Fast outflows quenching star formation at high redshift

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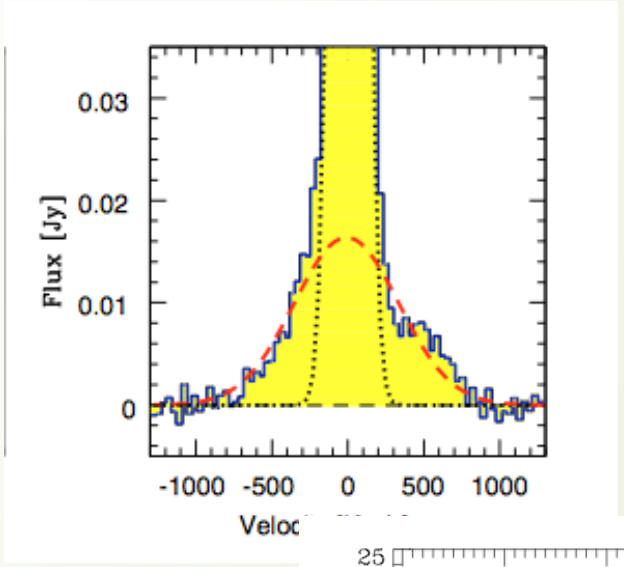
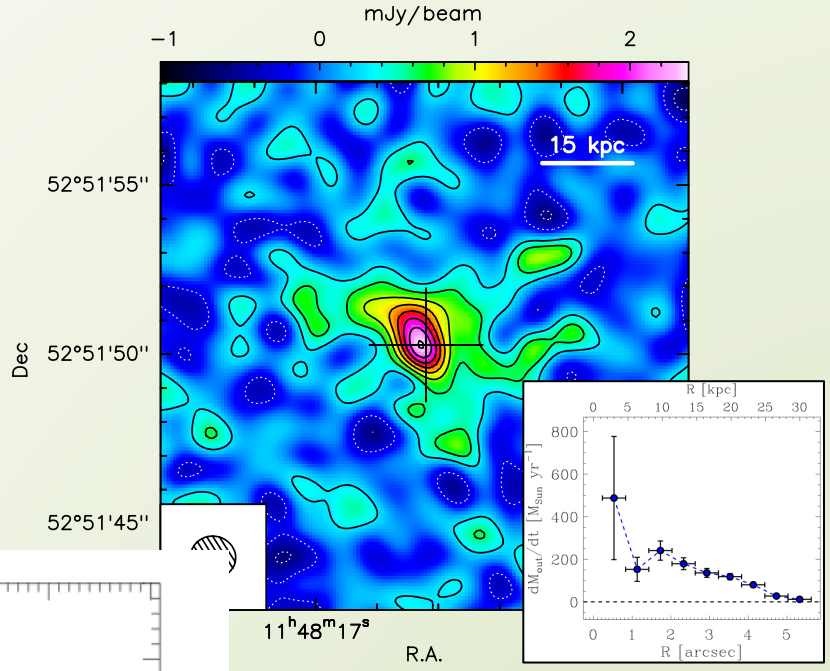
in collaboration with **A. Marconi**

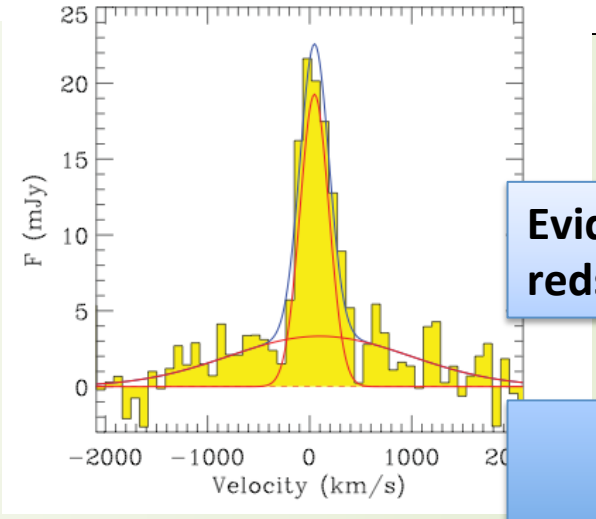
Outflows



Feruglio+10



Cicone+14b (arXiv:1409)



