AGN feedback through UFO and galaxy-wide winds in the early Universe

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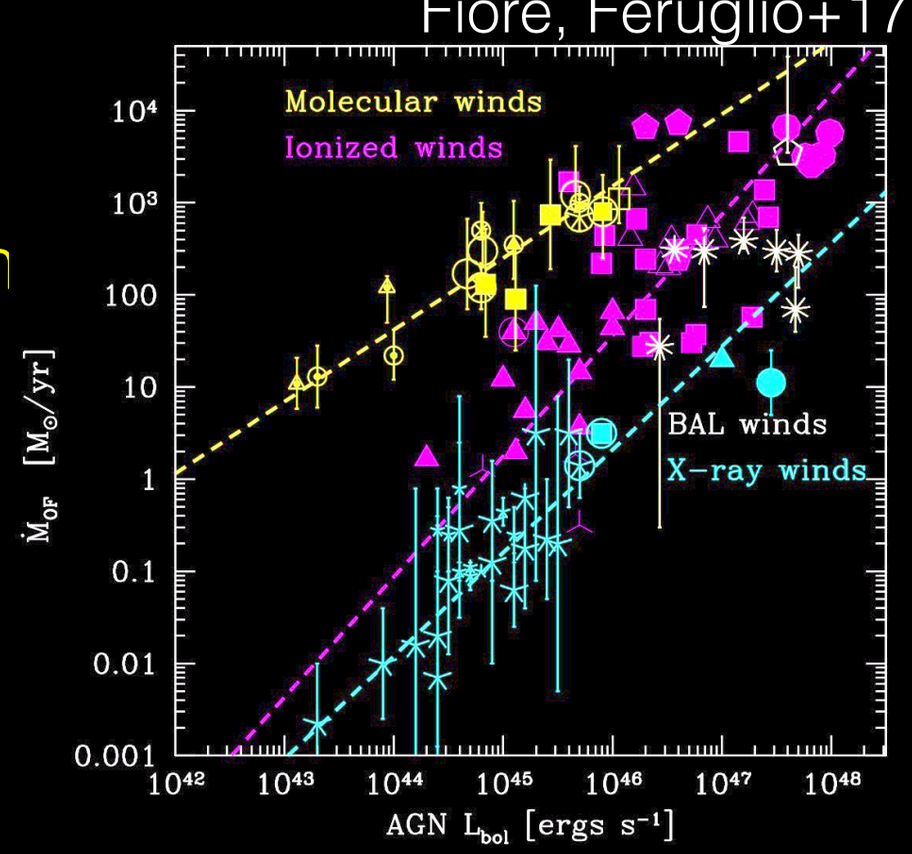
Thanks to:
E. Piconcelli, F. Fiore, M. Bischetti, R. Maiolino, R. Neri,
A. Ferrara, S. Gallerani,
D. Downes, C. Cicone, G. Vietri, L. Zappacosta

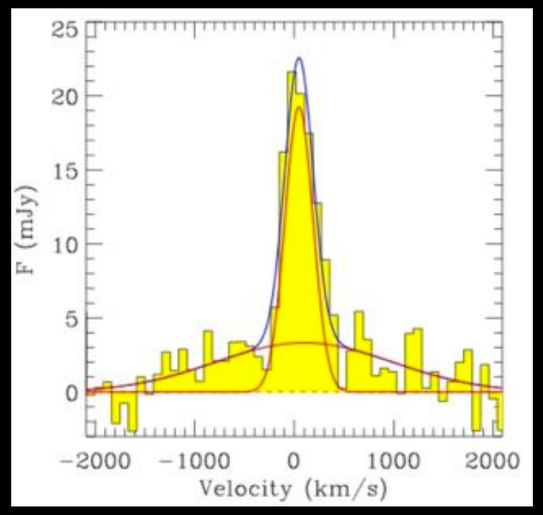
The X-ray Universe 2017 - Rome June 6th, 2017

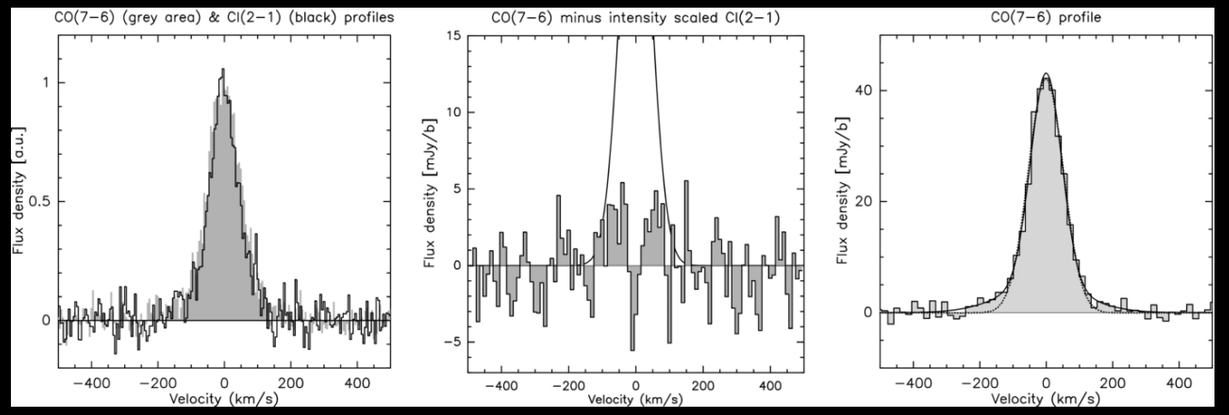
Motivation

- Nuclear / galactic outflows at z=0
- Galactic outflows at high z: only a few known
  - RX J0911+0550 at z=2.8 (Weiss+12)
  - Eyelash at z=2.7 OH absorption (George+14)
- J1148 z~6.4 : [CII] outflow

(Maiolino+12, Cicone+14)



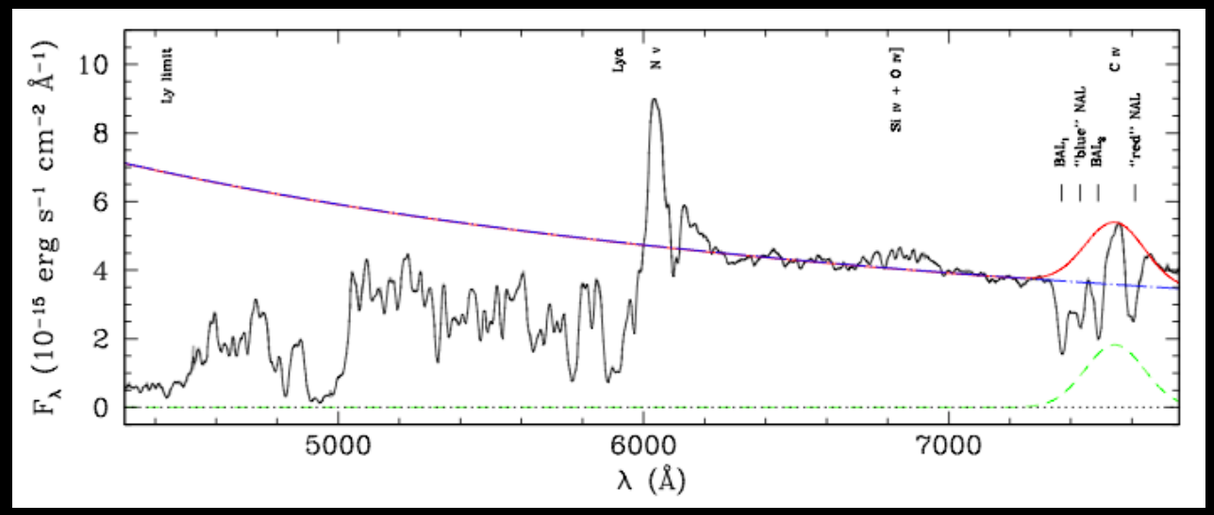




Why APM 08279

- High redshift z=3.912
- Bright, gravitationally lensed: $L_{bol} = 7e15\ m^{-1}\ L_o$

- CIV BAL , variable (Saturni et al. 2014, 2016, Trevese et al. 2013)



- Persistent, well studied, UFO

(Chartas+09, Saez&Chartas11,Hagino+16)

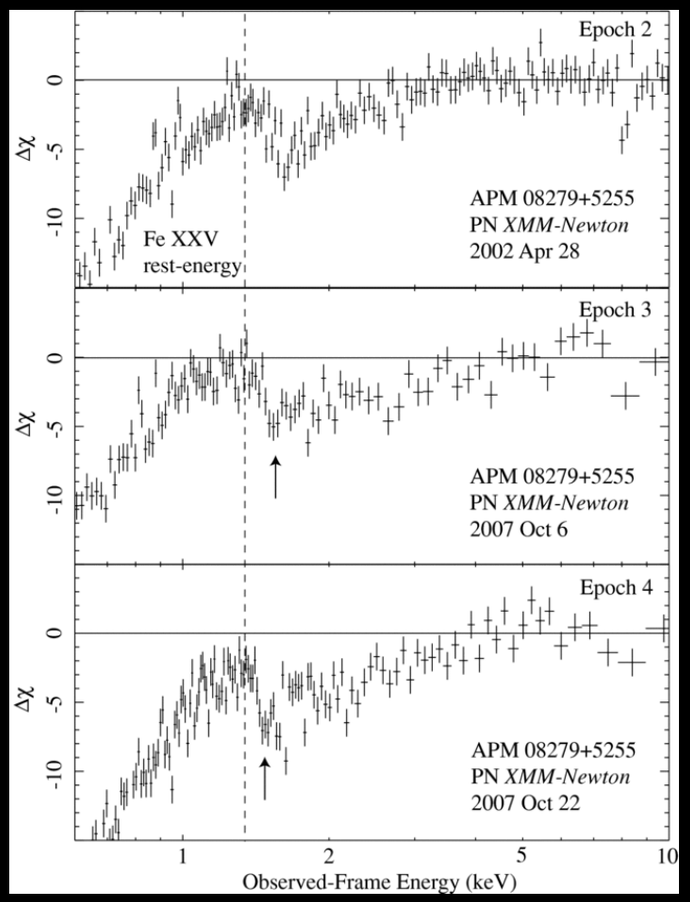
Ideal to probe QSO feedback at high z

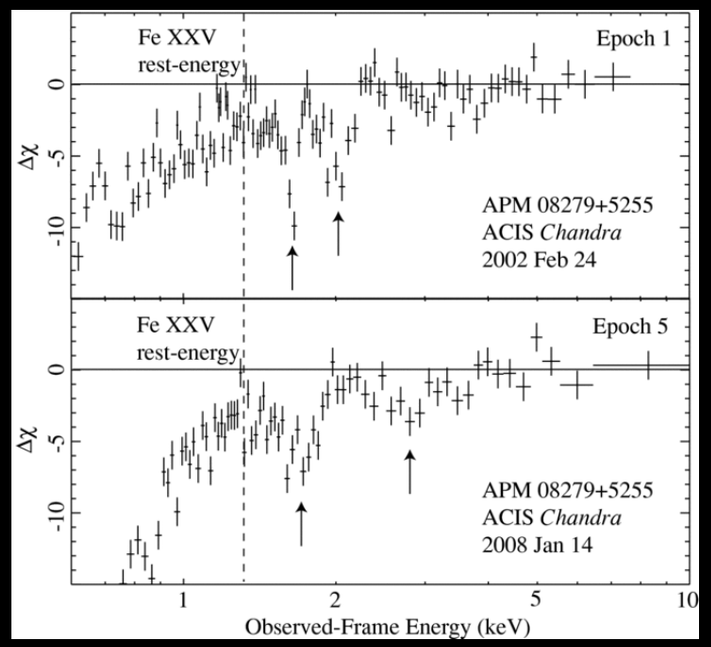
APM 08279 UFO(s)

Two main scenarios:

- Saez & Chartas 2011

Lensing magn. m=100
v(UFO)=0.16-0.36c
dM/dt(UFO)=21 Mo/yr

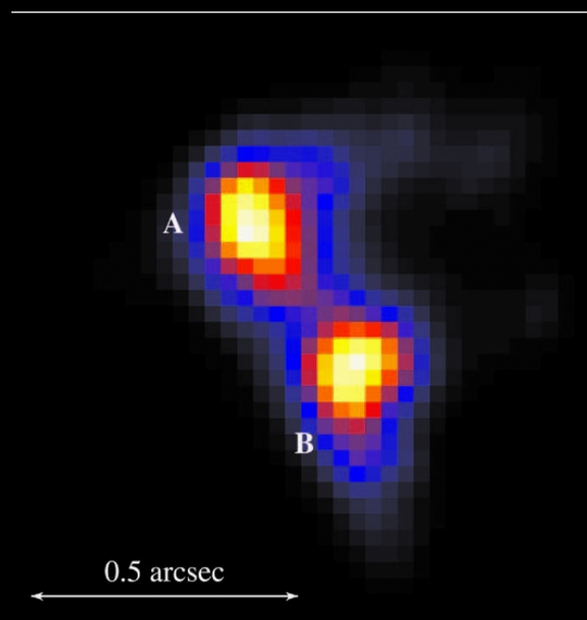




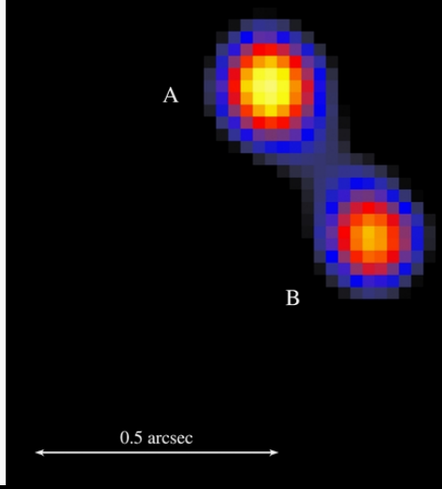
- Hagino+16

No/little magnification
v(UFO)=0.22c

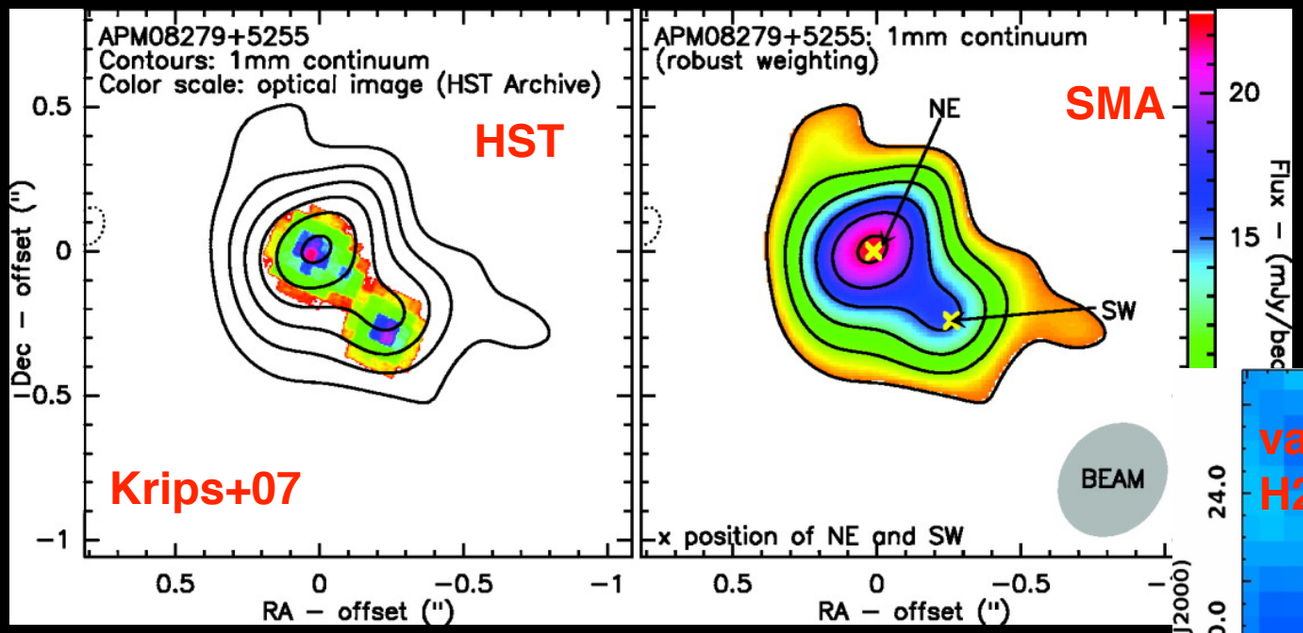
$$\dot{M}_{UFO} = 10.5 \frac{M(BH)}{2\times10^9} \frac{v_{UFO}}{0.3c} \; M_\odot/yr$$

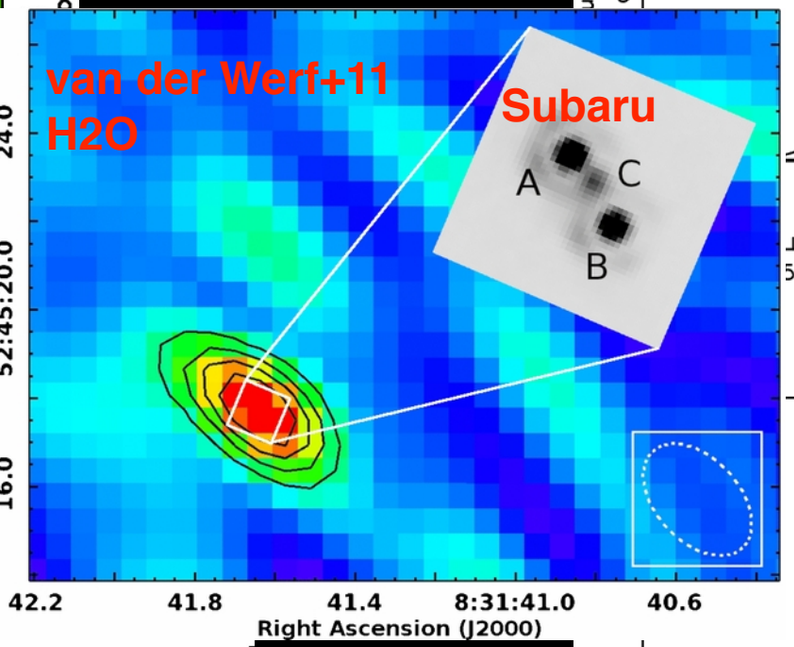


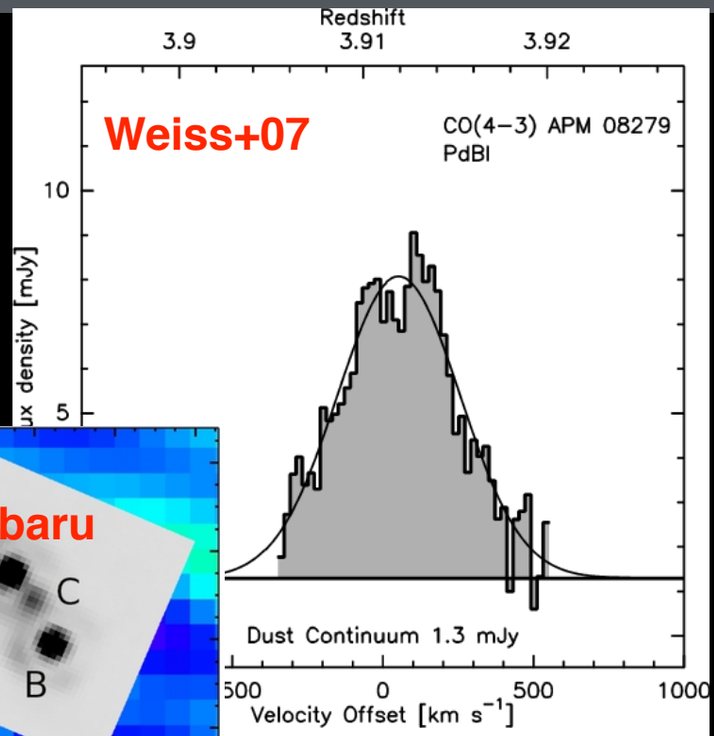
Chandra

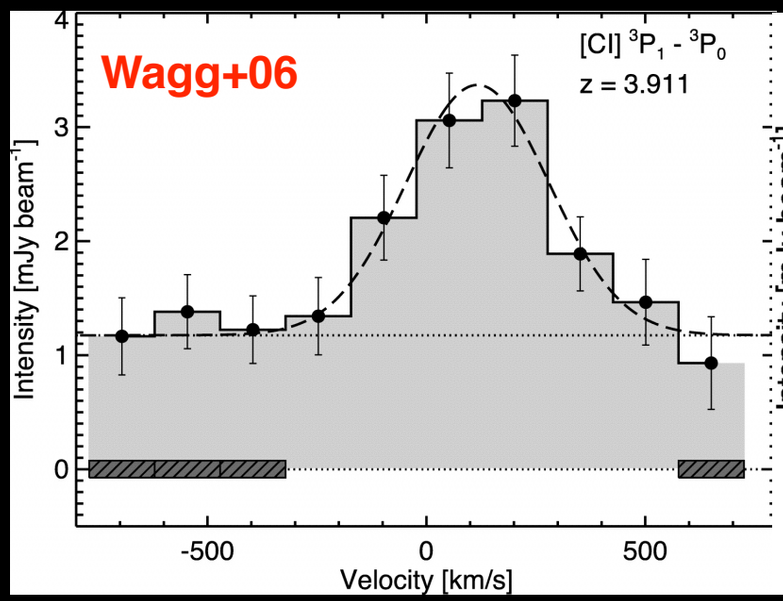


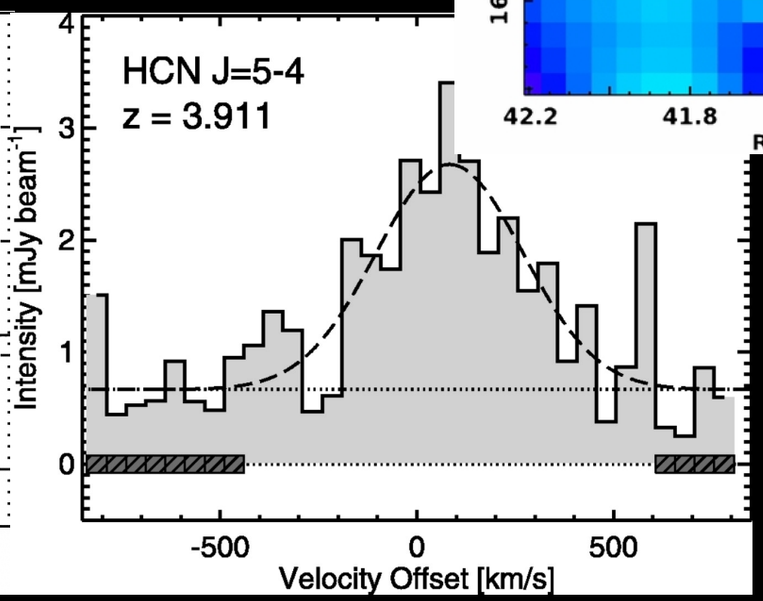
APM 08279 Host galaxy

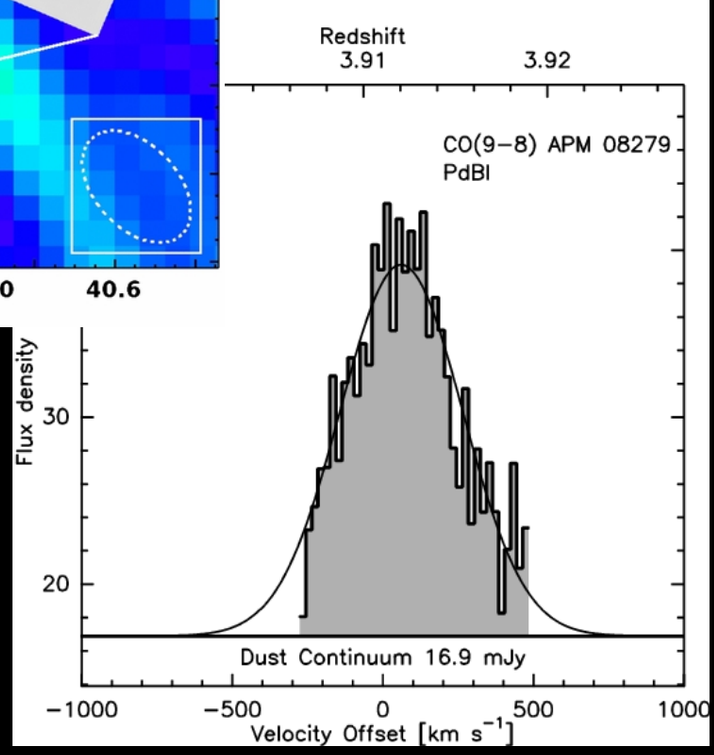












APM lensing models

Two main scenarios for the lensing model

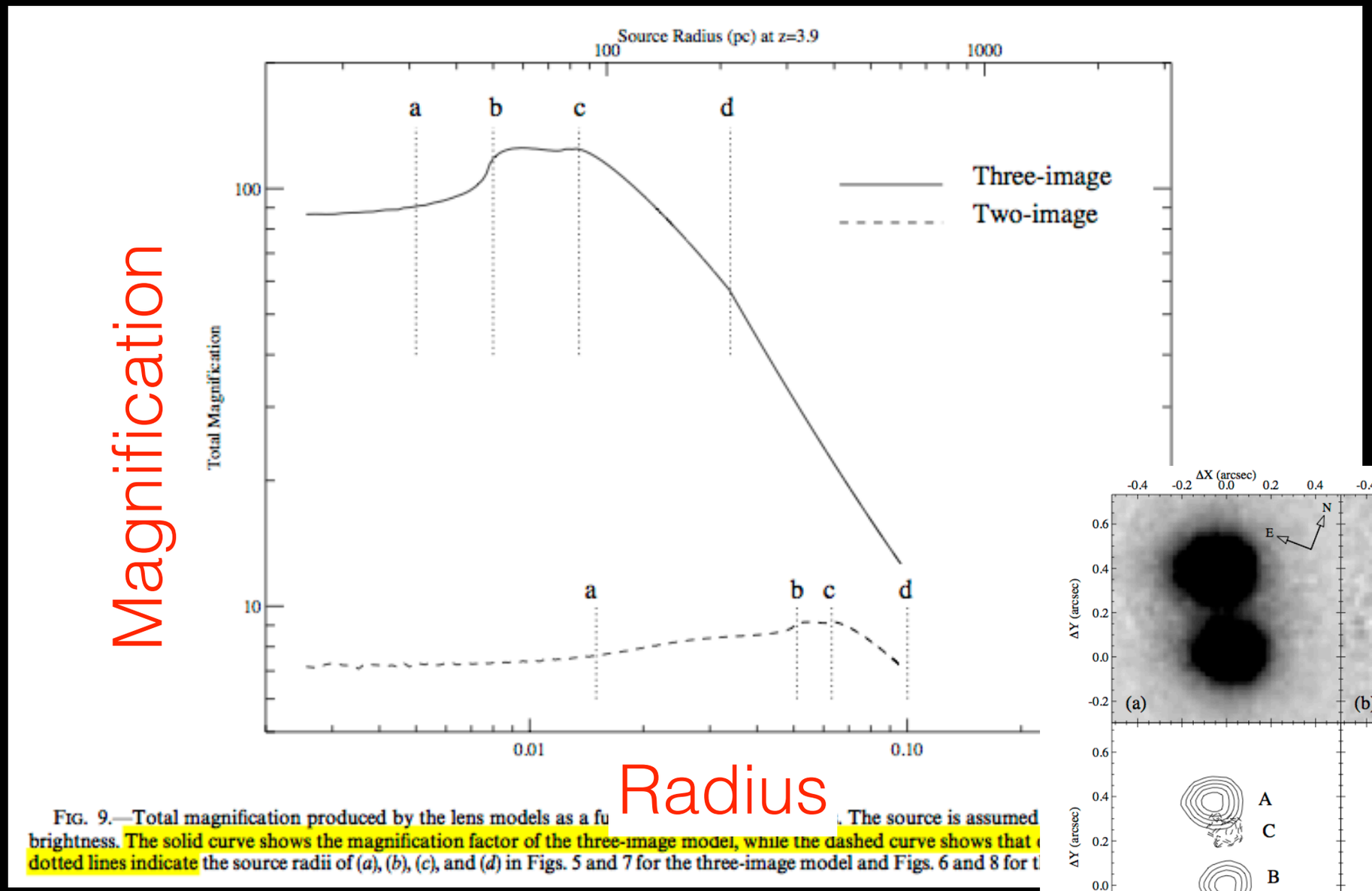
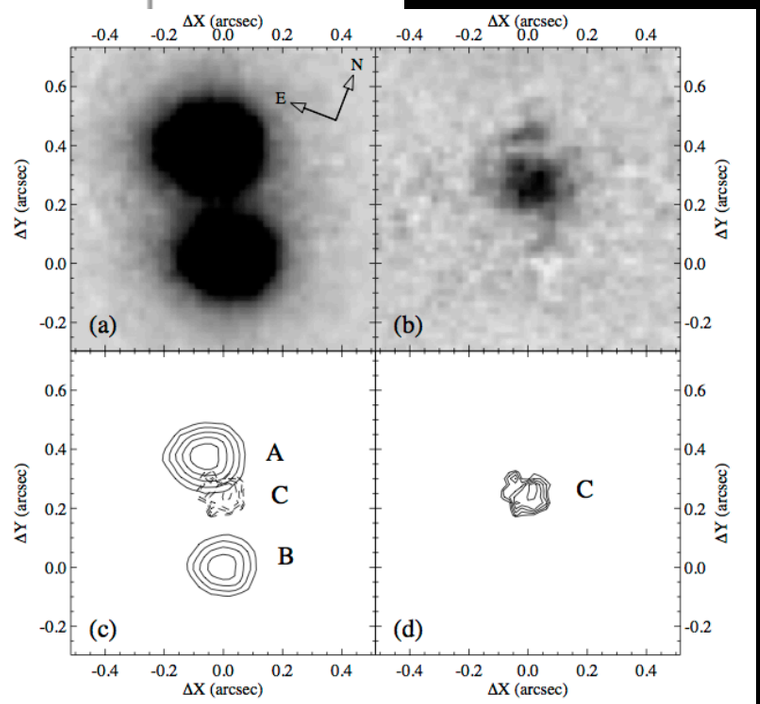


