UNIVERSITÀ DEGLI STUDI FIRENZE

The MAGNUM survey: outflows and star formation in nearby Seyfert galaxies from MUSE observations

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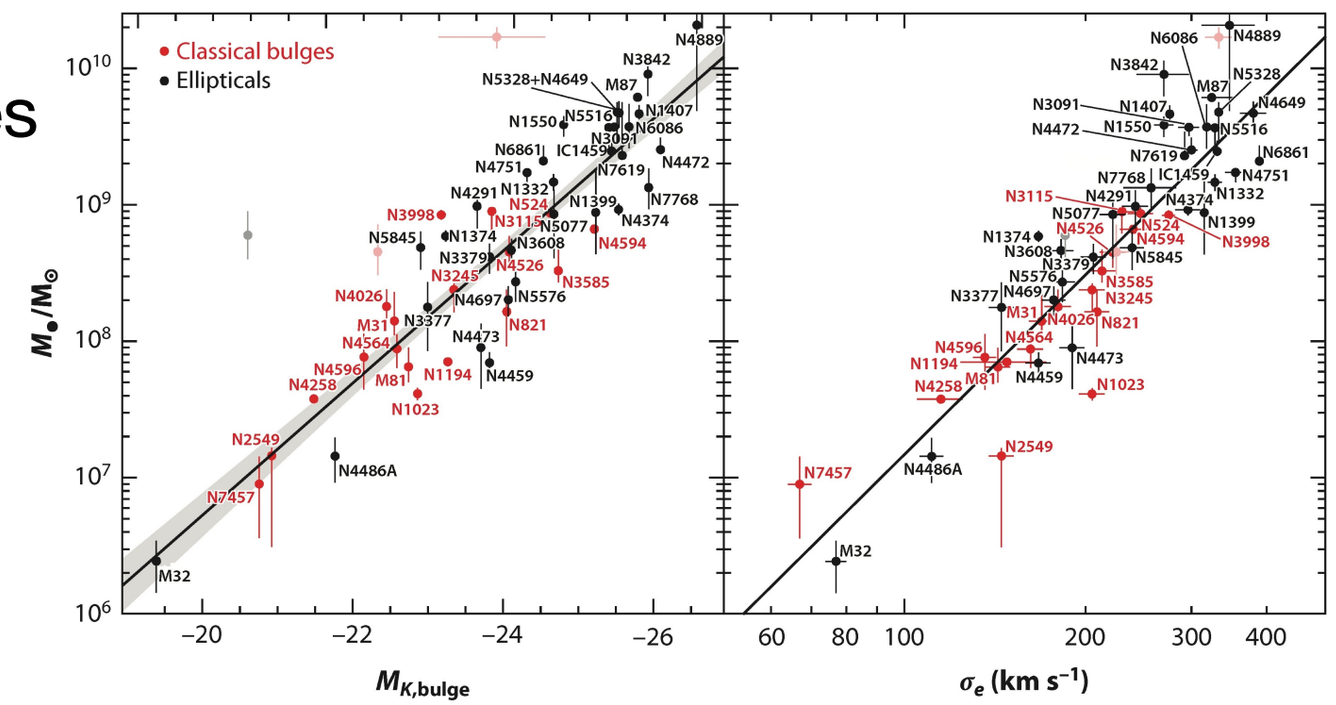
Co-evolution of BHs and Host Galaxies

- Relations between supermassive black holes and their host galaxies (e.g. M_{BH}-σ): *co-evolution*
- AGN feedback is the mechanism linking BHs to their host galaxies: *causes quenching of star formation and BH accretion*
- Evidences for feedback?



