

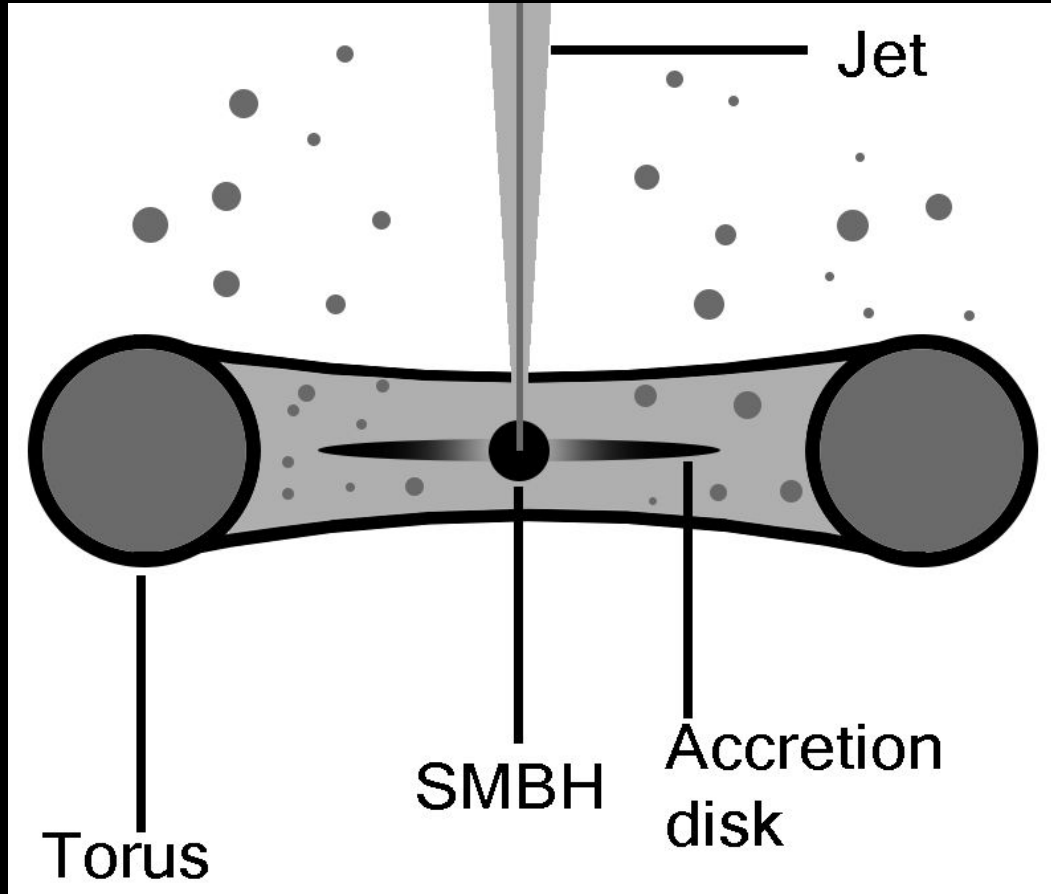
Multiphase outflows in IC 5063

Luke Holden

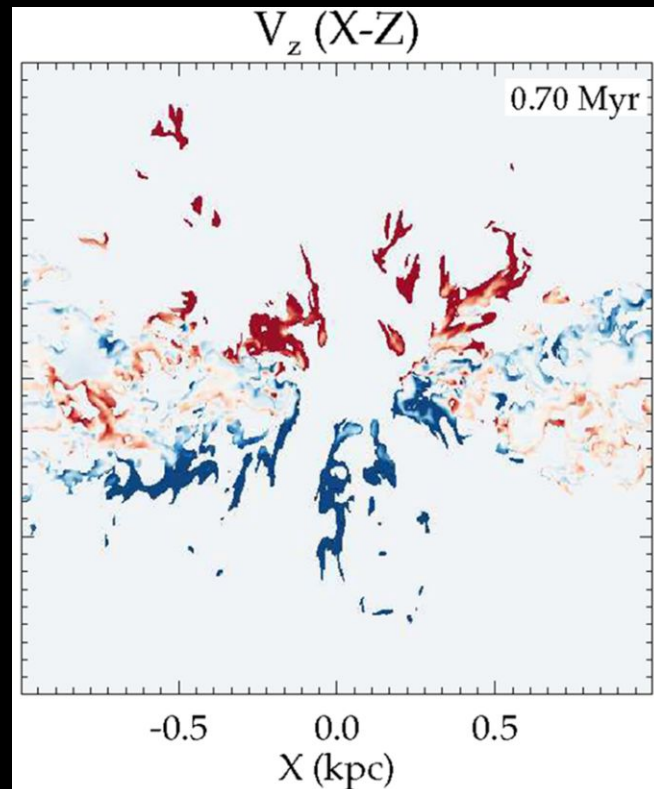
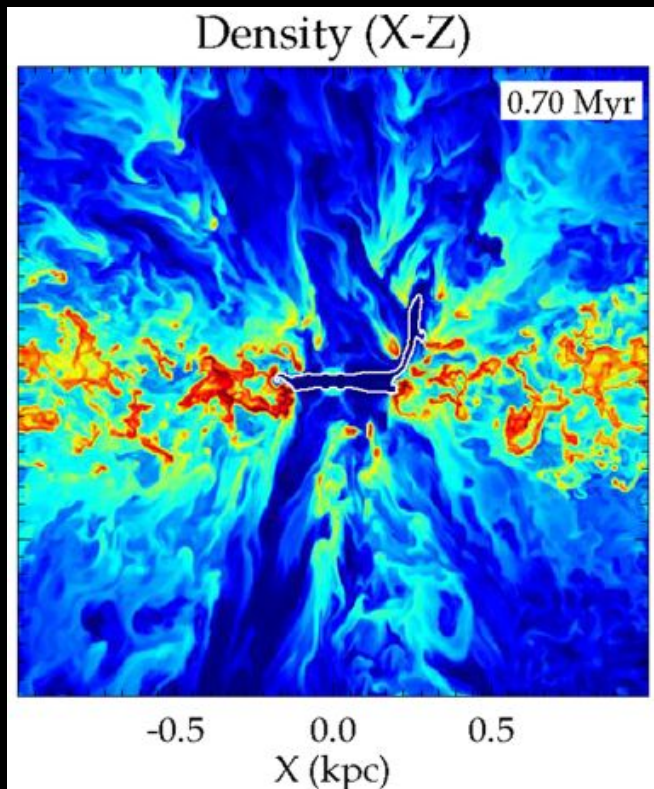
