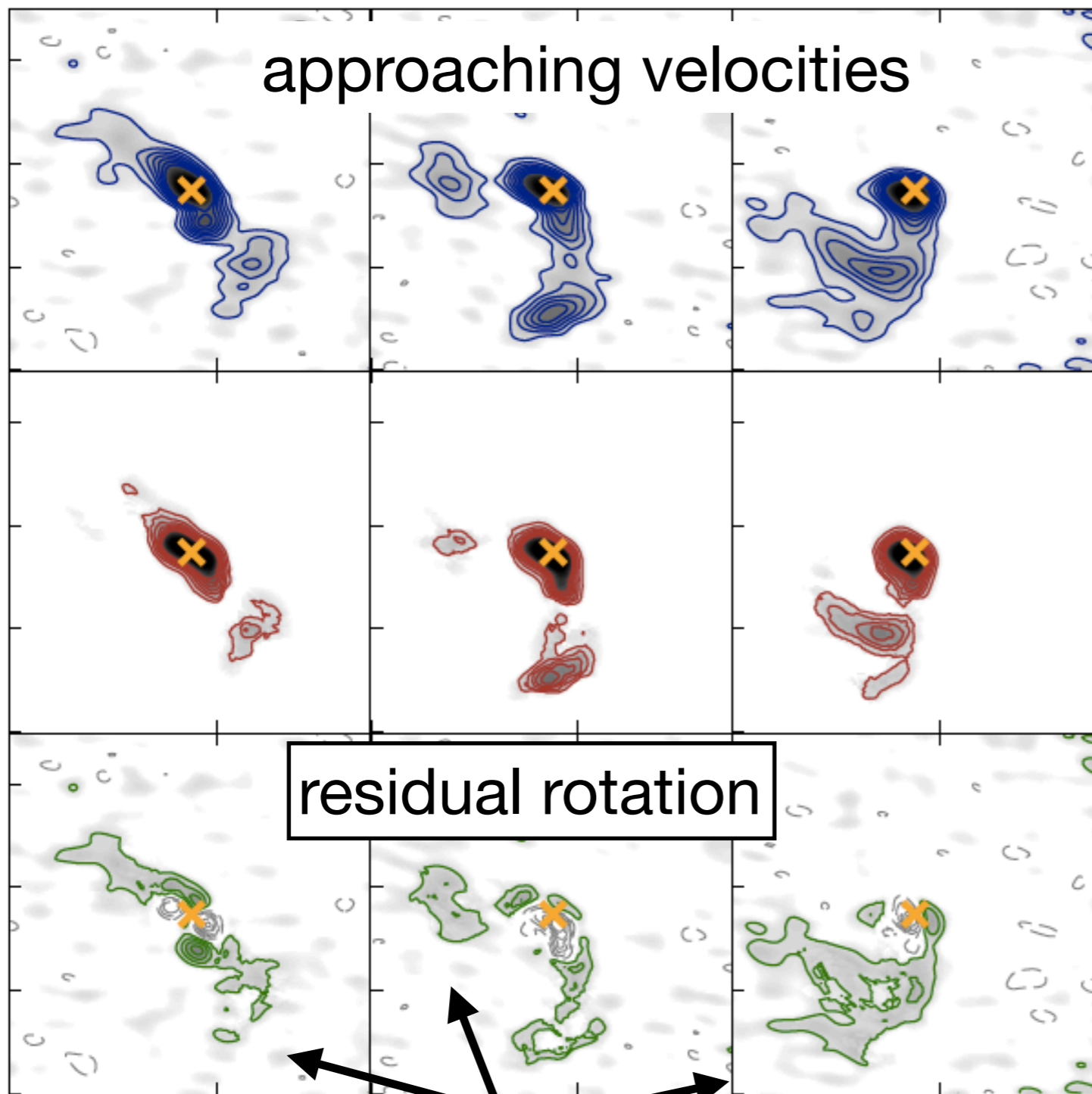
$v = -68$ km/s

$v = -121$ km/s

$v = -174$ km/s

$v = 193$ km/s

approaching velocities

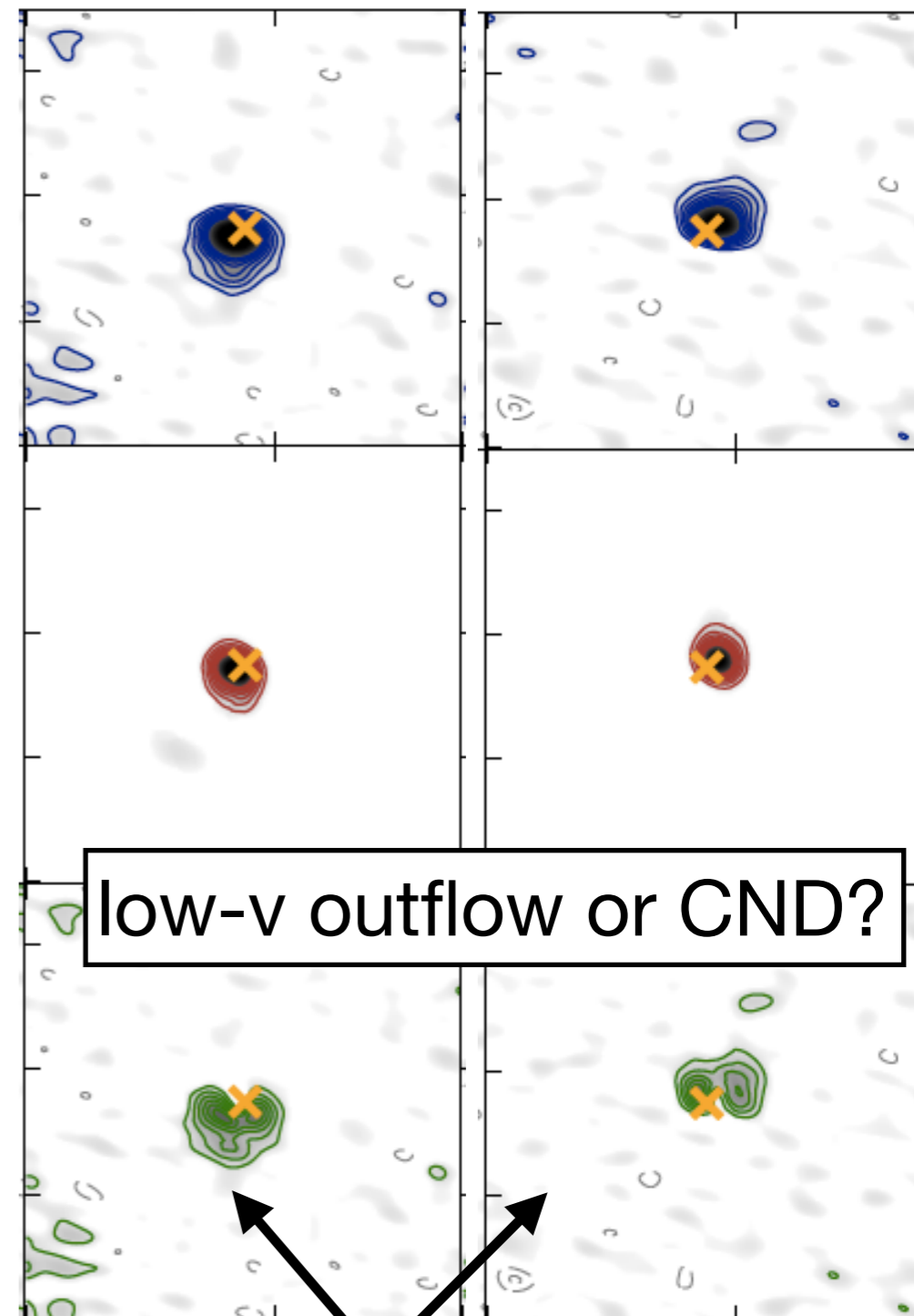


residual rotation

$3 \sigma_{rms}$

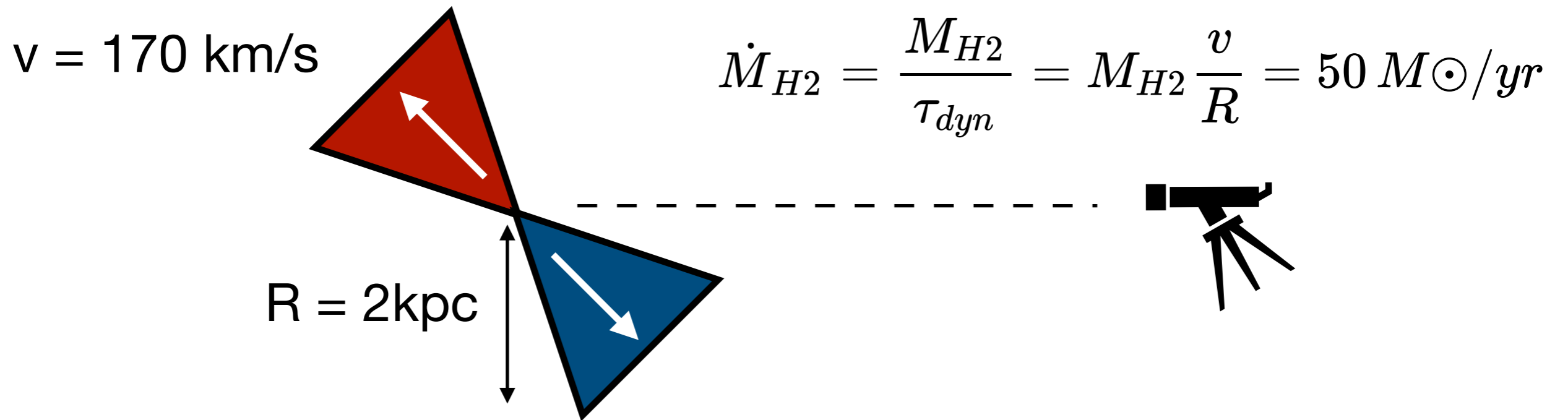
7

low-v outflow or CND?



