Black Hole Feedback in Dwarf Galaxies

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Thinkshop 15: The Role of Feedback in Galaxy Formation

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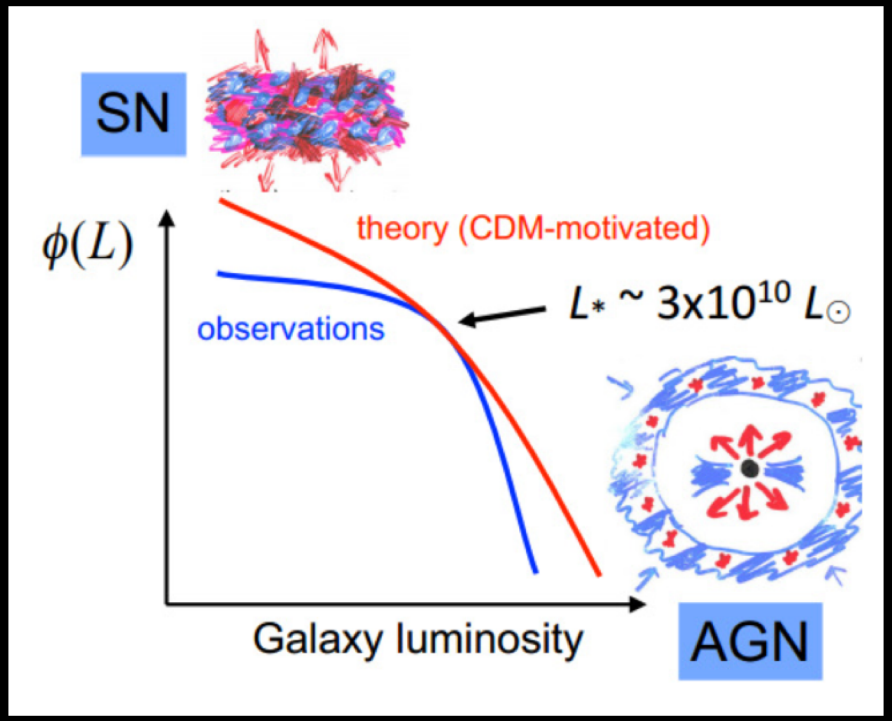
ASTRONOMY UCR

Feedback in Dwarfs

- Generally assumed that dominant source of feedback in dwarfs is radiation from young stars and supernova explosions

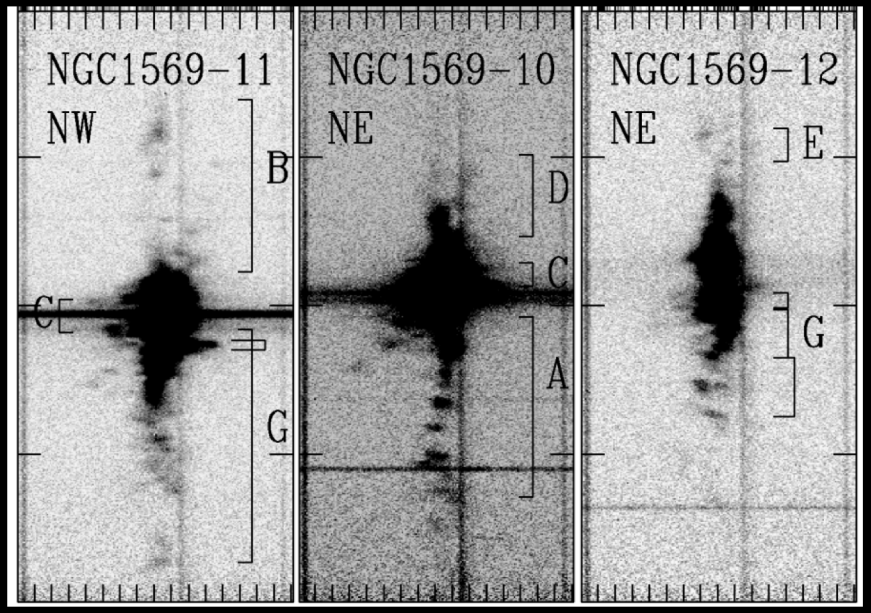


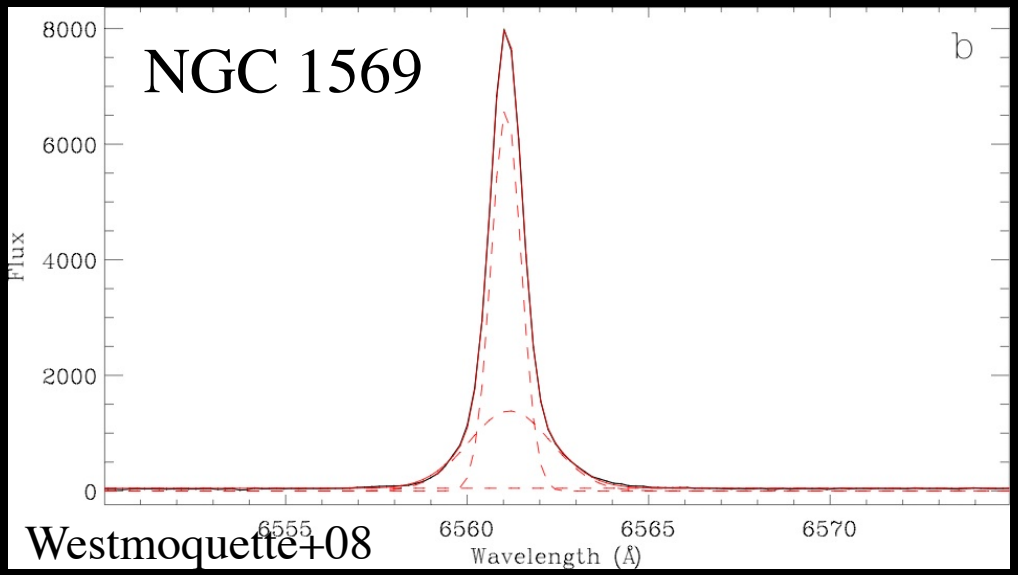
Silk & Mamon (2012)