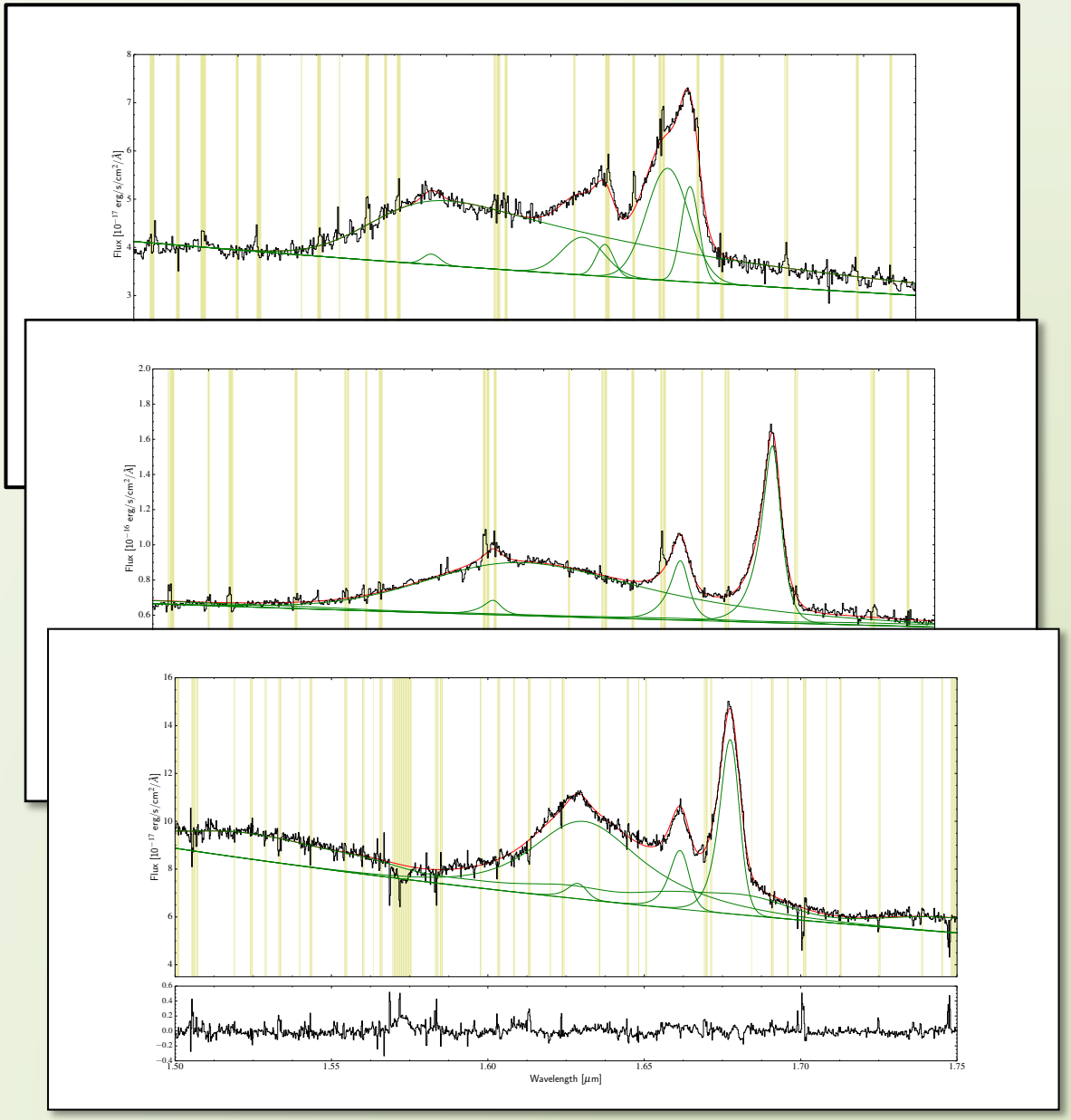
Maiolino+12

Evidence of outflows at high and low redshift but…

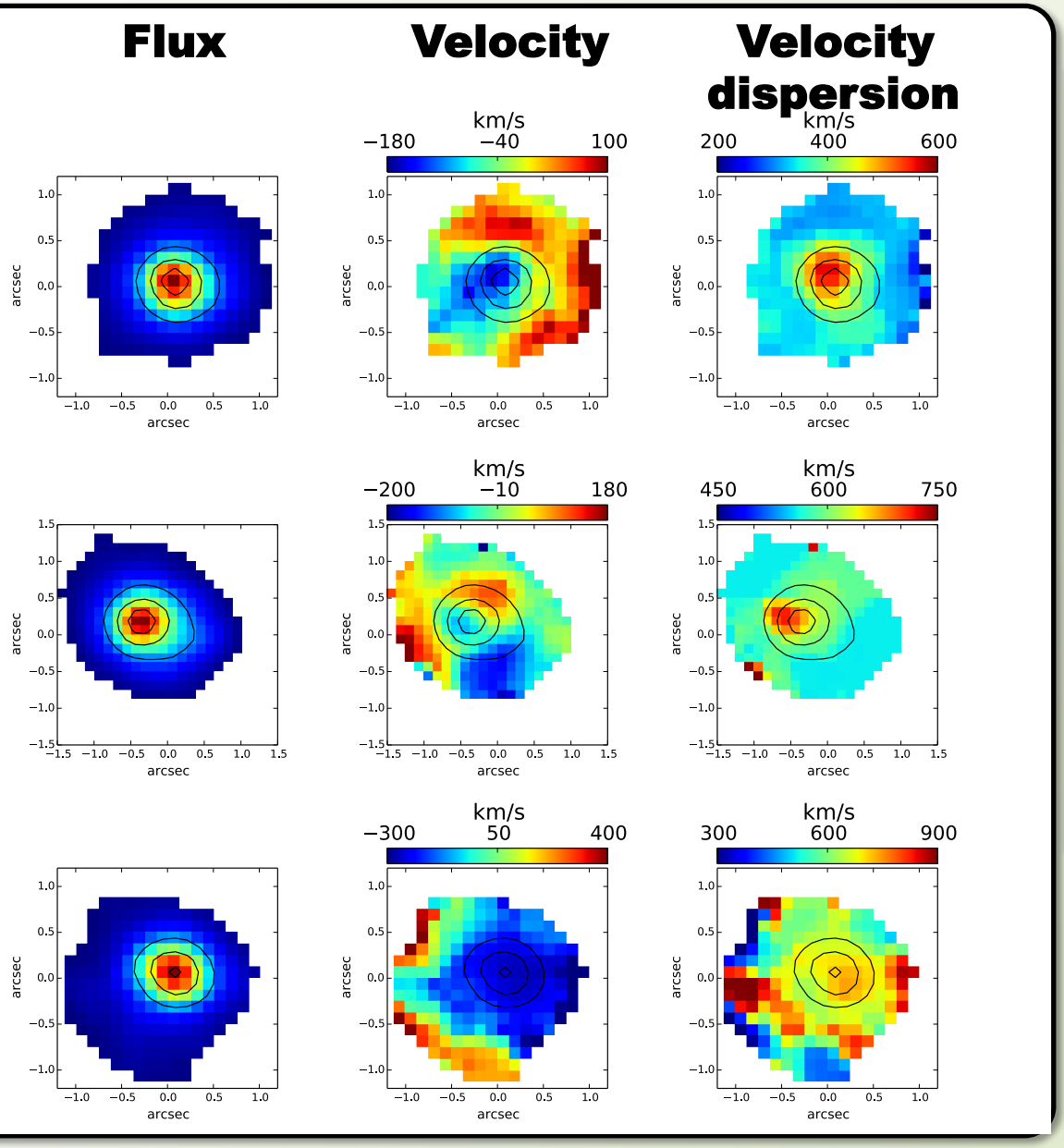
Evidence of AGN feedback?

Quasars z≈2.4

- **A sample of 6 QSOs at z = 2.3-2.5**
- **SINFONI@VLT**
  H-band
- **Seeing limited resolution (0.5”)**
- **L_{bol} ≈10^{46}-10^{47} erg/s**
- **Broad [OIII]**
  - **(FWHM >1000 km/s)**

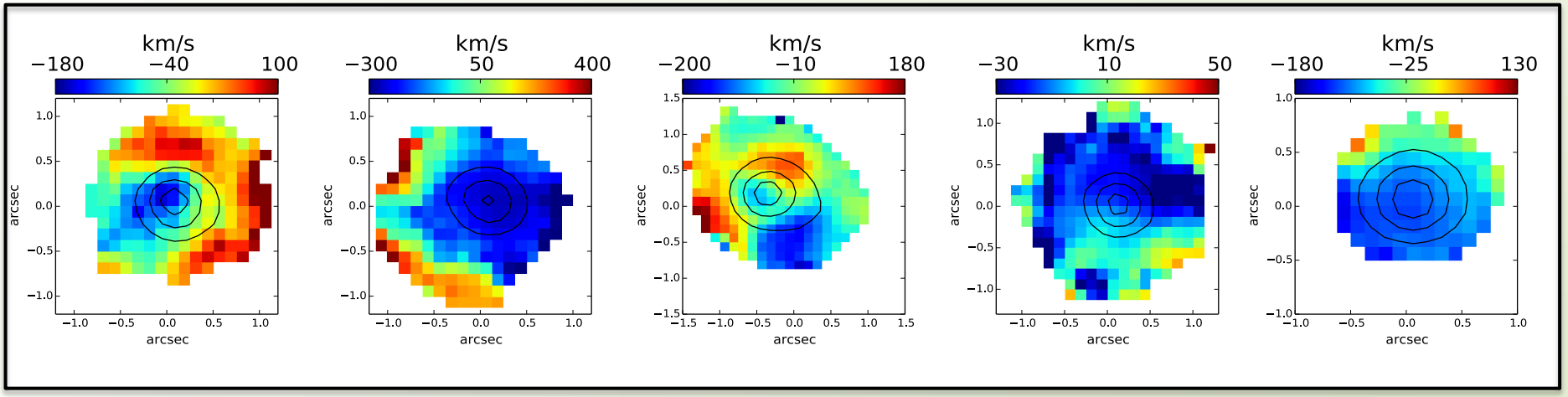


Kinematic analysis

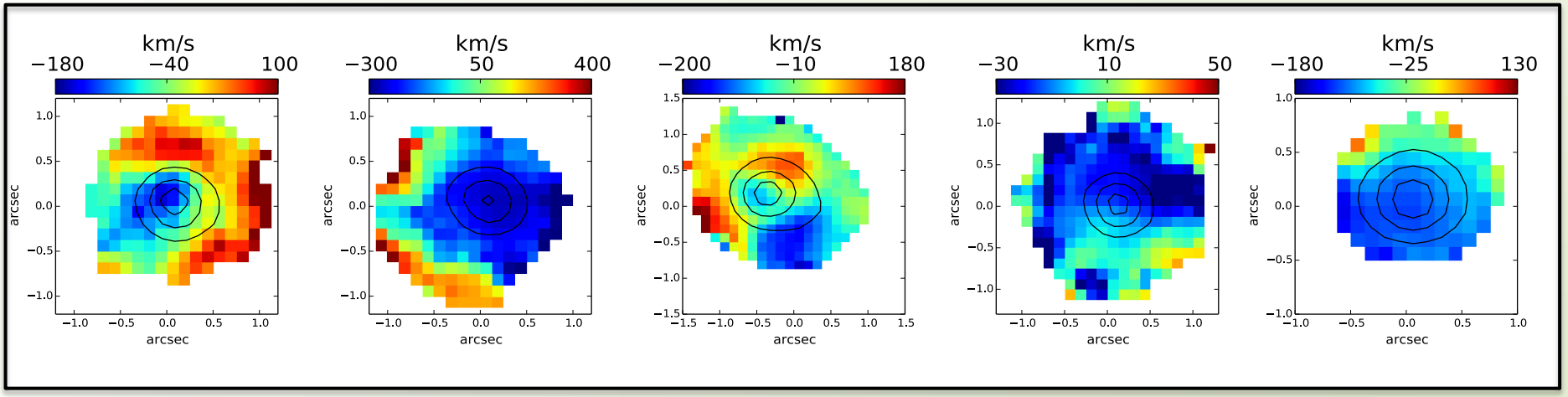


- Spatially resolved [OIII] kinematical maps in 5/6 objects
- Velocity dispersion up to 900 km/s
- Outflow velocities 300-700 km/s