$20 \sigma_{rms}$

Momentum-conserved outflow



This work

$$\dot{P}_{H_2} \sim 10^{35} \text{ g cm s}^{-2}$$

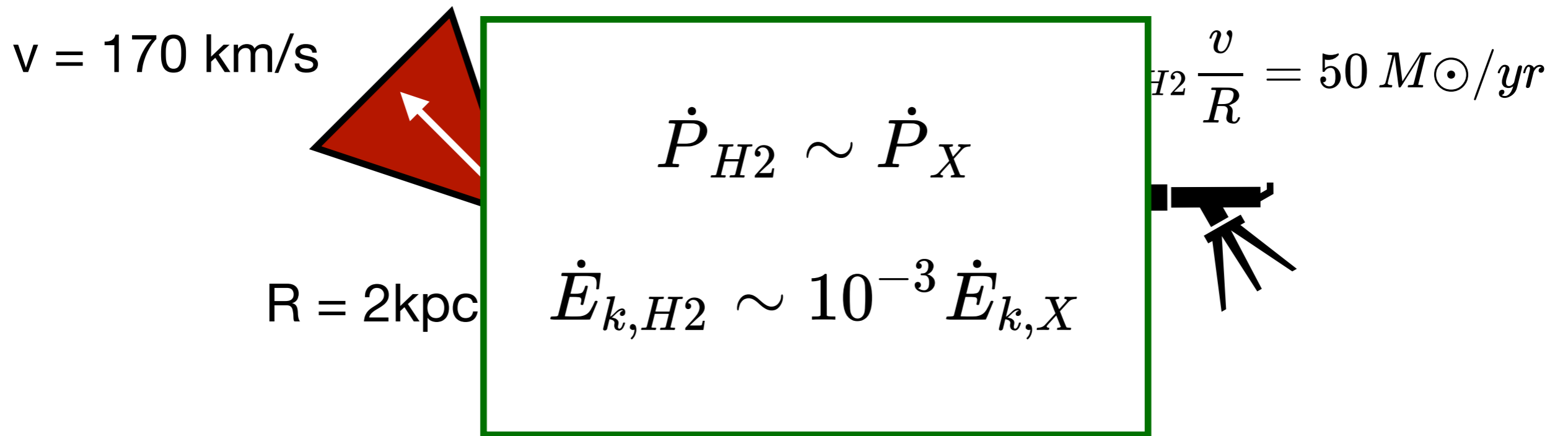
$$\dot{E}_{k,H_2} \sim 10^{41} \text{ erg s}^{-1}$$

Braito+2018

$$\dot{P}_X \simeq 2 \cdot 10^{35} \text{ g cm s}^{-2}$$

$$\dot{E}_{k,X} \simeq 2.4 \cdot 10^{44} \text{ erg s}^{-1}$$

Momentum-conserved outflow



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Braito+2018

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Optical spectrum: mid-scale wind?

