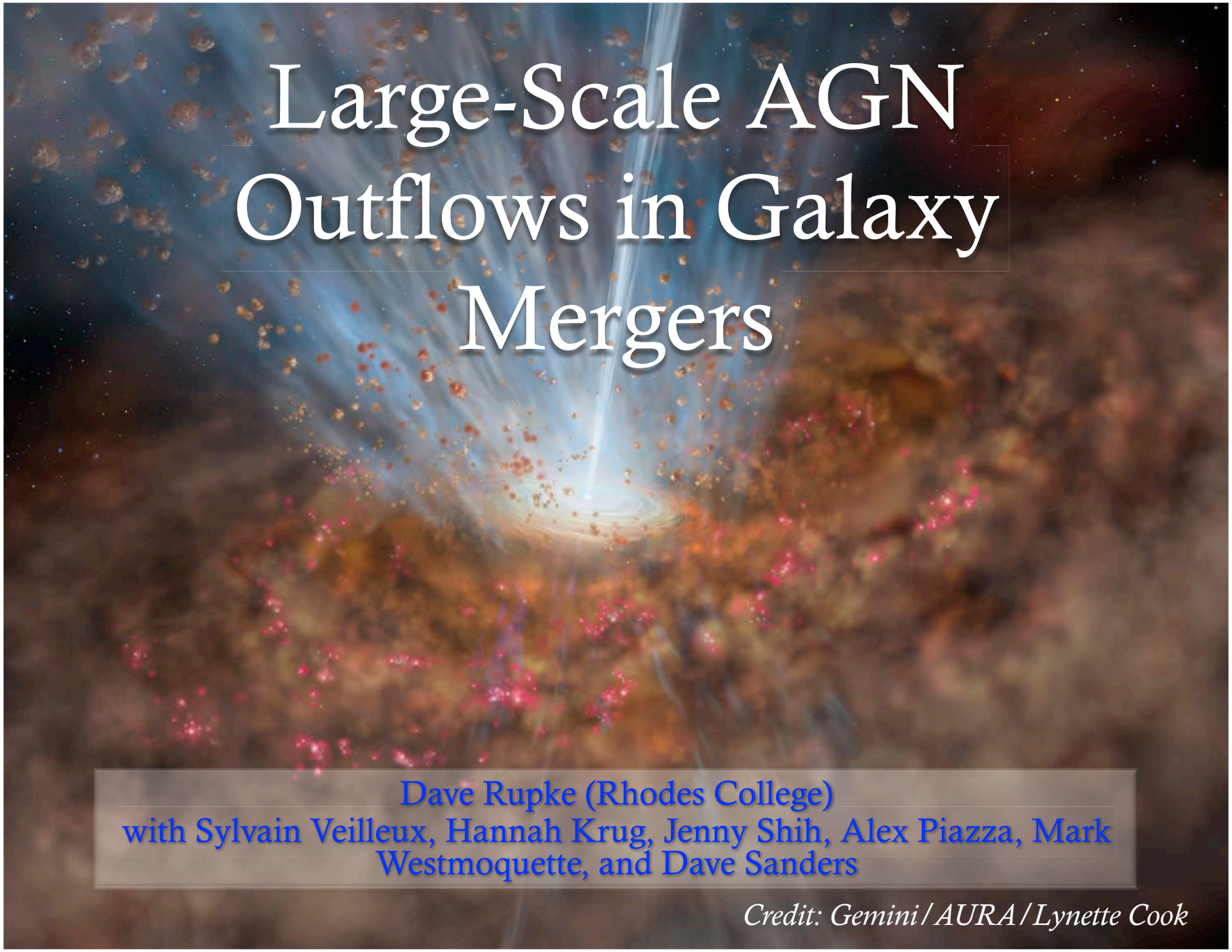
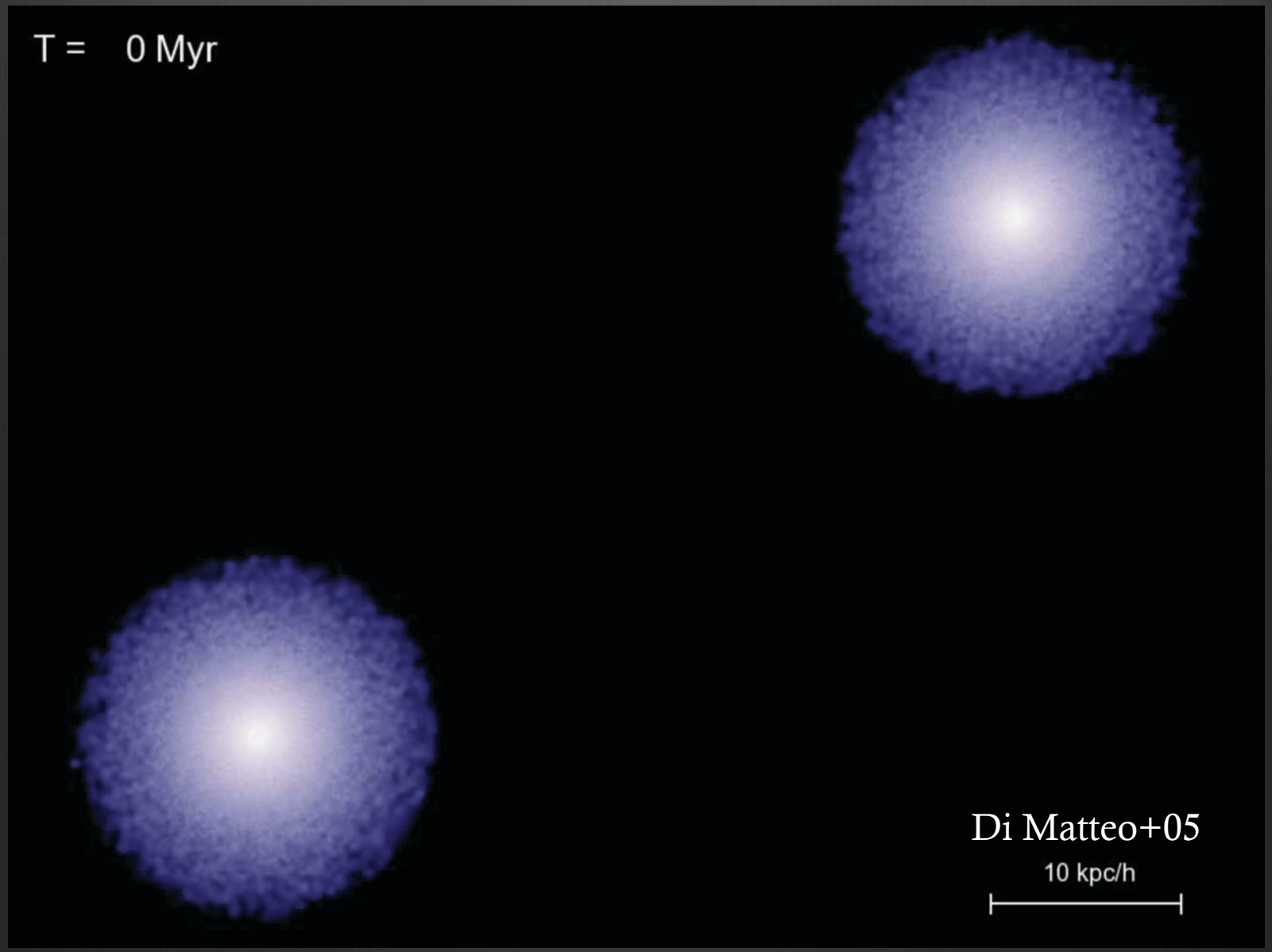
Large-Scale AGN Outflows in Galaxy Mergers



Dave Rupke (Rhodes College)
with Sylvain Veilleux, Hannah Krug, Jenny Shih, Alex Piazza, Mark Westmoquette, and Dave Sanders