Galactic winds in star forming dwarfs

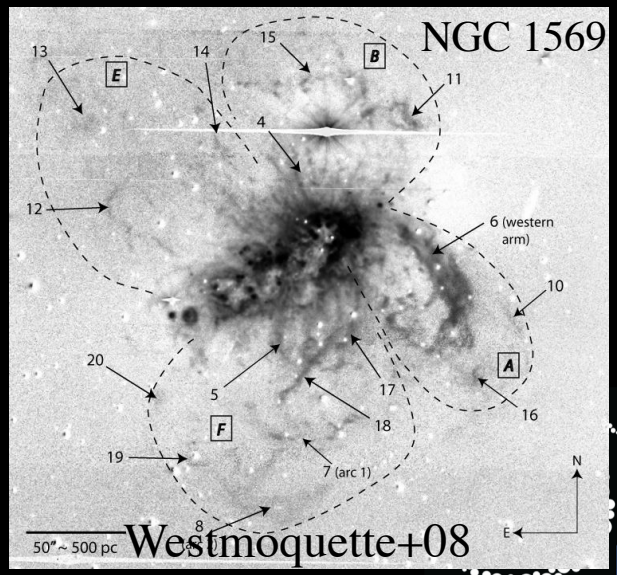
M82

Martin'98





Westmoquette+08



Westmoquette+08

AGN vs. stellar feedback in dwarfs

- Large samples of dwarfs hosting AGN have been assembled in the last five years (e.g., Reines+13, Moran+14, Sartori+15, Marleau+18)
- Analytic considerations of energetics suggest that BH feedback could be at least as important as stellar feedback (e.g., Silk+17, Dashyan+17).
- Can we find observational evidence of the existence of AGN-driven outflows in dwarfs?

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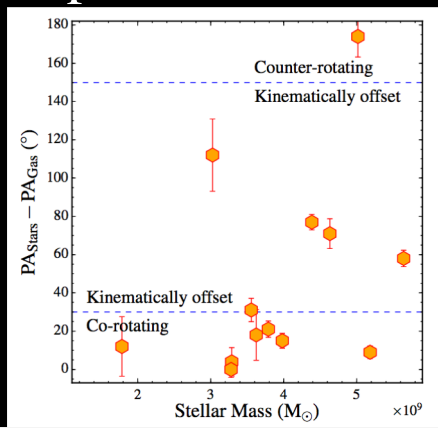
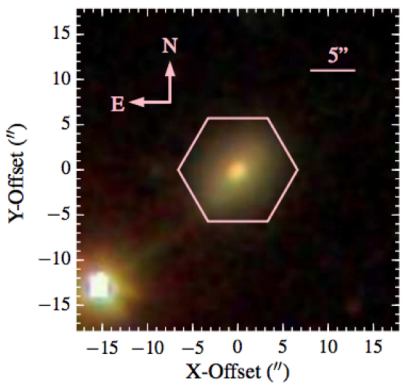
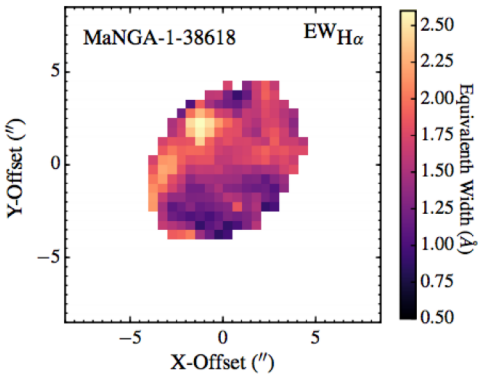
AGN feedback in dwarfs

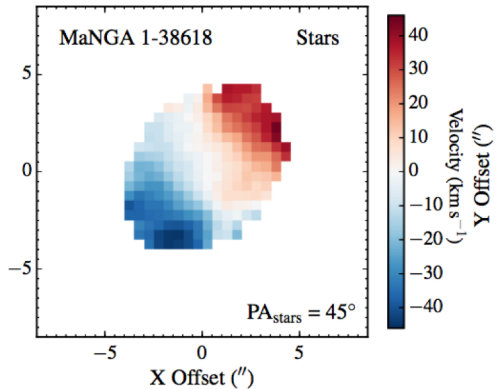
- Penny+18: Six out of 69 quenched dwarfs have signs of AGN activity.
- Five of those have a kinematically offset gas component, suggesting gas is either recently accreted or an outflow.
- They also show "bi-symmetric" structure in ionized gas expected from AGN outflows (Cheung+17)

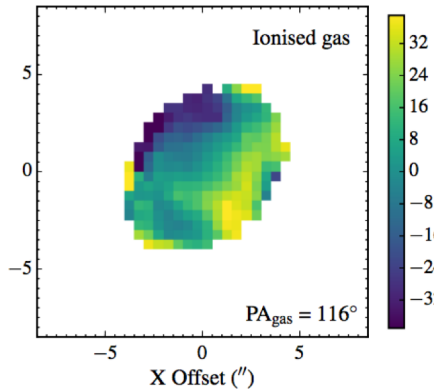
- These are encouraging hints of AGN feedback