FIG. 9.—Total magnification produced by the lens models as a fu . The source is assumed brightness. The solid curve shows the magnification factor of the three-image model, while the dashed curve shows that dotted lines indicate the source radii of (*a*), (*b*), (*c*), and (*d*) in Figs. 5 and 7 for the three-image model and Figs. 6 and 8 for t



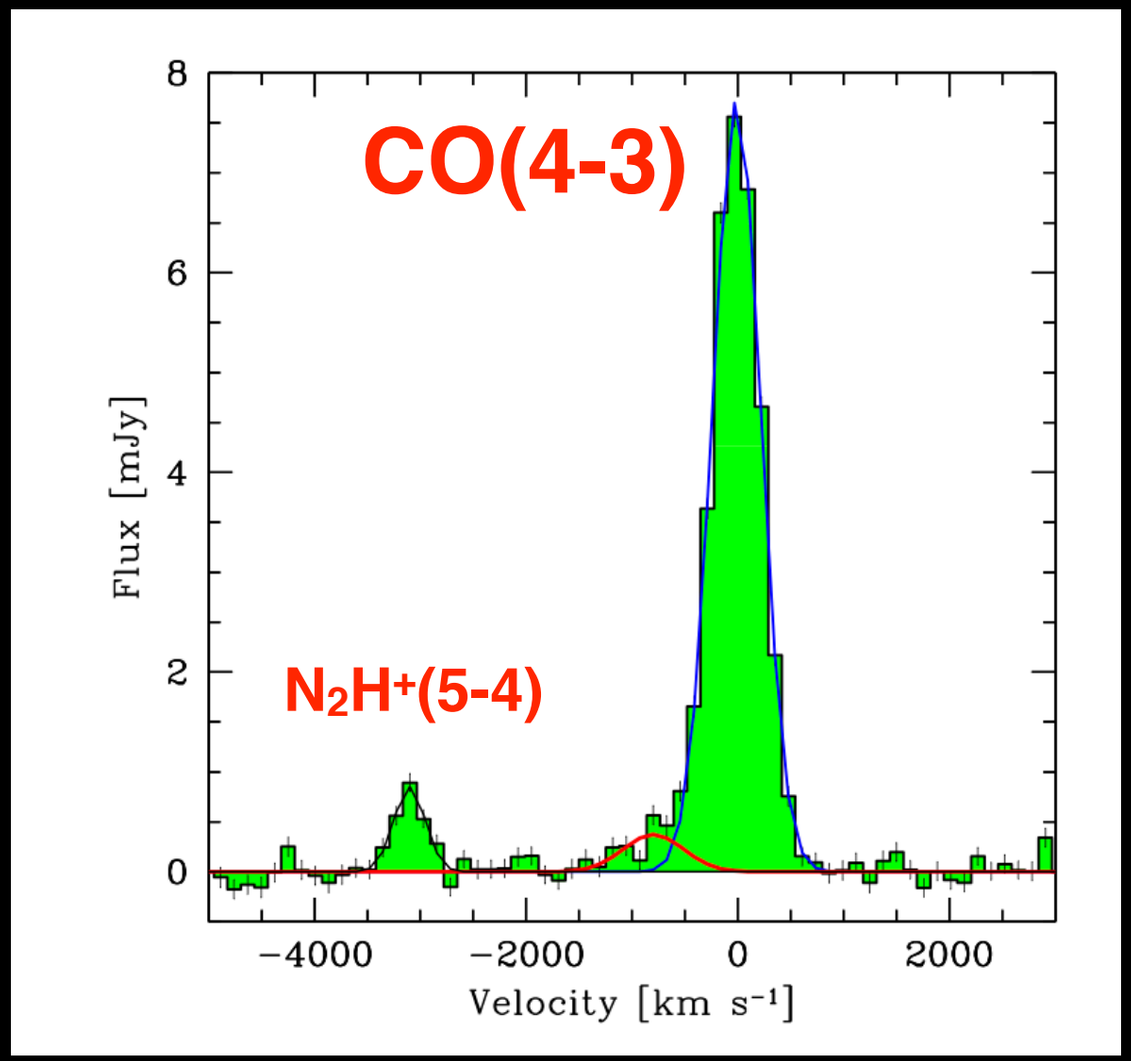
Egami+2000

APM 08279 Molecular Outflow

Feruglio+17, submitted

Blueshifted component with:

v_{max} = v95%= -1300 km/s



34 hour integration with NOEMA

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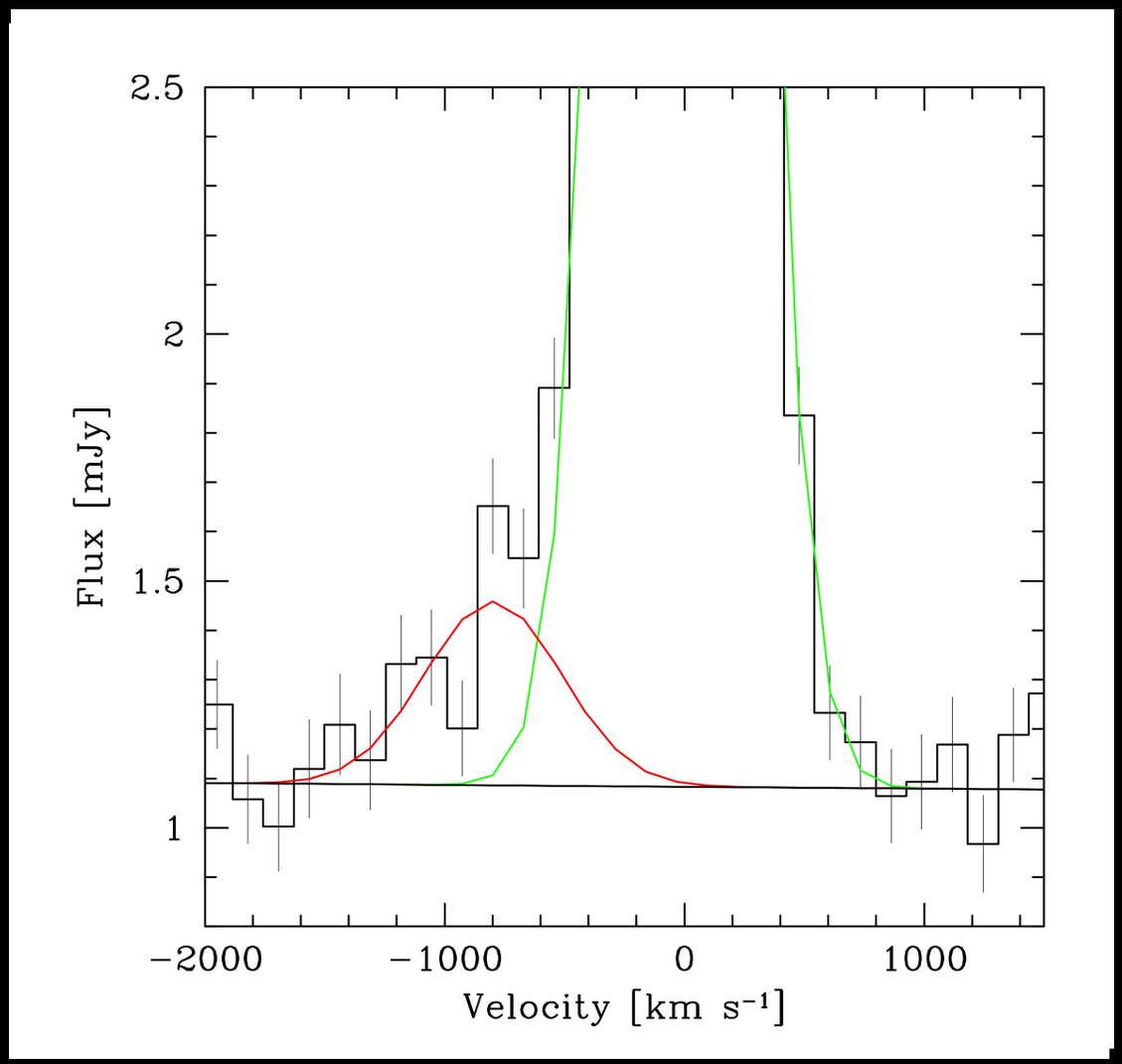

