

INTEGRAL FIELD SPECTROSCOPY OF HIGH REDSHIFT QUASARS

Mariana Cano Díaz

Supervisor: Roberto Maiolino

INAF-Osservatorio Astronomico di Roma



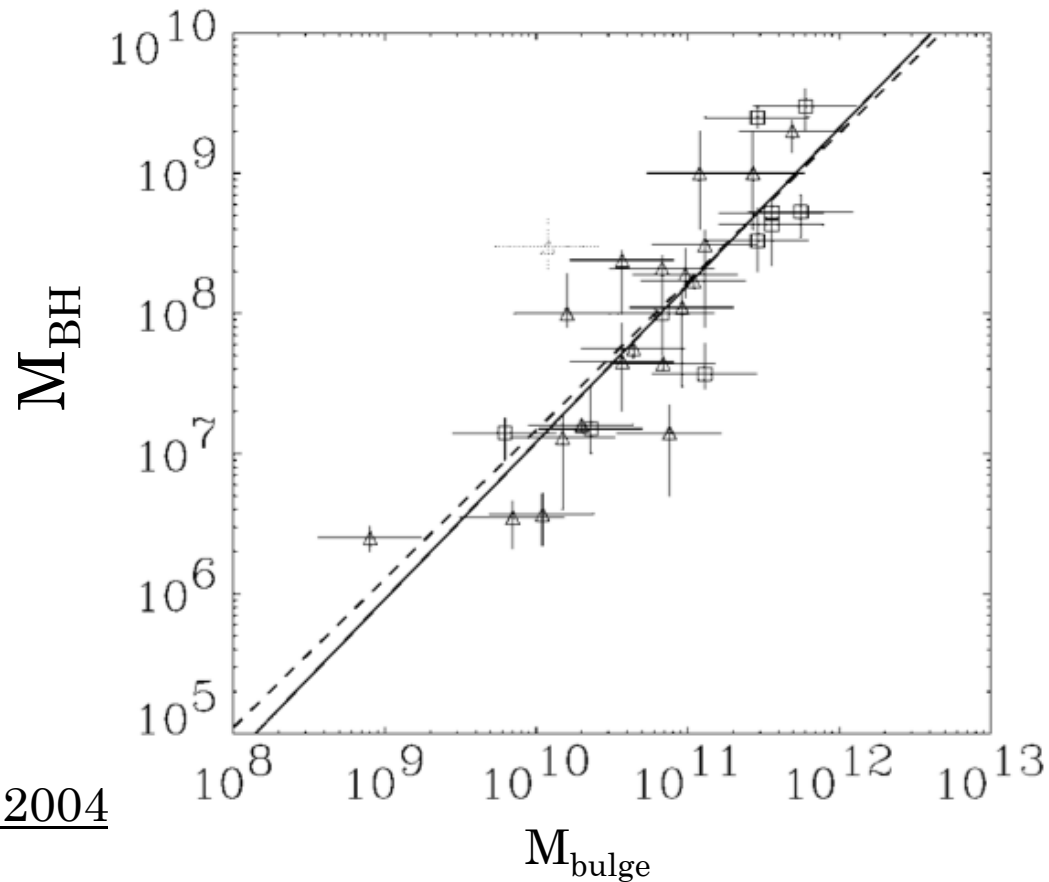
Madrid, October 5th 2011



ELIXIR meeting

GENERAL CONTEXT

- Observational results suggest a tight connection between galaxy formation and BH growth through the cosmic epochs ($M_{\text{BH}}-M_{\text{star}}$ local relation).



Häring & Rix, 2004



GENERAL CONTEXT

- Galaxy Formation models predict that at $z \sim 1-3$ the quasar activity should be at its maximum, generating energetic and massive outflows.
- These outflows are proposed to be responsible for blowing gas away from massive galaxies hence quenching star formation (quasar negative feedback), and also stop further BH accretion.
- Quasar feedback is expected to explain not only $M_{\text{BH}}-M_{\text{star}}$ relation, but it is also needed to preventing galaxies to overgrow (hence explaining the shortage of very massive galaxies in the local universe) and to explain the red colors of ellipticals.



