Black Hole Feedback in Dwarf Galaxies

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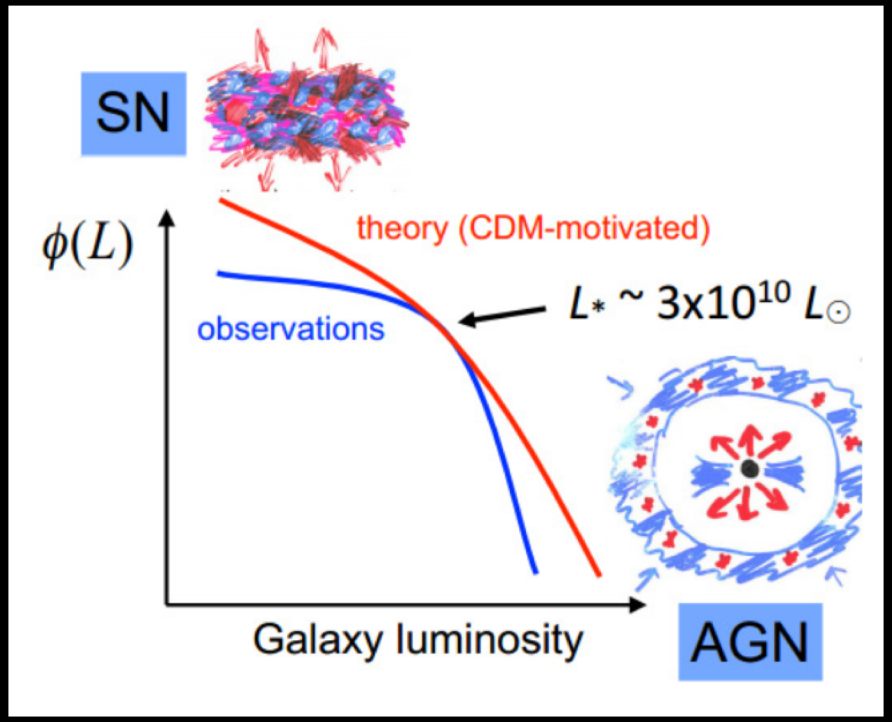
Feedback in Dwarfs

- Generally assumed that dominant source of feedback in dwarfs is radiation from young stars and supernova explosions (e.g., Benson+02, Bower+06)



Silk & Mamon (2012)

Until recently, very few dwarfs with AGN were known to exist

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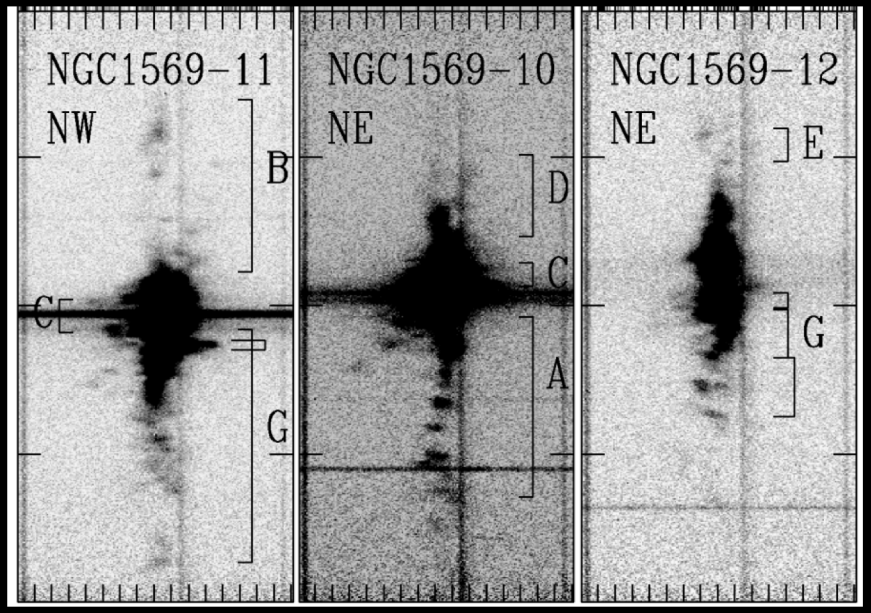
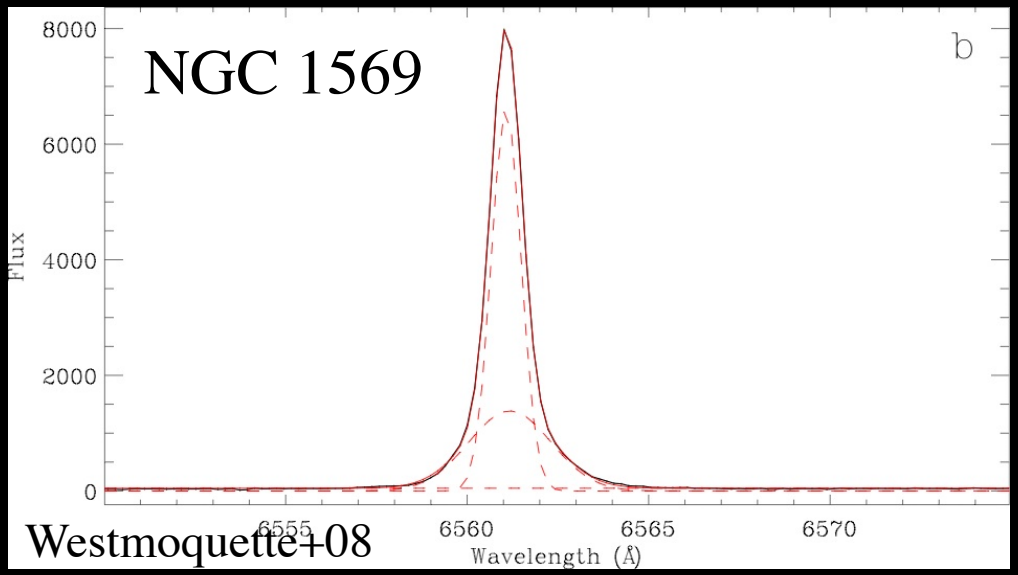
Galactic winds in star forming dwarfs