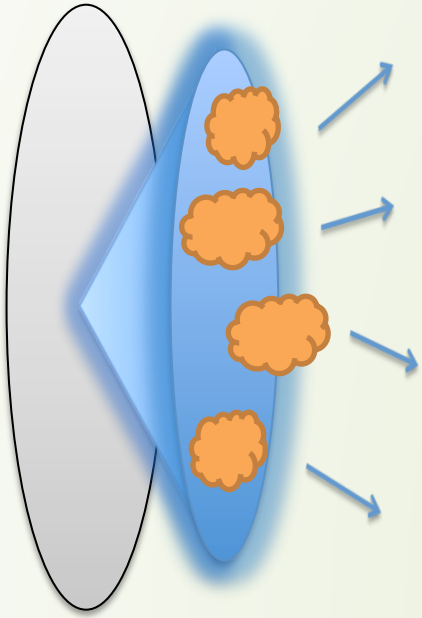
Ionized outflows



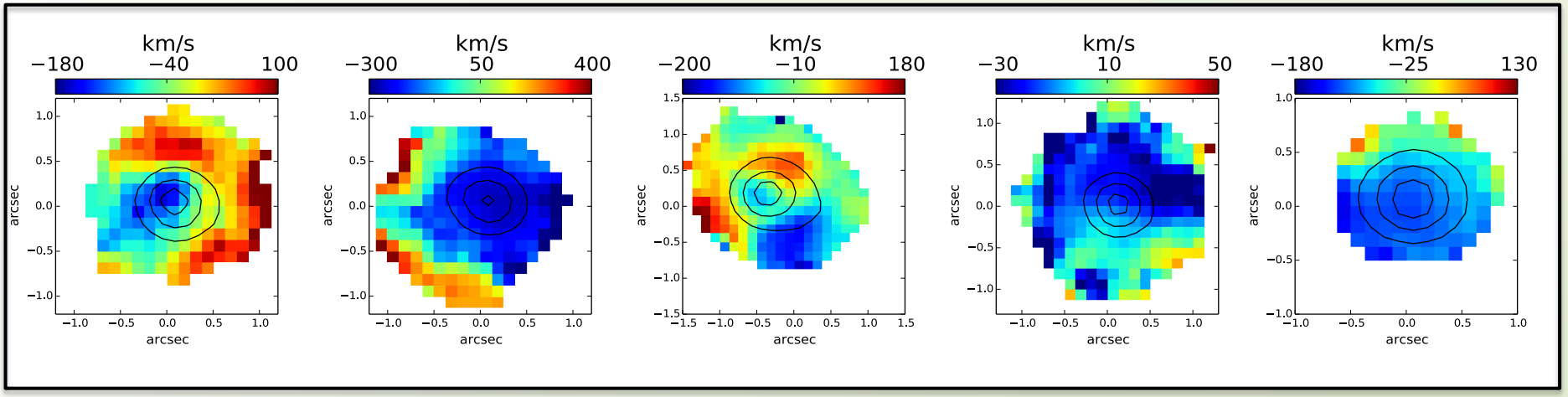
Ionized outflows



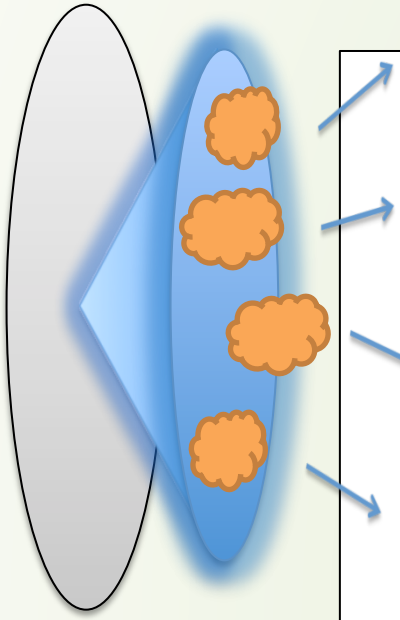
outflow model



Ionized outflows

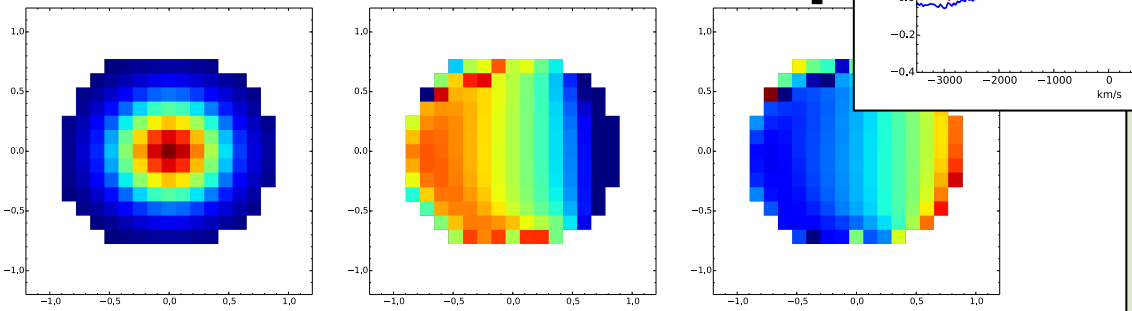


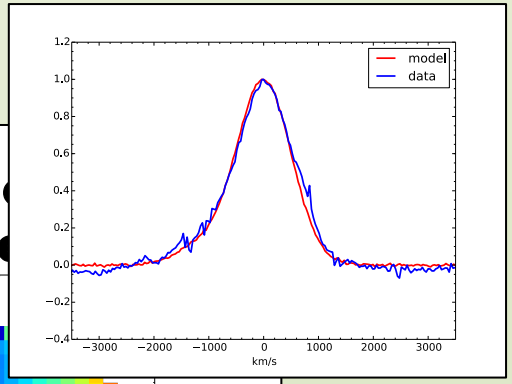
outflow model



Velocity maps confirm the presence of outflows

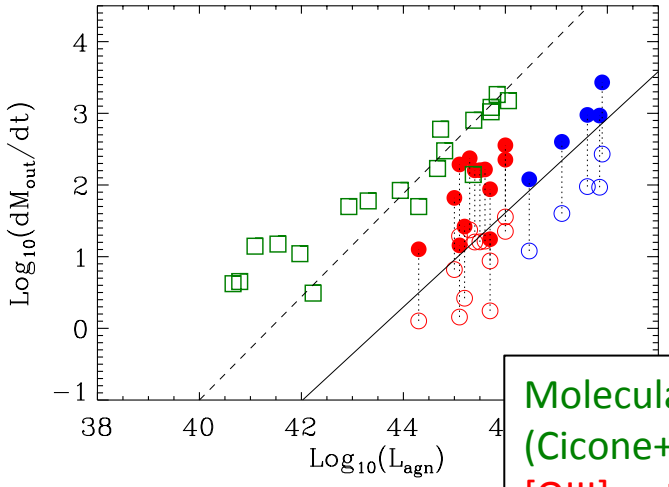
Flux **Velocity** **Vel dispe**



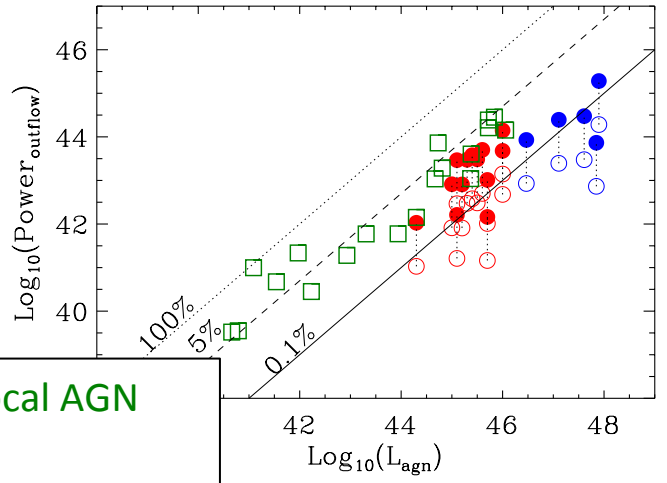


Ionized outflows

Outflow rate

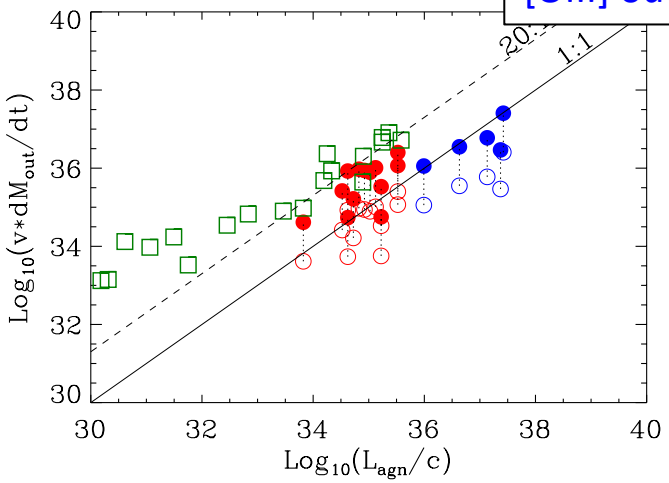


Kinetic power



Molecular outflows in local AGN (Cicone+14)
[OIII] outflows in Type 2 local AGN (Harrison+14)
[OIII] outflows in z≈2.5 quasars