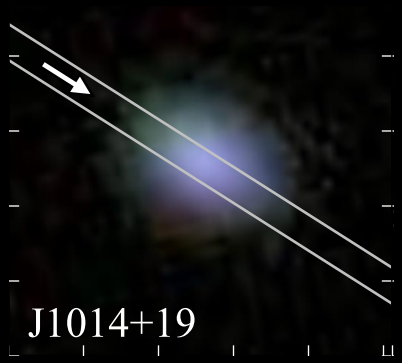


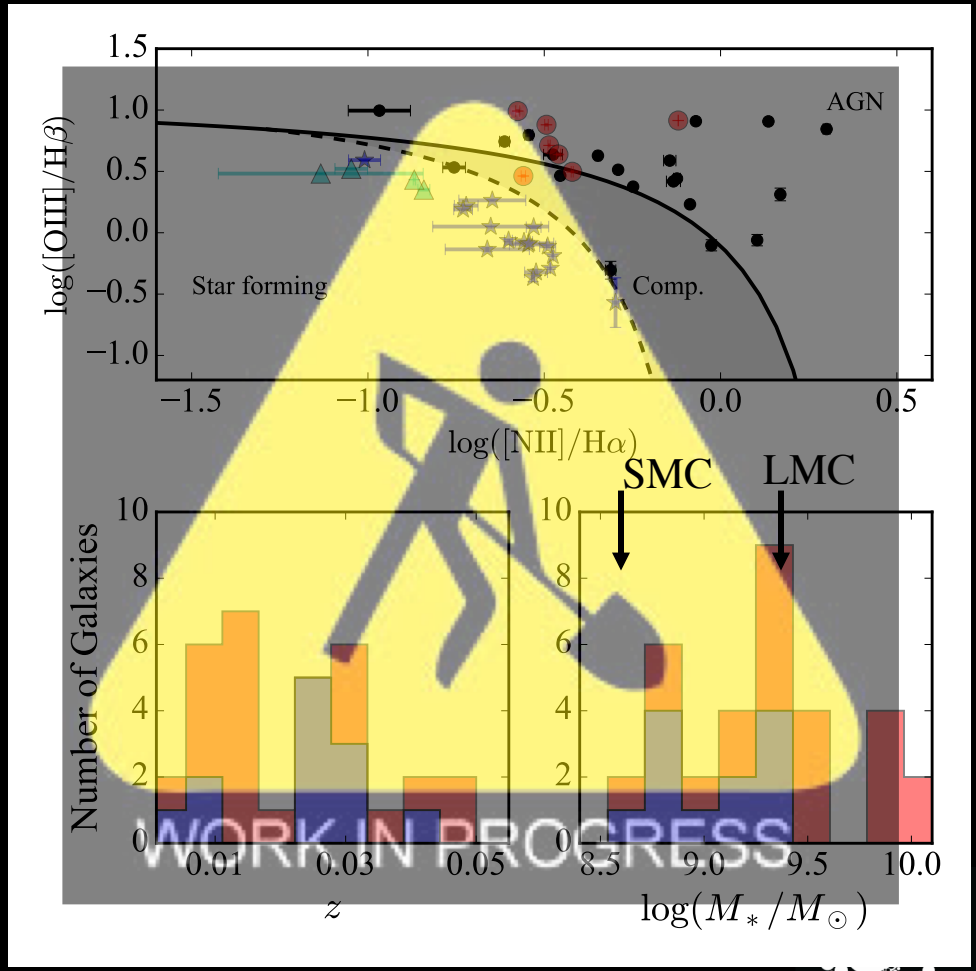


Our Project

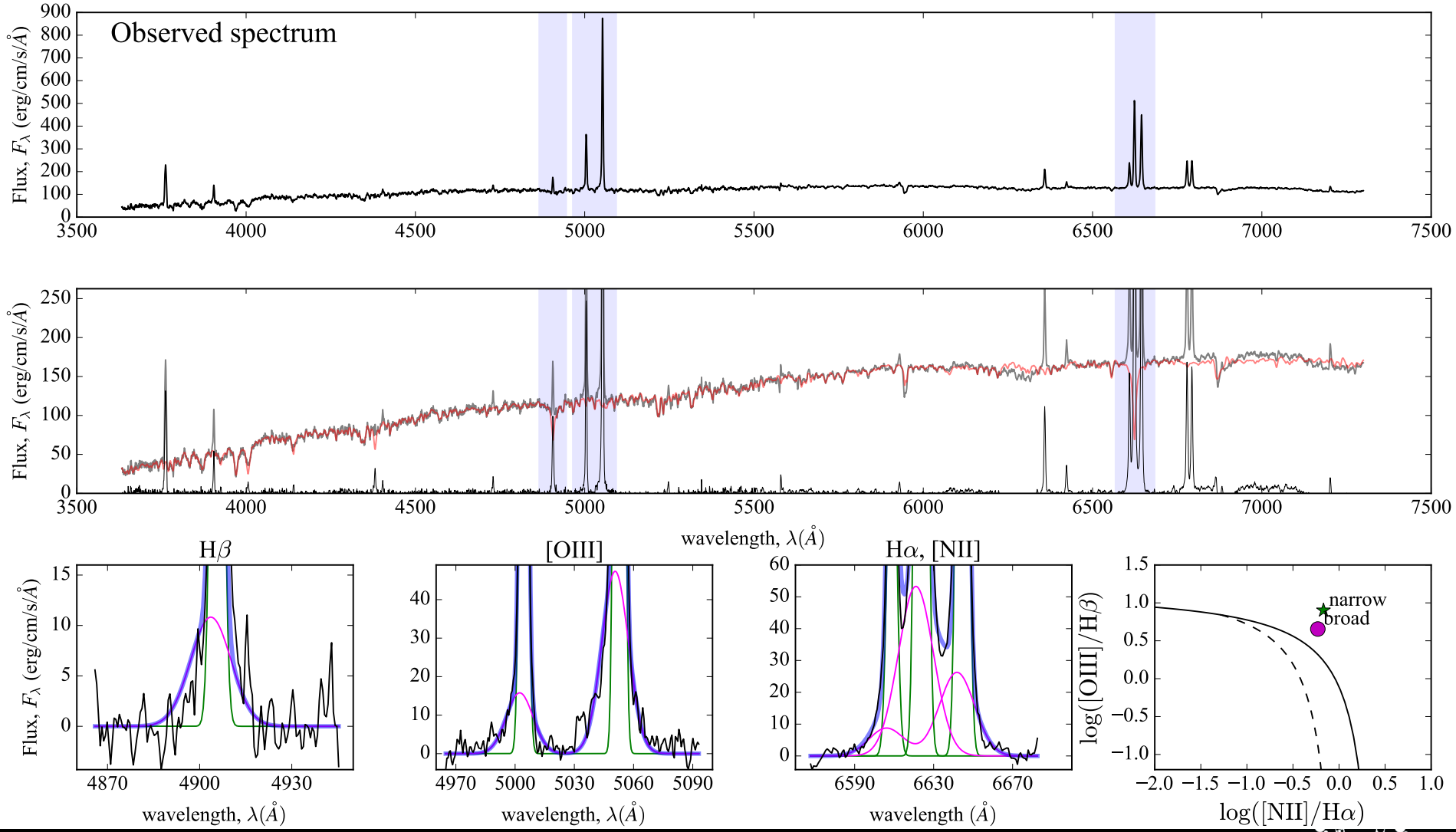
Christina Manzano-King

- Study of 21 nearby ($z < 0.045$) dwarfs ($\log M_*/M_\odot < 10.2$) hosting AGN with control sample of 12 inactive dwarfs
- Sample of AGN drawn from Reines+13, Moran+14
- Control sample drawn from the NASA-Sloan Atlas-selected catalog (Geha+12)
- Spatially resolved (< 300 pc) long-slit Keck/LRIS spectroscopy along major axis.