Collaborators:
Clive Tadhunter, Raffaella Morganti, Tom Oosterloo

Image credit: Judy Schmidt

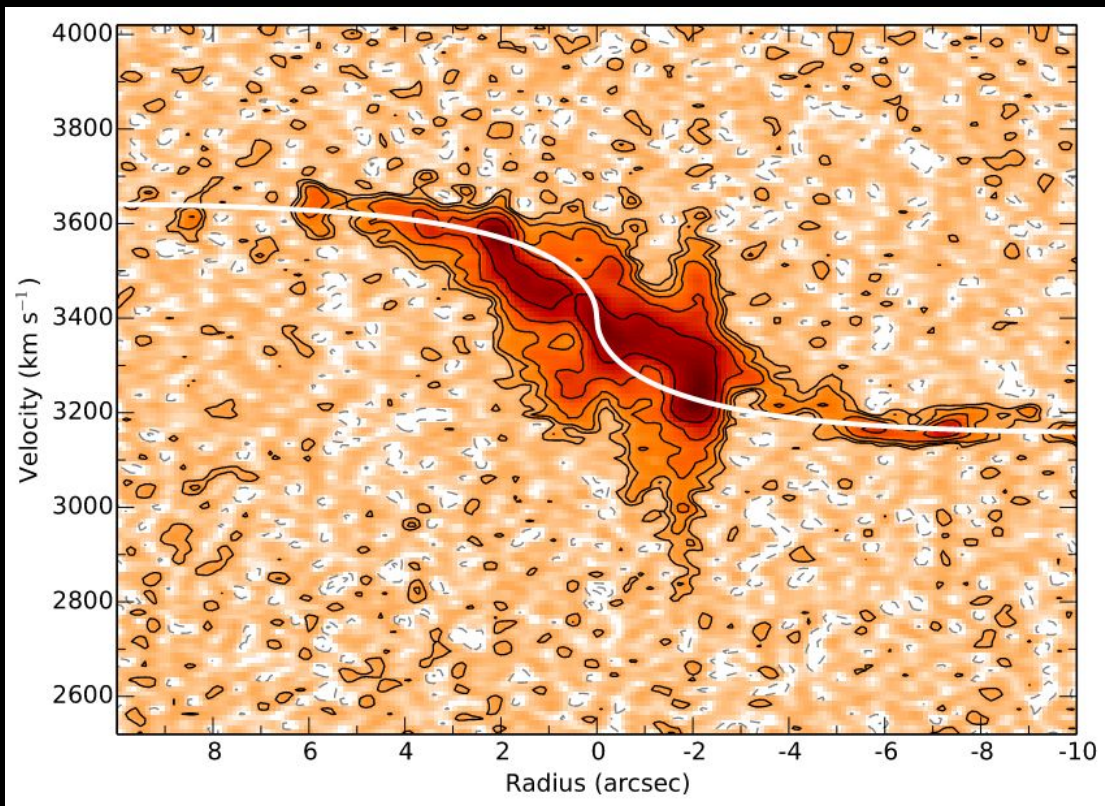
Active Galactic Nuclei (AGN)