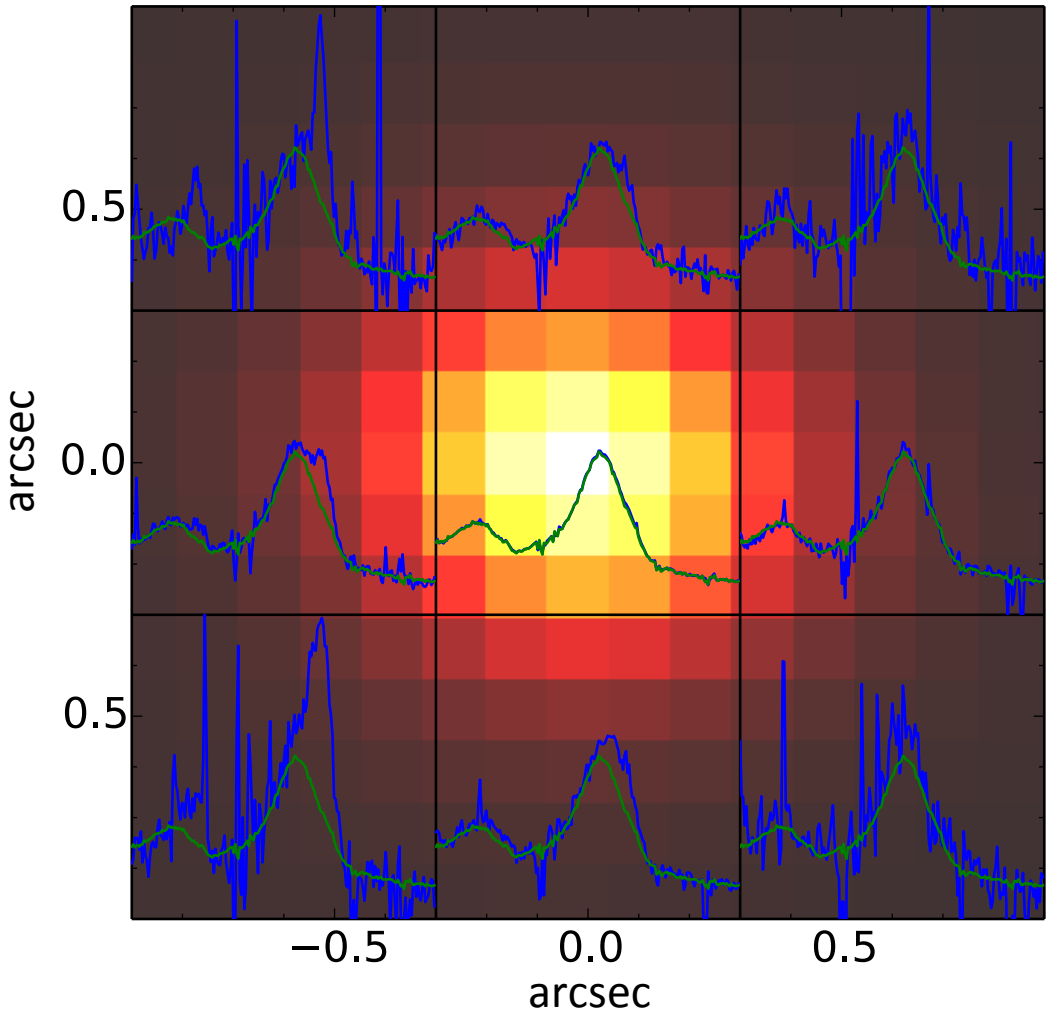
Momentum rate

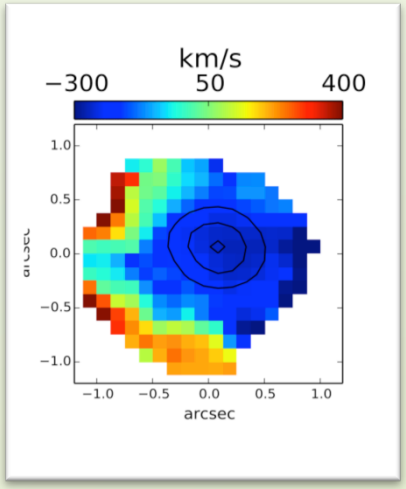


$$\dot{M} \simeq \frac{M_{outflow} v_{out}}{R_{out}}$$

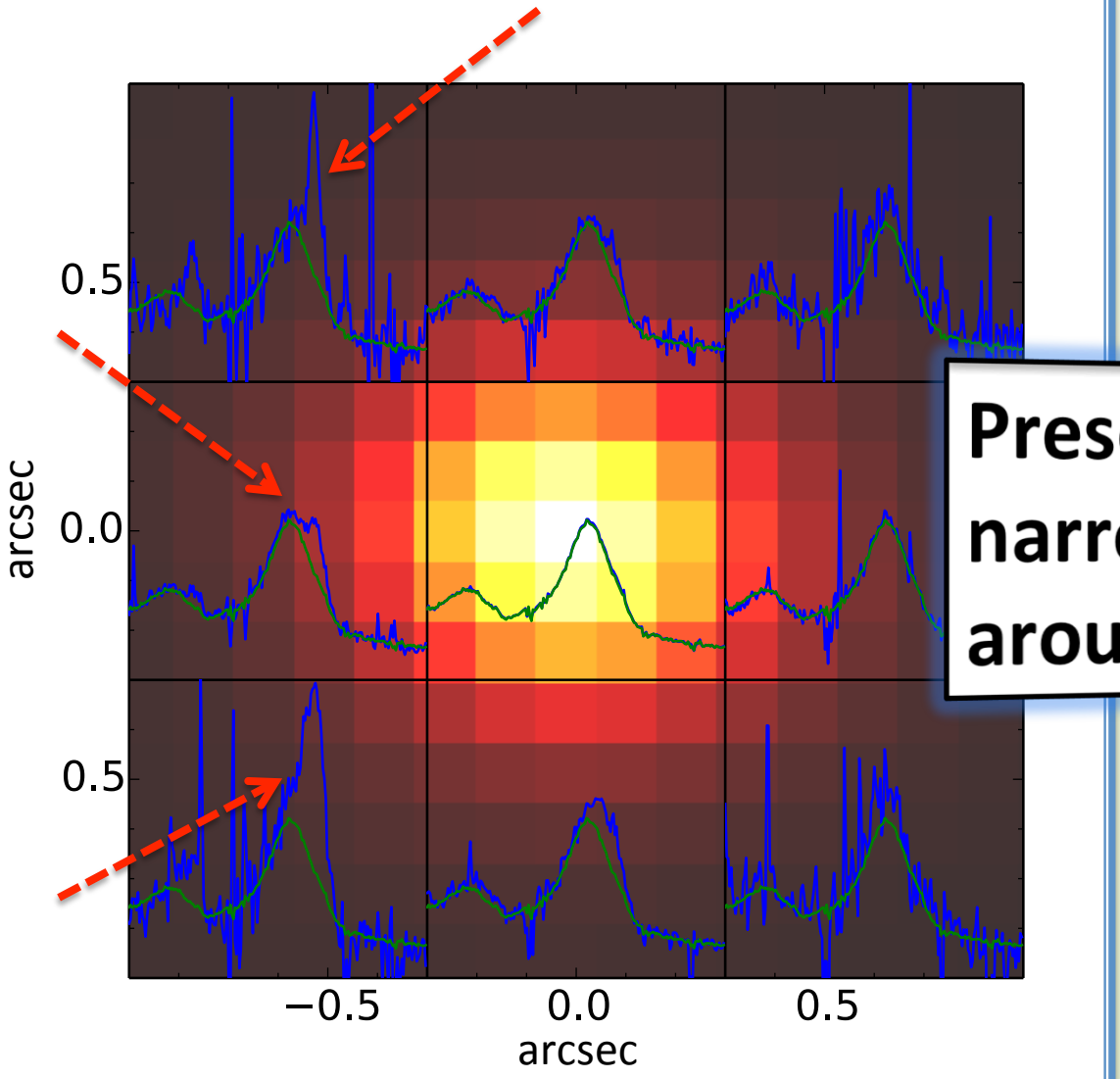
Physical properties of outflows
-> only ionized gas is traced