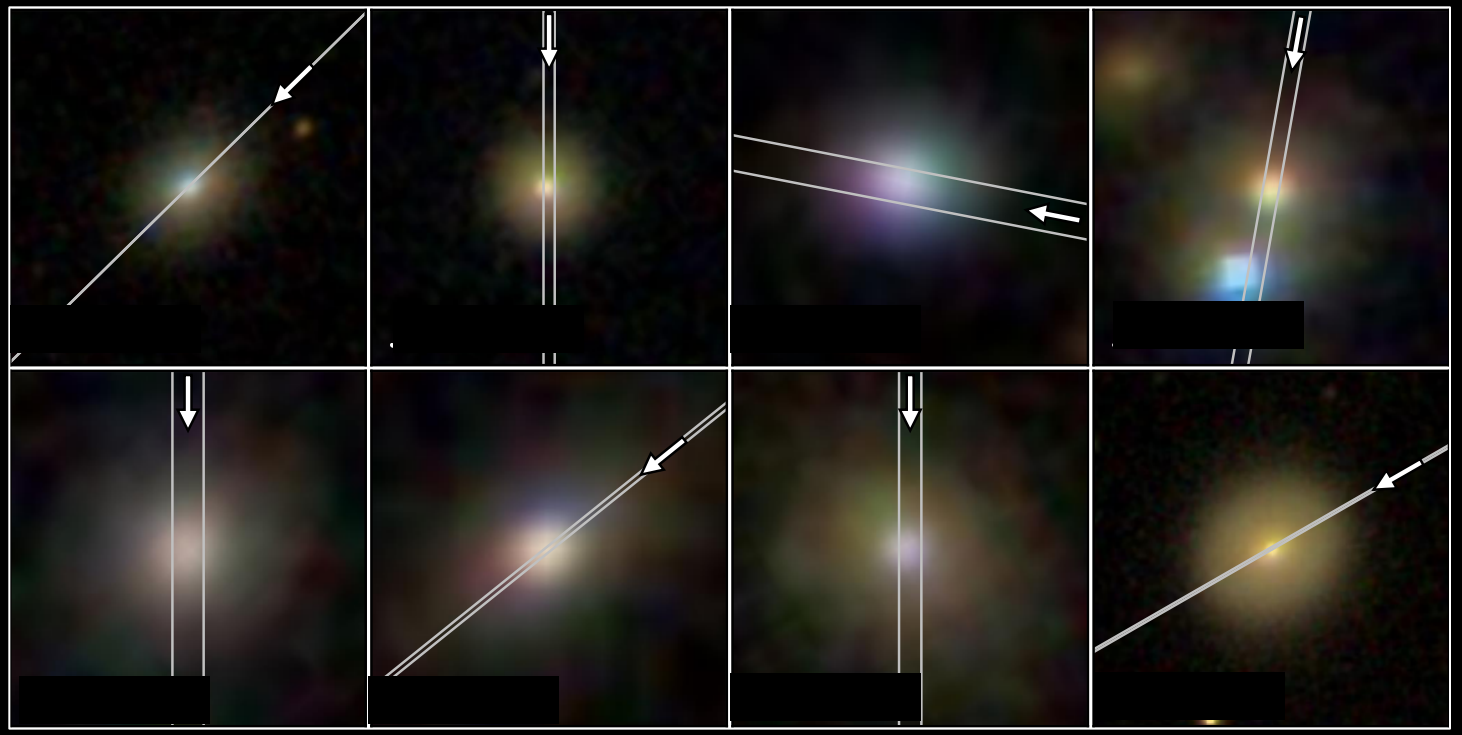


Keck longslit LRIS spectroscopy

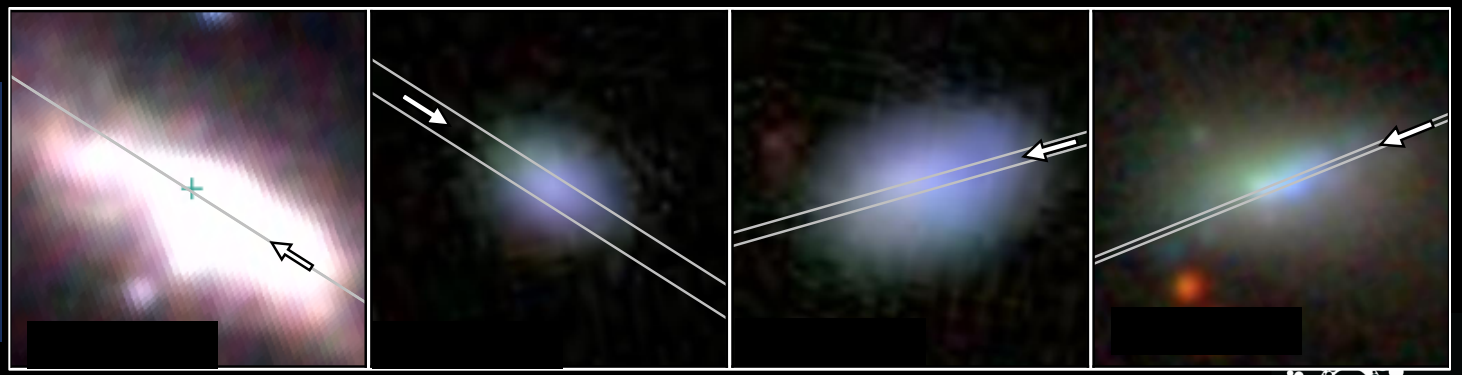


Galaxy-wide outflows detected in

8/21 AGN hosts

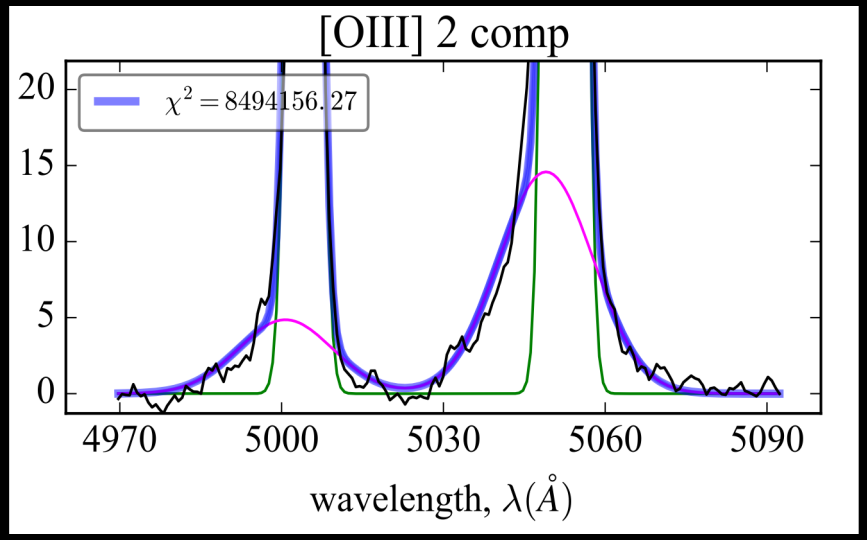


4/12 SF galaxies



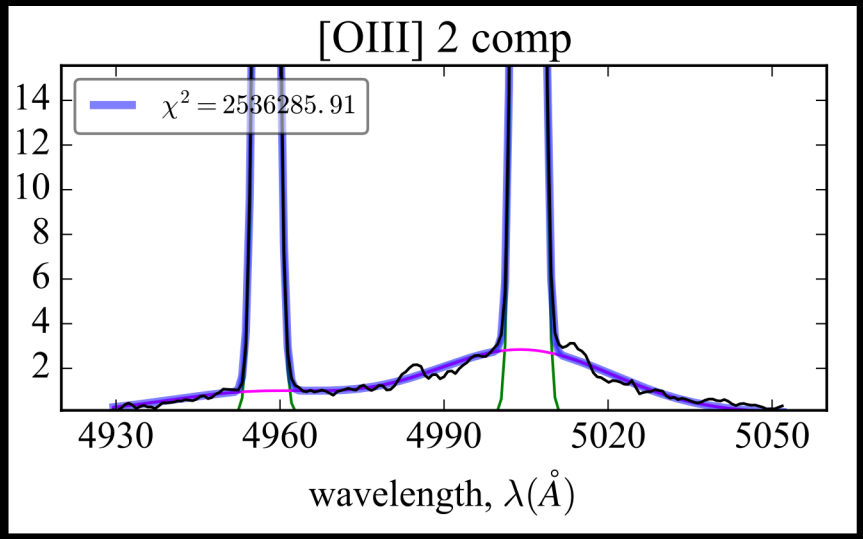
Outflows detected in ionized gas

- 8/21 AGN hosts