6dF Galaxy Survey - Jones+ 2009

two [OIII] lines:

blue wings FWHM=900km/s

fibre aperture = 6.7 arcsec = 4 kpc

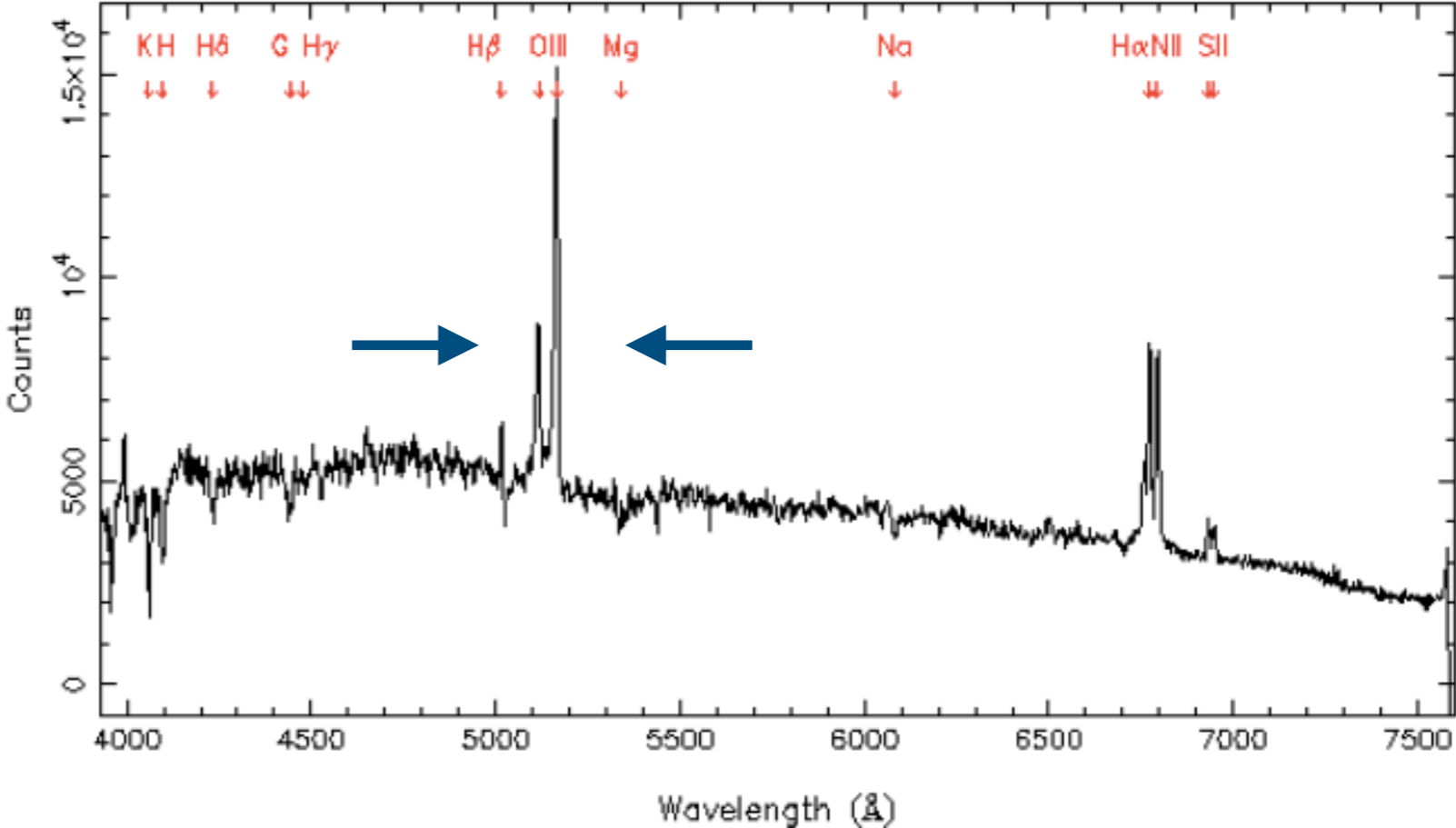
shifted by 500km/s

Braito+ 2018



possible outflowing

ionised gas @ 10-100 pc



Optical spectrum: mid-scale wind?