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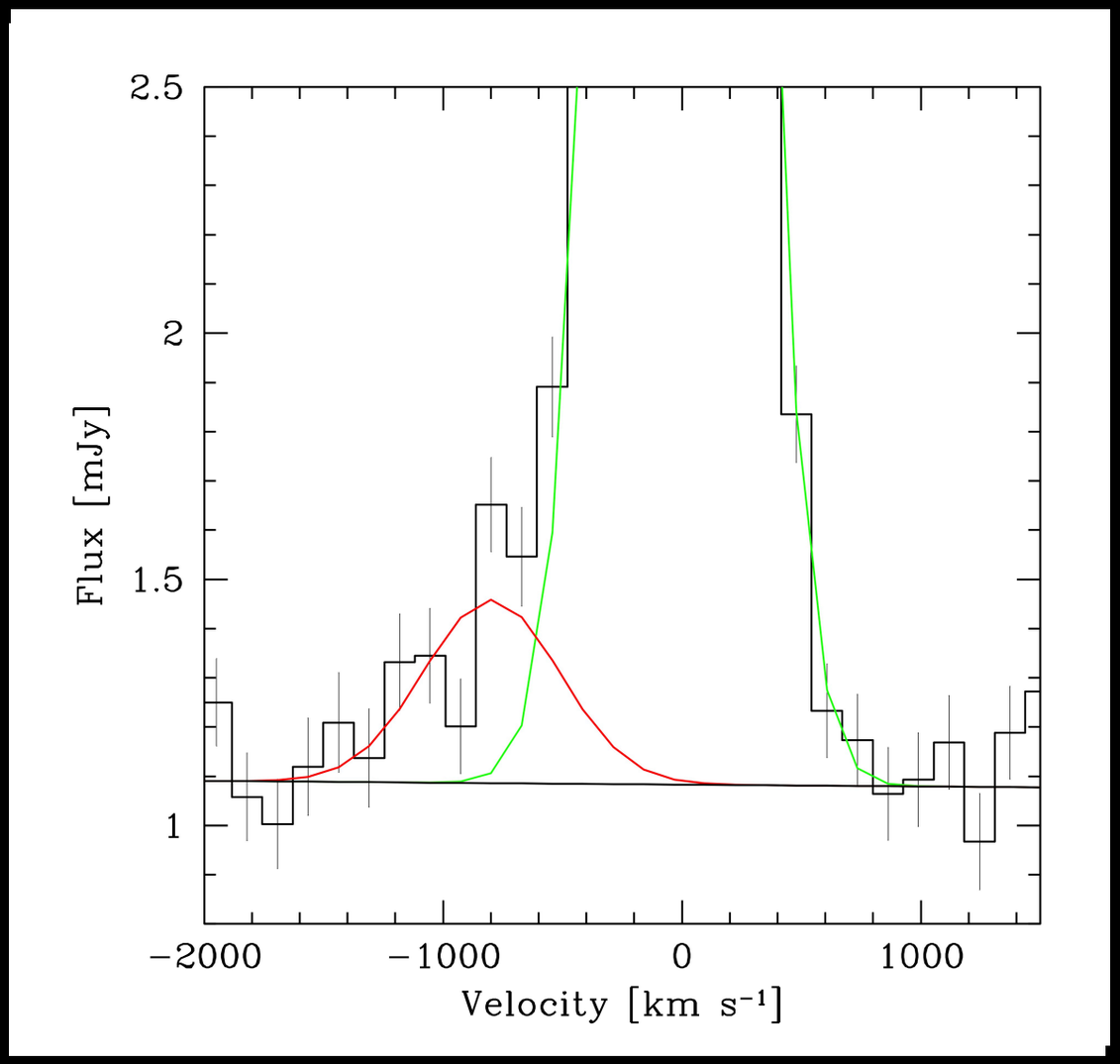
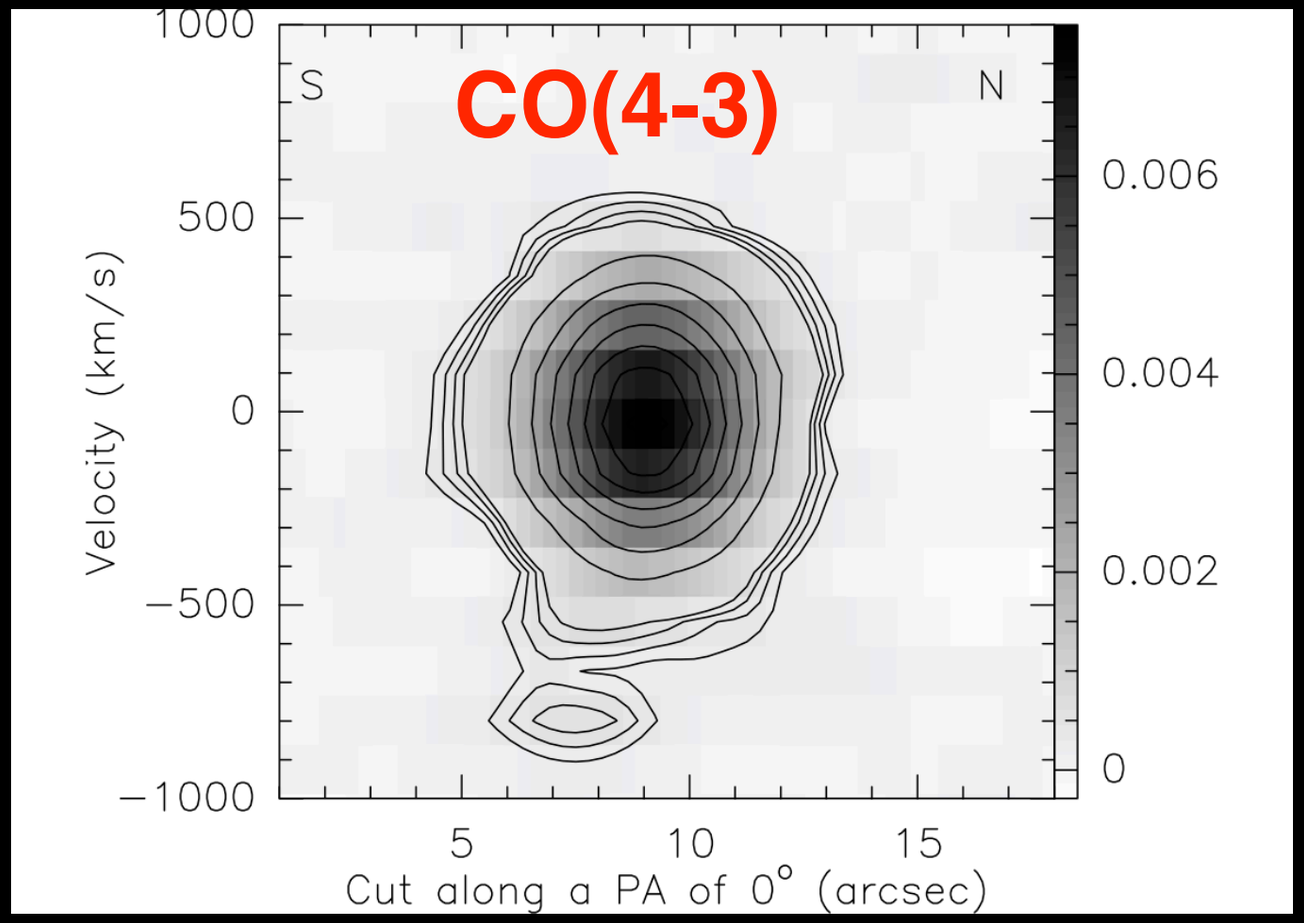


34 hour integration with NOEMA

Outflow max size

1.1” = 7.9 kpc

—> no lensing magnification



South-north cut through CO peak

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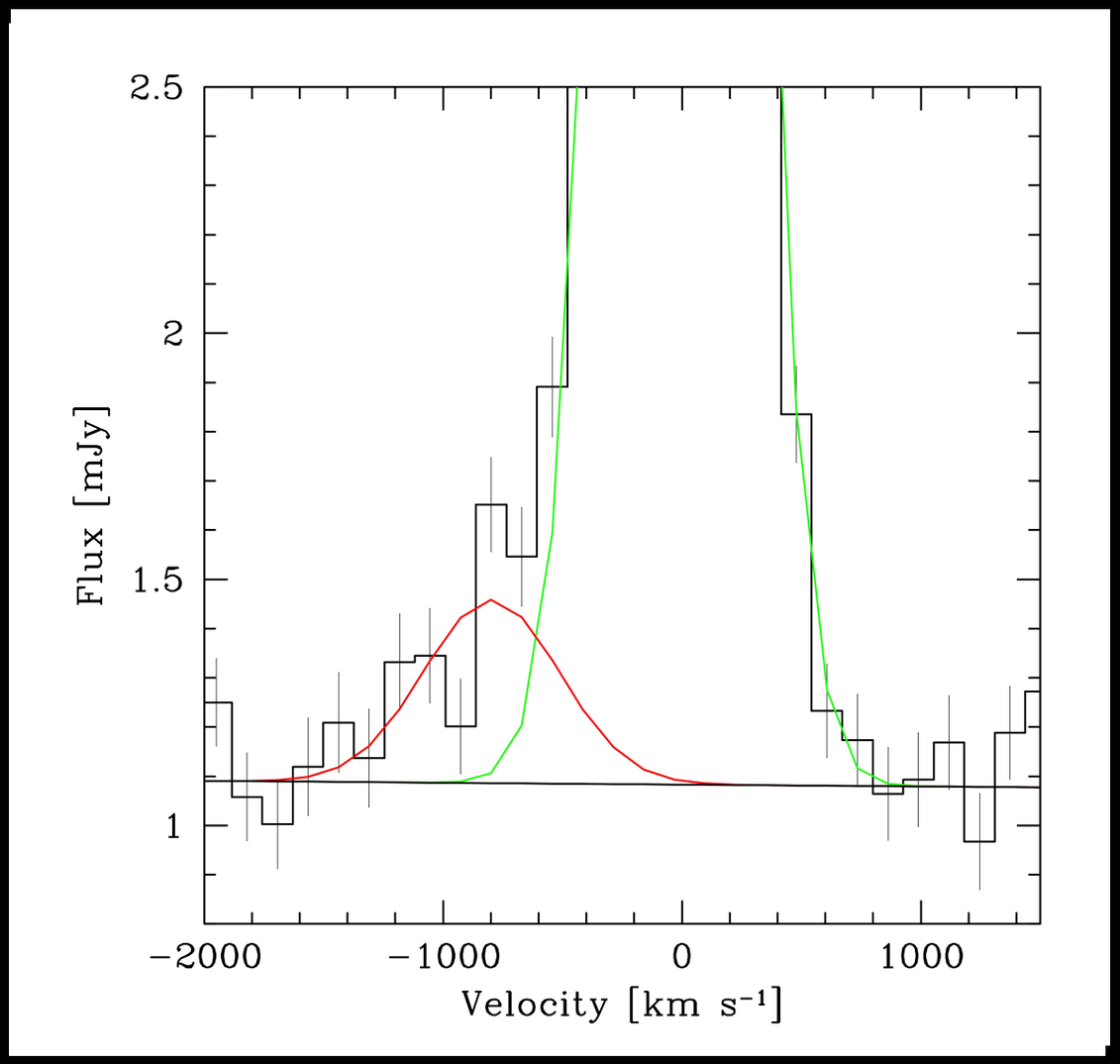

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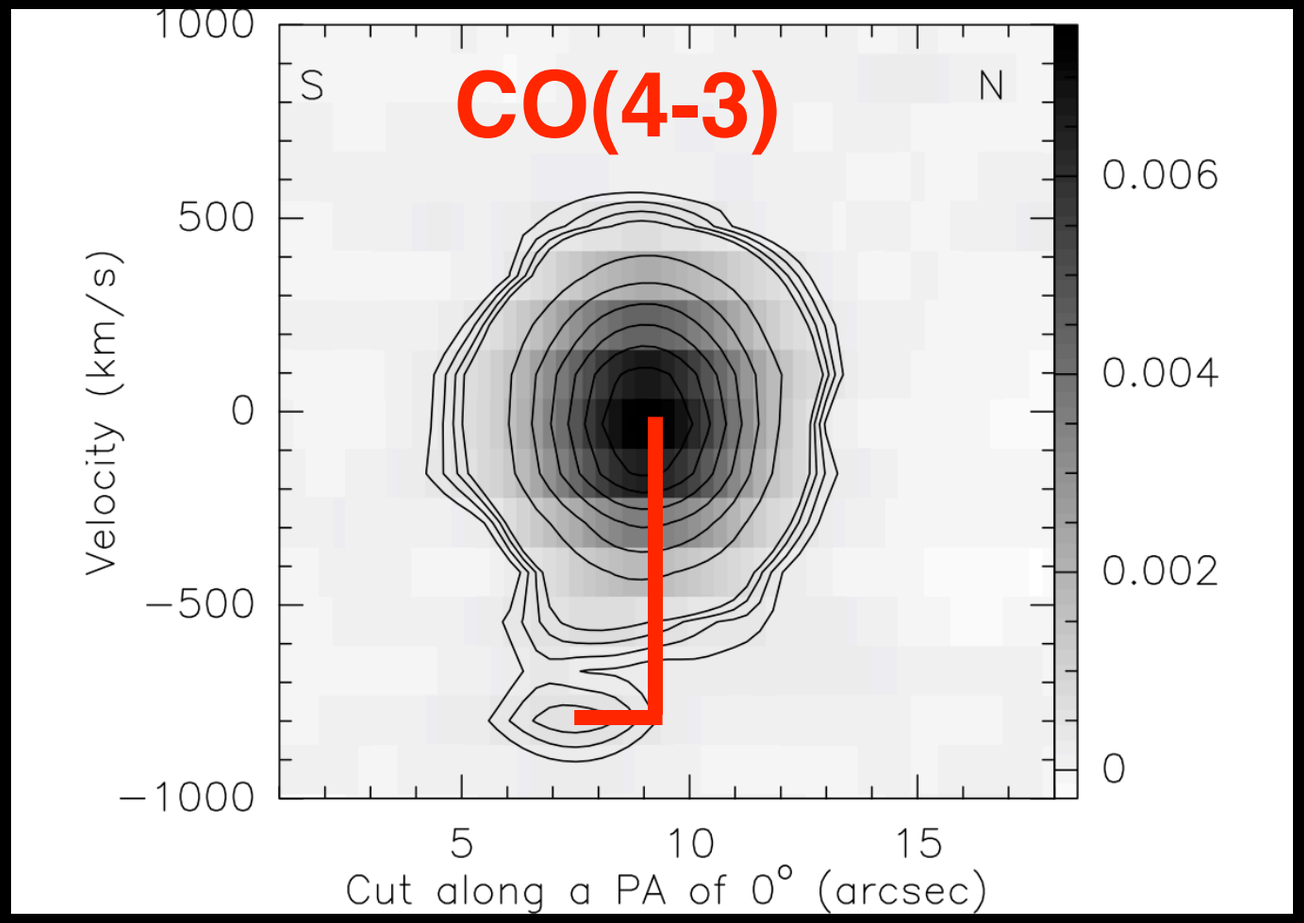

South-north cut through CO peak

APM 08279 outflows energy

Feruglio+17, submitted

Model	μ	R [kpc]	M(H_2) [$M_\odot$]	v_{max} [km/s]	$\dot{M}_{OF}$ [$M_\odot$/yr]	$\dot{P}_{OF}$ [dyn]
model1	20	0.270	1.98×10^8	−1340	3.0×10^3	2.5×10^{37}
model2	4	0.550	9.9×10^8	−1340	7.4×10^3	6.3×10^{37}
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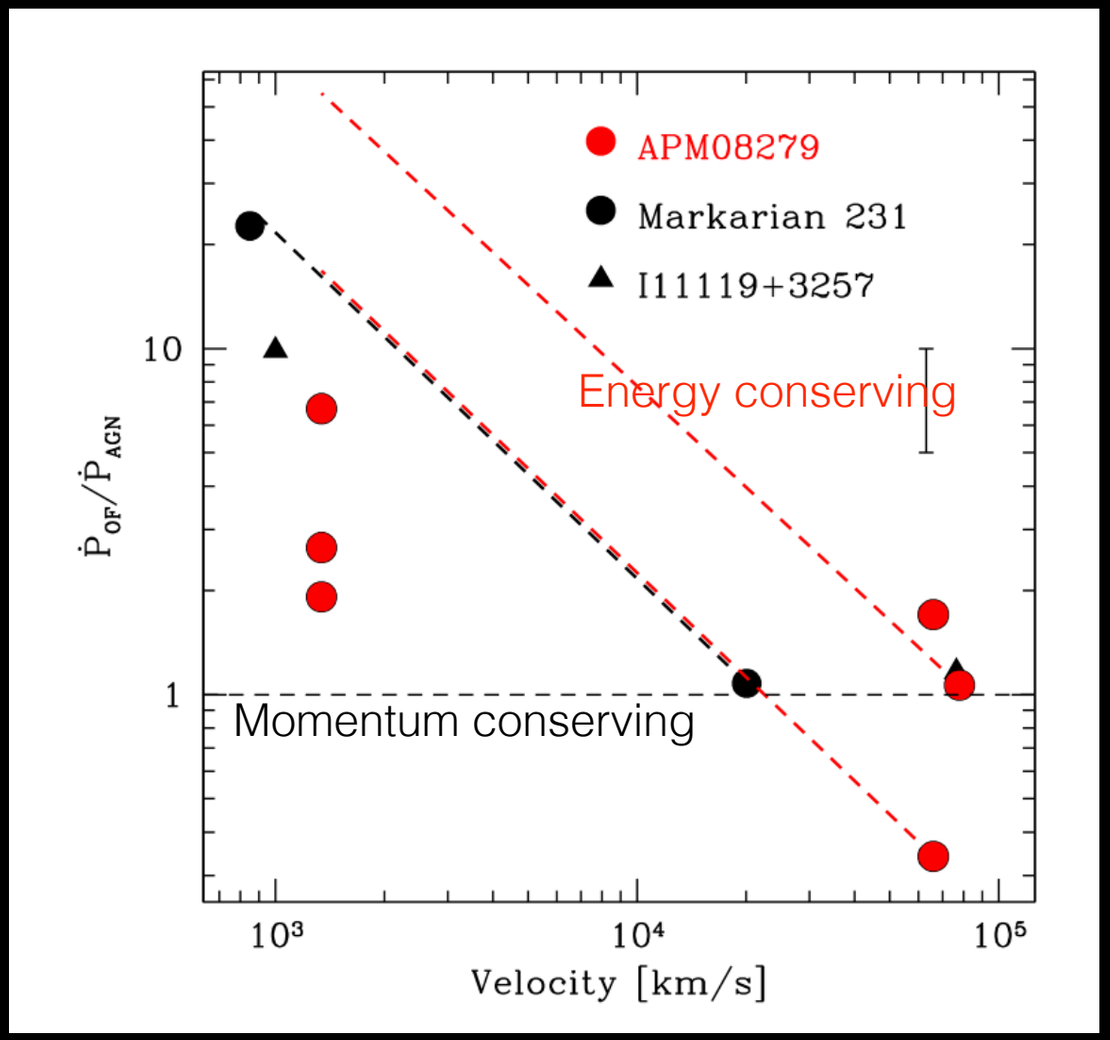