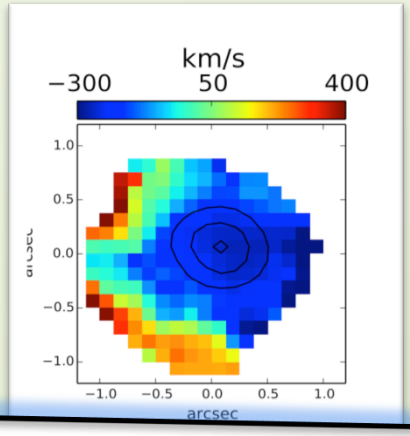
Faint narrow [OIII]





Faint narrow [OIII]





Presence of a faint narrow [OIII] around the QSO

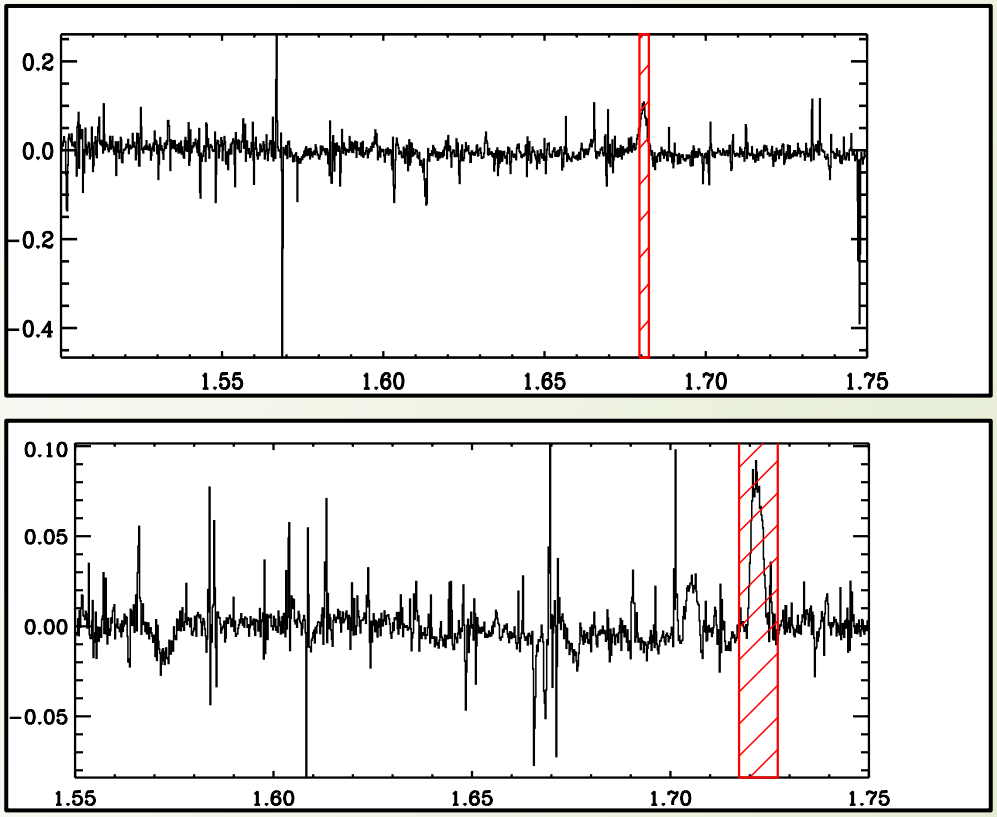
Faint narrow [OIII]

Subtract broad (> 1000 km/s) [OIII] component -> Outflows

Faint narrow [OIII]

Subtract broad (> 1000 km/s) [OIII] component -> Outflows

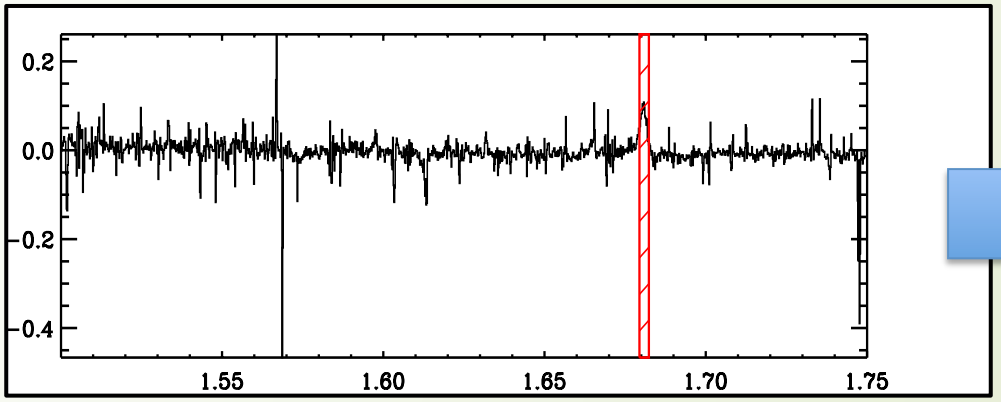
Faint narrow (≈ 150 km/s) [OIII] component

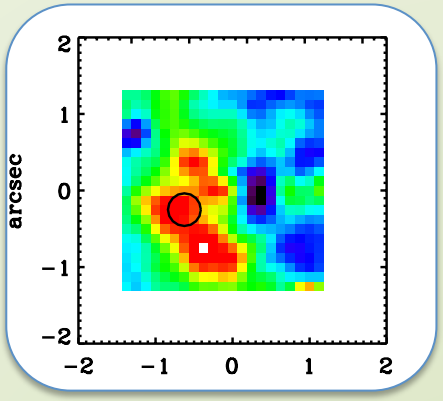


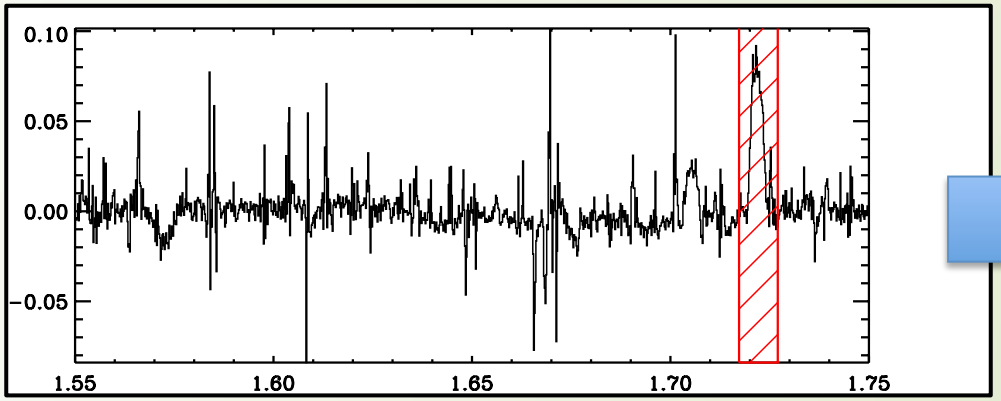
Faint narrow [OIII]

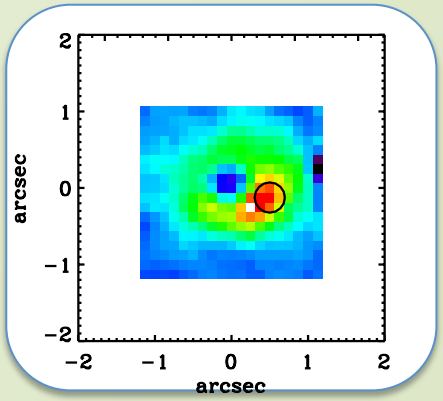
Subtract broad (> 1000 km/s) [OIII] component -> Outflows