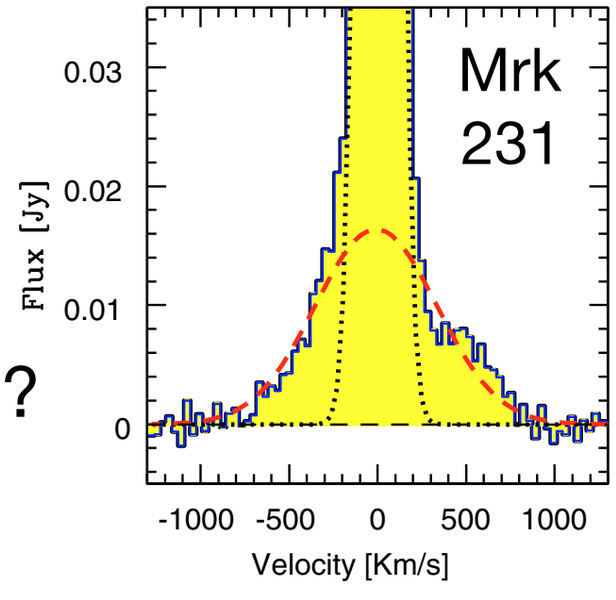
Kormendy & Ho 2013

Massive outflows in ionised and molecular gas

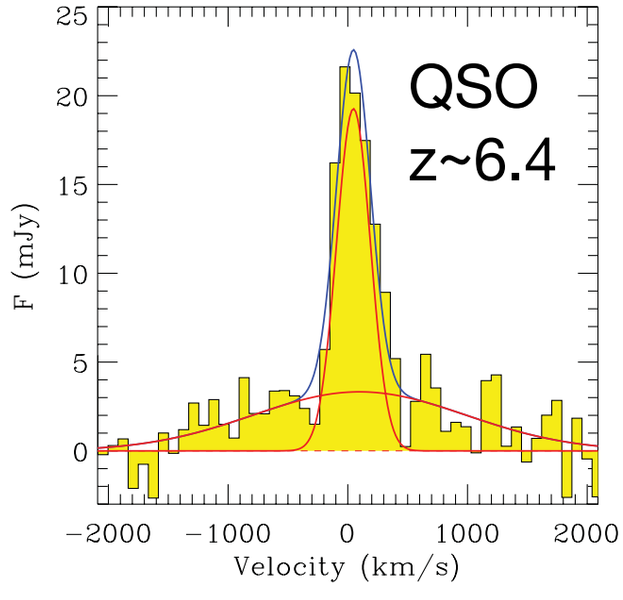
- large outflow rates for SFRs and gas masses (up to ~100-1000 $M_\odot$/yr, several ×SFR) ➙ short depletion time scale (~10^7 - 10^8 yr)

- Direct evidences for outflows quenching (enhancing) Star Formation?
- What is the driving/accelerating mechanism of (molecular) outflows?
- What is their impact on ISM?