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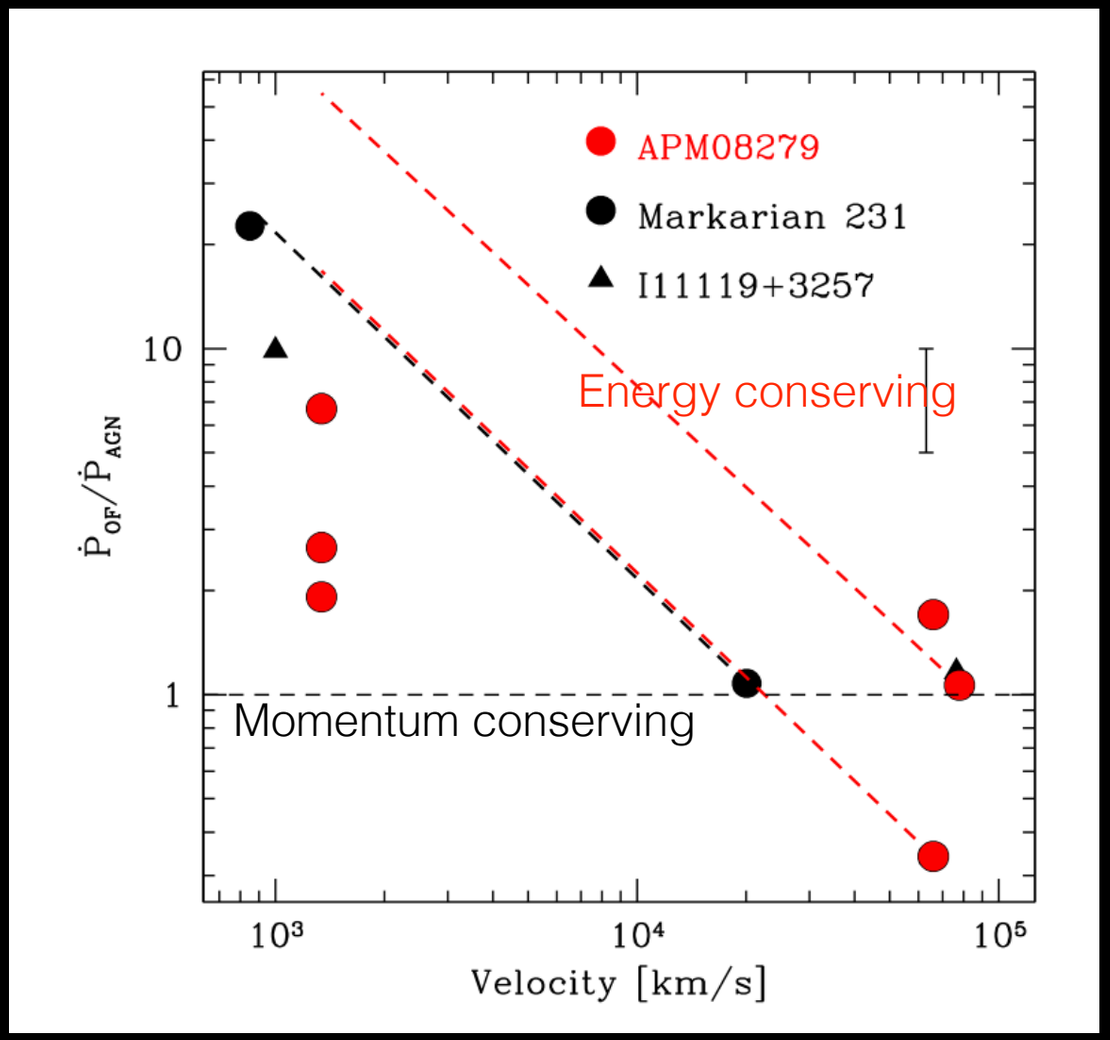

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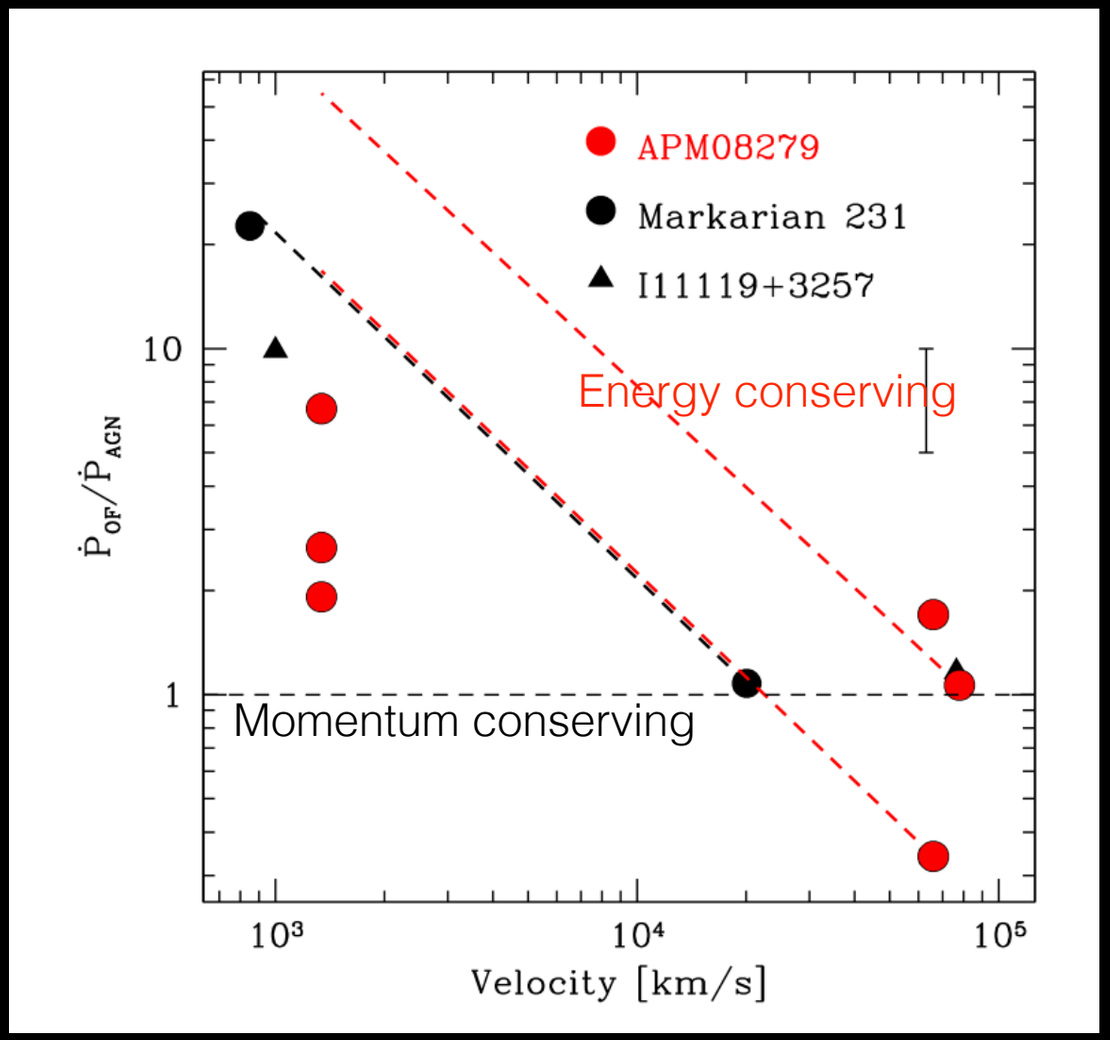

$\dot{P}_{OF}/\dot{P}_{AGN} = 2 - 8$

Momentum conserving flow

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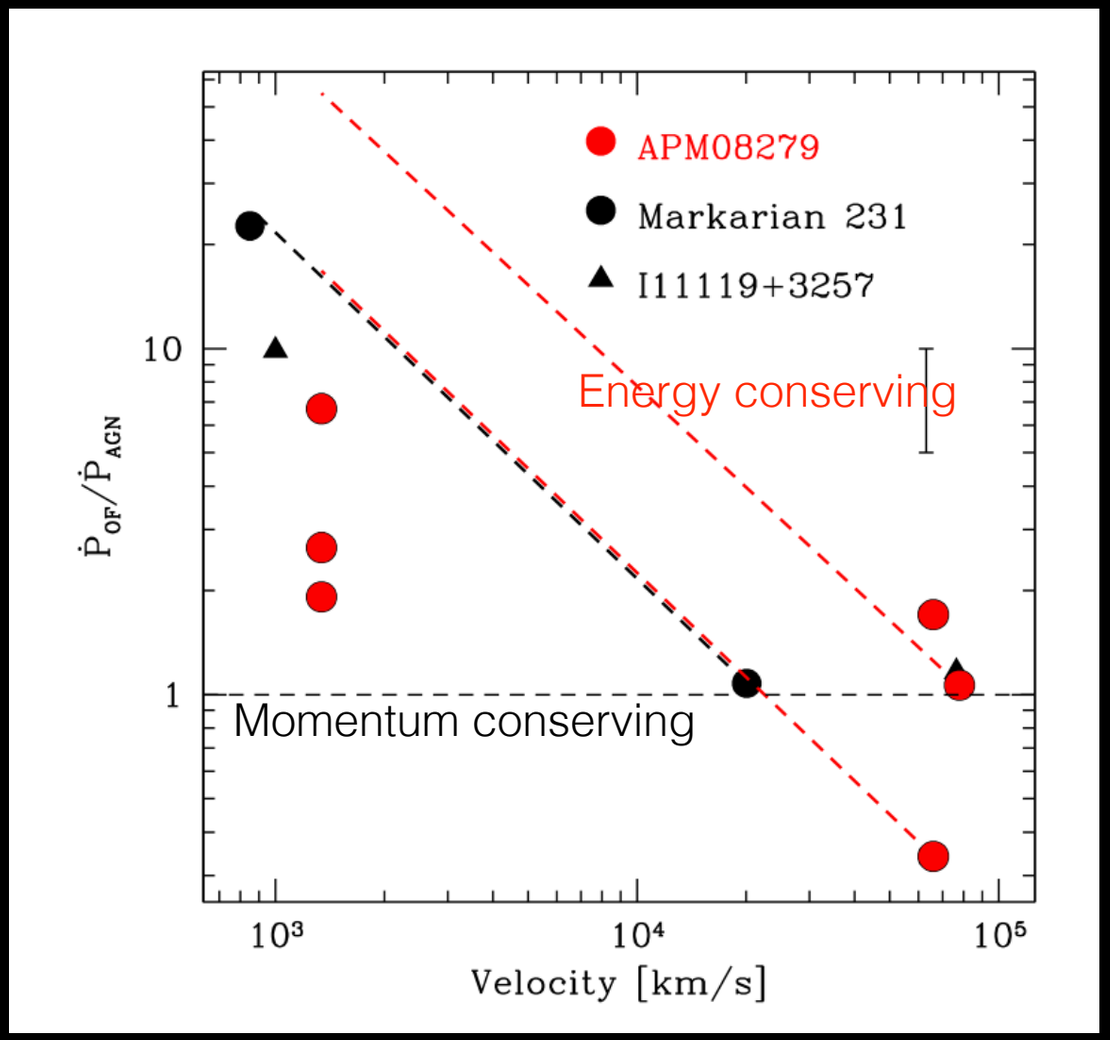