Faint narrow (≈ 150 km/s) [OIII] component





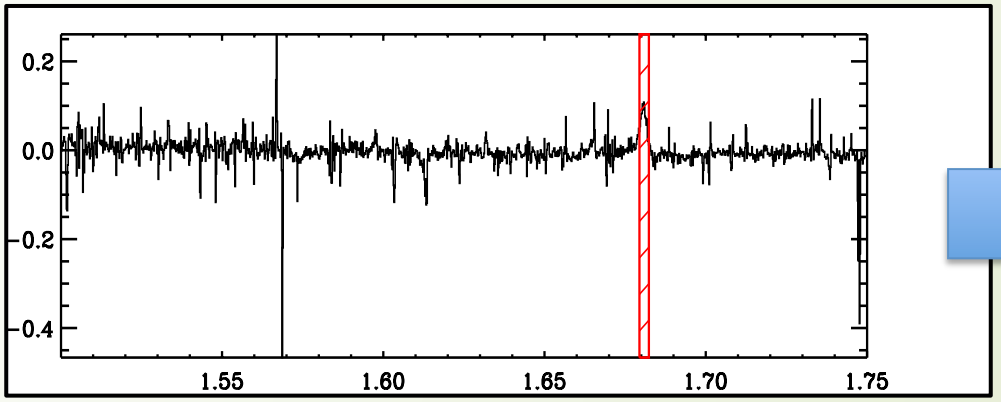


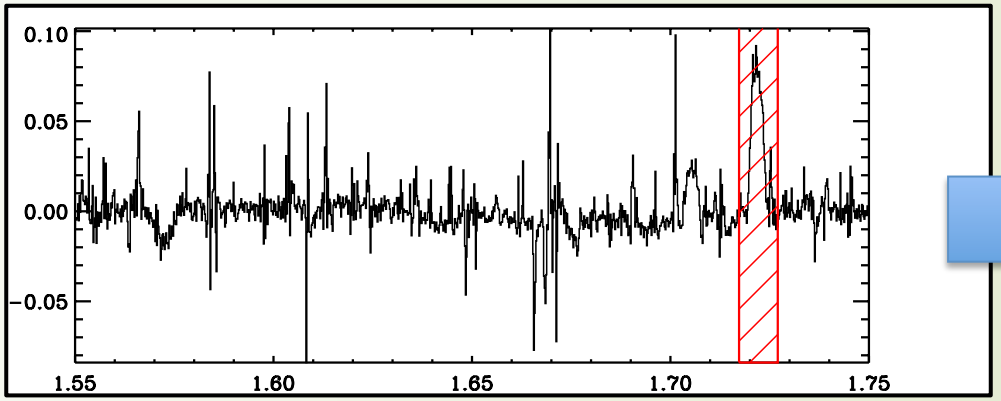


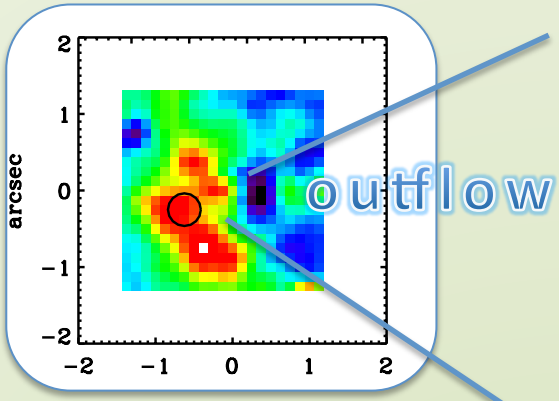
Faint narrow [OIII]

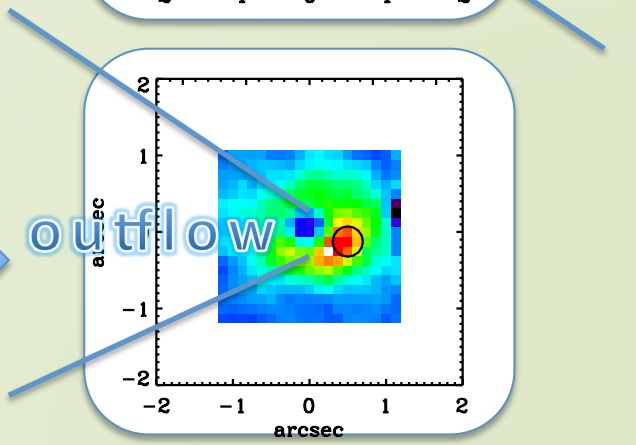
Subtract broad (> 1000 km/s) [OIII] component -> Outflows

Faint narrow (≈ 150 km/s) [OIII] component -> Star formation?



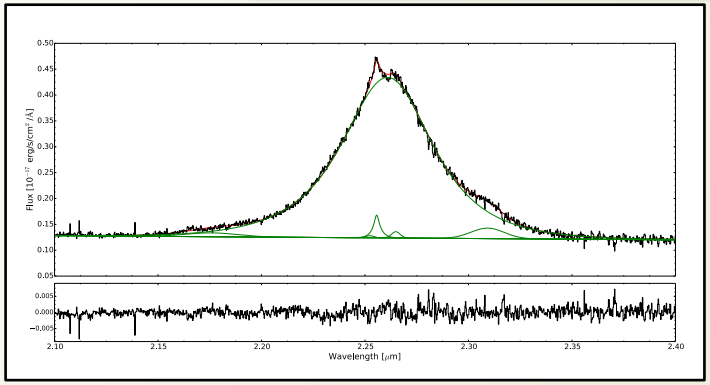






Origin of narrow [OIII] ?

K-band observations targeting Hα

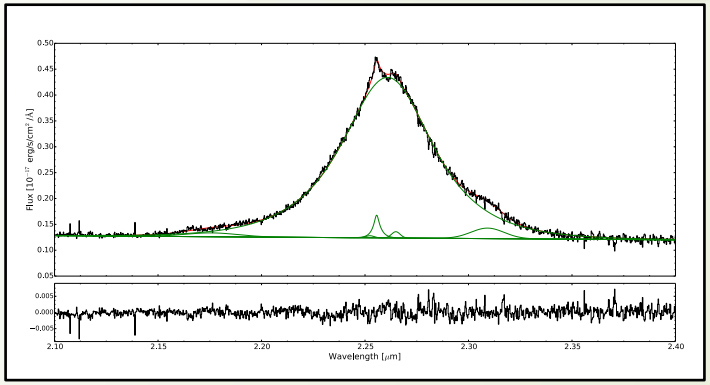


SINFONI@VLT

Seeing limited resolution (0.6”)

Origin of narrow [OIII] ?