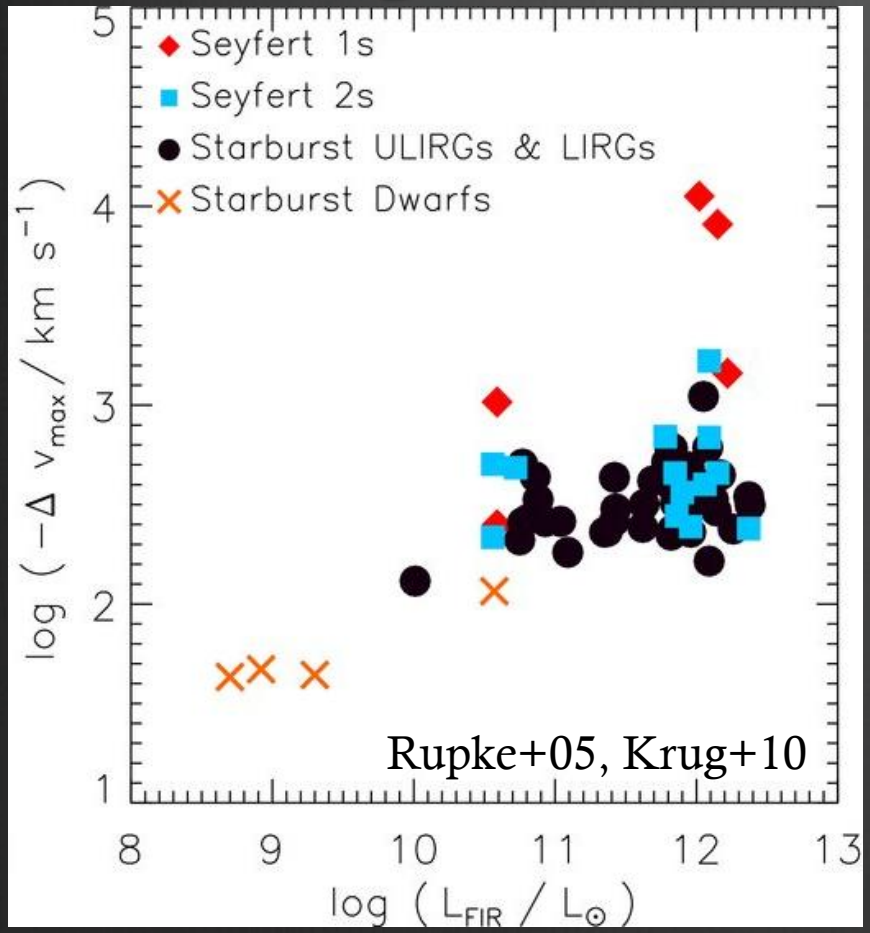
Credit: Gemini / AURA / Lynette Cook

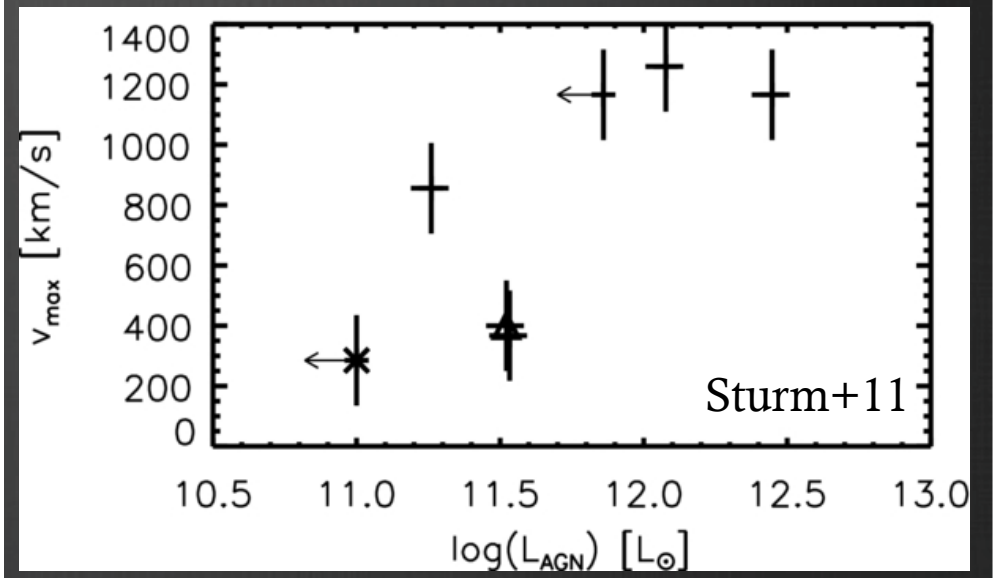
Motivation #1



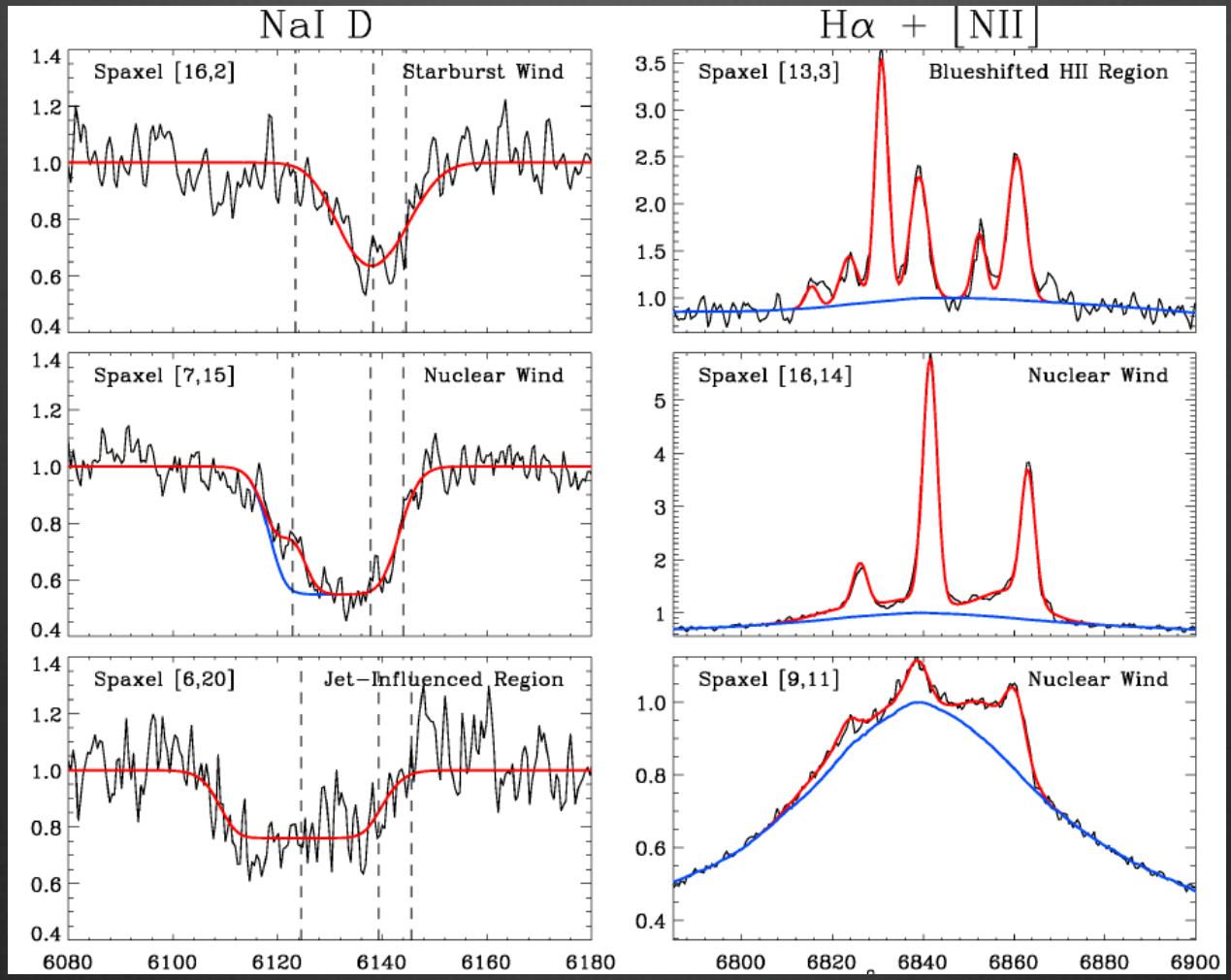
Motivation #2

- Do QSOs power large-scale, wide-angle winds in mergers?