Feruglio+11



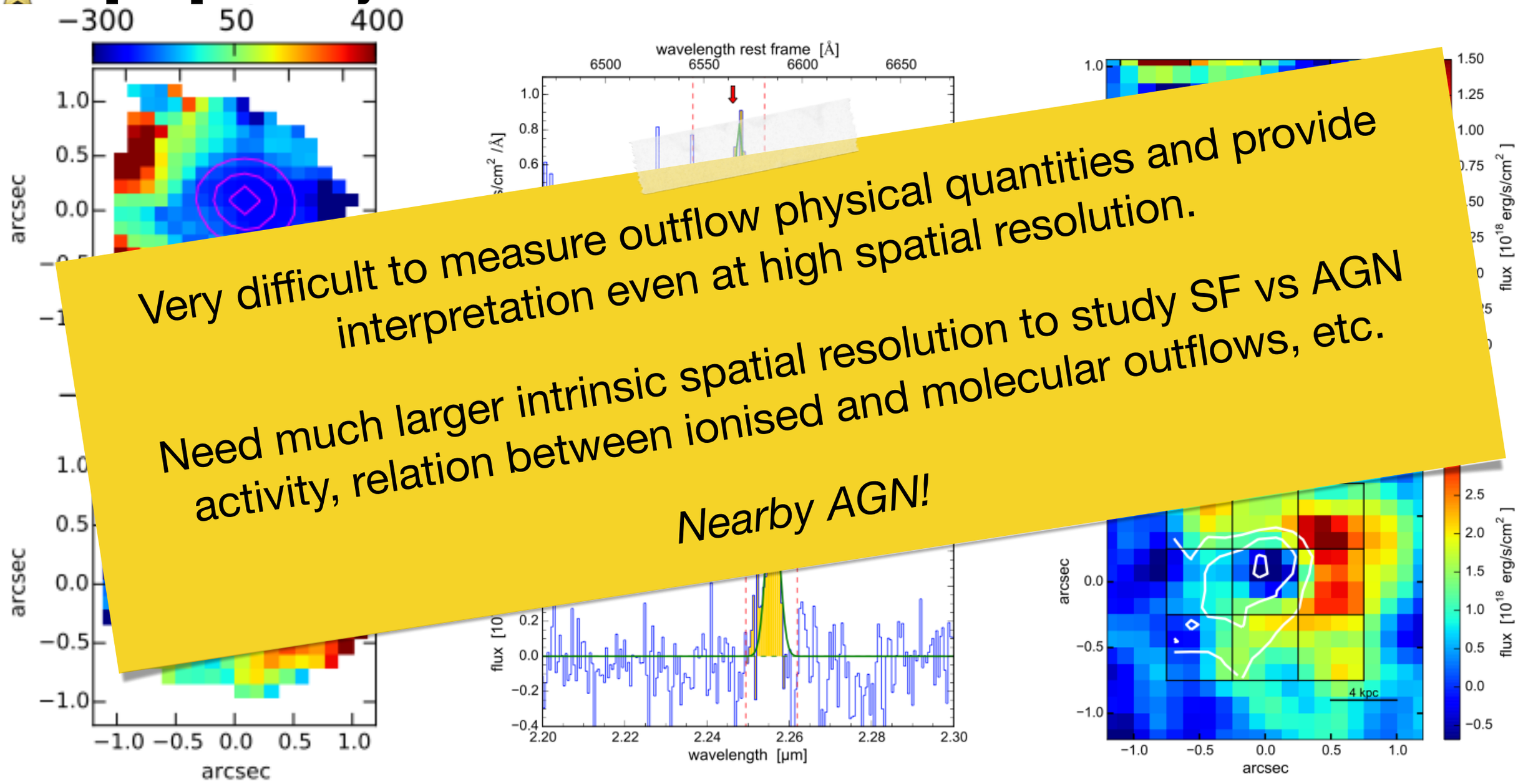
Maiolino+12



Evidences at high redshift

- Results from high redshift quasars (z~2.5): evidence for fast outflows quenching star formation, AGN feedback revealed! (?)

[OIII] velocity **K band: broad Hα subtracted** **Narrow Hα flux**



Very difficult to measure outflow physical quantities and provide interpretation even at high spatial resolution.

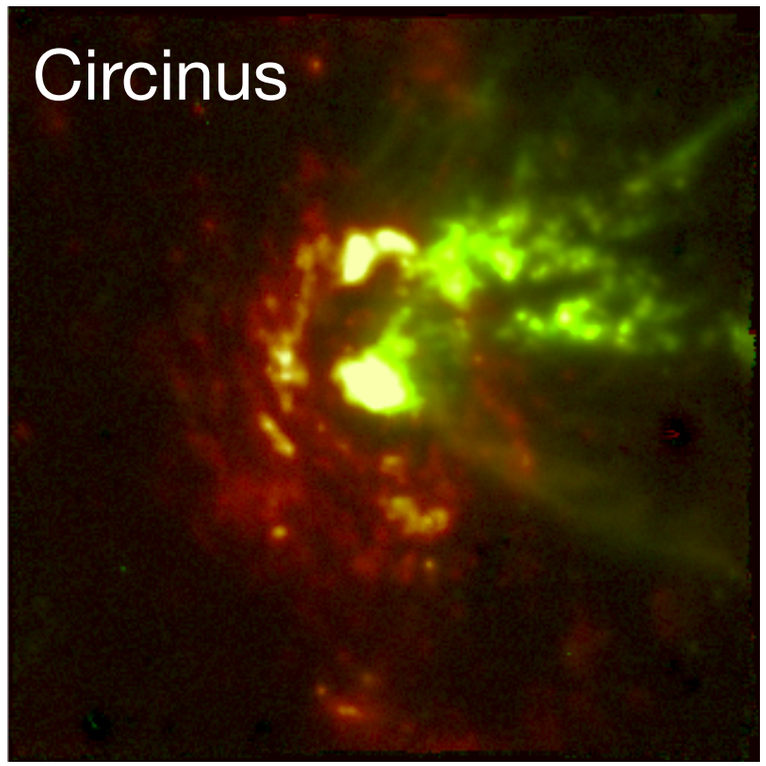
Need much larger intrinsic spatial resolution to study SF vs AGN activity, relation between ionised and molecular outflows, etc.