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Momentum conserving flow

Energy conserving for largest $\dot{P}_{OF}$

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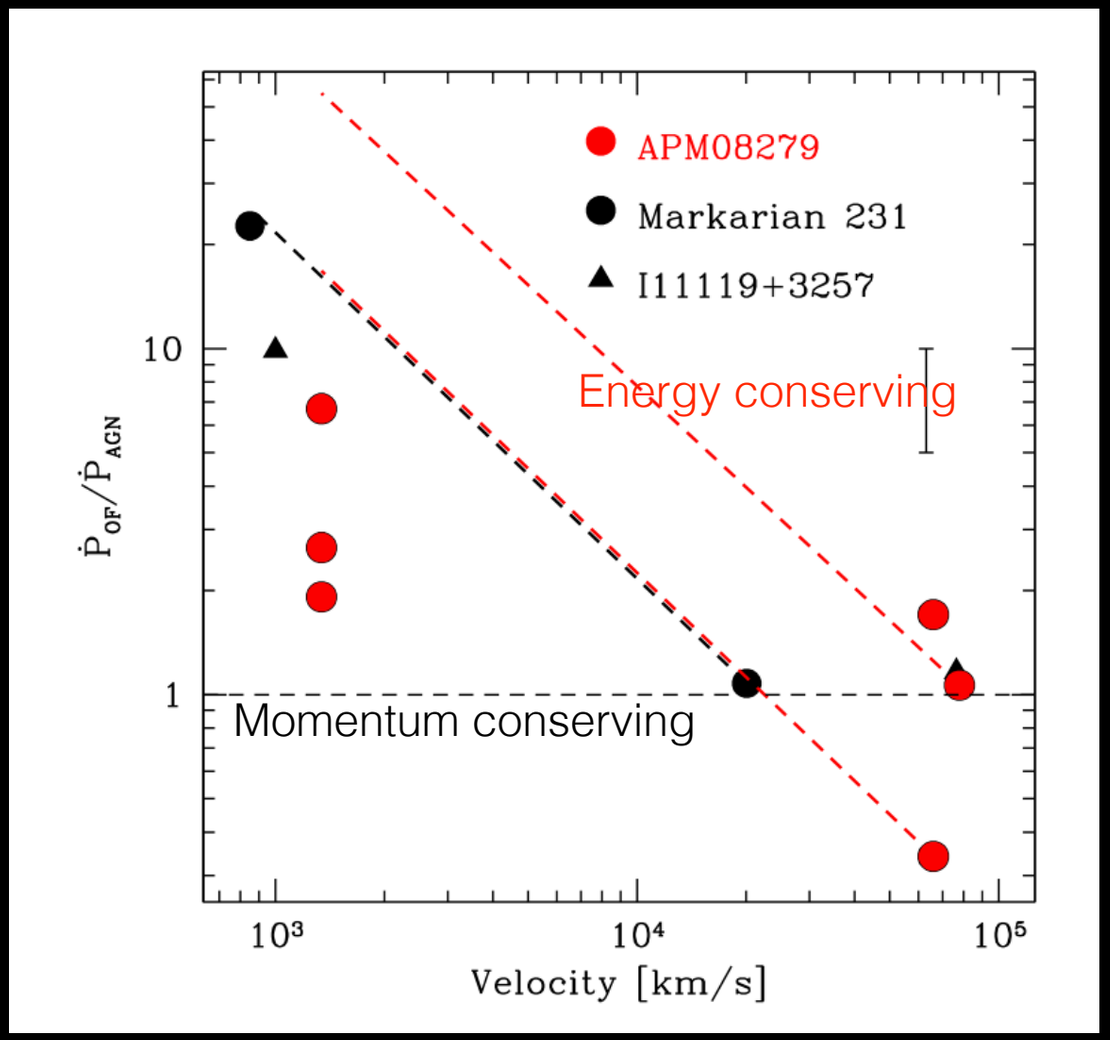


$\dot{P}_{OF}/\dot{P}_{AGN} = 2 - 8$

Momentum conserving flow

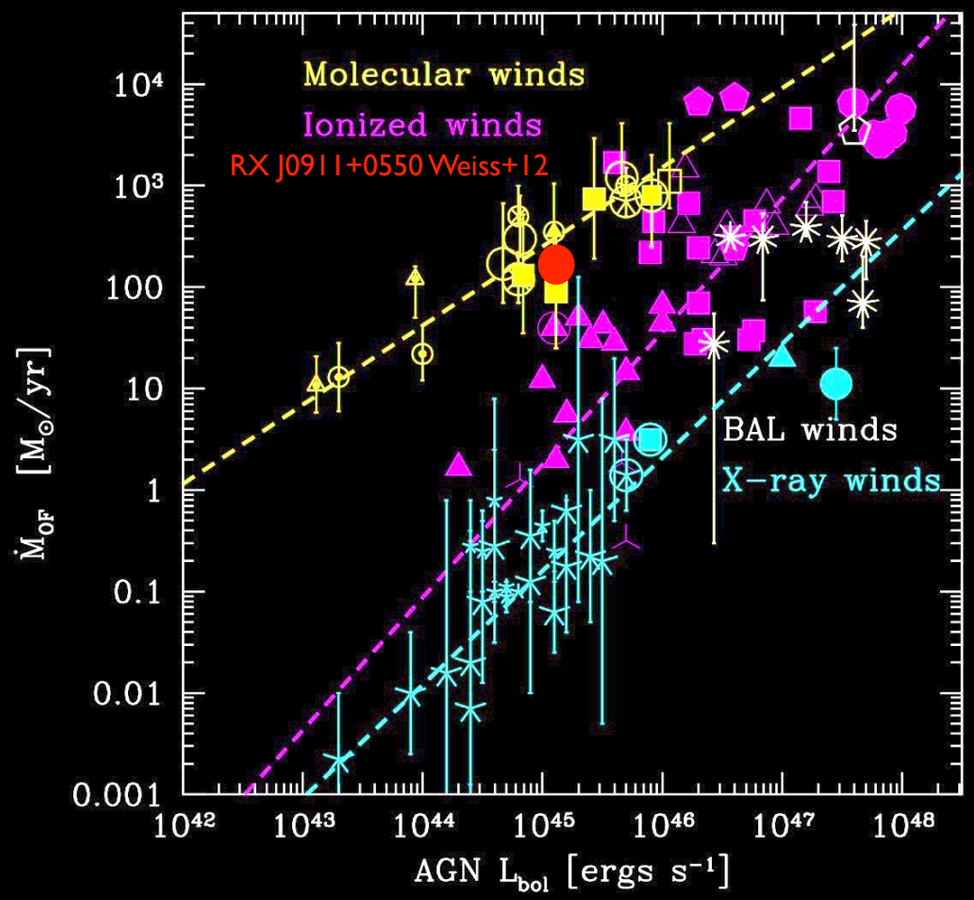
Energy conserving for largest $\dot{P}_{OF}$

Loading factor $\eta = \dot{M}_{OF}/SFR$ >>1

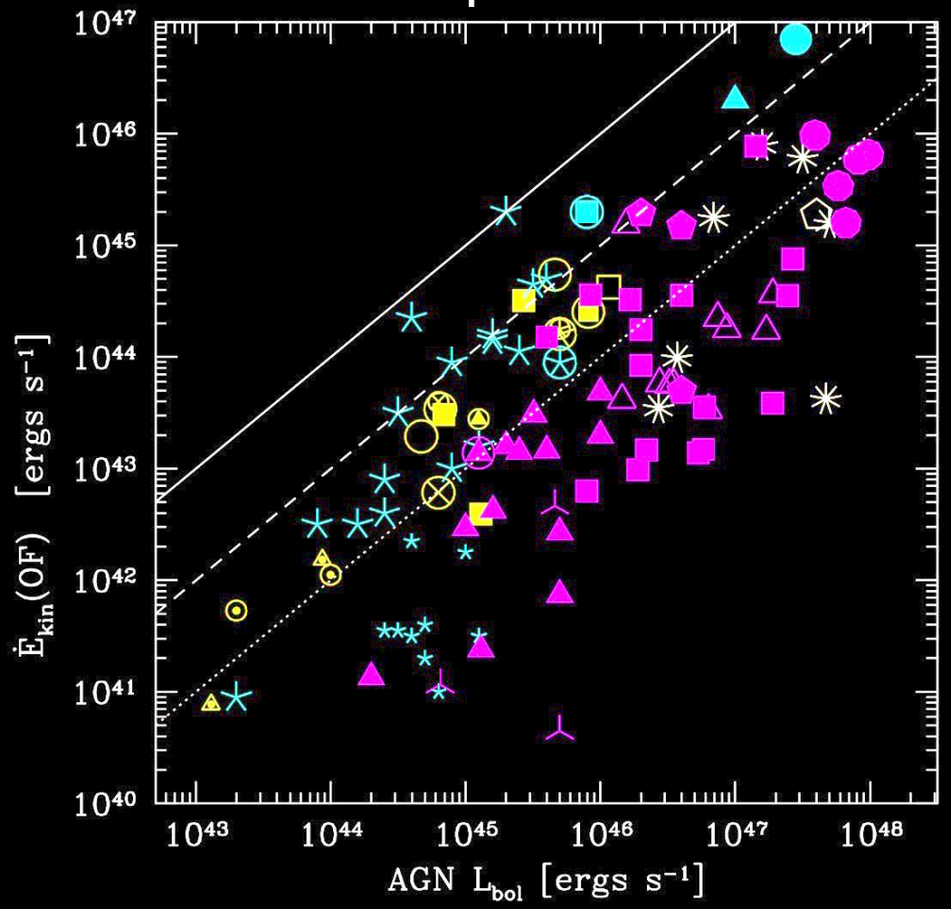
SFR = 25-200 Mo/yr (Weiss+07, Riechers+09)

APM 08279 outflow scaling

Outflow rate



Kinetic power



Fiore, Feruglio+17

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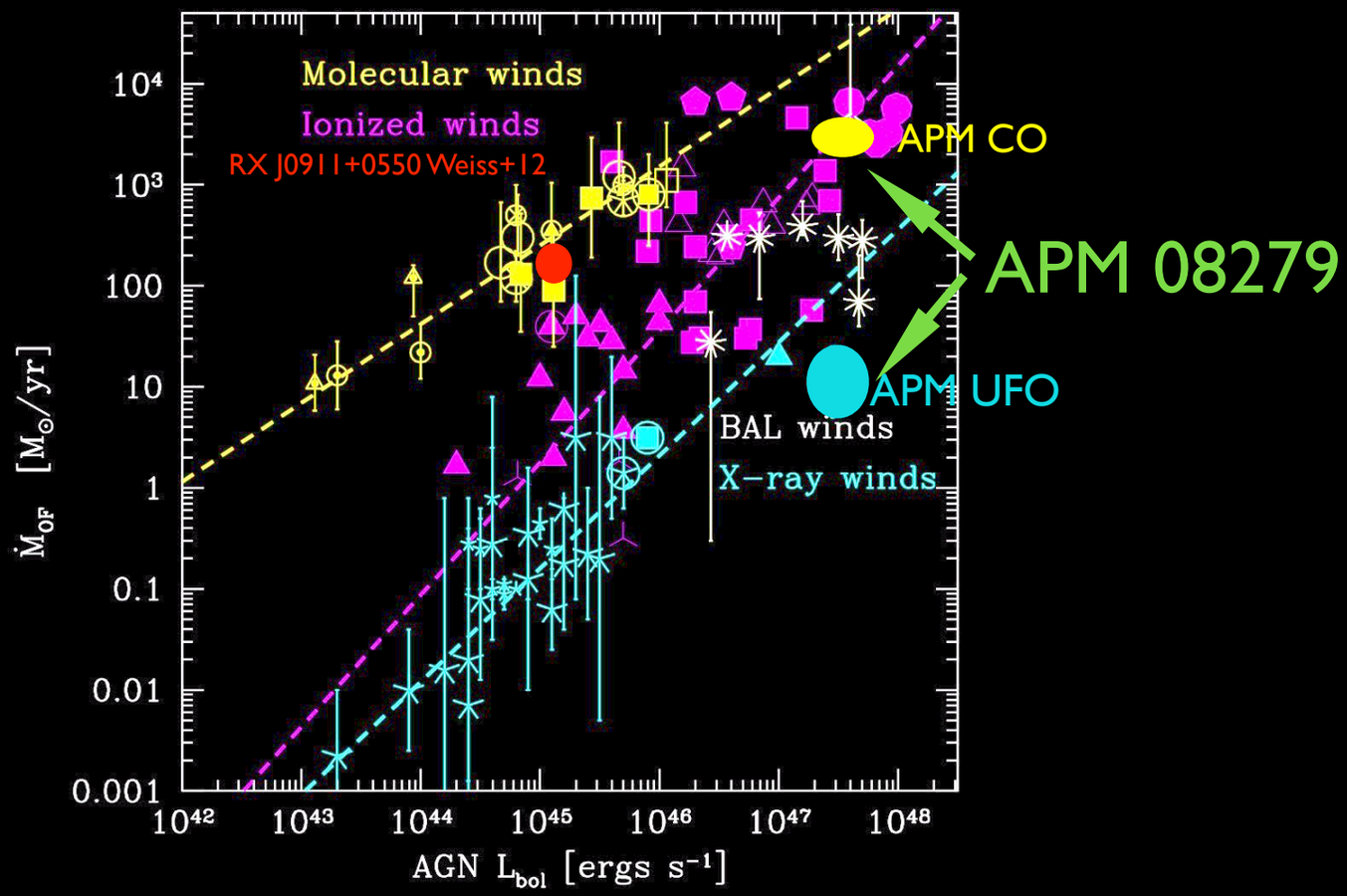

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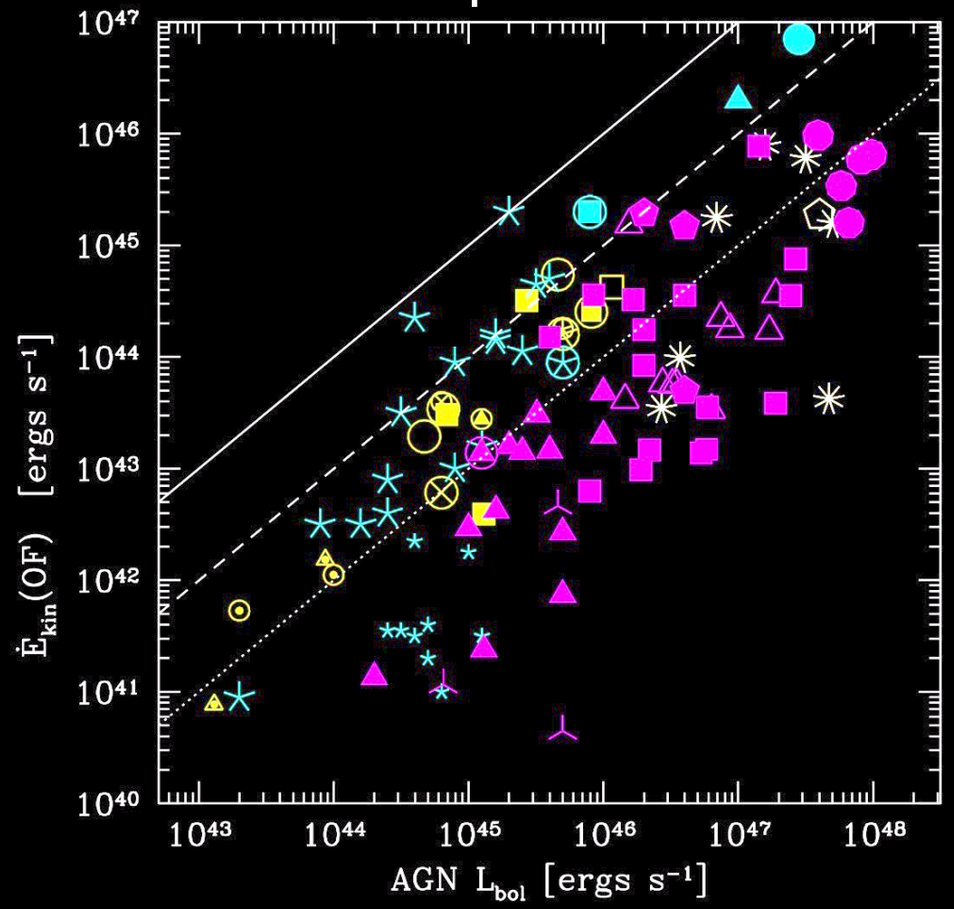