two [OIII] lines:

blue wings FWHM=900km/s

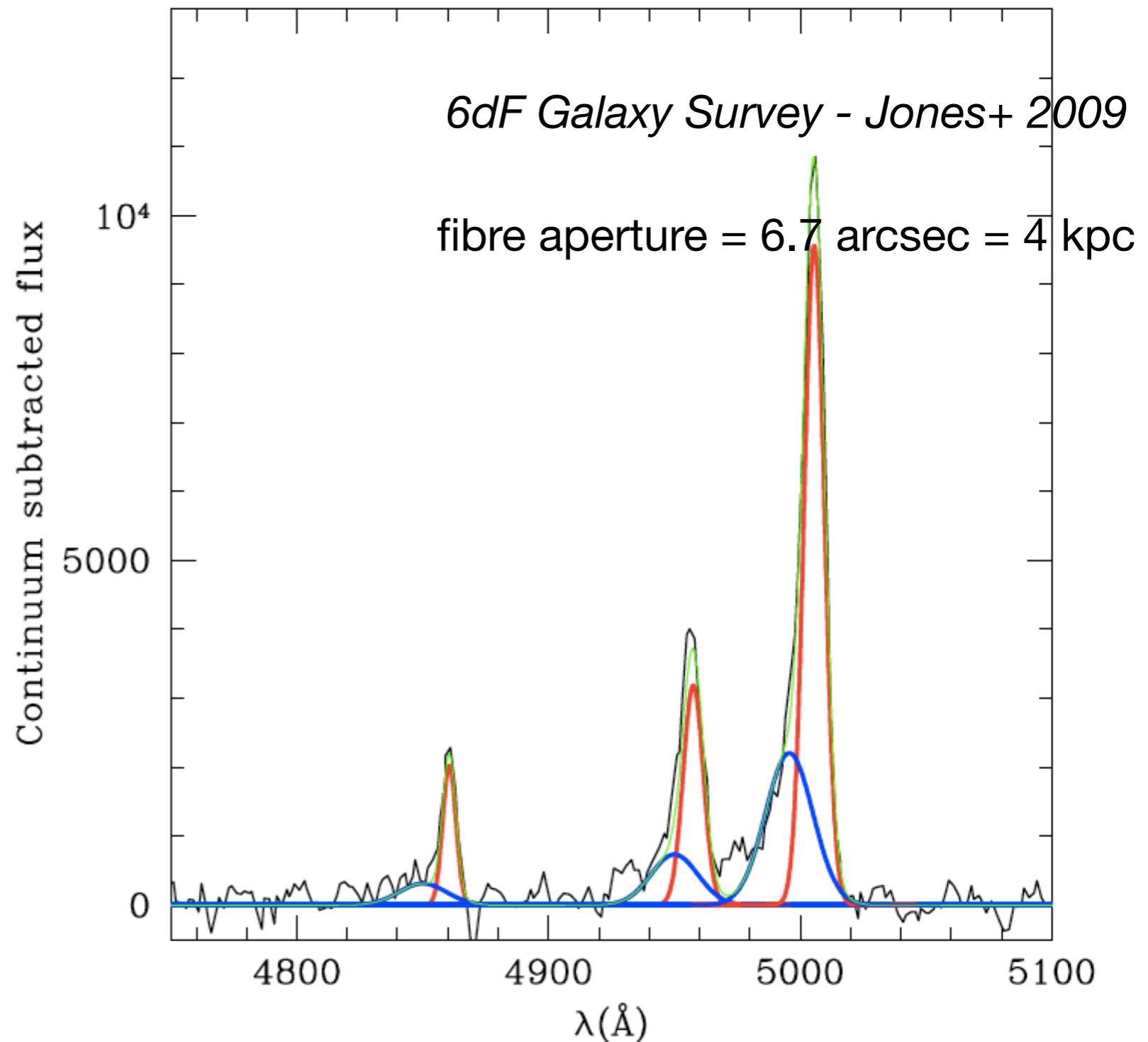
shifted by 500km/s

Braito+ 2018



possible outflowing

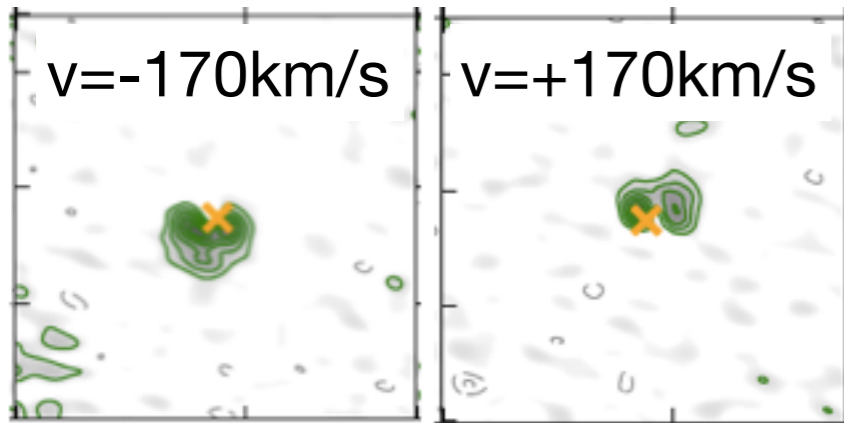
ionised gas @ 10-100 pc



Compact rotating structure

Residuals

rotating with a different geometry!