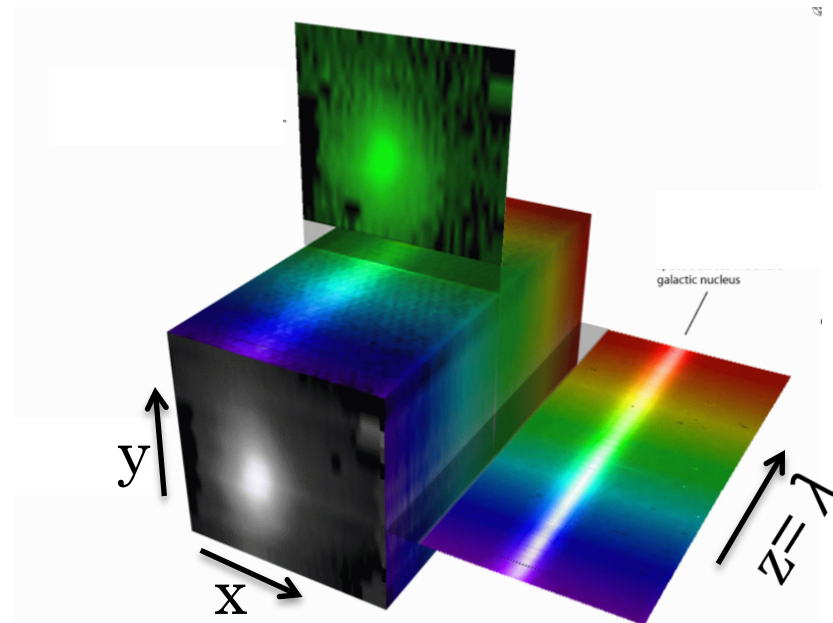
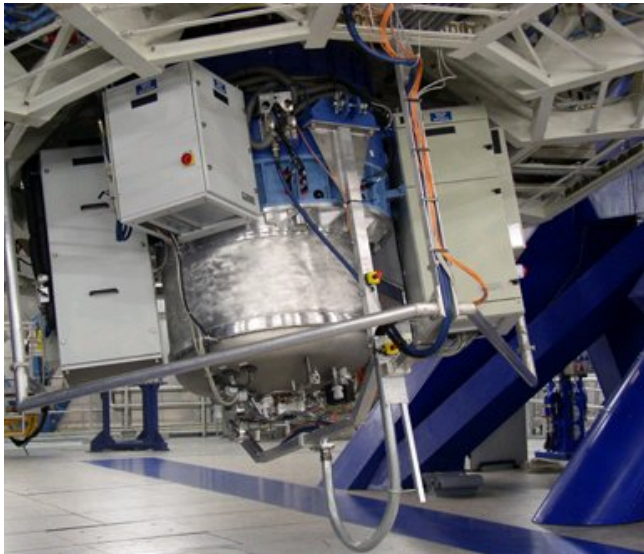
WHAT WE CAN DO

- In order to track the influence of the AGN on its host galaxy we have undertaken an IFU near-IR spectroscopic investigation of $z \sim 2$ quasars.
- Key diagnostics:
 - [OIII] (strong, redshifted into H band) to trace gas kinematics
 - Ha (narrow component, redshifted into K band) to trace star formation



WHAT WE CAN DO

- The instrument that suits our requirements is:
 - SINFONI - Spectrograph for INtegral Field Observations in the Near Infrared at the VLT
Delivering near-IR data cubes



DATA

- We have observed a sample of 10 QSOs (4 objects in the first year (H and K bands) and 6 in the second (H and H+K bands)).
- All under excellent seeing conditions (0.4"-0.6").
- The whole data reduction process was performed.
 - Flat field correction.
 - Sky subtraction.
 - Cosmic ray cleaning.
 - Wavelength calibration.
 - Distortion correction.
 - Alignment of the slitlets.
 - Flux calibration.
 - Final cube construction.