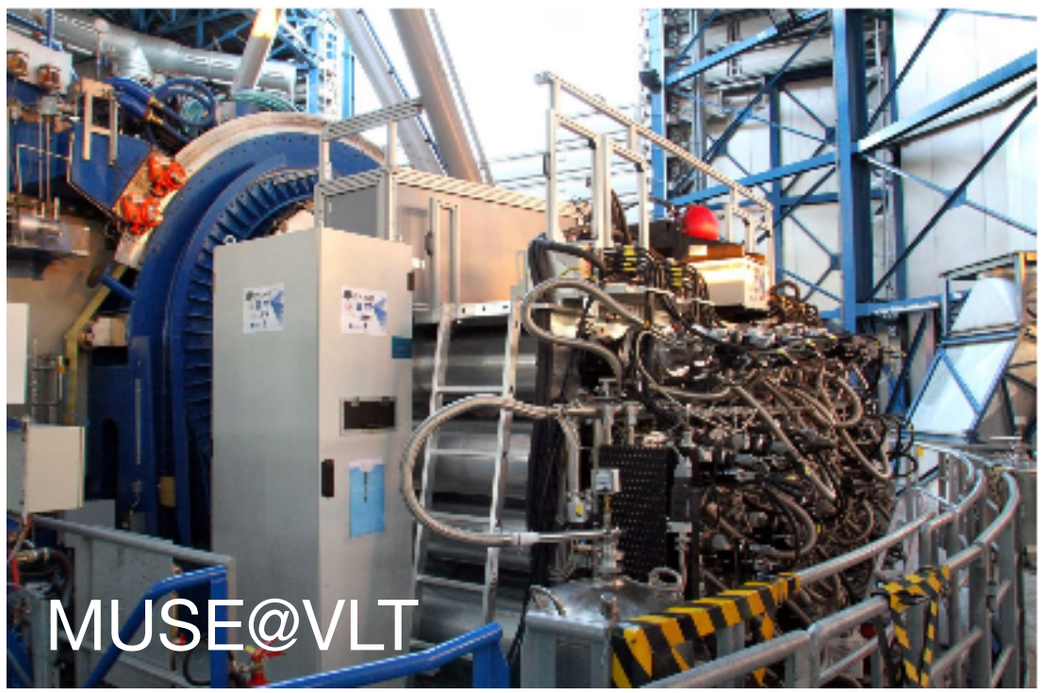
Nearby AGN!