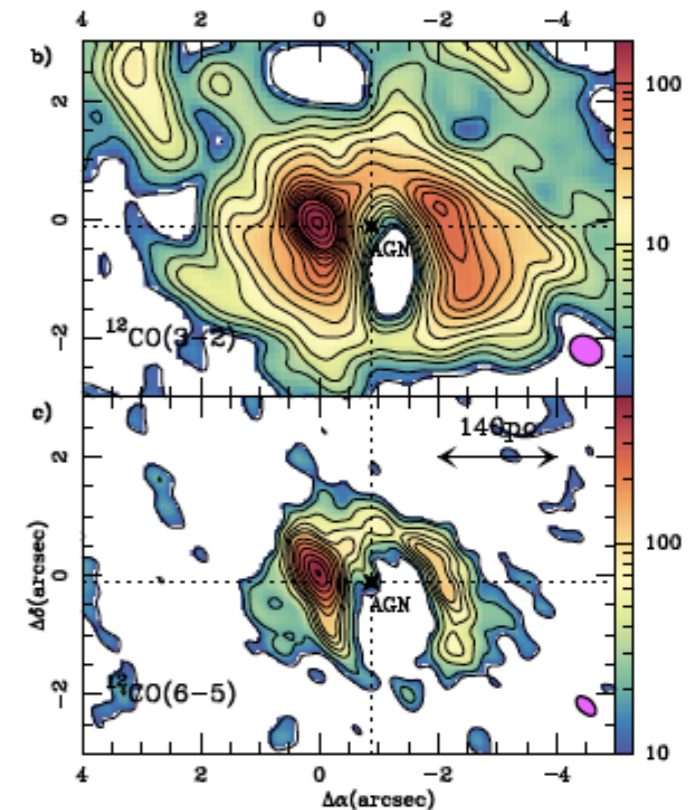
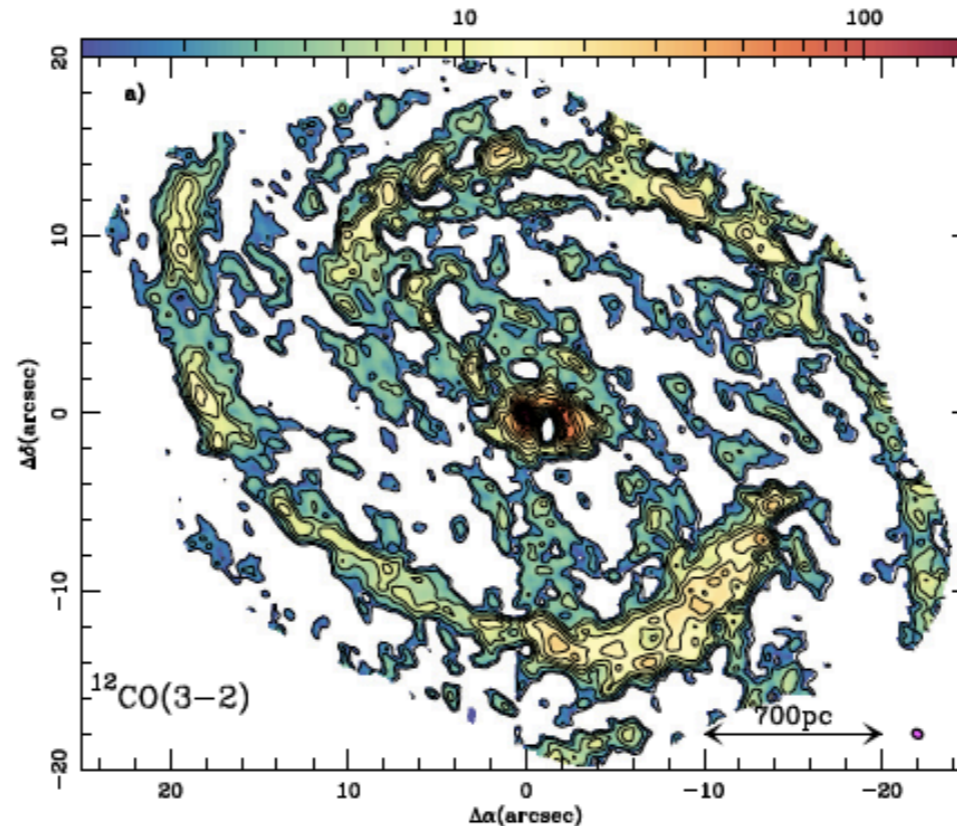
scale = 2 kpc