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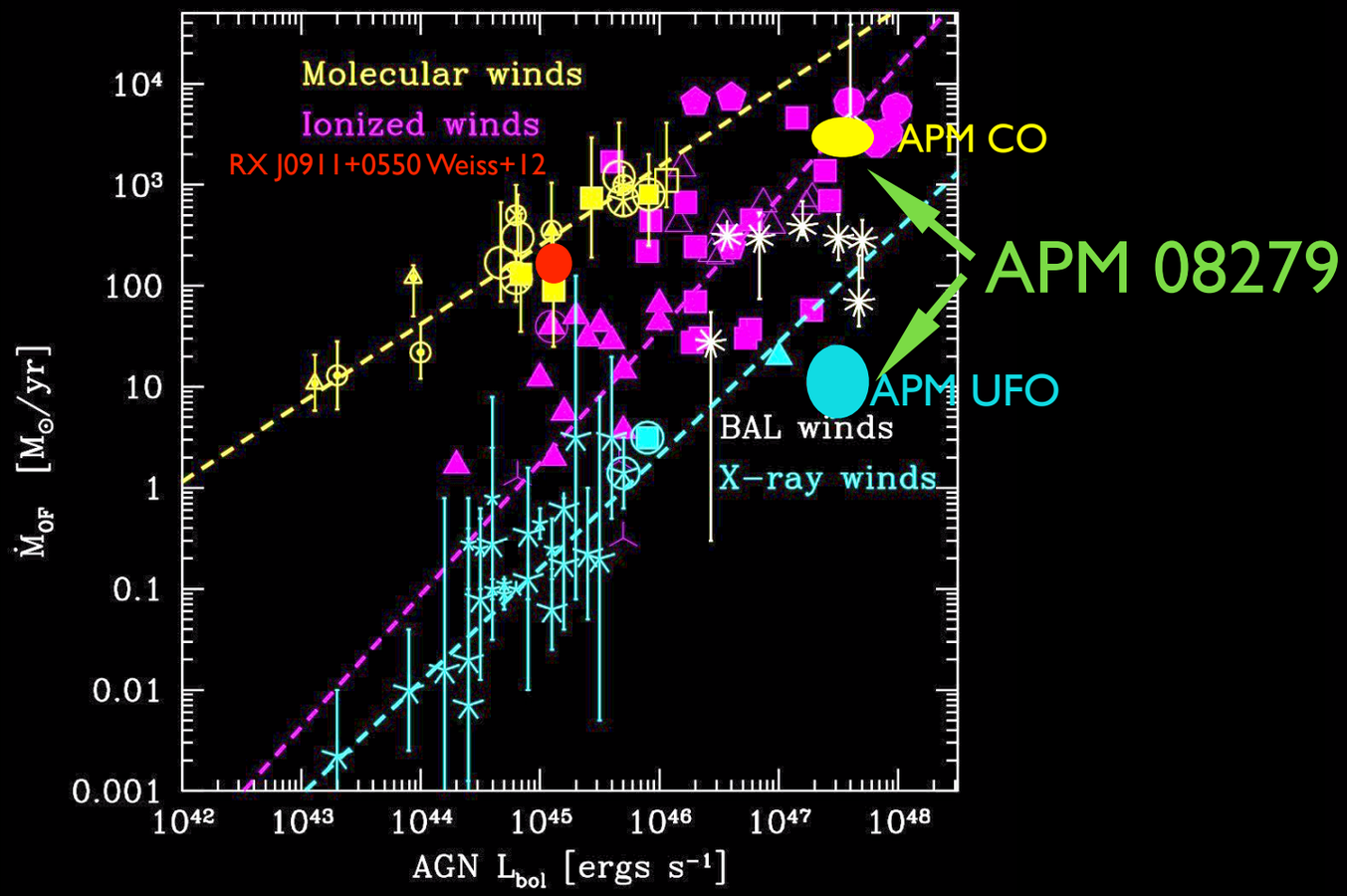

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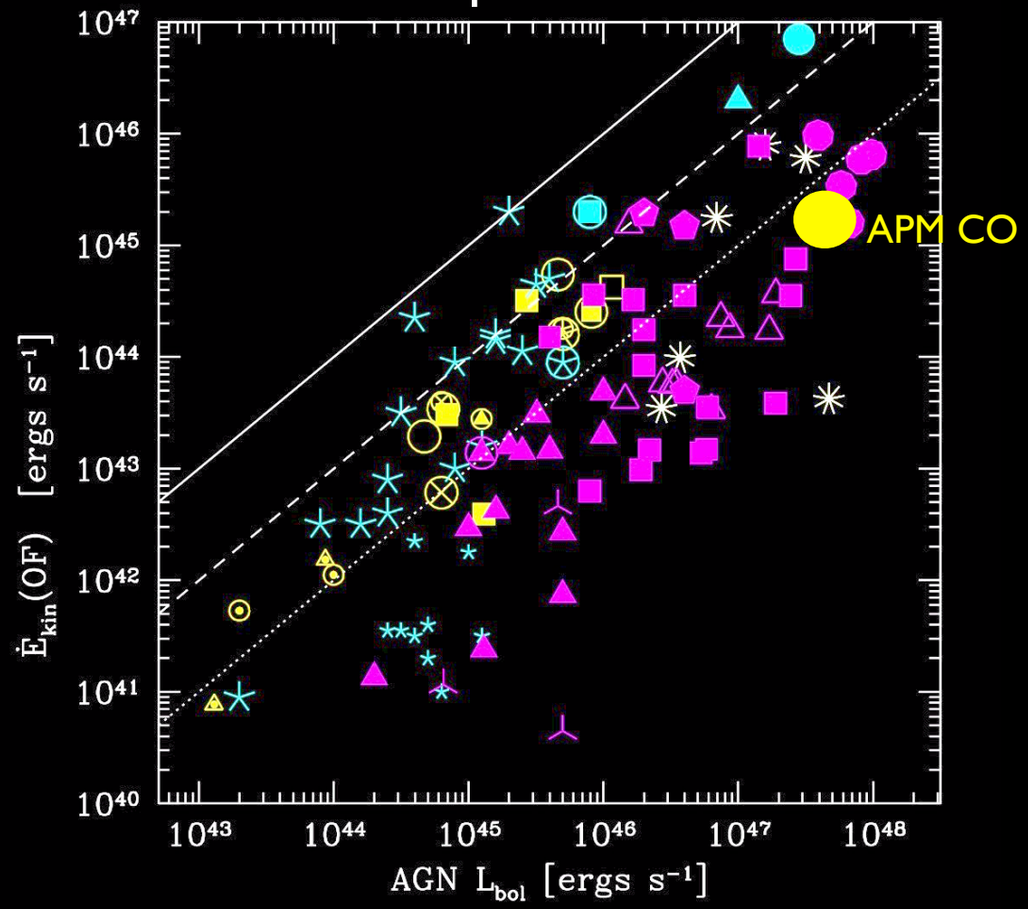
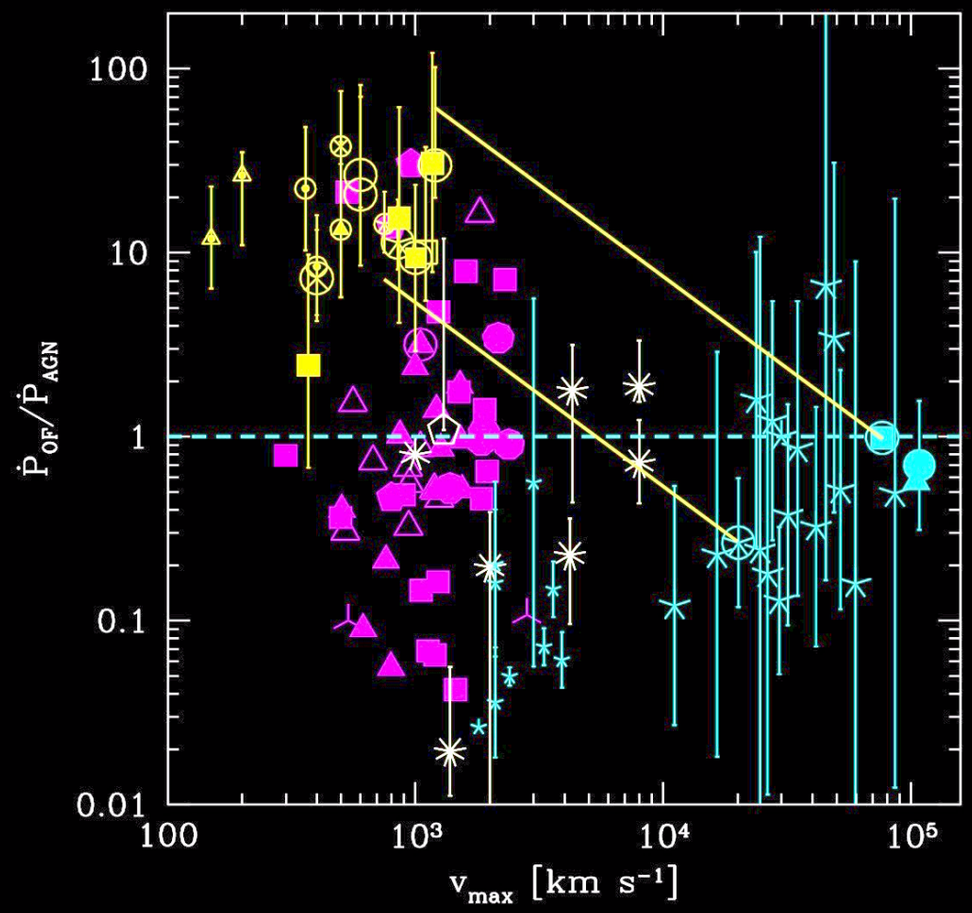