AGN-driven outflow acceleration



Cold molecular outflows?



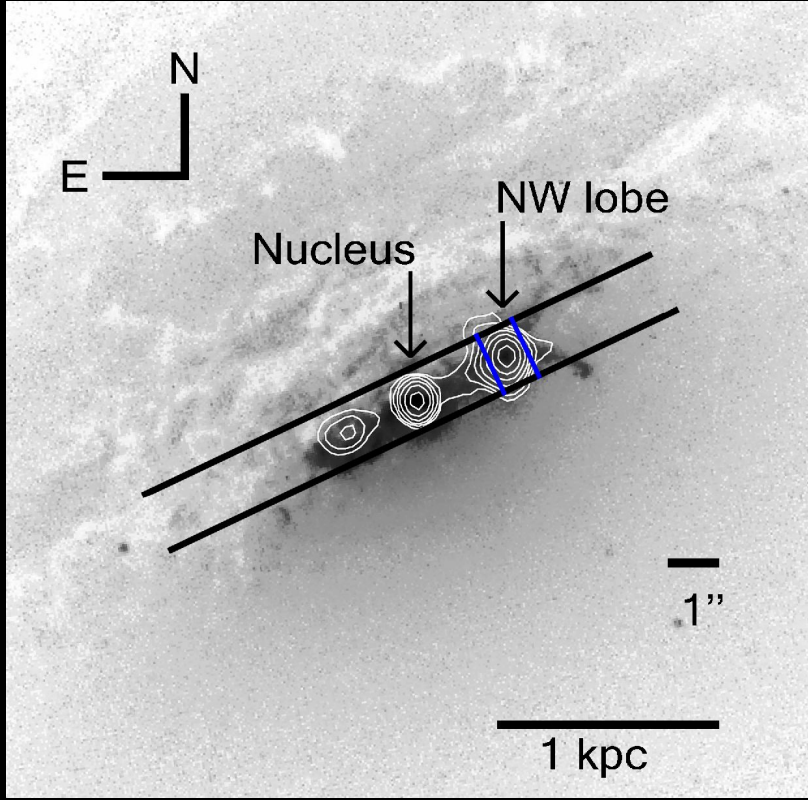
How does the cold gas survive
acceleration?

Maybe it reforms after the gas has been
accelerated (and heated) by a shock?

- Nearby Seyfert 2
($z = 0.01$)
 - Can spatially resolve outflows
- Clear signs of jet-driven outflows on kpc scales
- Previous observations covering all gas phases