prototype of CND

García-Burillo+2014

NGC1068

scale = 100 pc

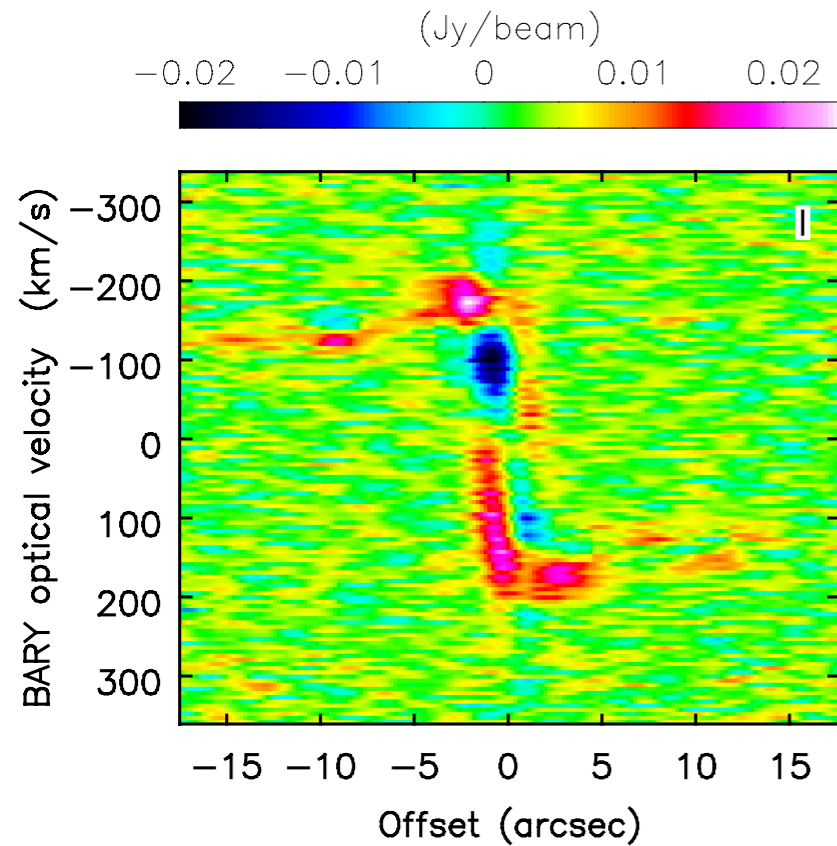


Summary

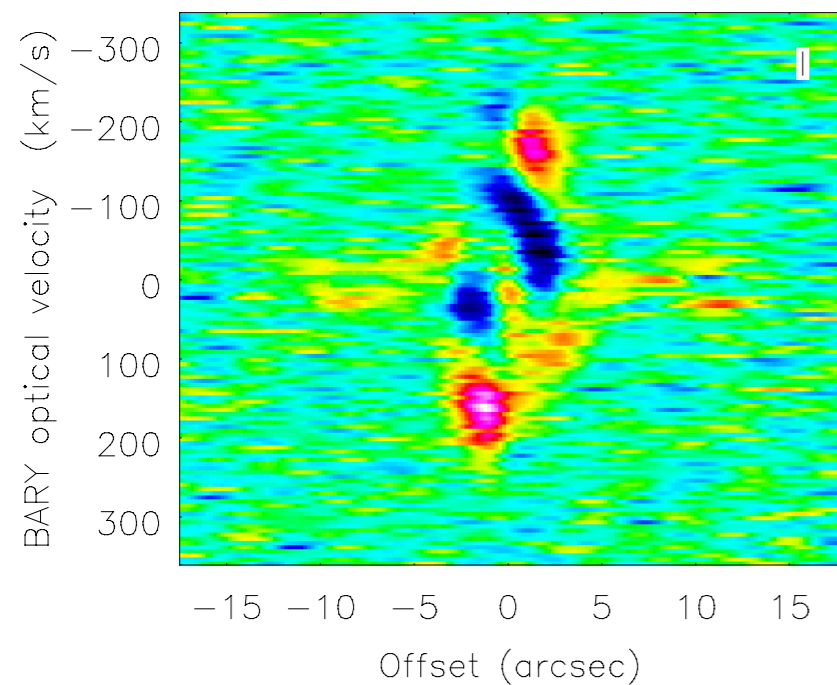
- MCG-03-58-007 best candidate for studying AGN feedback
- ALMA observations: rotation model and residuals
- molecular outflow consistent with **momentum-conserved** model

Thank you for the attention!