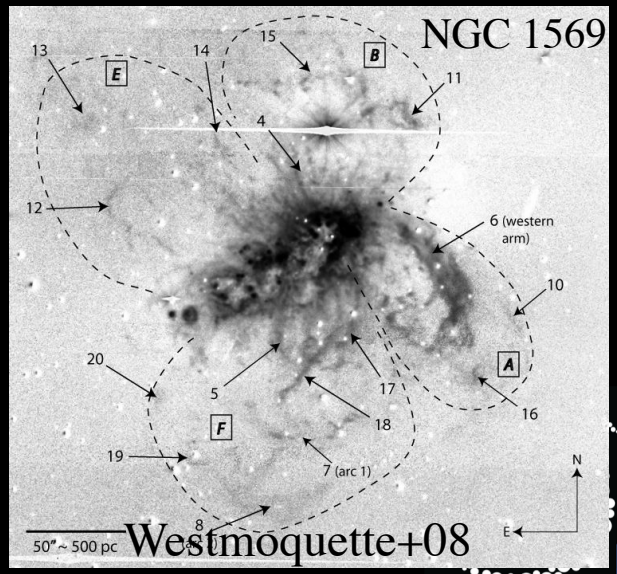
M82

Martin'98





Westmoquette+08



Westmoquette+08

AGN vs. stellar feedback in dwarfs

- Large samples of dwarfs hosting AGN have been assembled in the last few 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).
- Some simulations suggest that AGN feedback may hinder cosmic gas inflows, indirectly regulating star formation (Koudmani+19)
- Recent studies (Penny+18, Bradford+18, Dickey+19) show a connection between quiescence or low SFR with signs of AGN activity in dwarfs
- Can we find more direct observational evidence of the existence of AGN-driven outflows in dwarfs?