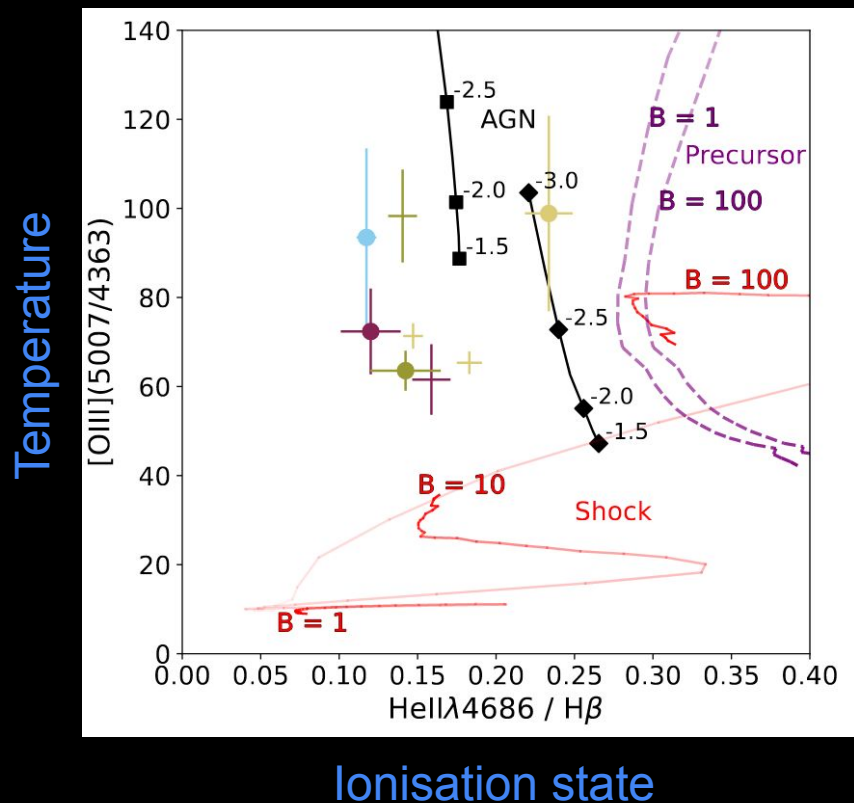


IC 5063 - Xshooter observations



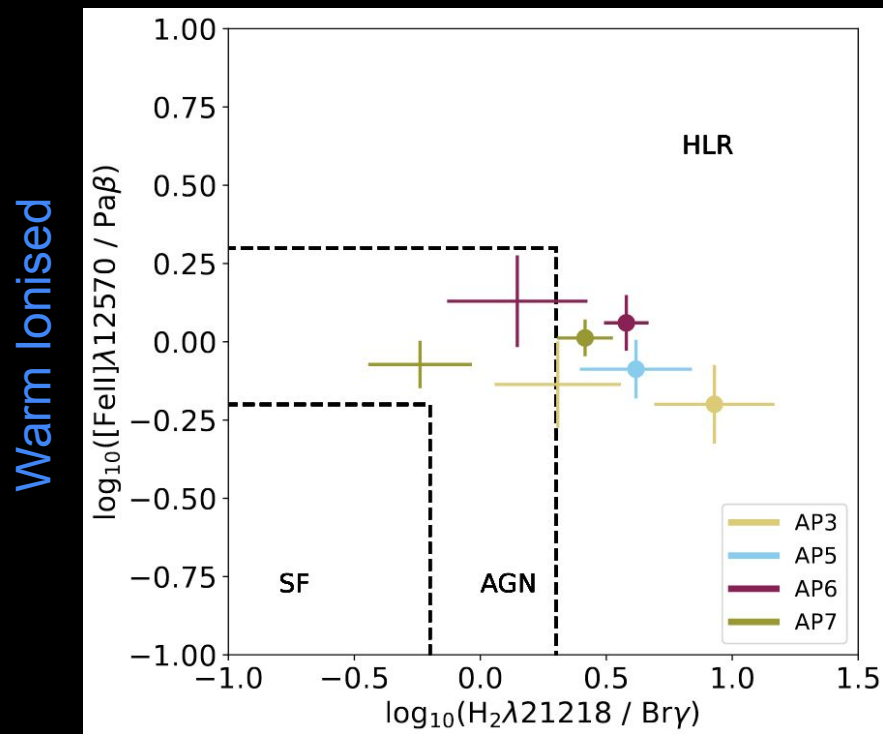
Warm ionised gas - ionisation

- Warm ionised ($T > 10,000$ K)
- Both outflows and quiescent gas are **AGN-photoionised**
- This does not rule out *shock-acceleration*