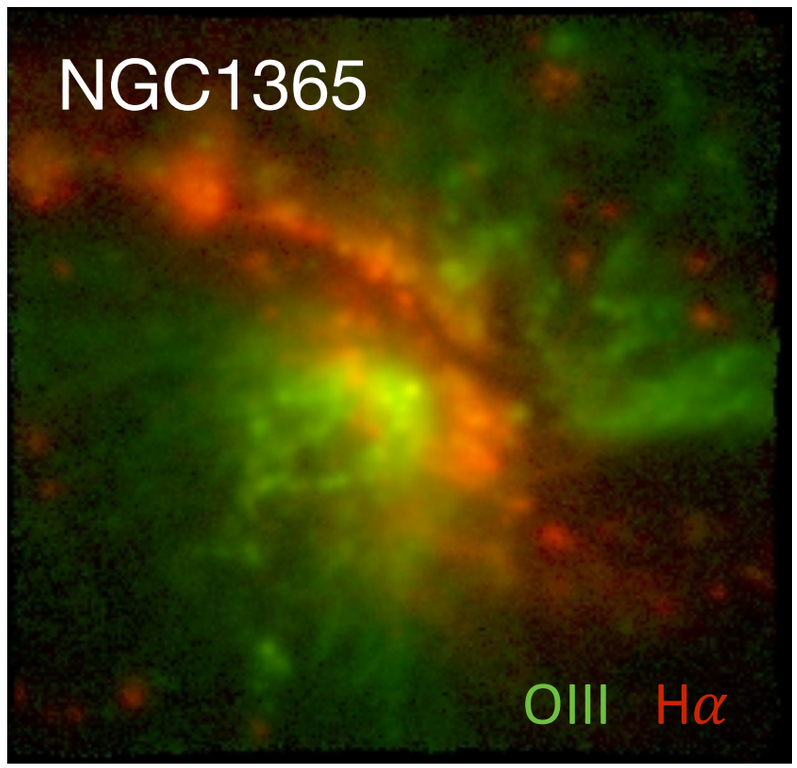
Carniani+2015

The MAGNUM survey

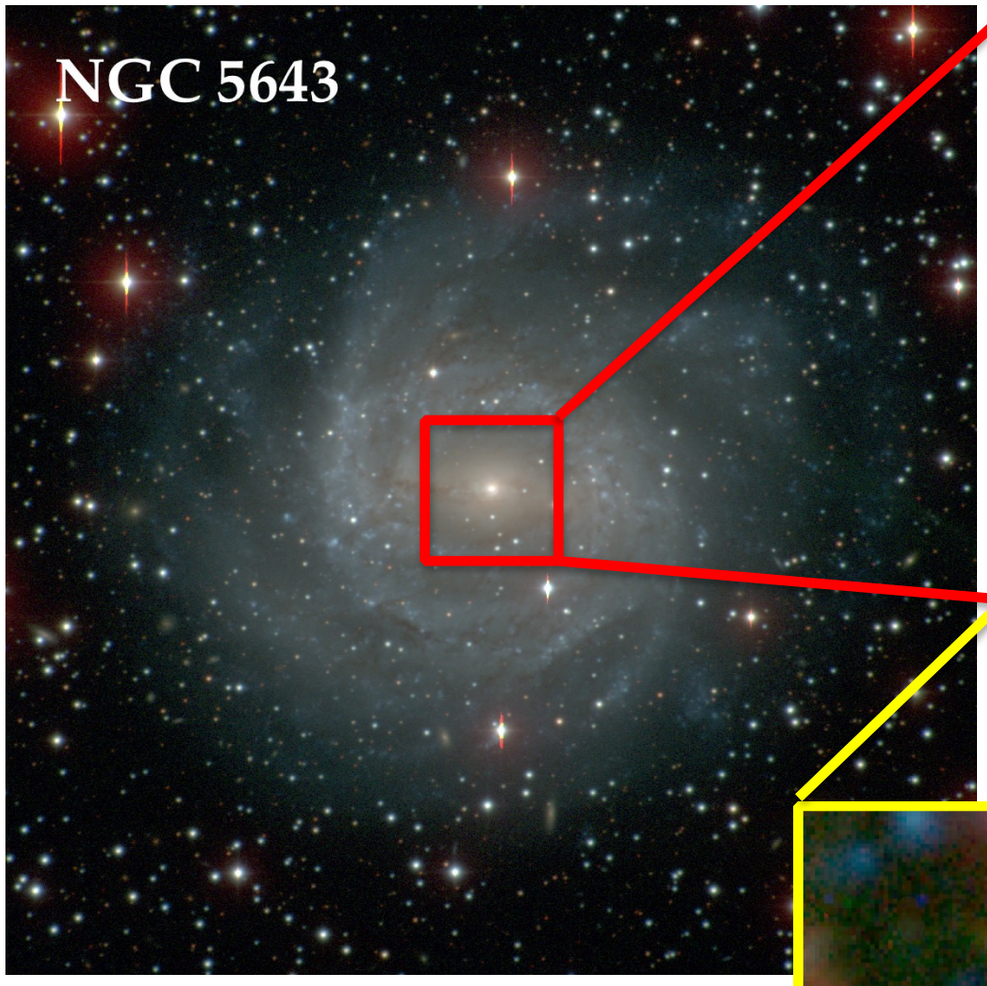
- **M**easuring **A**ctive **G**alactic **N**uclei **U**nder the **M**USE microscope
- 1′×1′ FOV, 0.2′′ sampling (300×300 spaxels)
  4800-9300 Å wavelength range
- Nearby AGN (D < 30 Mpc) observable from ESO
- Seeing limited (~1”):
  15 pc (@4Mpc)
  115 pc (@30Mpc)
- 10 objects so far
- Multi-wavelength data: *Chandra, XMM-Newton, Galex, HST, Spitzer, Herschel, ALMA, Radio*