Note: Proposal to followup some sources with SINFONI+Adaptive Optics and with The X-shooter IFU has been submitted to ESO.

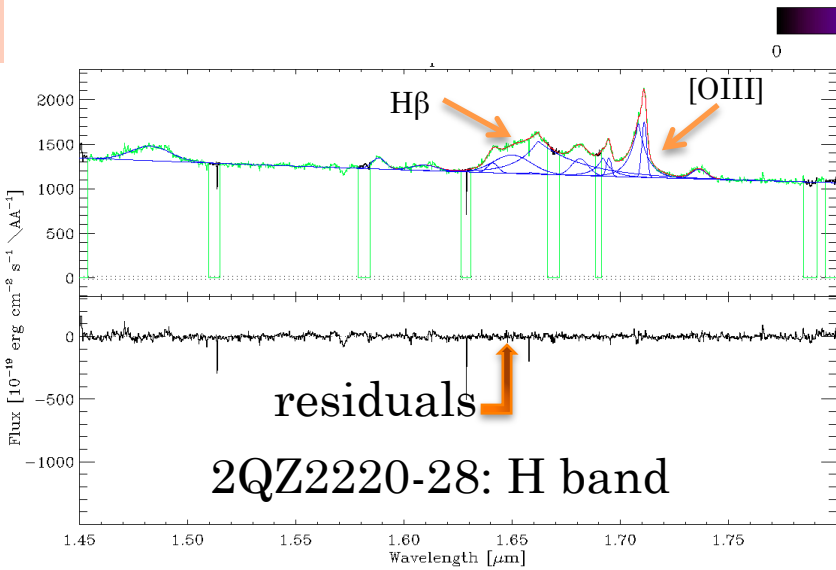


DATA

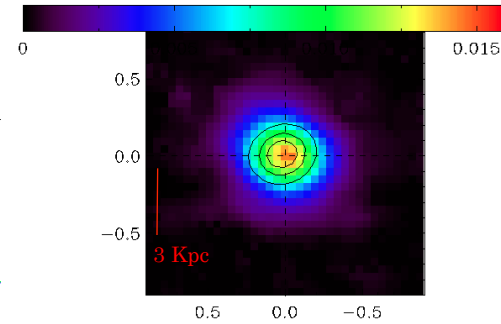
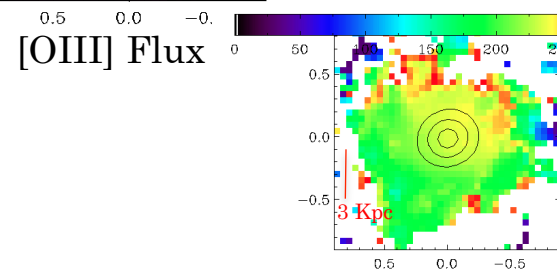
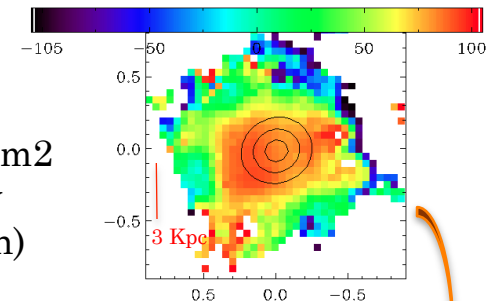
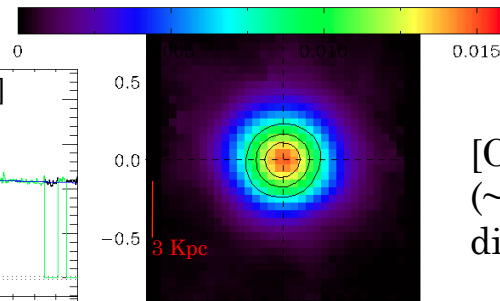
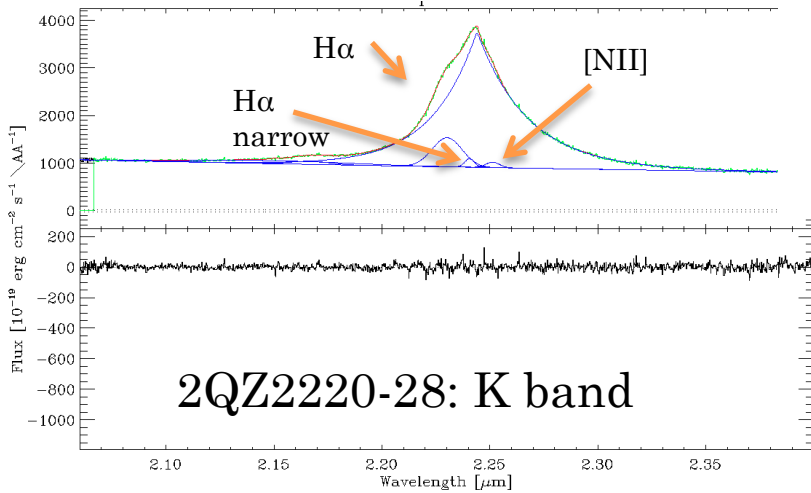
- A spectral fitting process and analysis was performed for all the sources.
- At first the fitting is performed only in a single aperture in order to select and optimize the required spectral components (multiple gaussians and power-laws to reproduce the shape of the emission lines).
- Then the same components are used to fit the spectrum in each spatial pixel of the cube (by constraining some of the components).
- The shape of the “broad lines” (from the BLR) is kept fixed (only intensity is allowed to vary, and it’s tracing the seeing, since the BLR is unresolved).
- The output are: flux maps, velocity field and velocity dispersion each line/component.