Method: Optical IFS



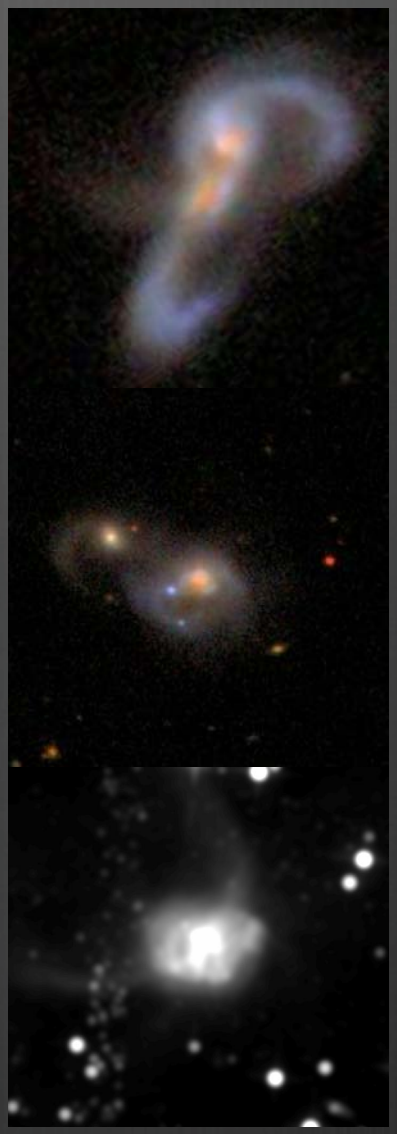
Rupke+Veilleux 11

Sample

- $z < 0.1$
- ULIRGs
- Mix of properties

1. F10565+2448: Shih+Rupke 10
2. Mrk 231: Rupke+Veilleux 11
3. 6-galaxy sample: Rupke+12, in prep.

Starbursts



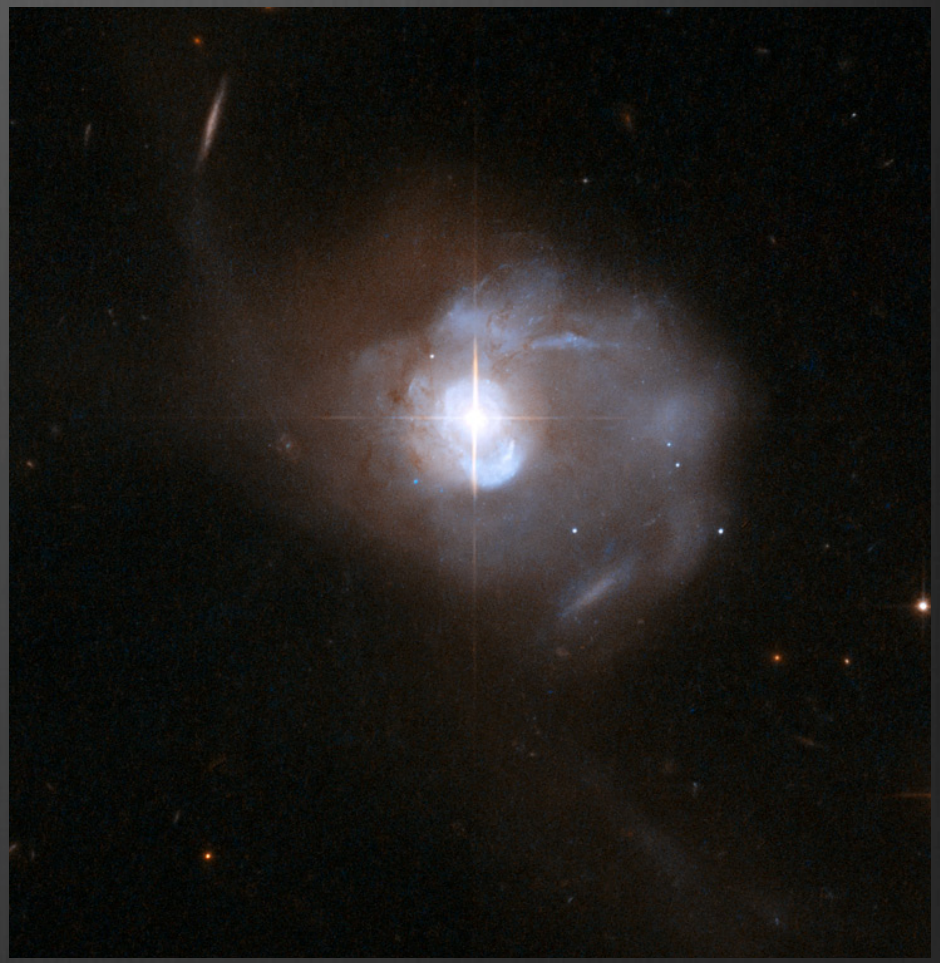
AGN

Images: SDSS + HST

QSO Wind: Mrk 231

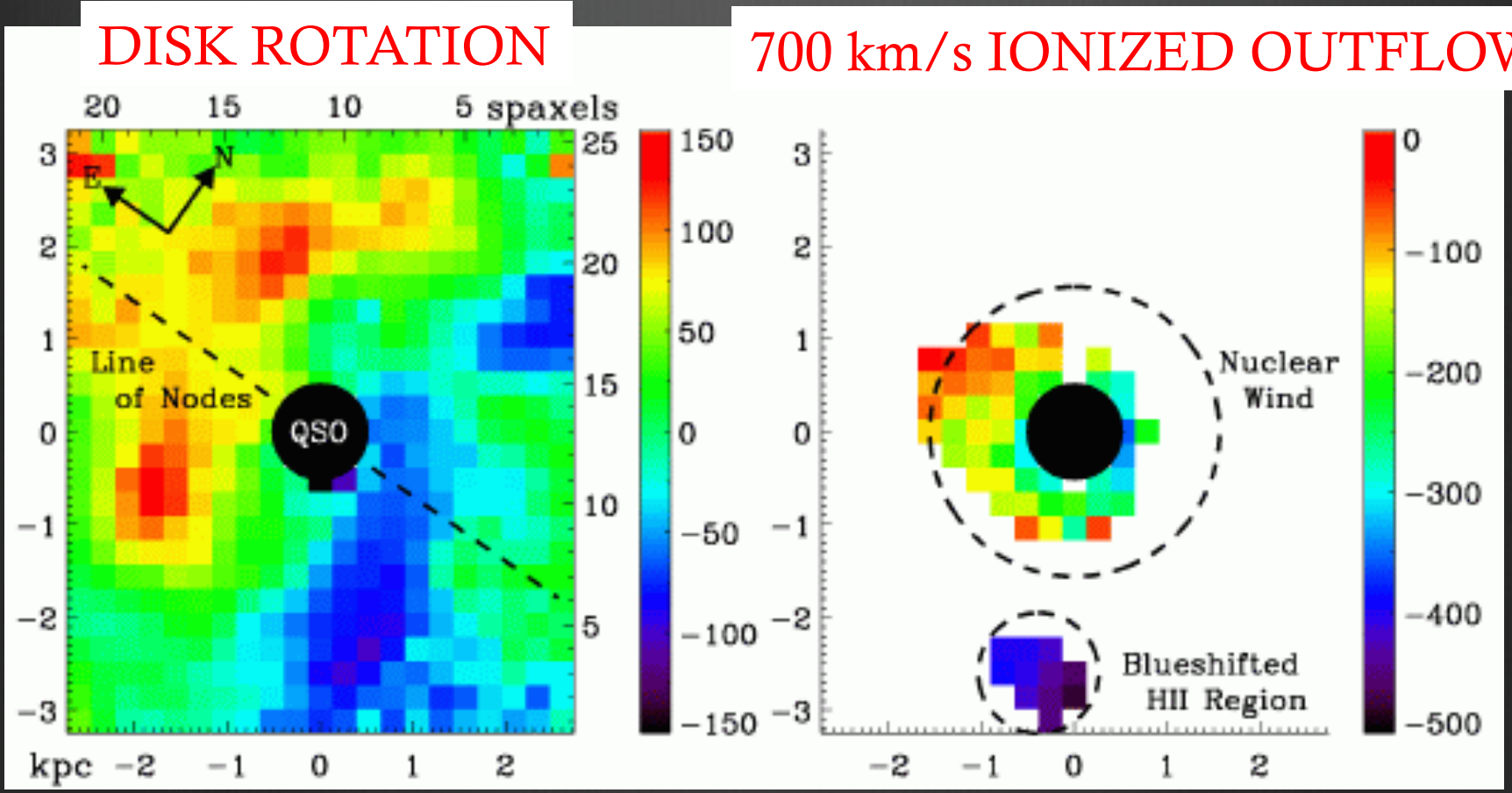
- Nearest:
  - QSO
  - QSO in a merger
  - (FeLo)BAL QSO

