New Constraints on Molecular Gas Outflows in SFGs

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Rationale

Outflows are believed to be the main driver of star formation (SF) quenching in galaxies. At z = 1 – 3, SF- and AGN-driven outflows are ubiquitous in massive main sequence (MS) [1].

- But are almost only detected in the ionized gas phase!

To measure the outflow's ability to deplete gas, we use the mass loading factor:

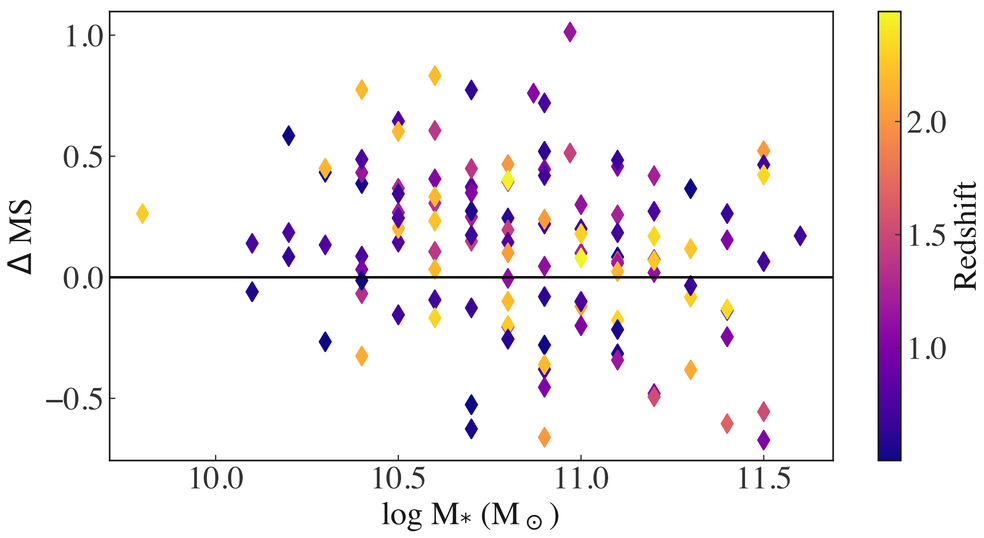
$$\eta = \frac{\dot{M}_{out}}{SFR}$$

- For ionized gas outflows, $\eta < 1$ [1].
- ***Ionized gas outflows alone cannot quench star formation***