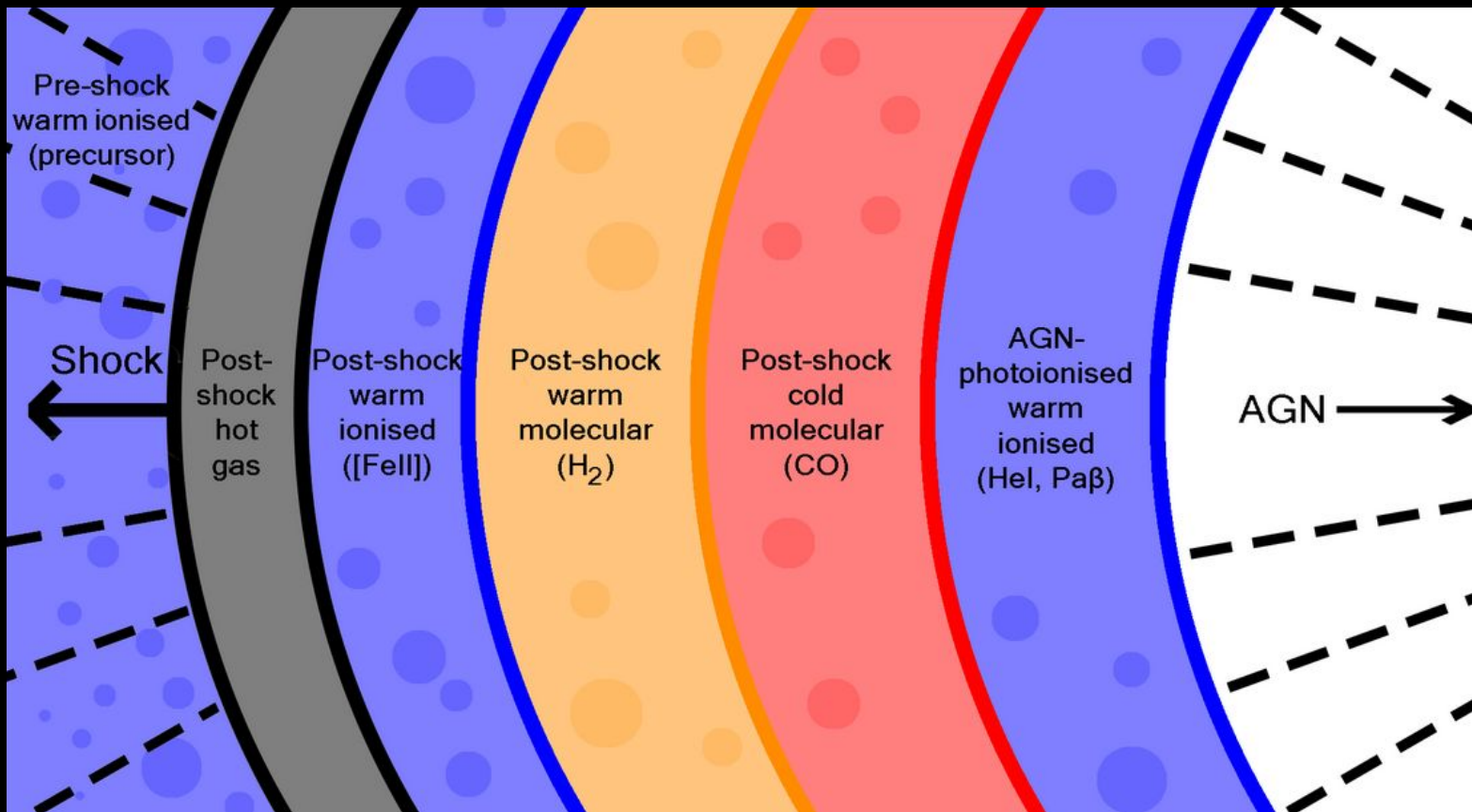


Warm molecular gas - excitation

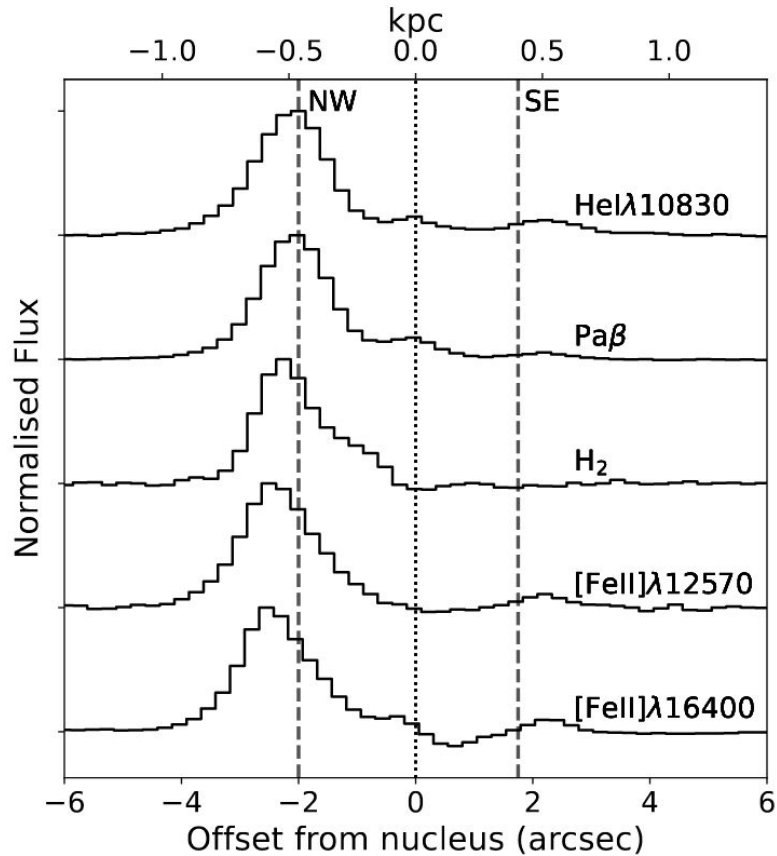
- Warm molecular (~1000-5000 K)
- Warm molecular outflows are **shock-ionised**.
- Quiescent gas is AGN-photoionised



A post-shock cooling sequence



Spatial flux distributions of NIR lines



AGN-photoionised warm ionised gas