PV diagrams of residuals



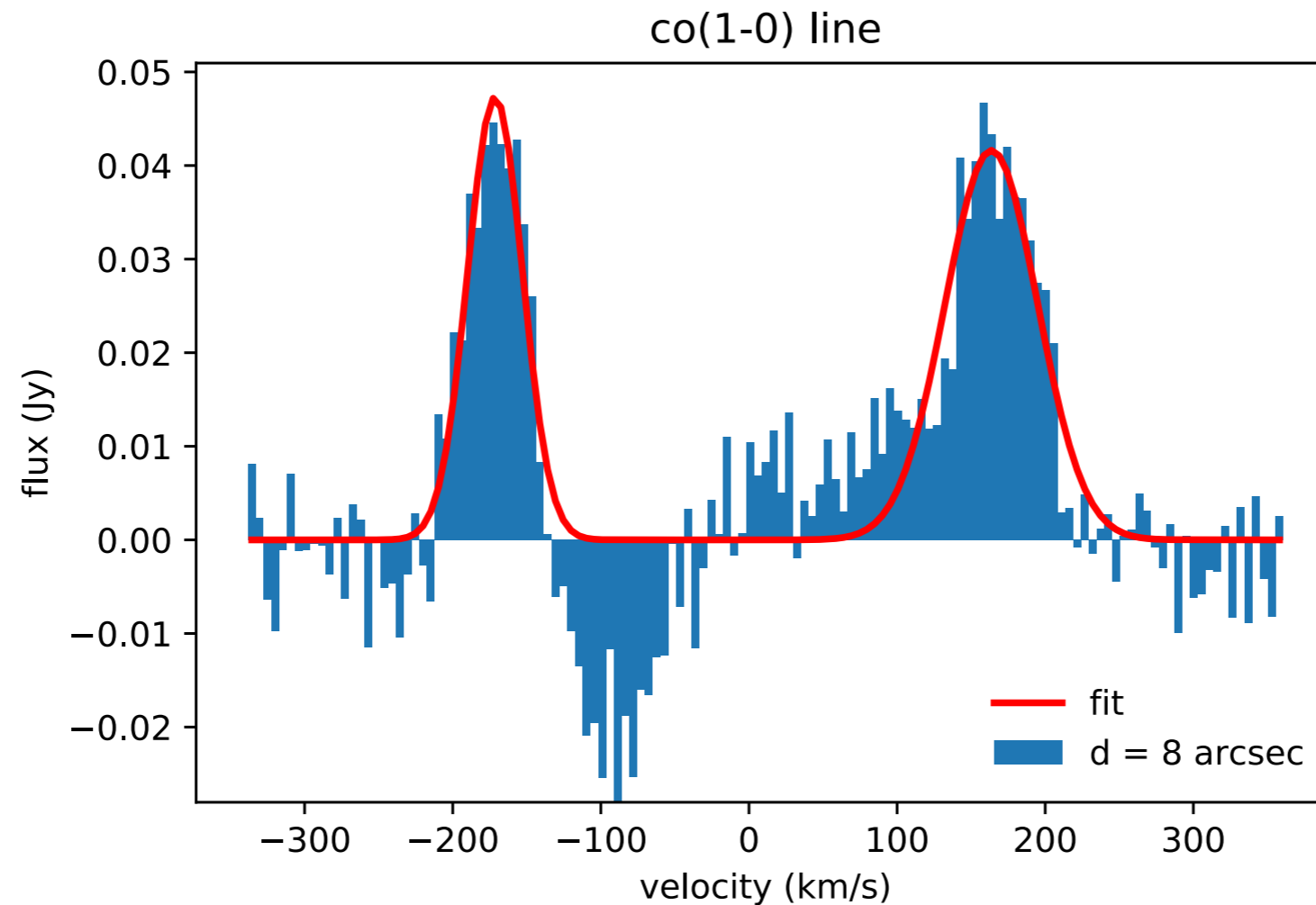
along major axis -> residual rotation



along minor axis -> no counter-rotation

From luminosity to mass

Solomon 2005



residual wings flux \rightarrow CO luminosity \rightarrow H₂ outflowing mass

conversion factor = 2.1

Cicone+2018