SOME RESULTS



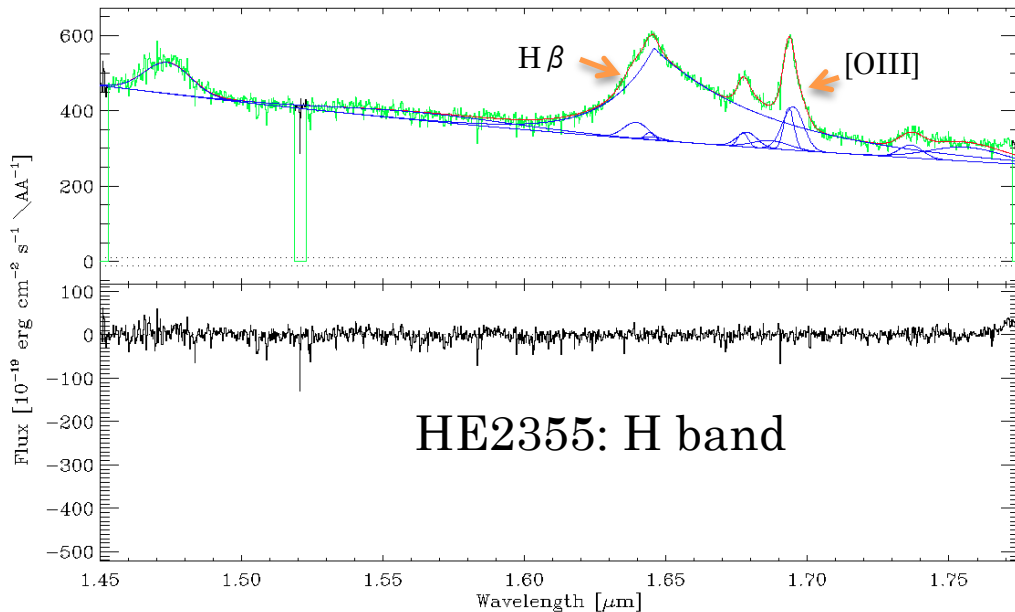
Central 0.5" aperture



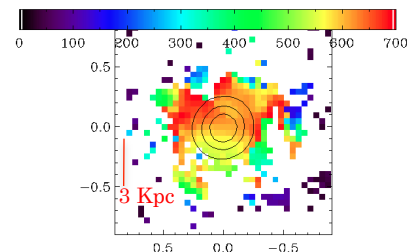
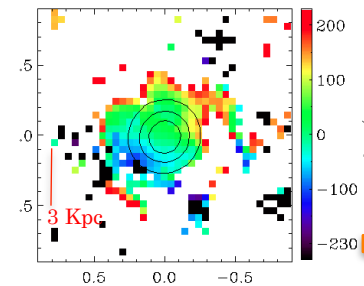
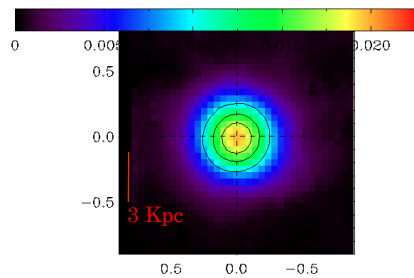
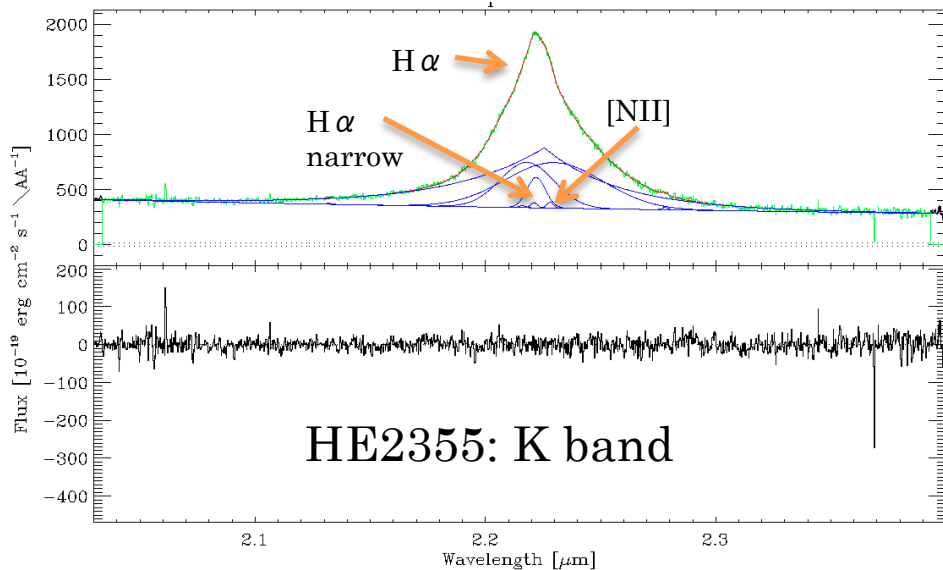
No signs of rotation, disturbed field
Probably, tracing a recent merging.

Peak of emission in the center: BH and galaxy co-evolution.