- Known outflows:
  - BAL (4000-8000 km/s)
  - Radio jet
  - extended (~1000 km/s)
    - neutral (Rupke+05)
    - molecular (Fischer+10, Feruglio+10)



Credit: NASA / ESA / Hubble Heritage / A. Evans

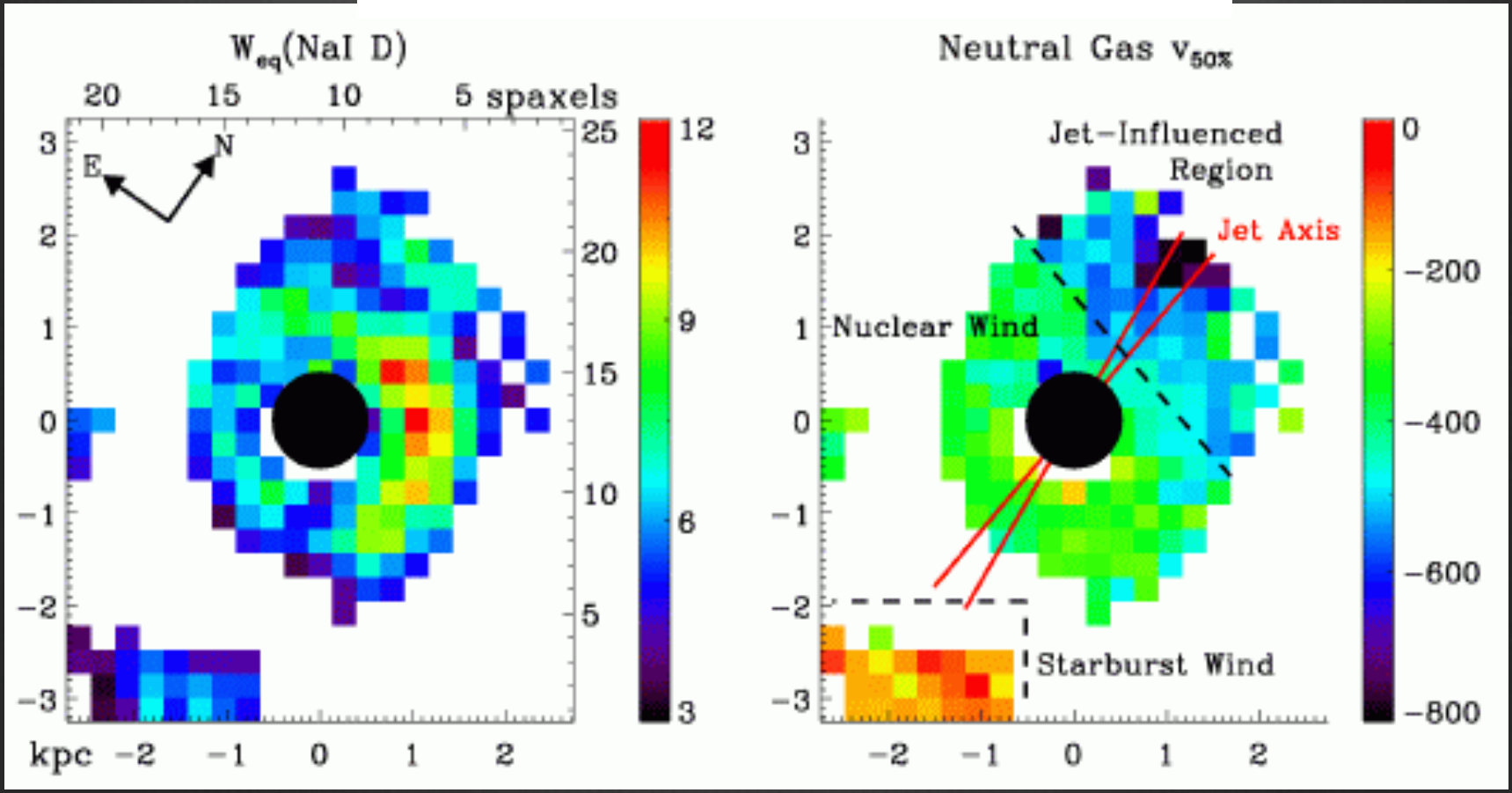
QSO Wind: Mrk 231



Rupke+Veilleux 11

QSO Wind: Mrk 231

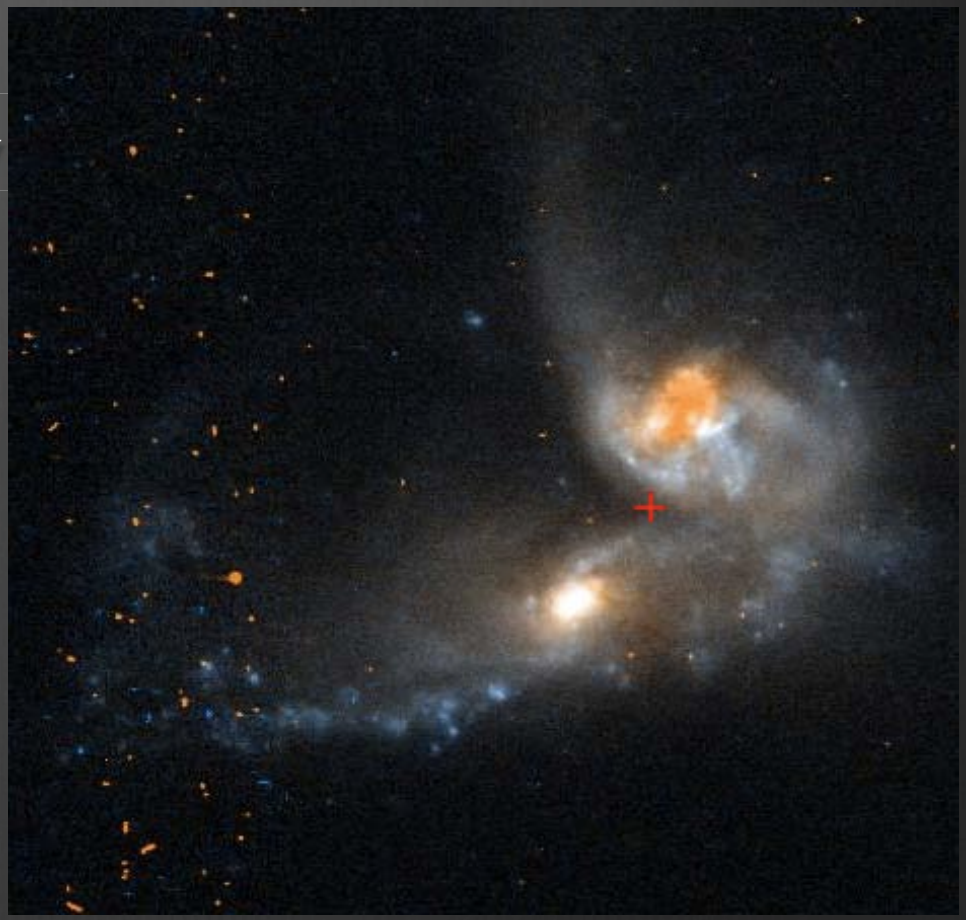
900 km/s NEUTRAL OUTFLOW