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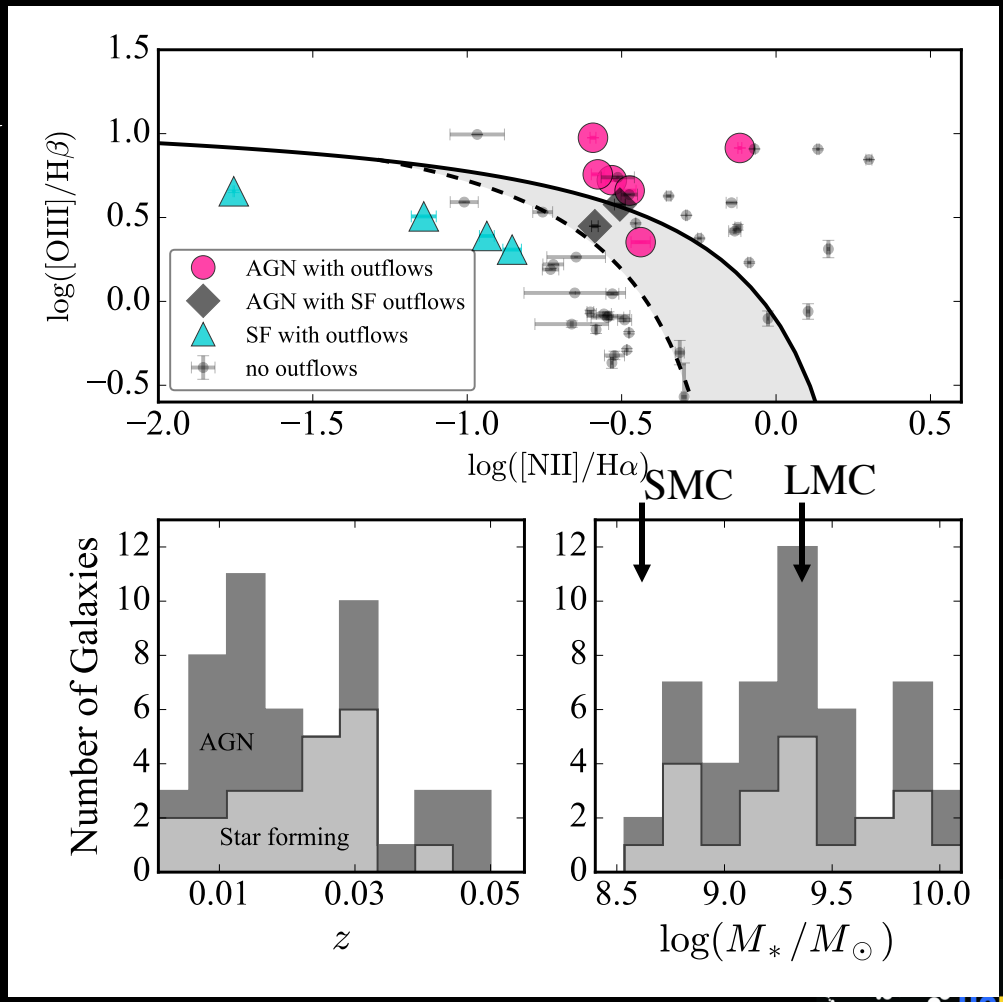
Our Project

Christina Manzano-King

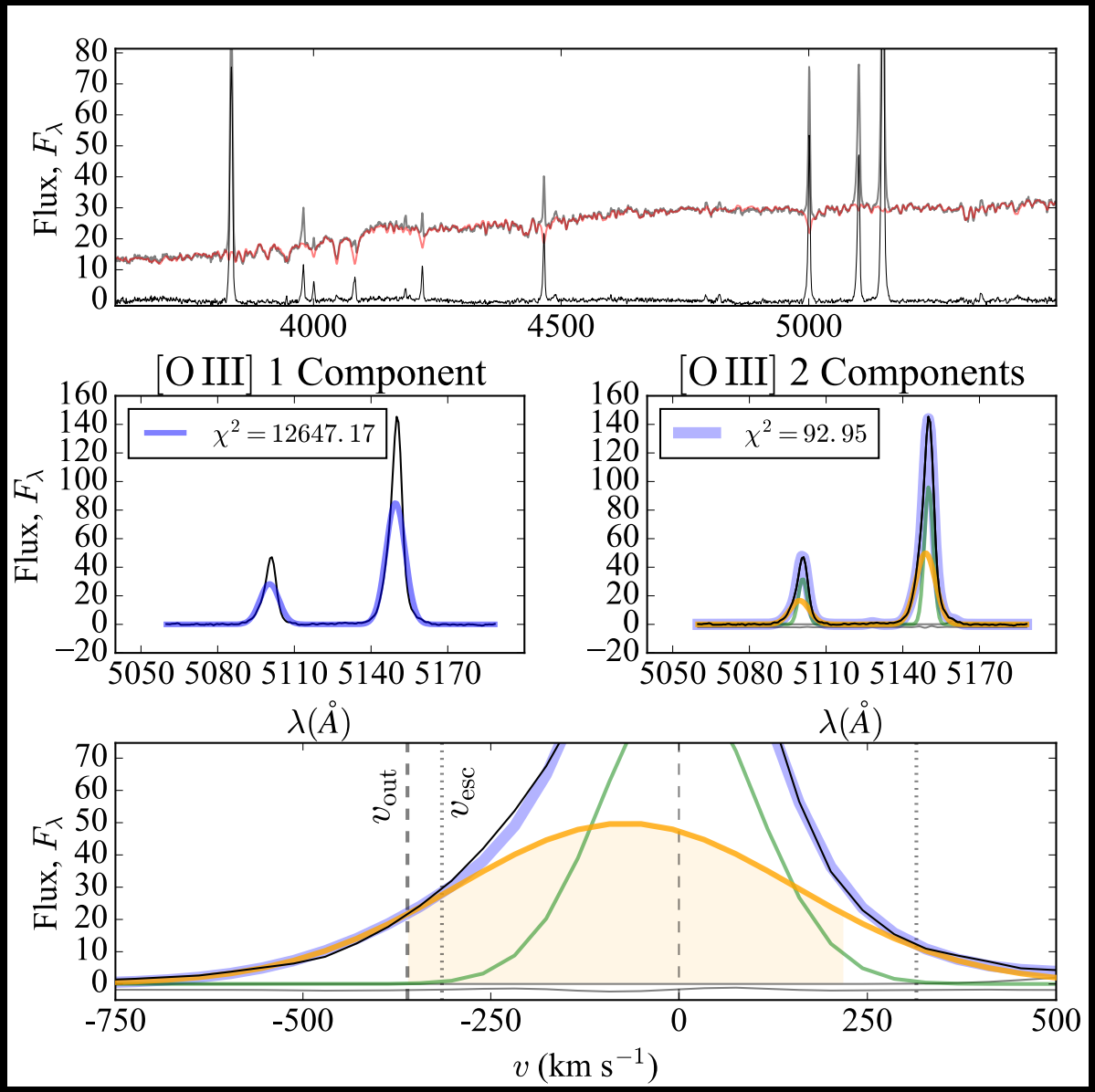
- Study of 50 nearby ($z < 0.05$) dwarfs ($\log M_*/M_\odot < 10.2$)
- 29 AGN drawn from SDSS (Reines+13, Moran+14)
- Control sample of 21 star forming galaxies with no optical, MIR [nor x-ray when available] signs of AGN
- Spatially resolved (< 300 pc) Keck/LRIS longslit spectroscopy along major axis.