- Always blueshifted

- 4/12 SF galaxies



- More symmetrical and slightly redshifted

For both: velocities of some of the gas can be above 2,000 km/s

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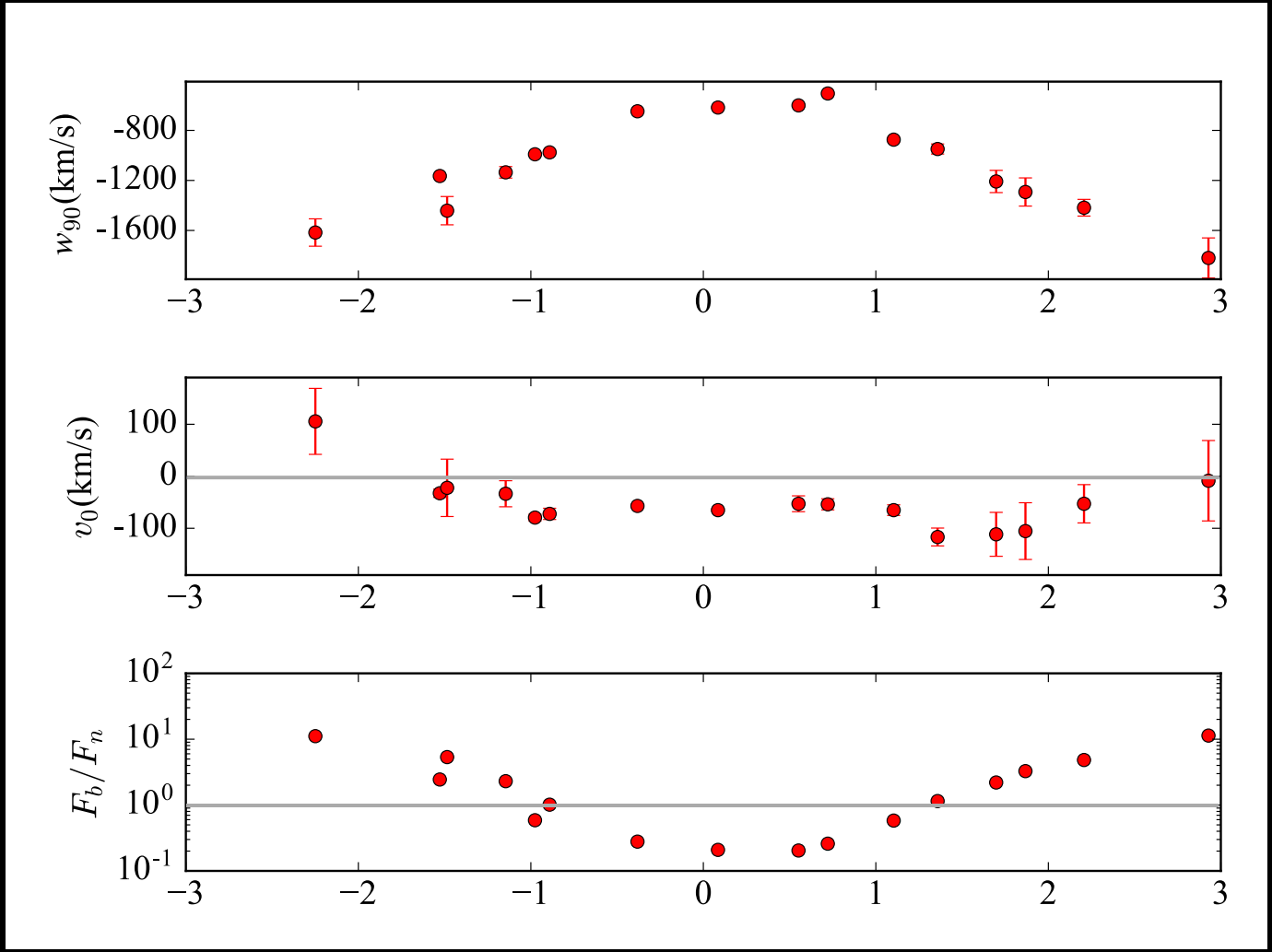
Spatially resolved outflows - AGN

velocity @ 90% (km/s) (or `W90')

velocity offset (km/s)