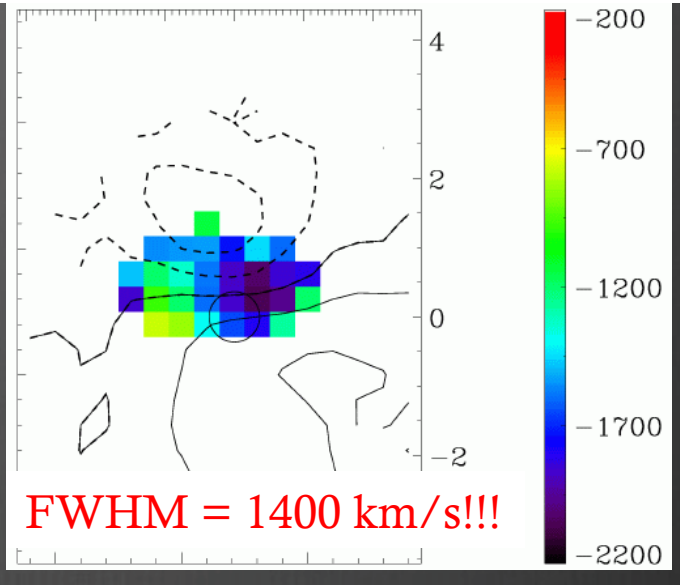
Rupke+Veilleux 11

Obscured QSO Wind: F08572+3915

- Double nucleus
  - IR source is a very heavily obscured QSO in the northwest nucleus.
- Molecular outflow (Sturm +11)

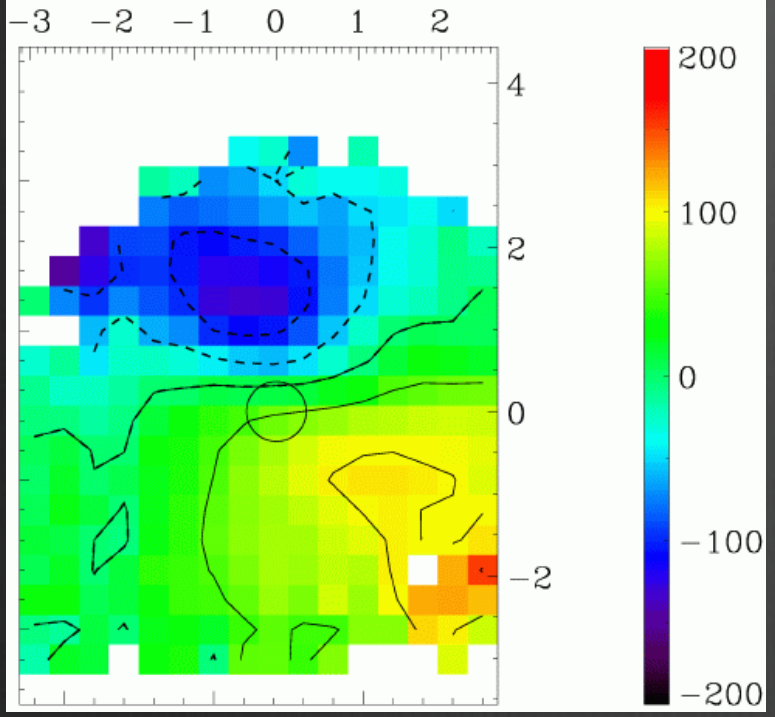


2800 km/s IONIZED OUTFLOW

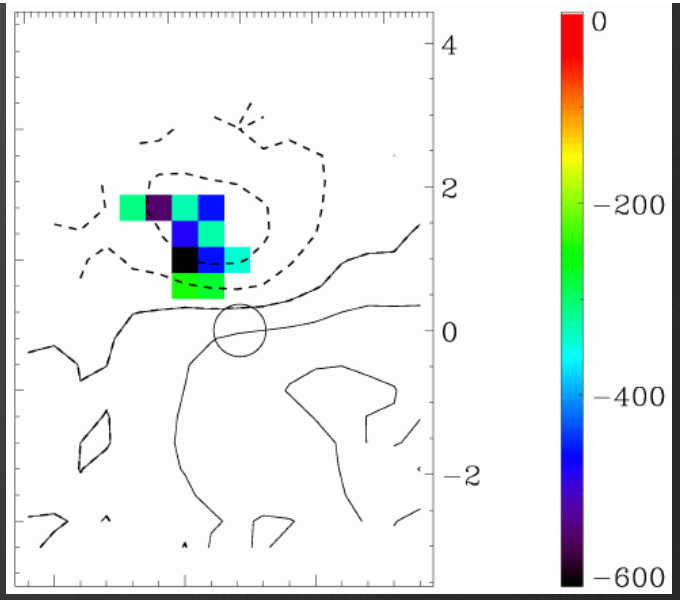


FWHM = 1400 km/s!!!