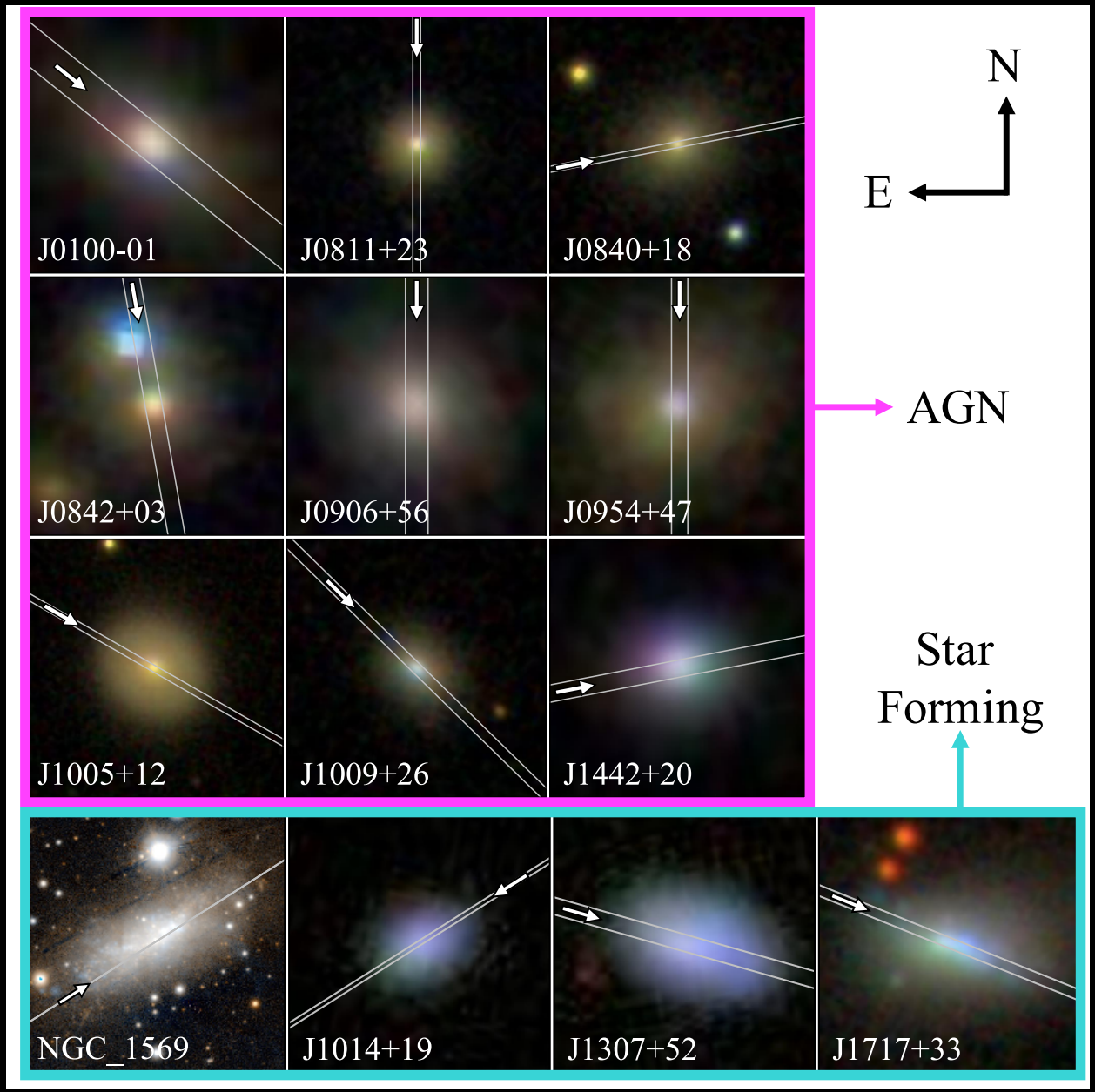
Manzano-King+arXiv:1905.09287

Keck longslit LRIS spectroscopy

Manzano-King+arXiv:1905.09287



Galaxy-wide outflows detected in



9/29 AGN hosts

4/21 SF galaxies

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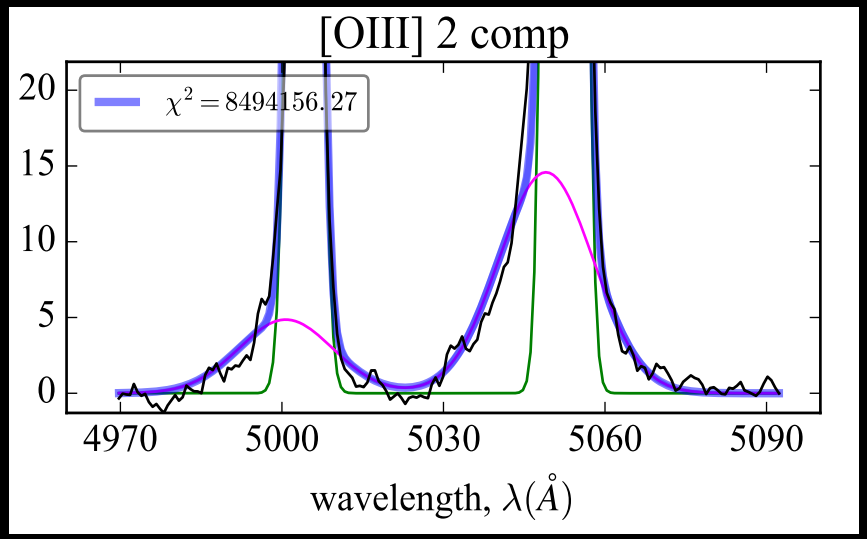
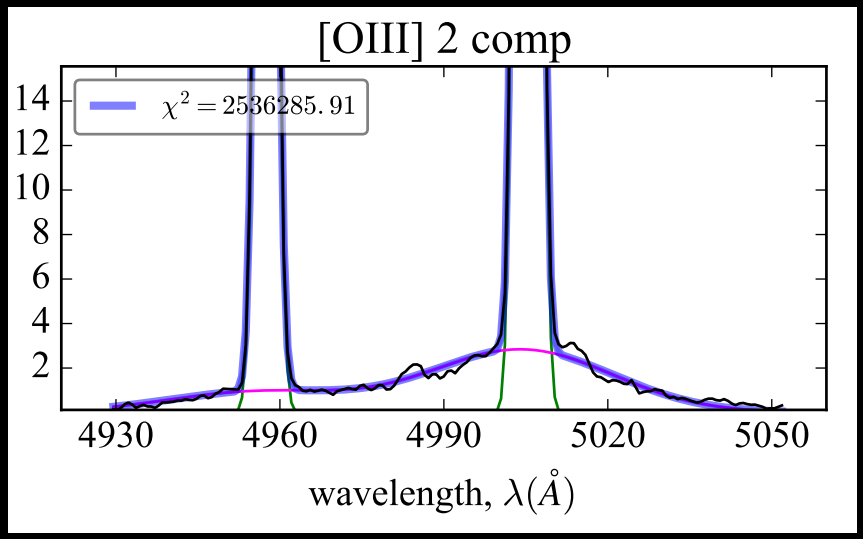
Outflows detected in ionized gas