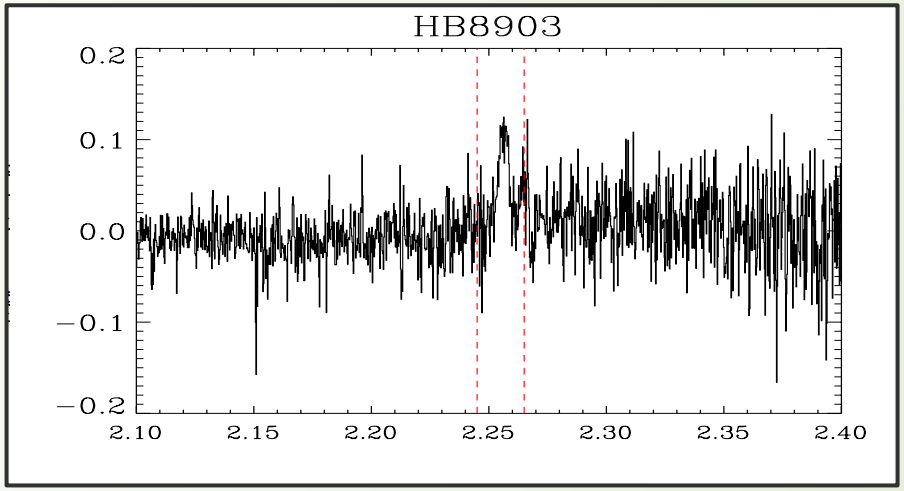
K-band observations targeting Hα

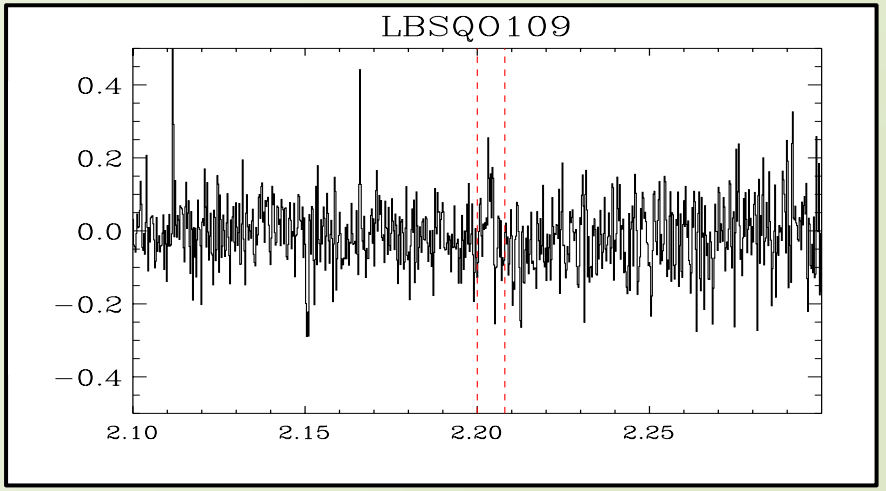


SINFONI@VLT

Seeing limited resolution (0.6”)

Subtract broad Hα and outflow components





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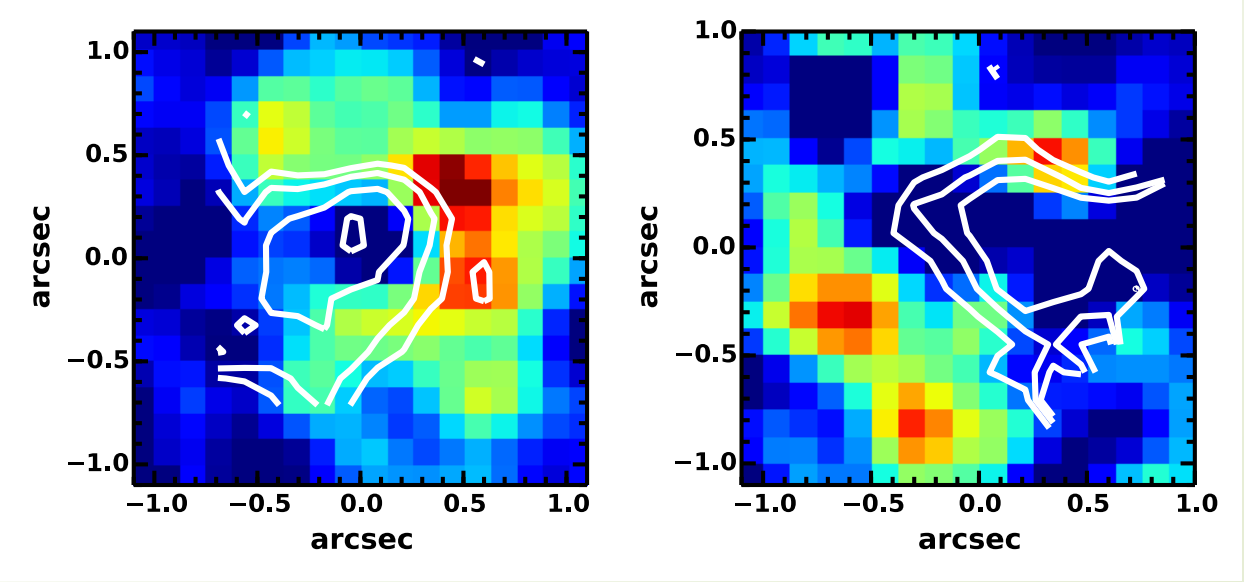