DISK ROTATION

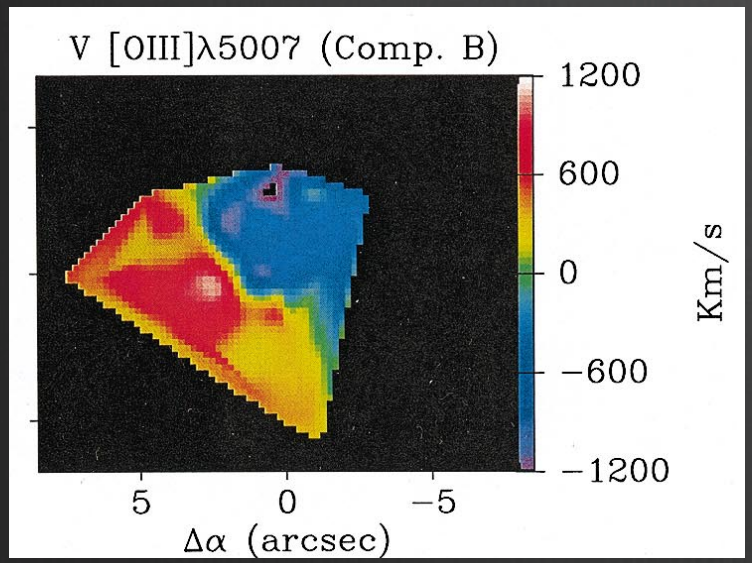


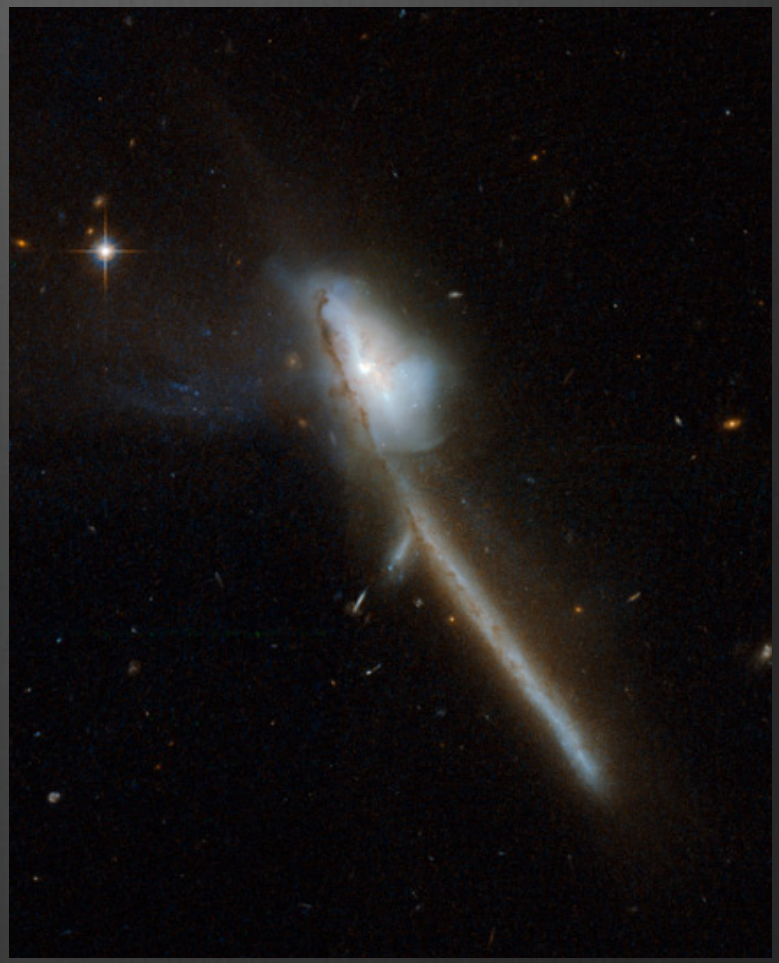
900 km/s NEUTRAL OUTFLOW



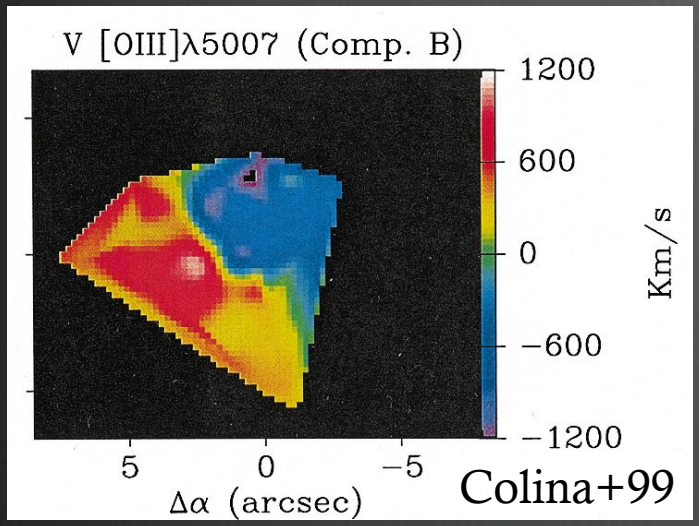
Obscured QSO Wind: Mrk 273

- Possible binary AGN? (Iwasawa+11)
- Colina+99: "starburst-driven superwind"