We need to look into other gas phases

The PHIBSS Sample

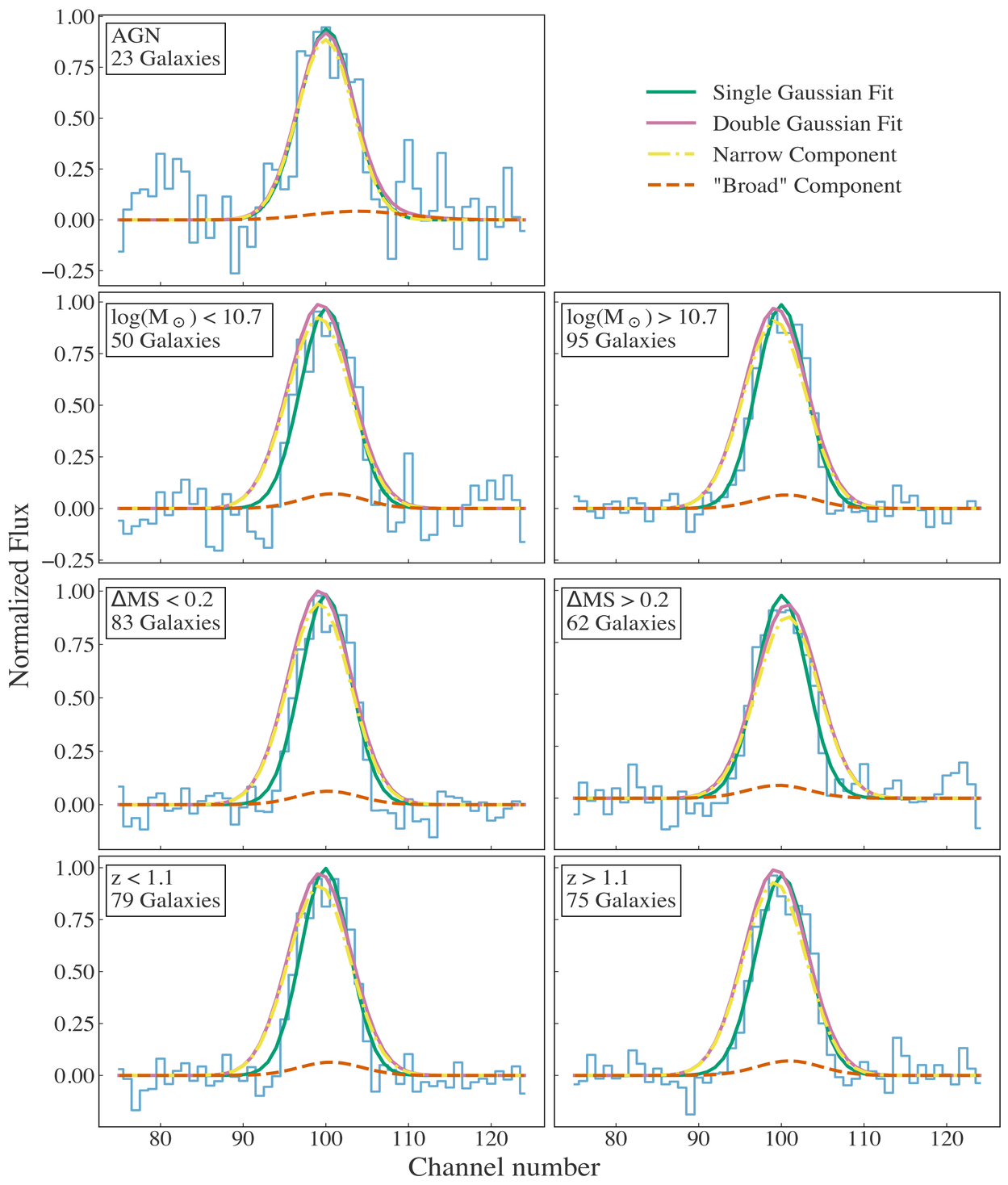
The Plateau de Bure High-Blue Sequence Survey (PHIBSS) is a molecular gas survey of **175 typical MS galaxies** spanning 0.5 < z < 2.6, observed using NOEMA [1-3] to target mostly the CO (3-2) line [2-4].



Method and Results

We use spectral stacking to increase the SNR of our spectrum to detect any faint underlying broad component (ie: any outflow signature) [1], reaching **SNR > 20** in some cases. We stack the full sample and physically motivated subsamples using *LineStacker* [5].

We observe ***no outflow signatures in any of the stacked spectra!***



Conclusion & Interpretation

Plot: Upper limit on outflow properties spanned by outflows below the noise limit of our spectra:

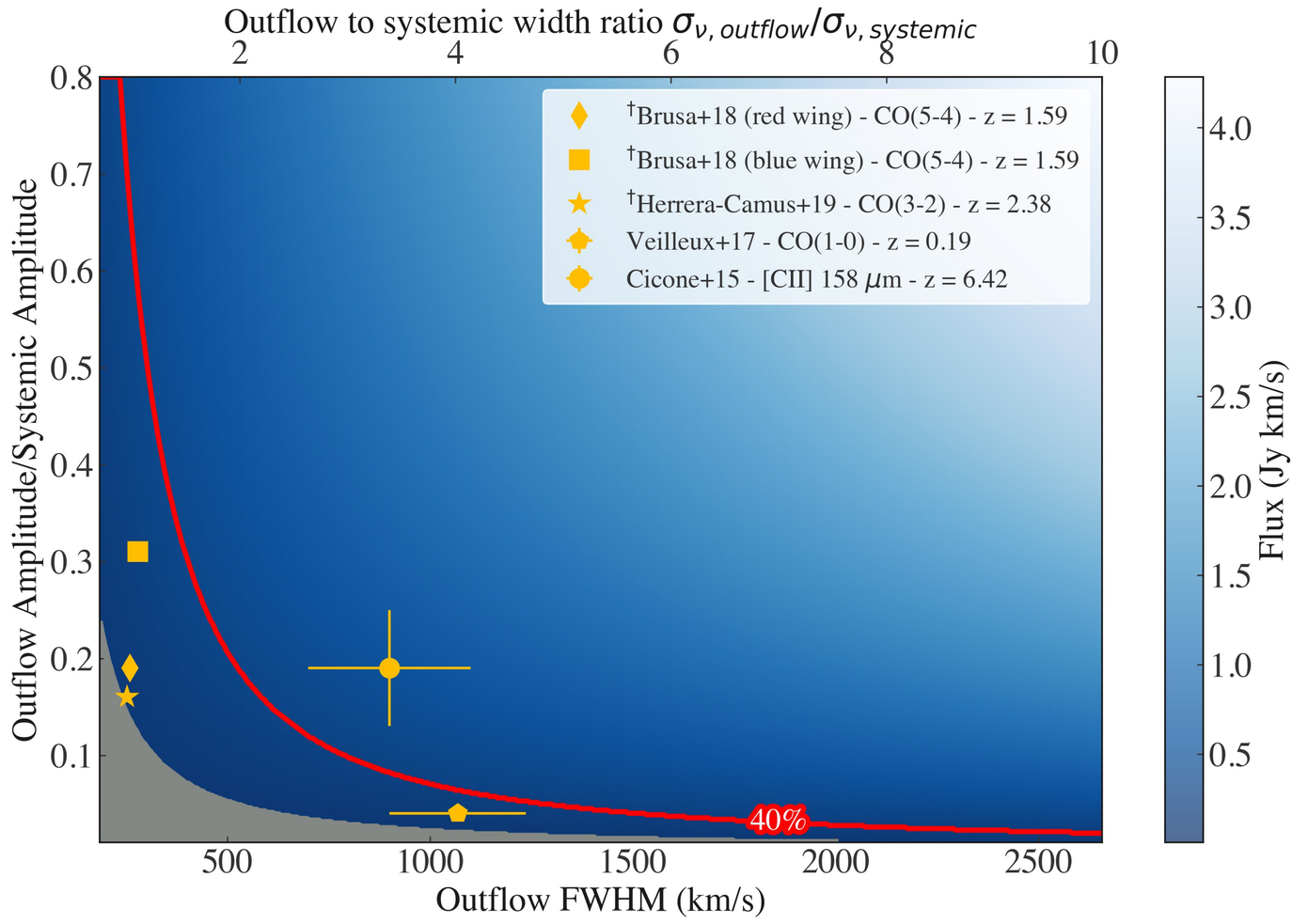
- 100% incidence – grey shaded area
- 40% incidence – red curve
  - Estimated sample incidence

Conclusion: for outflows to be below the "stacked" noise, they must have either:

- a low incidence,
- a low amplitude and/or low velocities
- a precise localization in the galaxy.

Alternatively, cold molecules might get dissociated in typical SFs:

- **Is the bulk of the outflow in atomic and/or neutral phase?**



[1] Förster Schreiber, N. M., ApJ, vol. 875, no. 1, IOP, 2019. **[2]** Tacconi, L. J., ApJ, vol. 768, no. 1, IOP, 2013 **[3]** Tacconi, L. J., ApJ, vol. 853, no. 2, IOP, 2018. **[4]** Freundlich, J., A&A, vol. 622, 2019. **[5]** Jolly, J.-B., Knudsen, K. K., and Stanley, F., MNRAS, vol. 499, no. 3, OUP, pp. 3992-4010, 2020. **[6]** Cicone, C., A&A, vol. 574, 2015. **[7]** Veilleux, S., ApJ, vol. 843, no. 1, IOP, 2017. **[8]** Brusa, M., A&A, vol. 612, 2018. **[9]** Herrera-Camus, R., ApJ, vol. 871, no. 1, IOP, 2019.