Post-shock warm molecular gas

Post-shock warm ionised gas

Conclusions

Kpc-scale outflows driven by jet-induced shocks may be an important source of AGN feedback

Different gas phases may constitute a cooling sequence, in which the cold gas reforms post-shock



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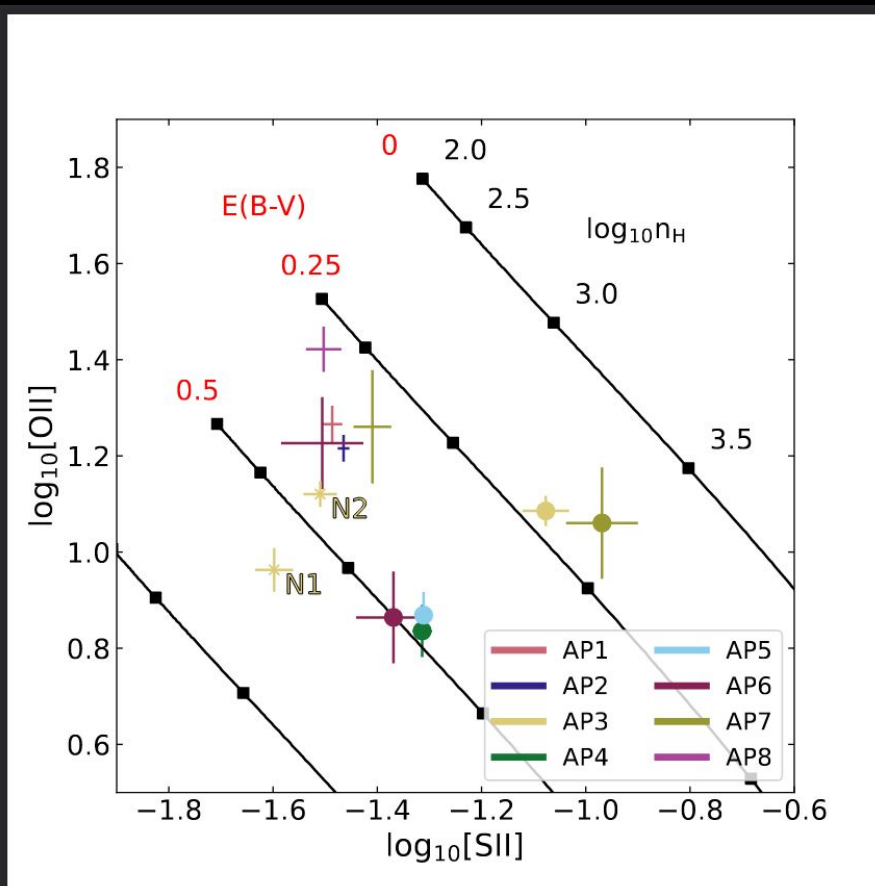
@AstroHolden