log flux ratio broad/narrow component

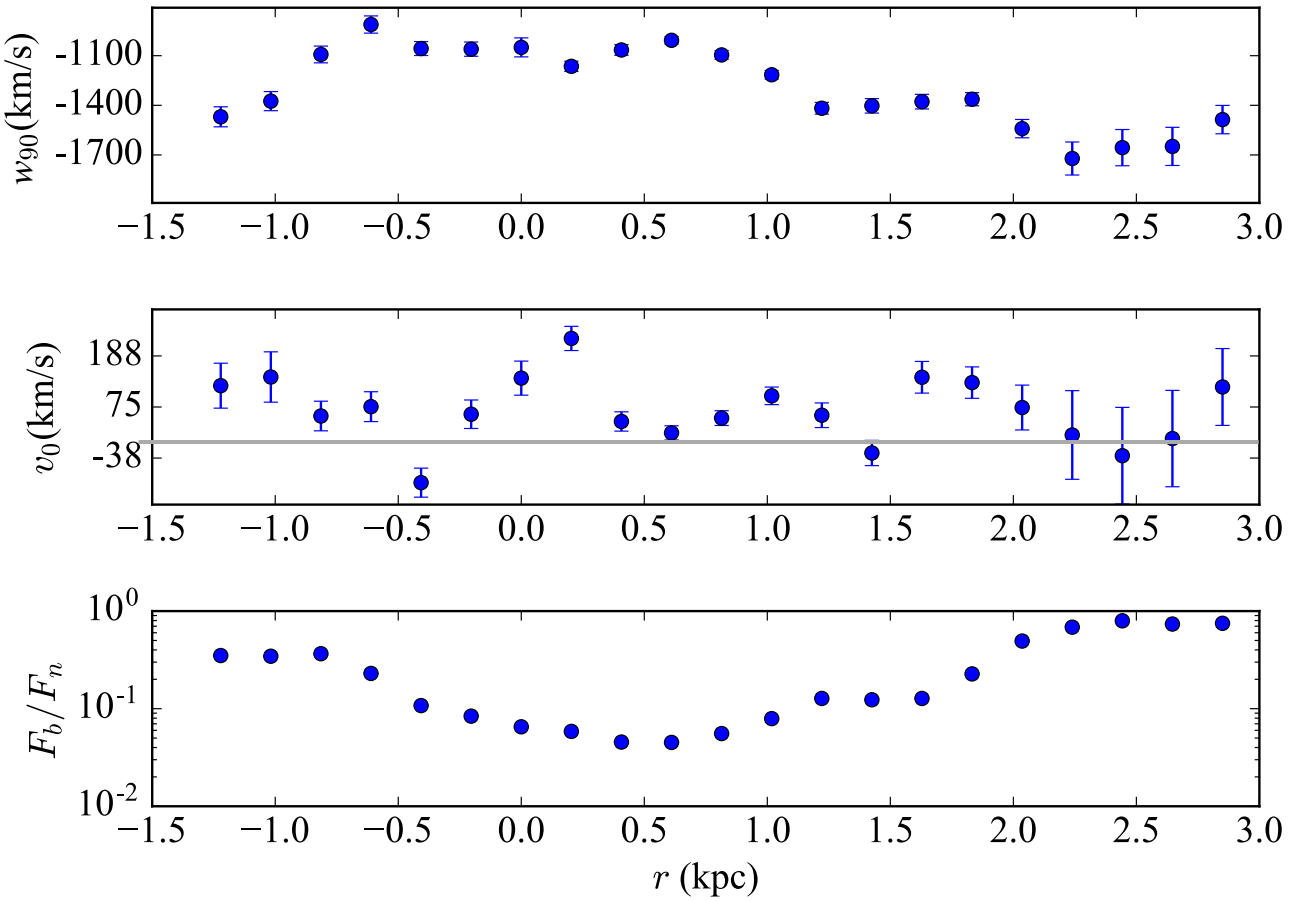


Spatially resolved outflows - SF

velocity @ 90% (km/s) (or `W90')

velocity offset (km/s)

log flux ratio broad/narrow component



Distance from center (kpc)