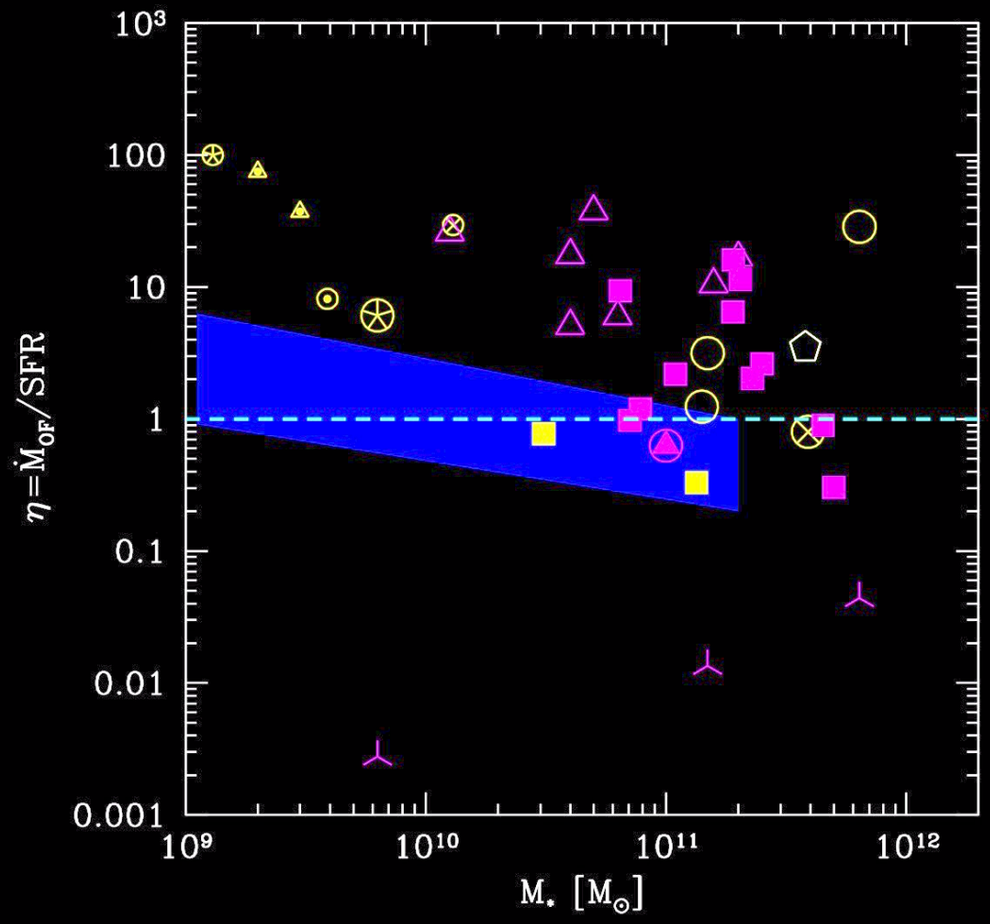
APM 08279 outflow scaling

Momentum rate



Fiore, Feruglio+17

Loading factor



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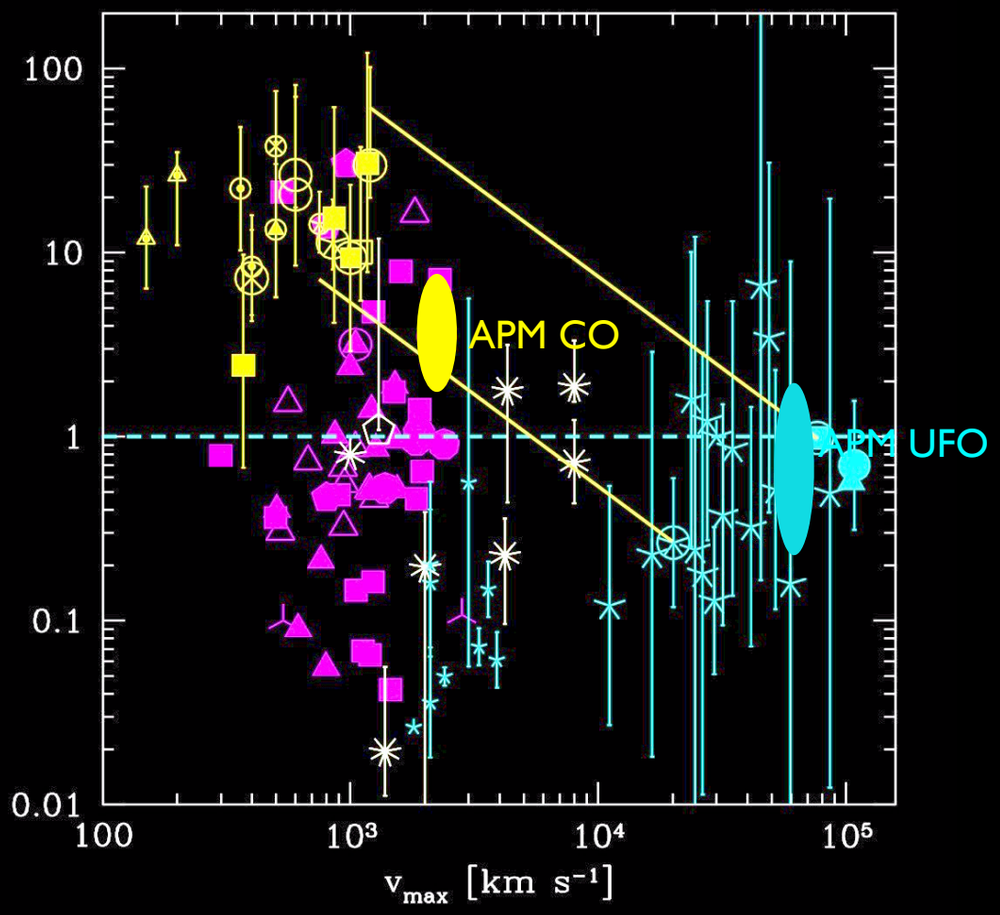

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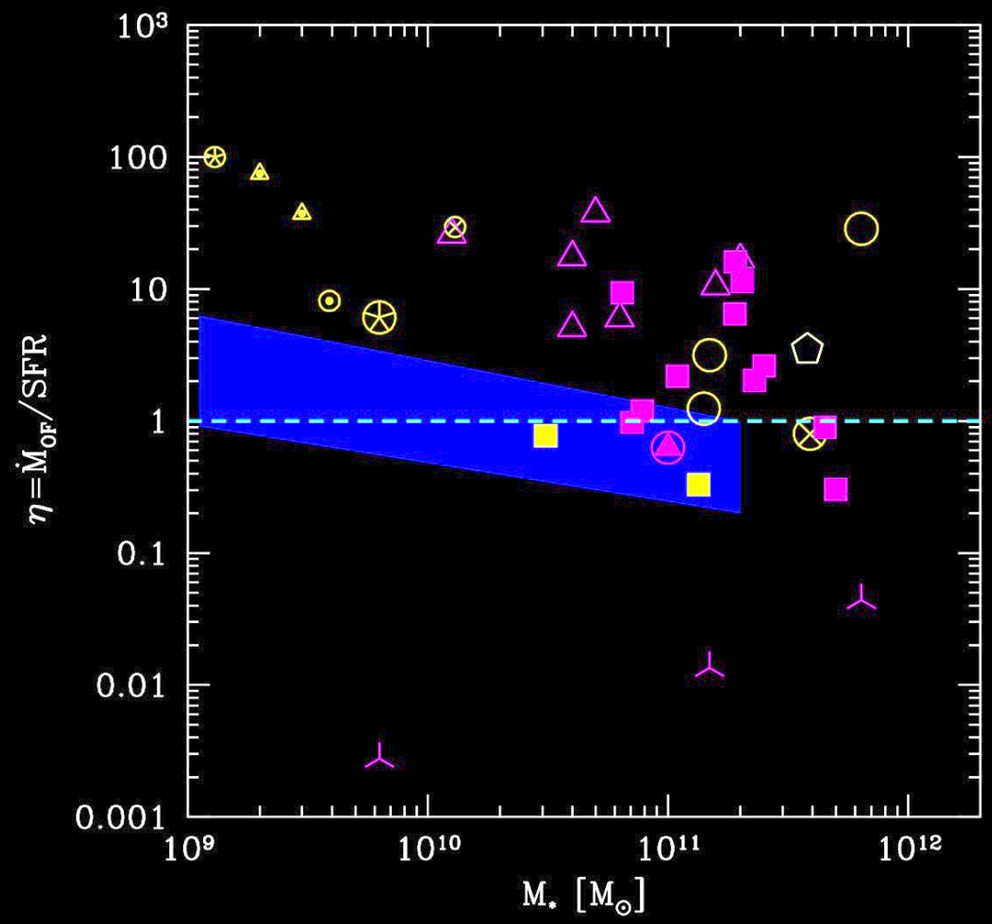

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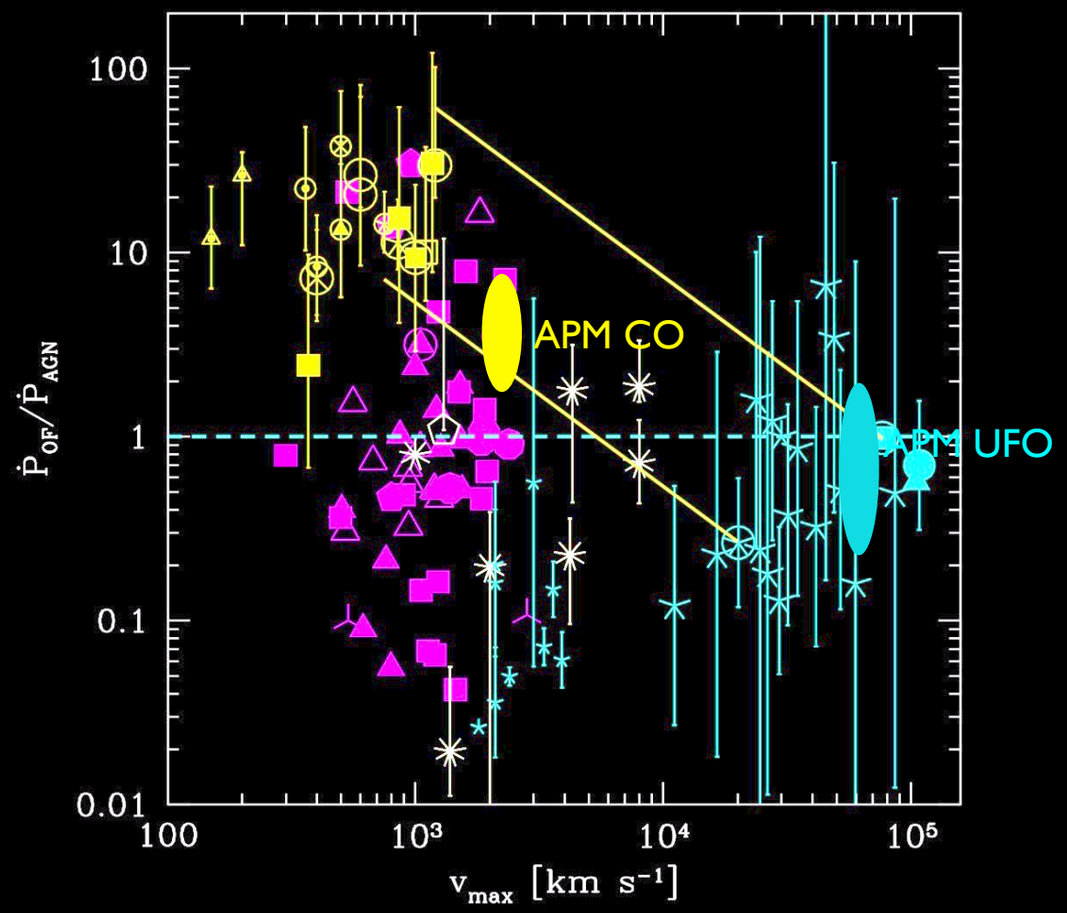

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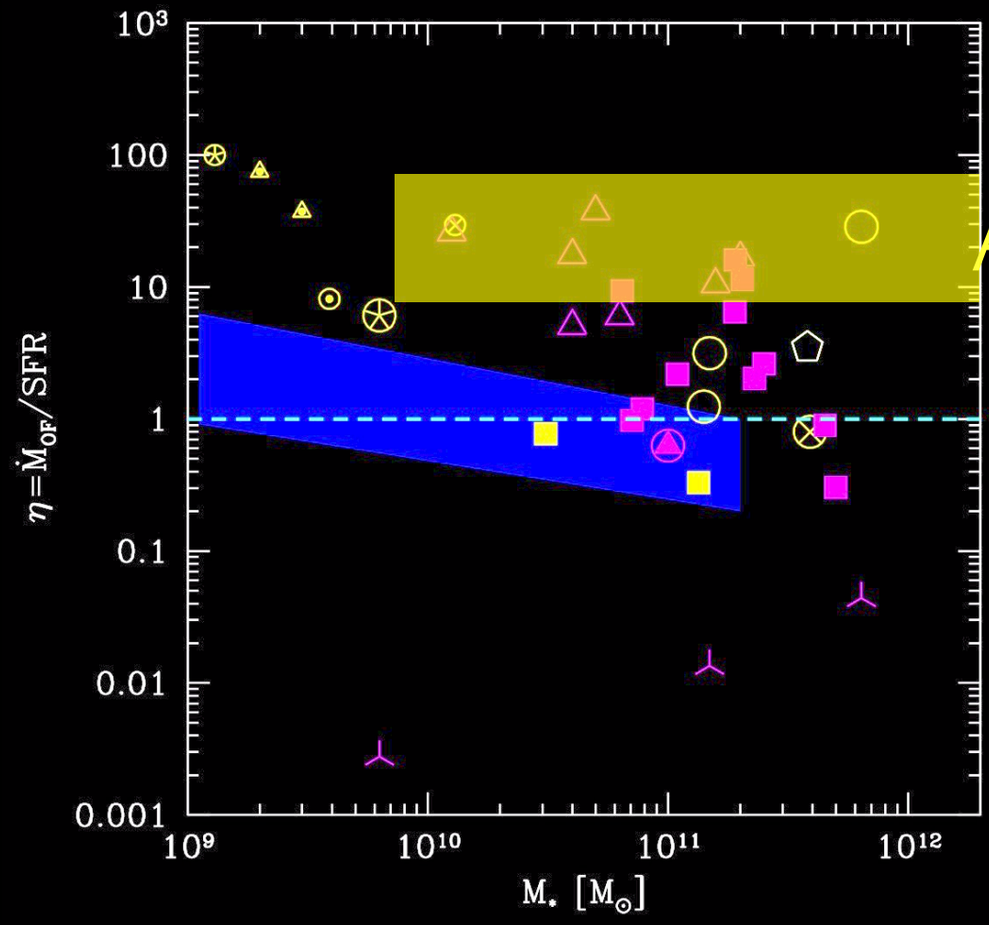

Conclusions

- Massive, ~8 kpc wide molecular outflow detected in APM 08279

- Hard to discriminate between momentum/energy conservig flow with current data

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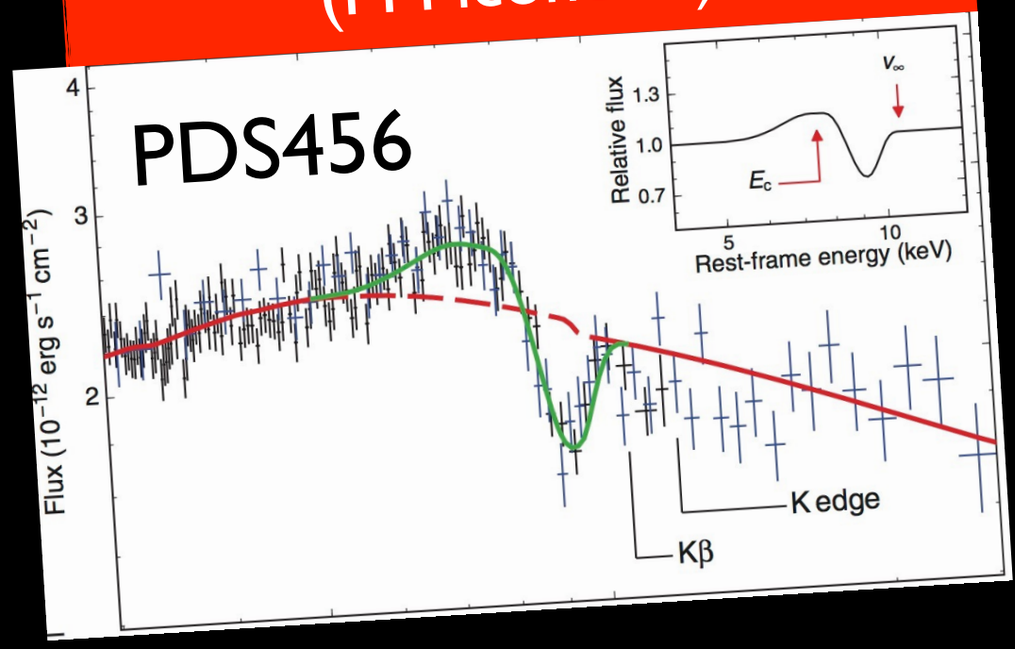
More insights expected from **ALMA on PDS456** (PI Piconcelli)



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Thank you

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