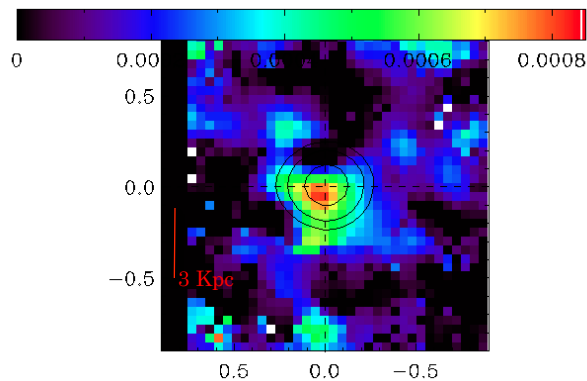
SOME RESULTS



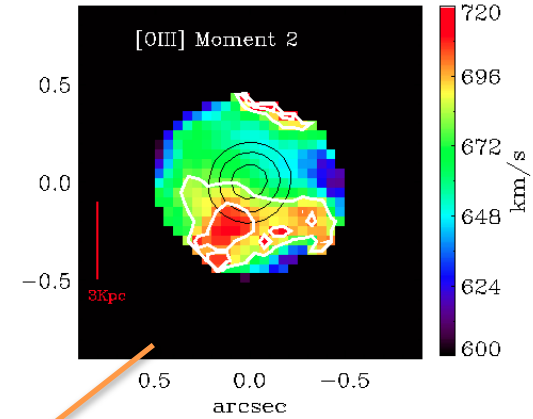
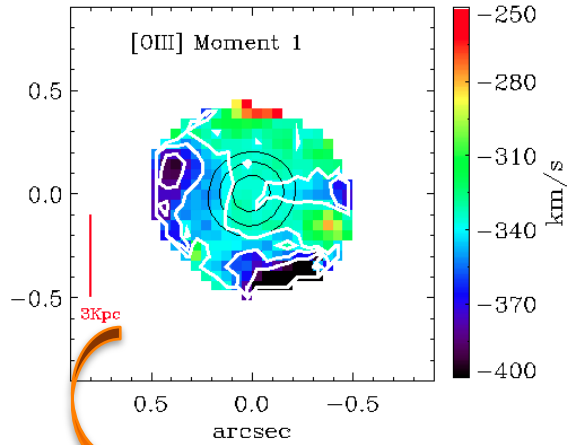
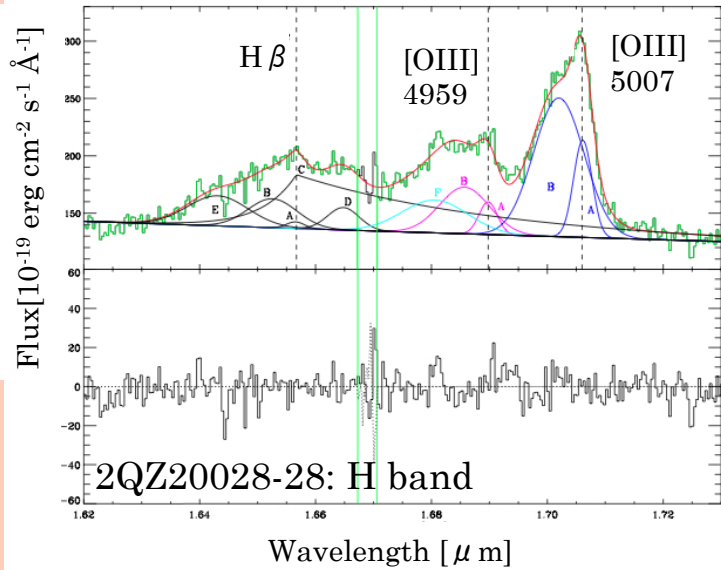
Central 0.5" aperture



Signs of rotation?



HIGHLIGHTING RESULT



Evidence of (quasar-driven) outflow

$$\dot{M}_{\text{ion}}^{\text{out}} = 4.2 \cdot 10^7 \frac{L_{[\text{OIII}]44}^{\text{out}}}{n_3^{\text{out}}} M_{\odot}$$