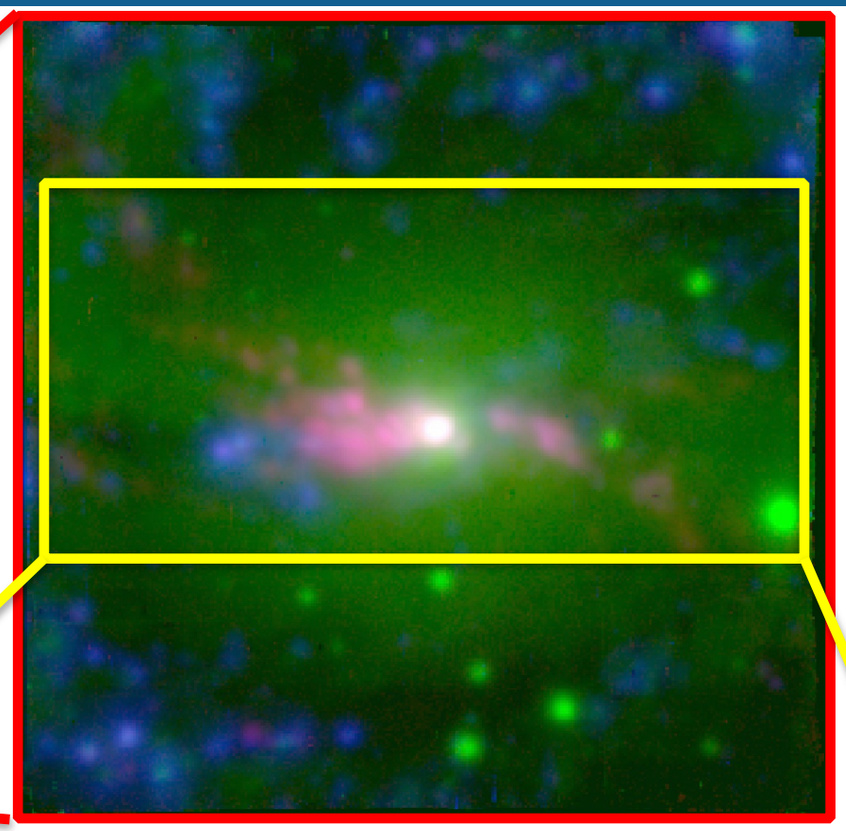




NGC 5643: a barred Seyfert 2



Optical B-V-R (CGS survey)

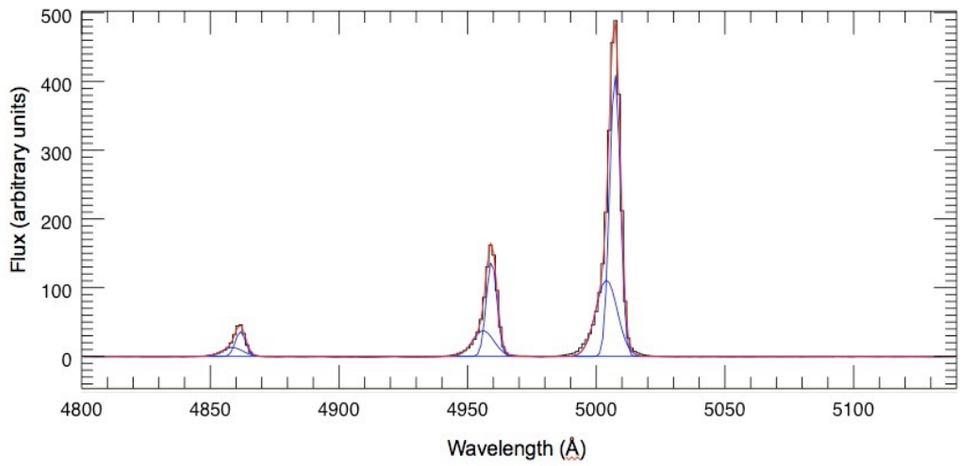


MUSE@VLT view
Green: Continuum; Blue: Ha; Red: [OIII]

Green: [NII] ; Blue: Ha; Red: [OIII]