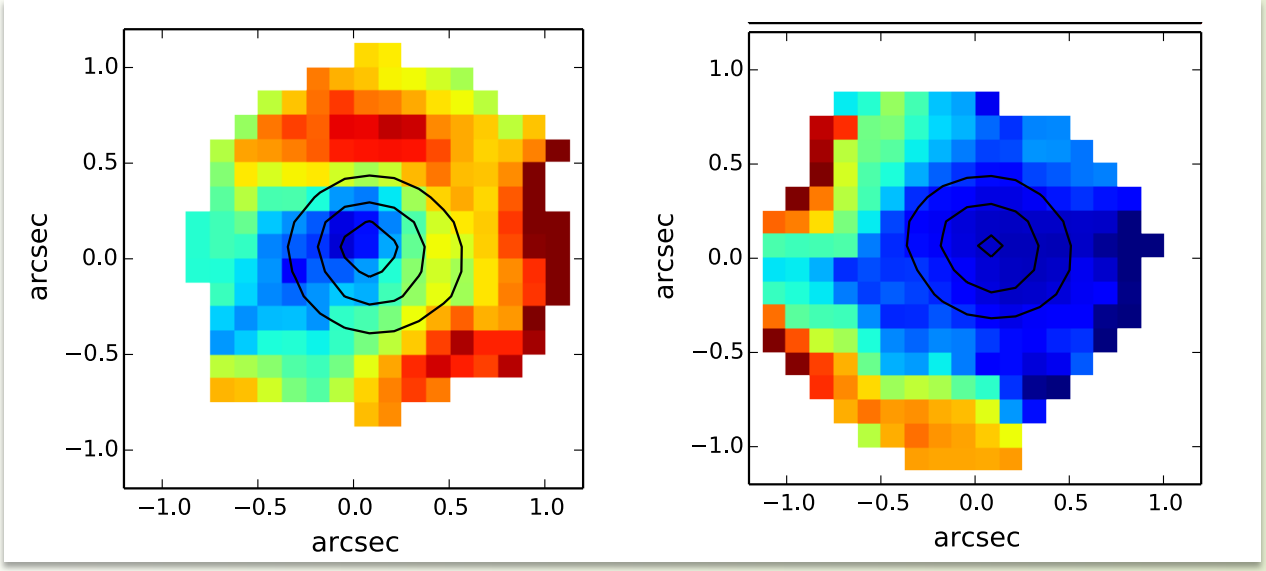

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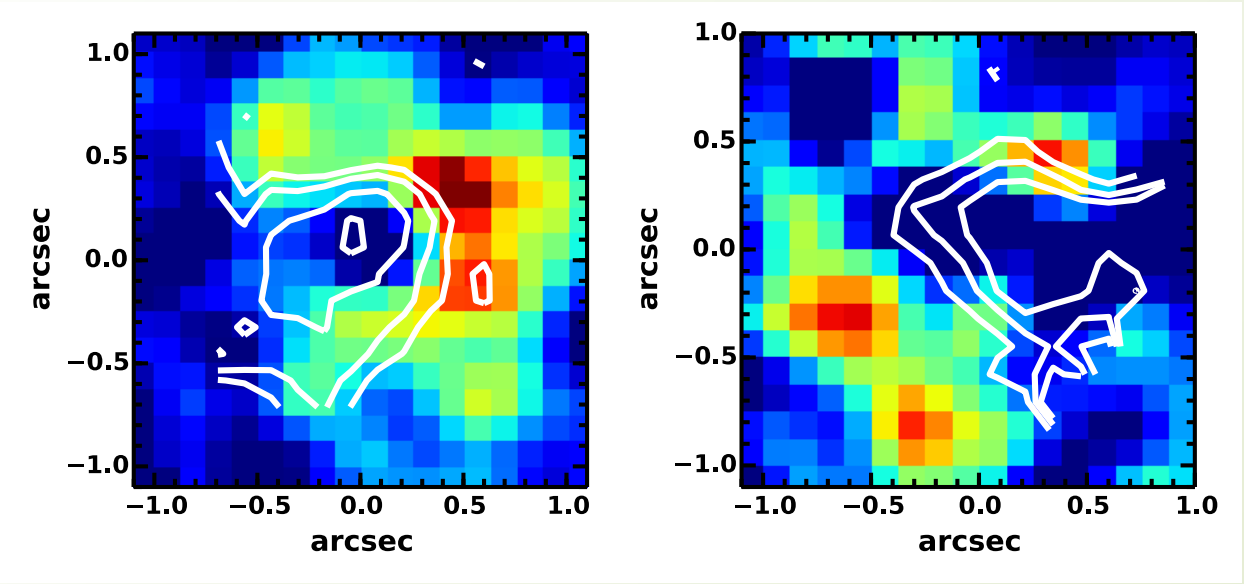
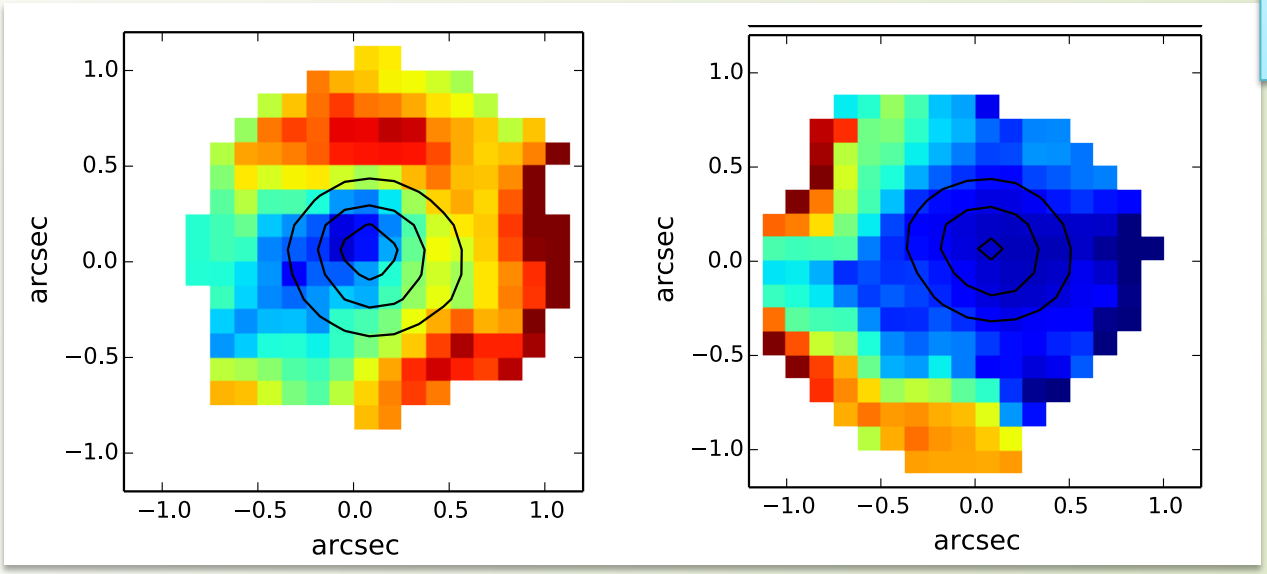
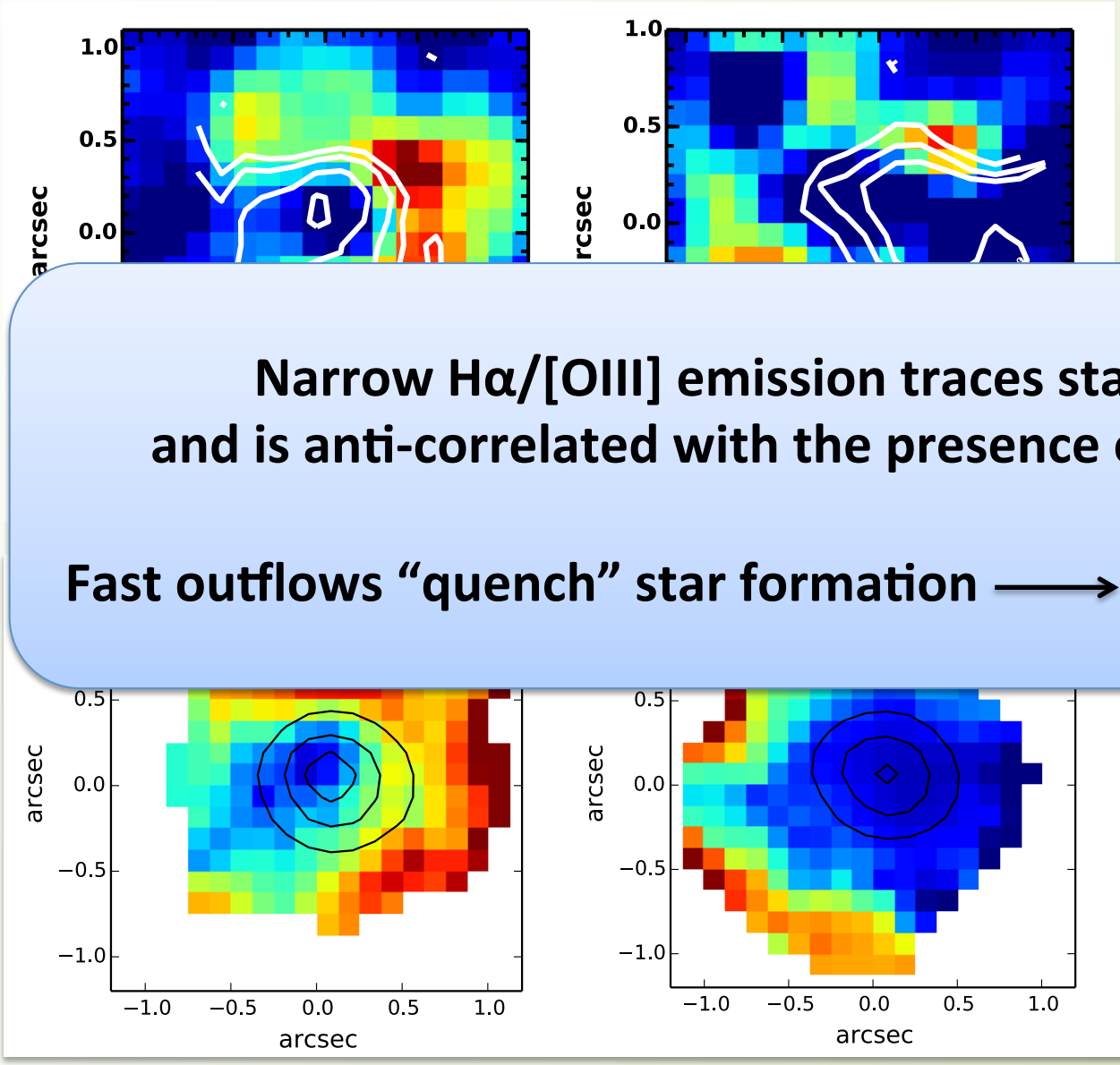




No [NII], upper limit on [NII]/Hα excludes AGN excitation

→ ***star formation!***

Origin of narrow [OIII] ?

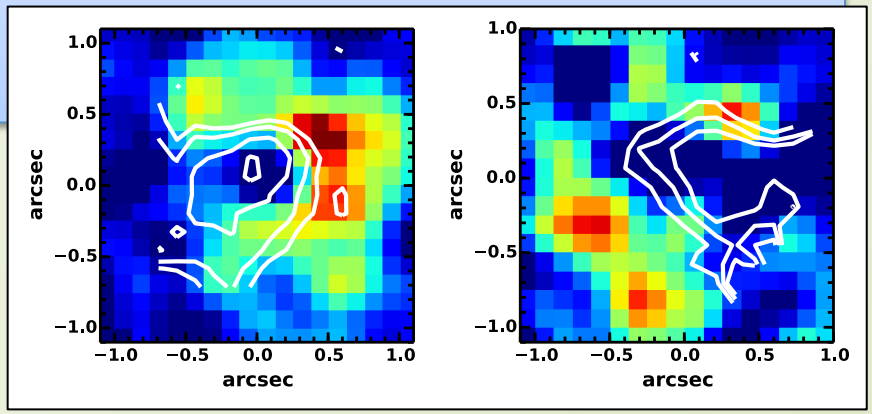


Narrow Hα/[OIII] emission traces star formation and is anti-correlated with the presence of fast outflows!

Fast outflows "quench" star formation ⟶ <u>feedback revealed</u>!

Conclusions

- **Ionized outflows sweep away gas in host galaxies**
- **Star formation is suppressed in the region affected by outflow processes**
- **Feedback mechanisms do not significantly depress star formation over the whole galaxy**



$\mathrm{SFR} \sim 180 \mathrm{M}_{\odot}/\mathrm{yr}$ $\mathrm{SFR} \sim 100 \mathrm{M}_{\odot}/\mathrm{yr}$

Next Steps

- ❑ Improve outflow model to compare with our results
- ❑ Compare molecular and ionized outflows using future ALMA observations