- 9/29 AGN hosts



- Always blueshifted

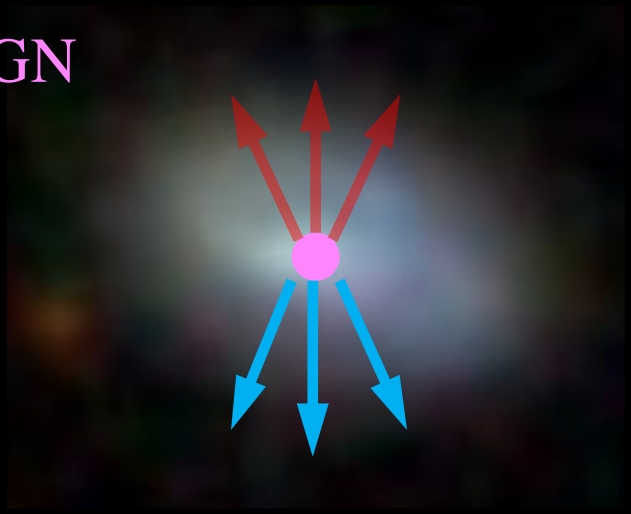
- 4/21 SF galaxies



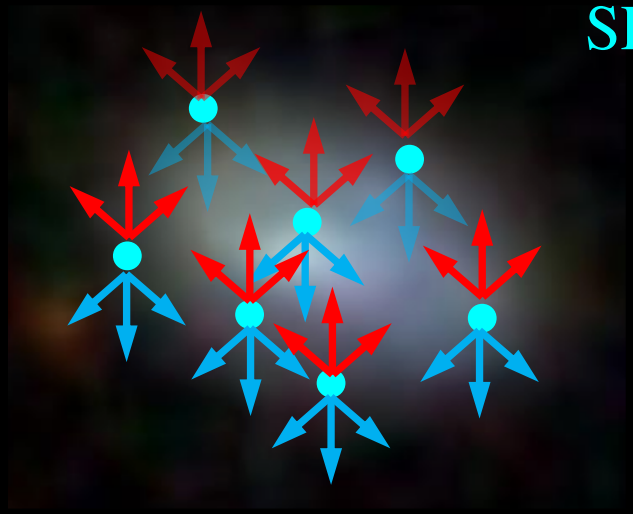
- More symmetrical

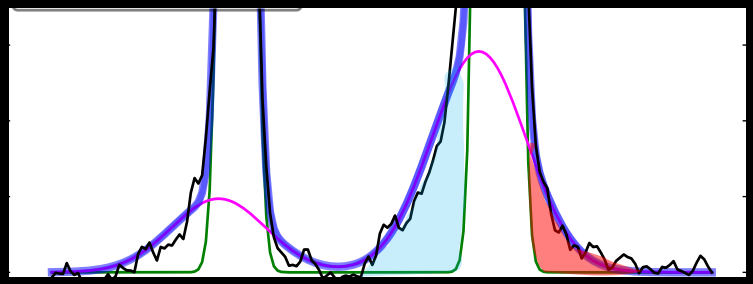
Difference in profiles may be due to the physical position of the source of the winds