Mass of ionized outflowing gas

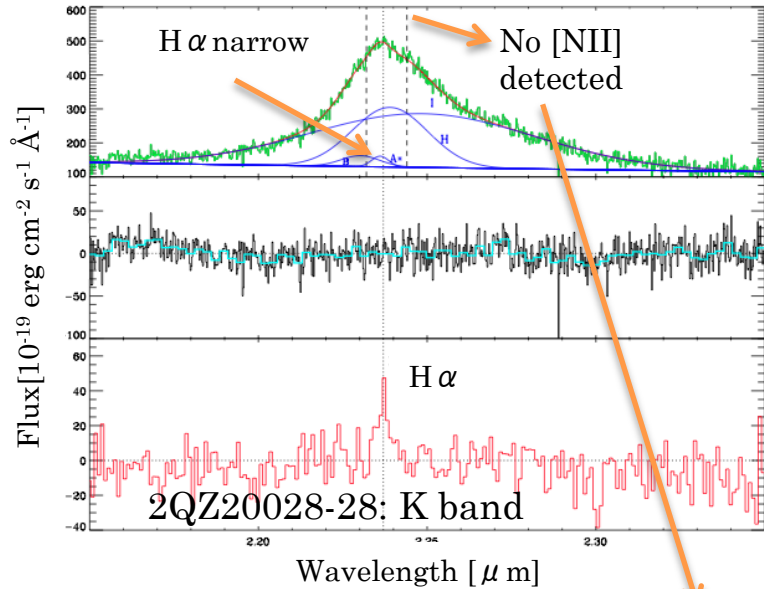
$$\dot{M}_{\text{ion}}^{\text{out}} = 130 \frac{L_{[\text{OIII}]44}^{\text{out}} v_3^{\text{out}}}{n_3^{\text{out}} R_{\text{kpc}}} M_{\odot} \text{ yr}^{-1}$$

Mass outflow rate of ionized gas

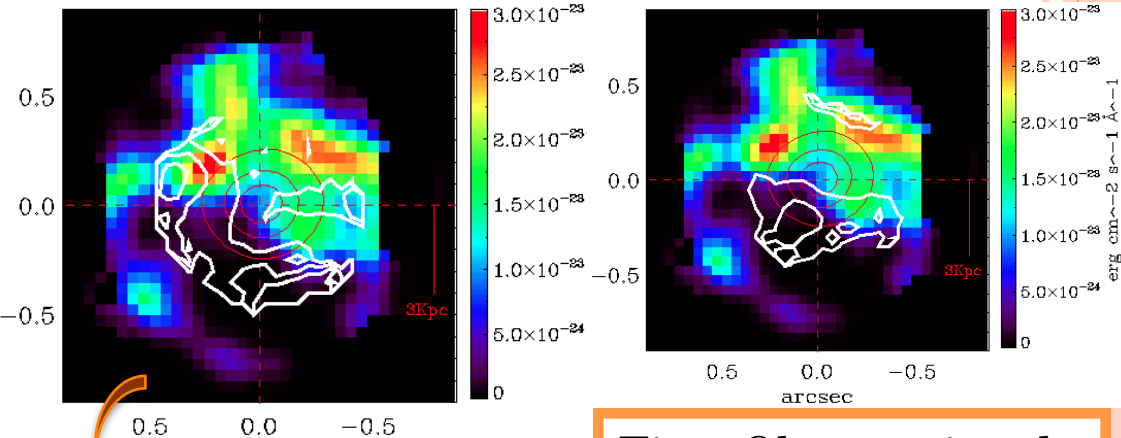
$\sim 500 M_{\text{sun}}/\text{Yr}$



HIGHLIGHTING RESULT



H α narrow is tracing Star Formation



Quenched star formation in correspondence of the outflow

SFR $\sim 100 M_{\text{Sun}}/\text{yr}$

First Observational evidence for quasar feedback quenching Star formation at high-z!



CONCLUSIONS

- We have also derived BH masses for all sources.
- We are currently performing astro-spectroscopy.
- Future work:
 - Determine dynamical mass/ rotation curve for rotation cases.
 - Look for confirmation of AGN feedback.
- Additional parallel program aimed at investigating the BH-galaxy relation in obscured quasars at $z \sim 2$ (by detecting broad $H\alpha$ to measure BH masses) exploiting LUCIFER-LBT and SINFONI-VLT data.