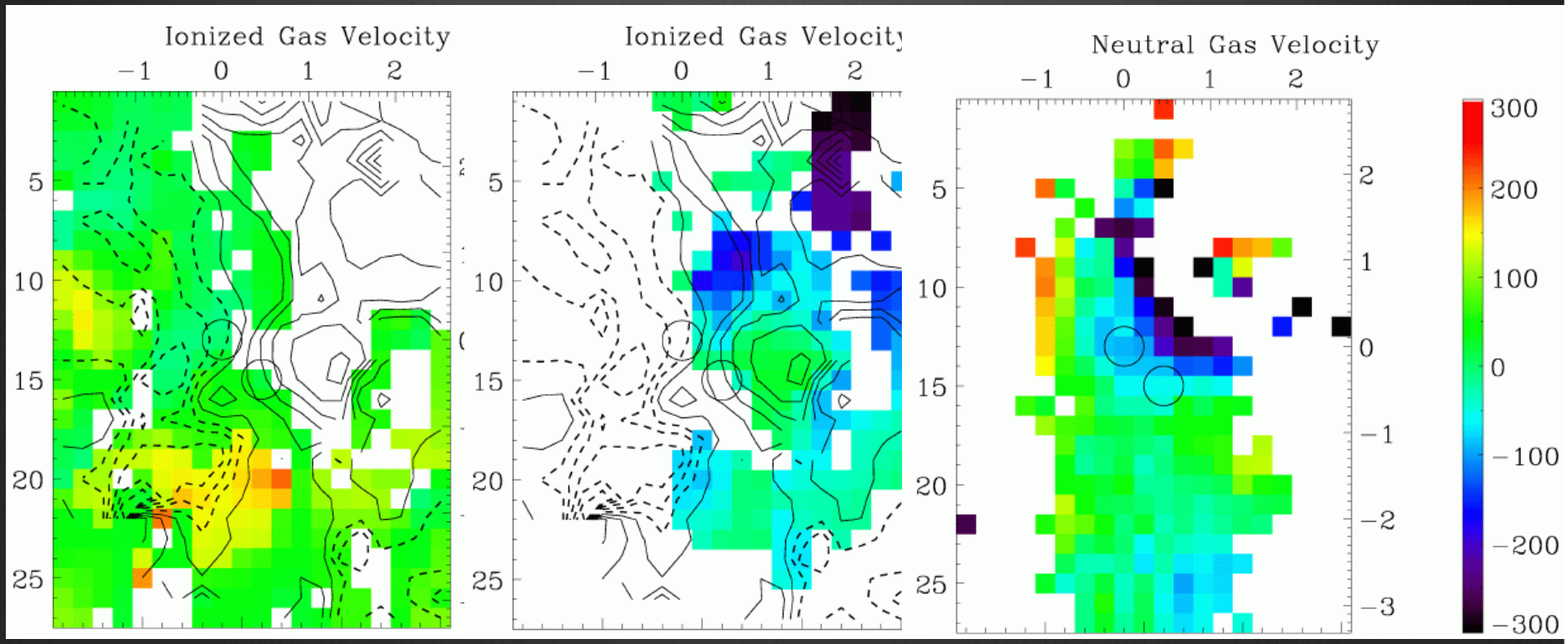


Credit: NASA/ESA/Hubble Heritage/A. Evans

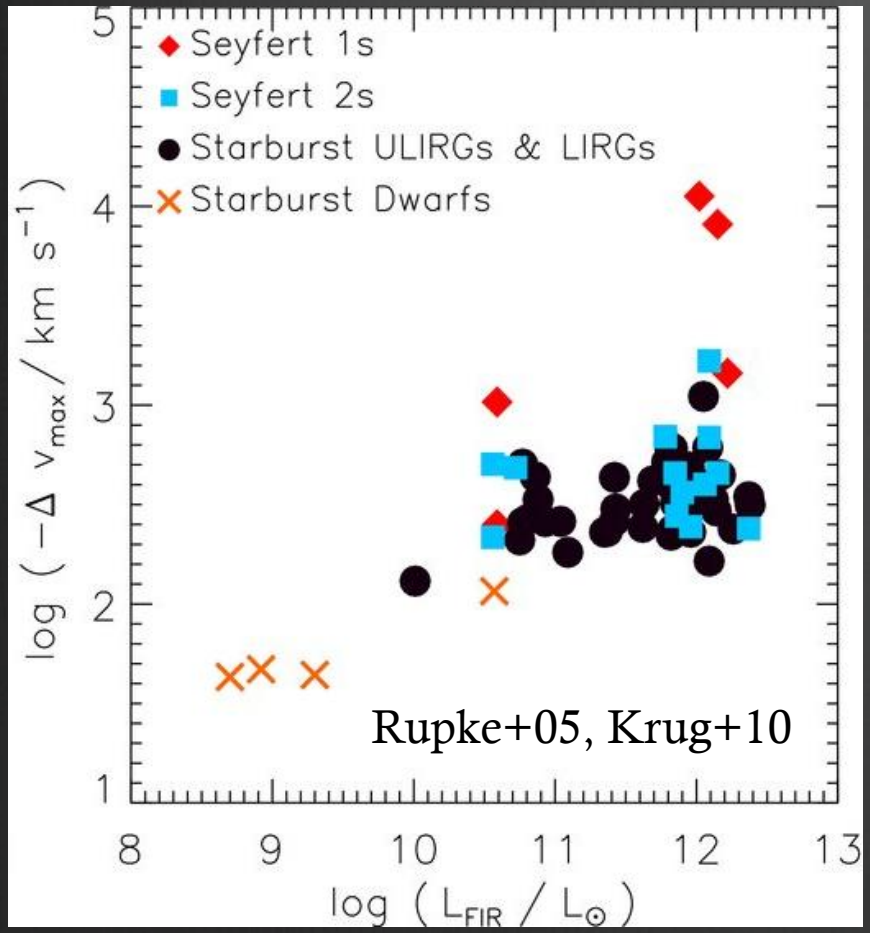


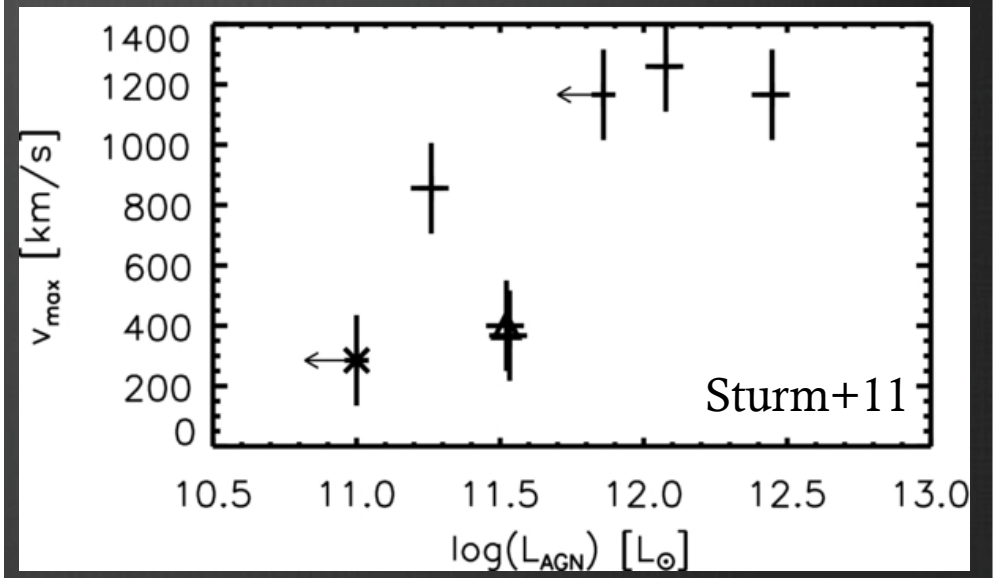
1000 km/s IONIZED OUTFLOW

400 km/s NEUTRAL OUTFLOW



Do QSOs power large-scale, wide-angle winds in mergers?





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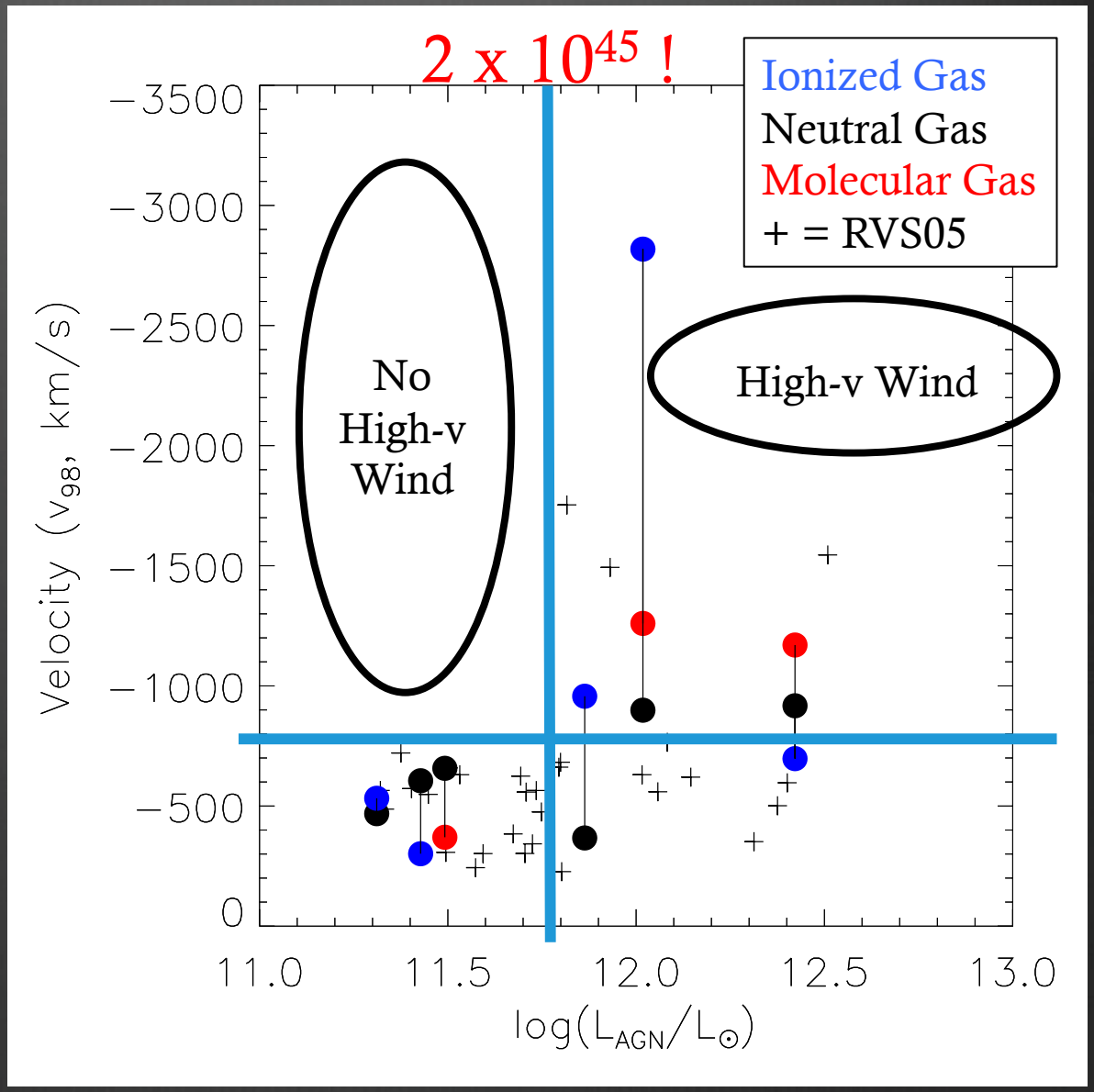