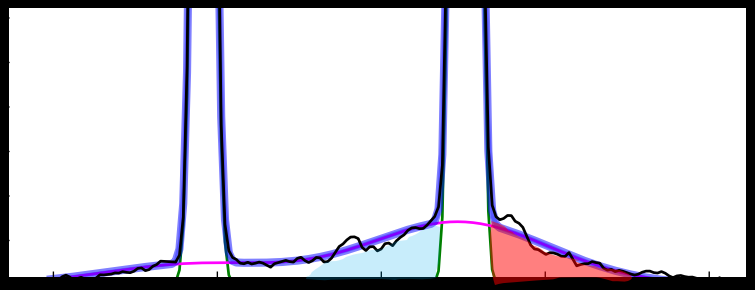
AGN



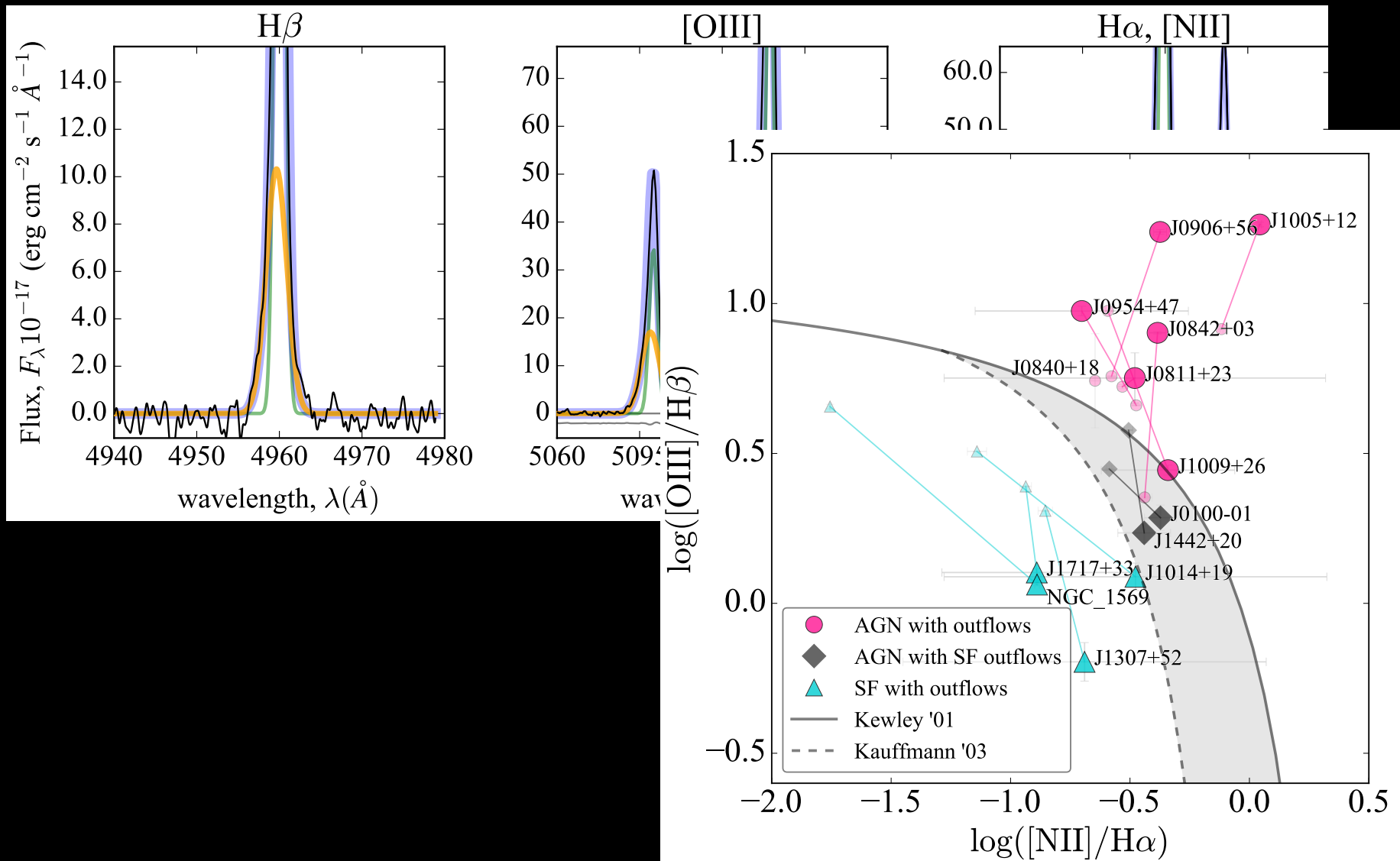
SF







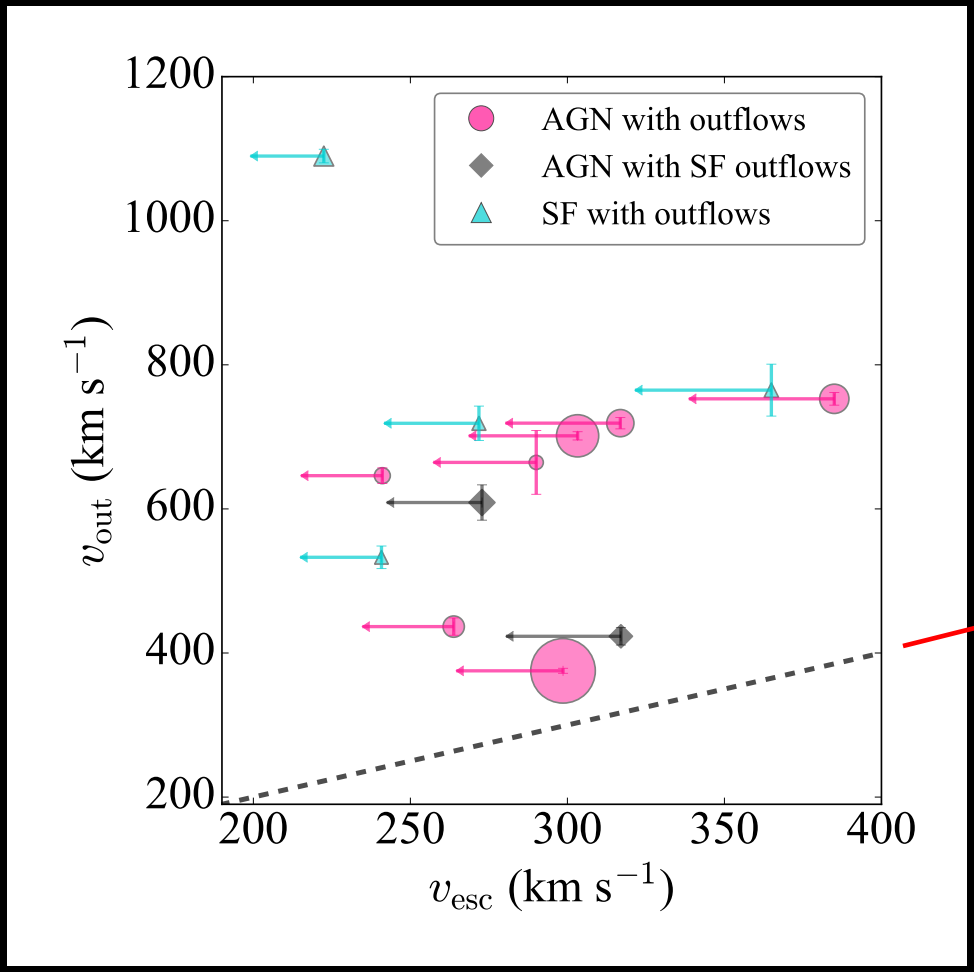
Broad component BPT ratios



Fast enough to escape DM halo

$$v_{\rm out} = -v_0 + \frac{W_{80}}{2}$$

Outflow velocity

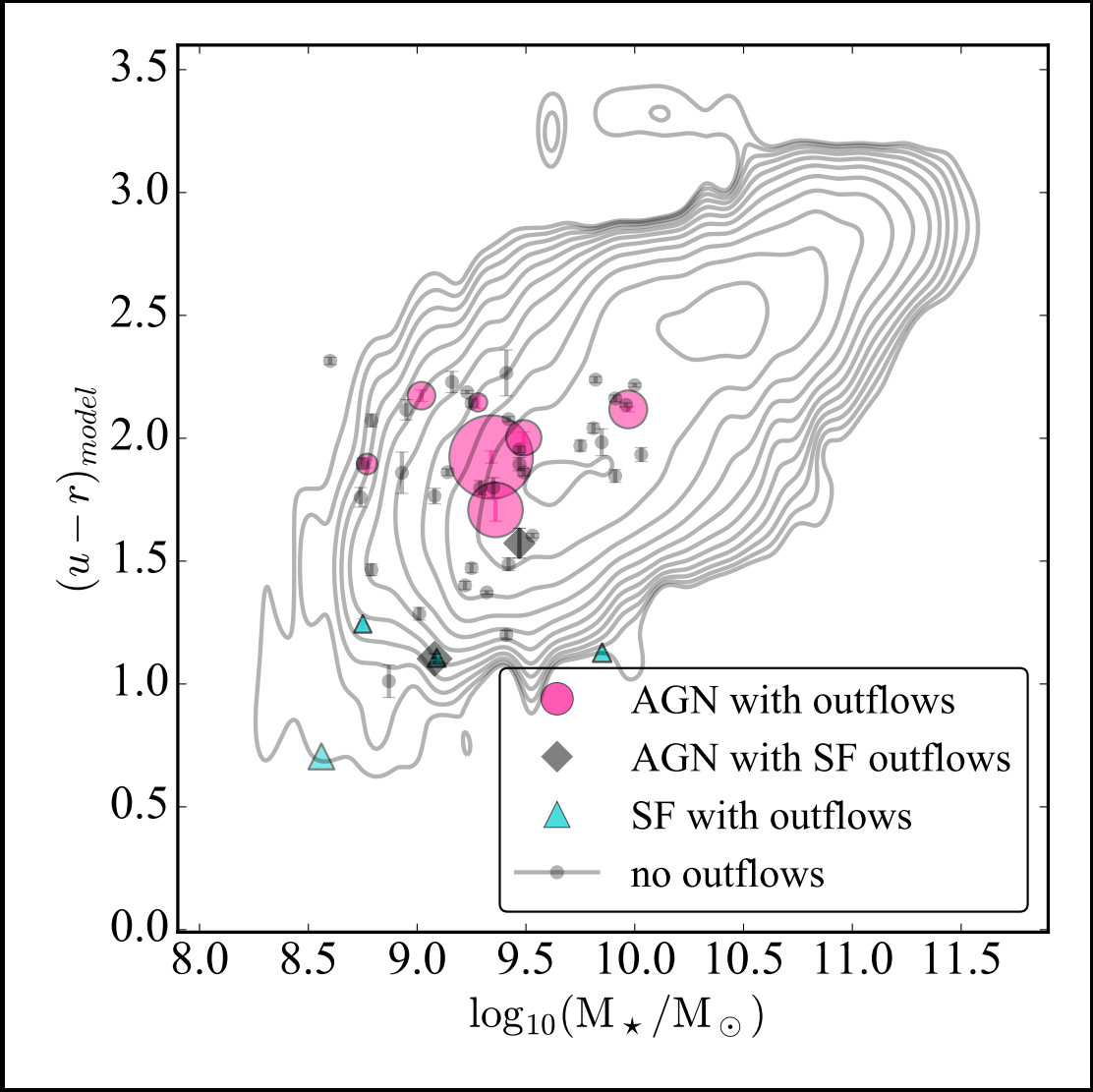


*Size of symbol represents fraction of flux in broad component

Escape velocity via abundance matching

Manzano-King+arXiv:1905.09287

On the way to quiescence?



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Summary

- Galaxy-wide fast outflows detected in ionized gas in dwarf galaxies, both AGN (9/29) and star forming (4/21)
- Outflows in most AGN hosts have broad component 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
- The position of AGN with outflows on the color-magnitude diagram suggests that AGN feedback may play a role in the quenching of star formation.

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The End