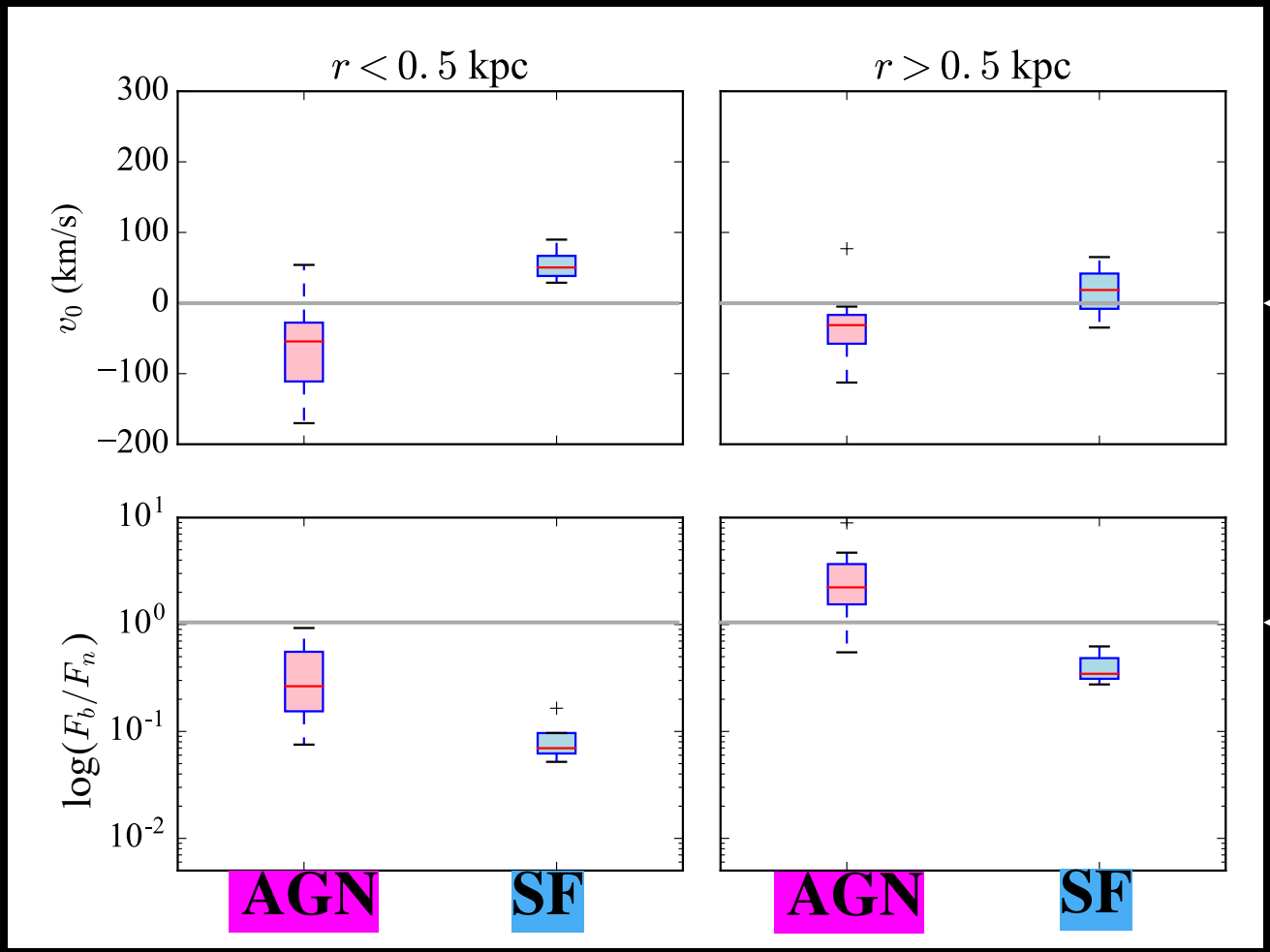
AGN vs. SF Outflows

Central kpc

Outer regions

velocity offset (km/s)

log flux ratio broad/narrow component



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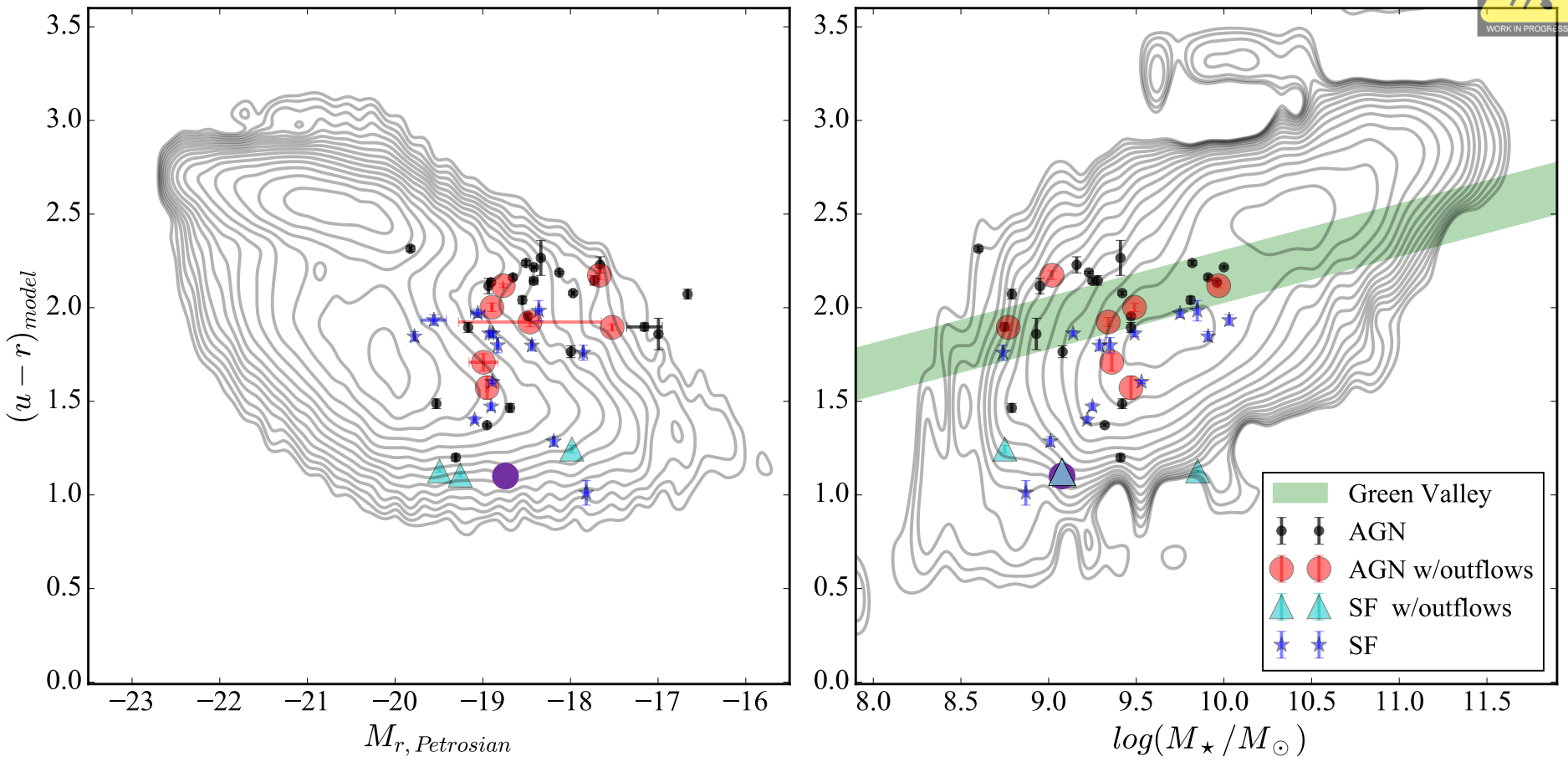
Does feedback quench star formation?



Manzano-King, GC & Sales, in prep

Summary

- Galaxy-wide outflows detected in ionized gas in ~one third of dwarf galaxies, both AGN (8/21) and star forming (4/12)
- Outflows in AGN hosts have line ratios that suggest they are powered by the AGN itself
- AGN outflows are generally more blueshifted and comprise a larger fraction of the gas at any given radius than their SF counterparts
- A fraction of the gas in both AGN and SF outflows can reach velocities above 1000 km/s, much larger than the escape velocities of their hosts
- AGN with outflows are closer to the Green Valley. This suggests that AGN feedback may play a role in the quenching of star formation.

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