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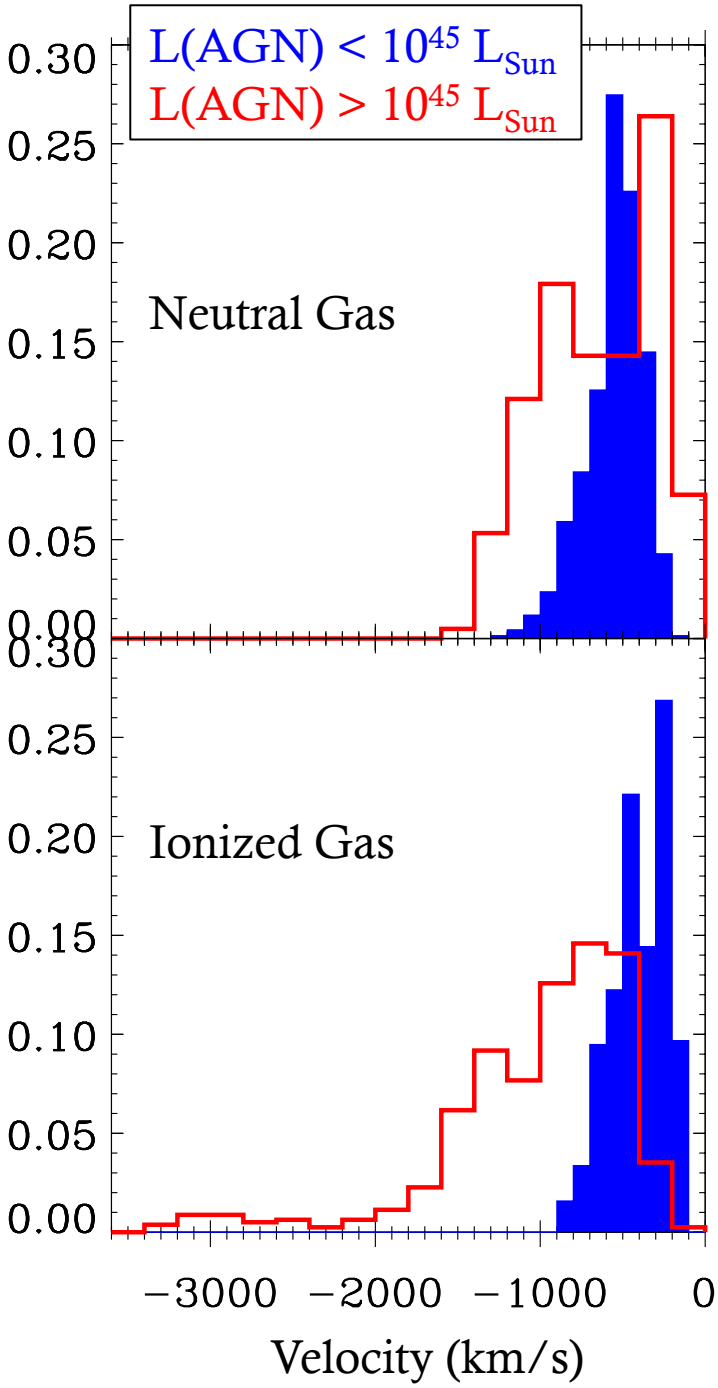
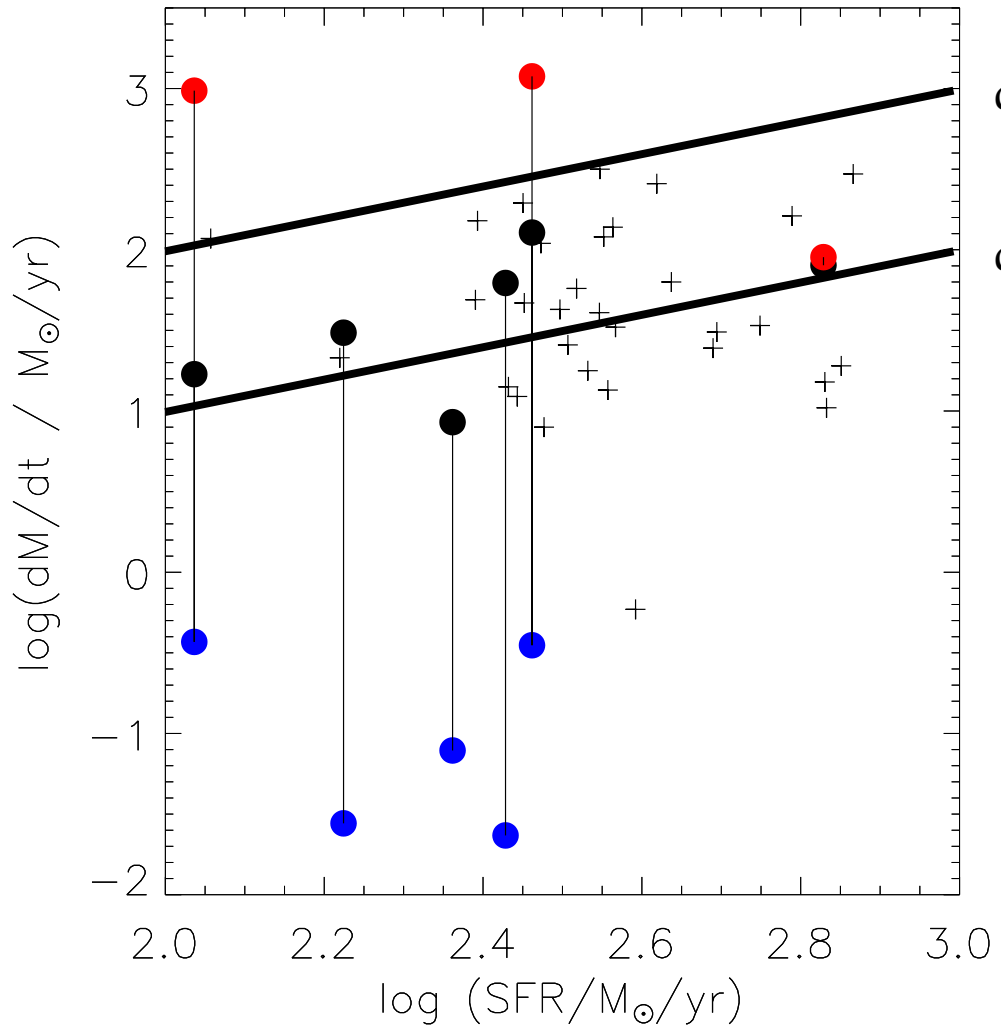


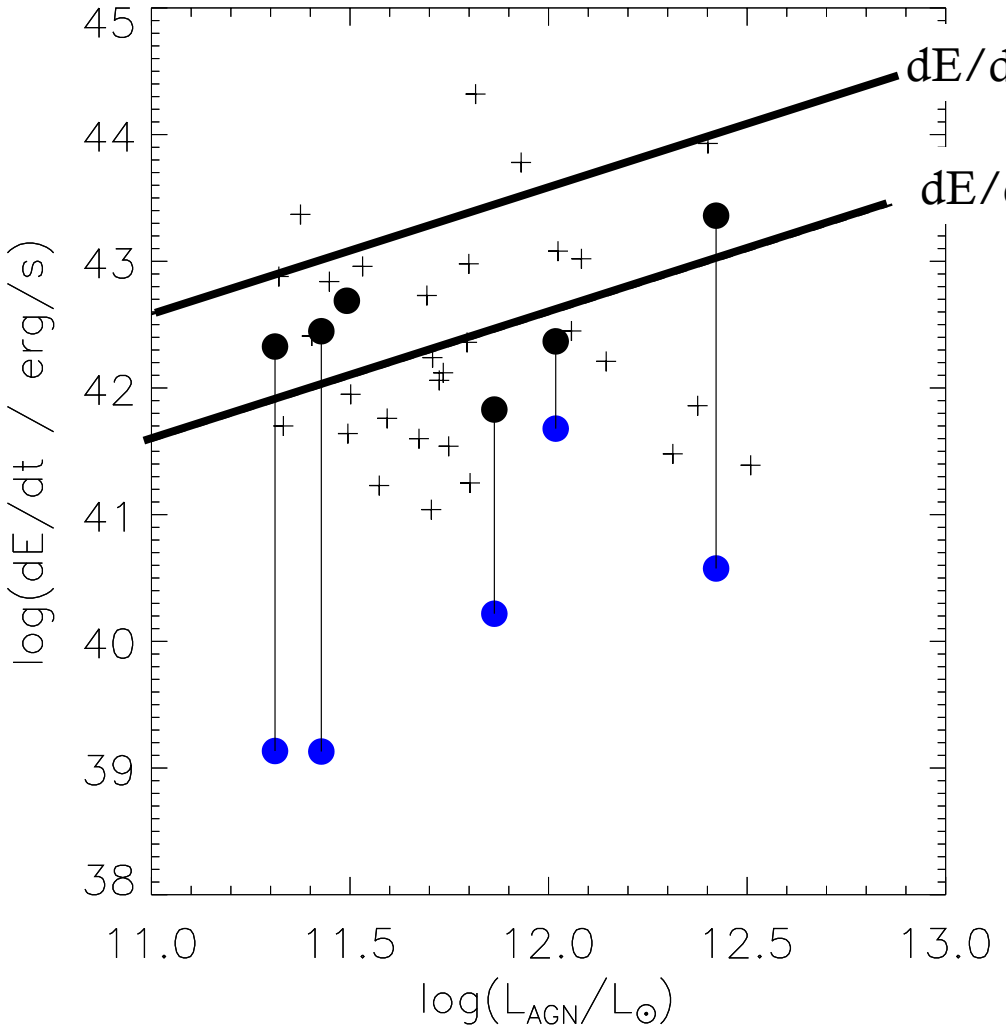
And what are their properties?



dM/dt = 100% SFR

dM/dt = 10% SFR

And what are their properties?



Important Questions

- Do QSOs power large-scale, wide-angle winds in mergers?
  - Rupke+05: Maybe.
  - Rupke+11: YES!
  - And it's blowing away the obscuring screen.
- What are their properties?
  - Size > 1 kpc
  - Primarily neutral / molecular
  - Maximum velocities > 1000 km/s (depending on phase)
  - Mass flow rates ~ 10-100% of SFR
  - Energy flow rates <1% of L(AGN)