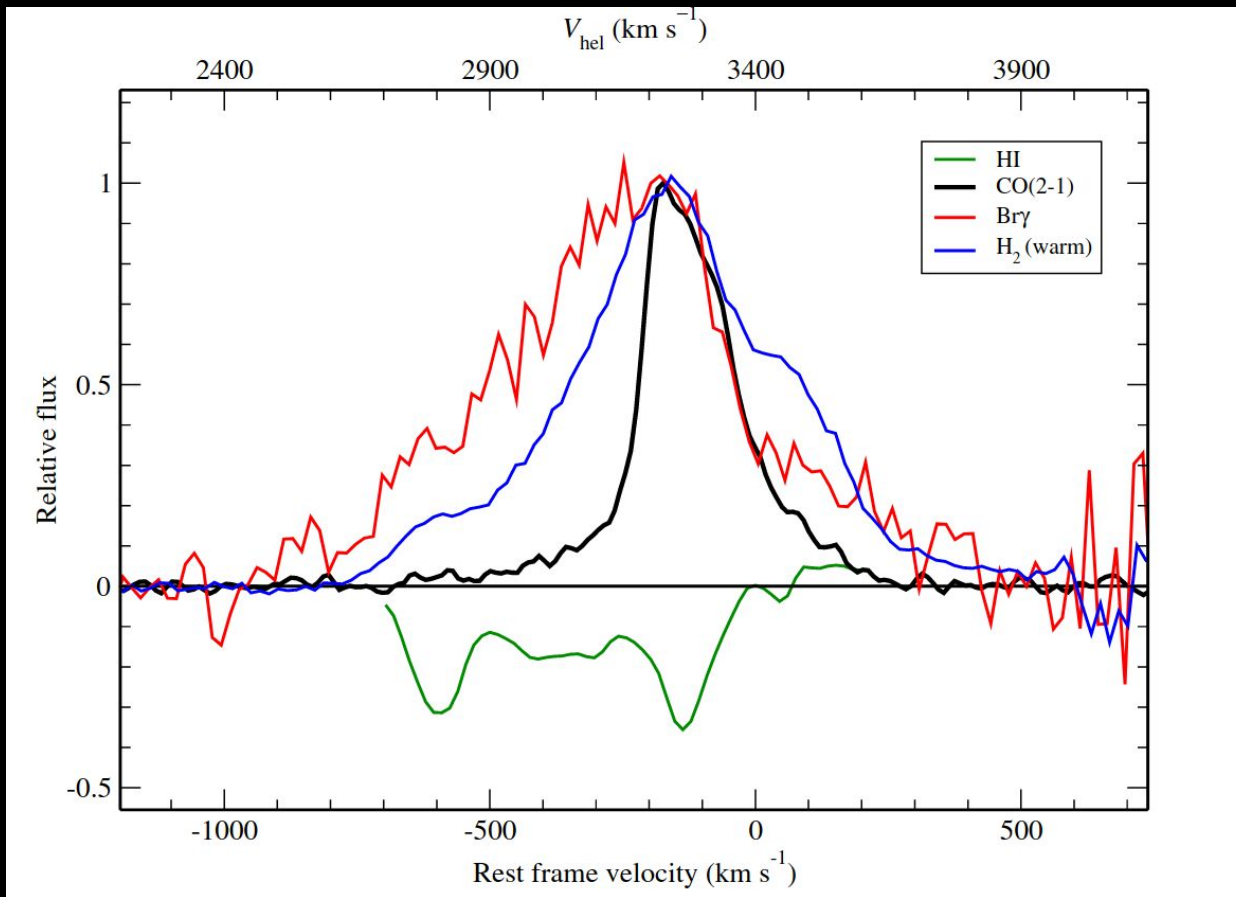
Gas phase energetics

Gas phase	Mass outflow rate ($M_{\text{Sun}} \text{ yr}^{-1}$)	$E_{\text{Kin}} / L_{\text{Bol}}$	Reference
Warm ionised ($T > 10,000\text{K}$)	0.18 ± 0.06	$(2.7 \pm 1.7) \times 10^{-3} \%$	Holden et al. (submitted)
Neutral atomic ($T \sim \text{few } 1000\text{K}$)	35	0.18%	Morganti et al. (2007)
Cold molecular ($T \sim \text{few } 100\text{K}$)	0.79	$3.1 \times 10^{-3} \%$	Morganti et al. (2013) Oosterloo et al. (2017)

Gas densities



Co-spatial outflows in IC 5063



Morganti et al. 2015
+
Tadhunter et al. 2014
+
Morganti et al. 1998