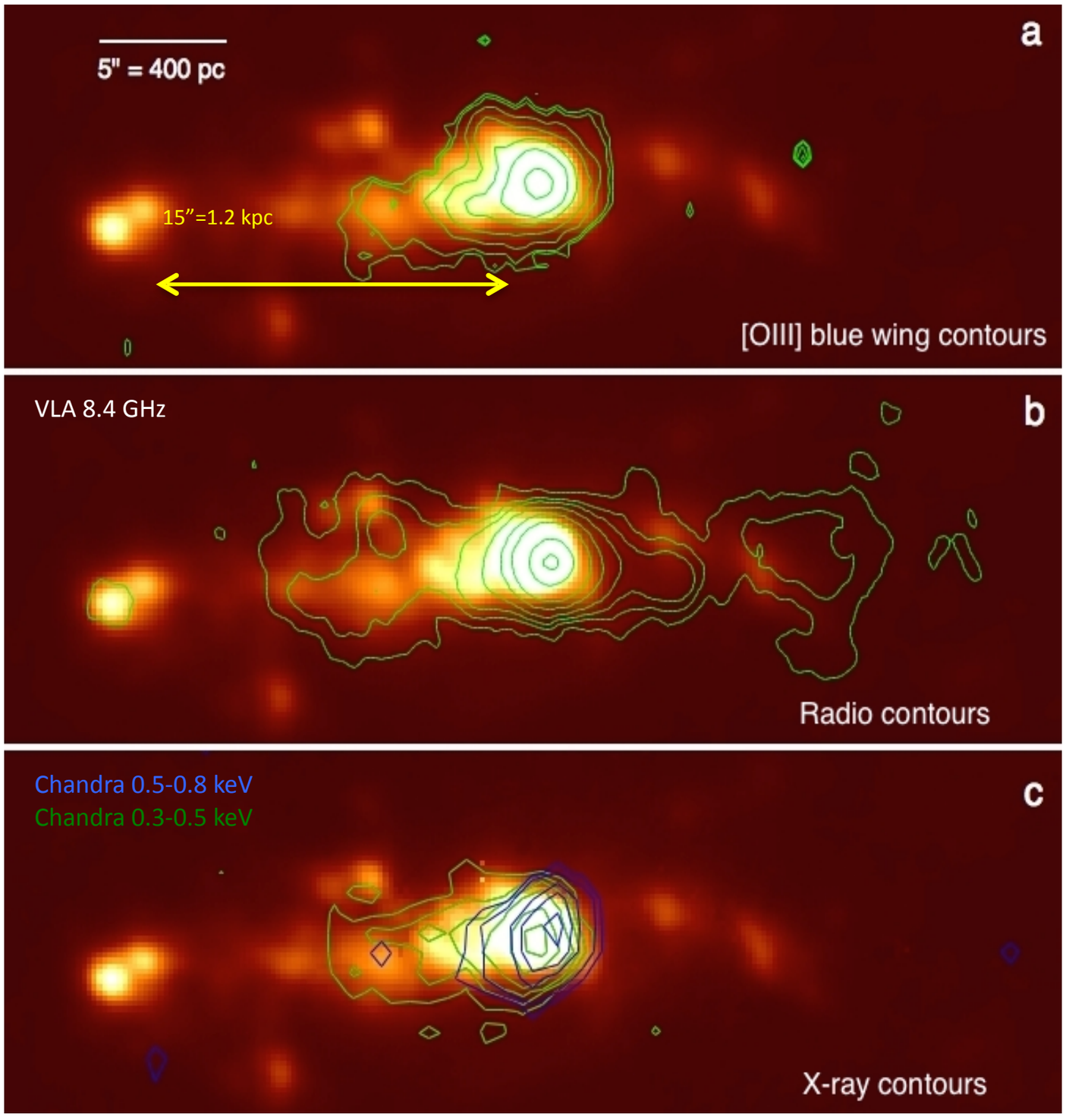
Cresci, AM et al., 2015

Nuclear Outflow in NGC5643



Evidences for outflowing gas in the nuclear region:

- [OIII], [NII] asymmetric line profiles
- Diffuse radio jet from VLA (Leipski et al. 2010)
- Chandra X-ray data

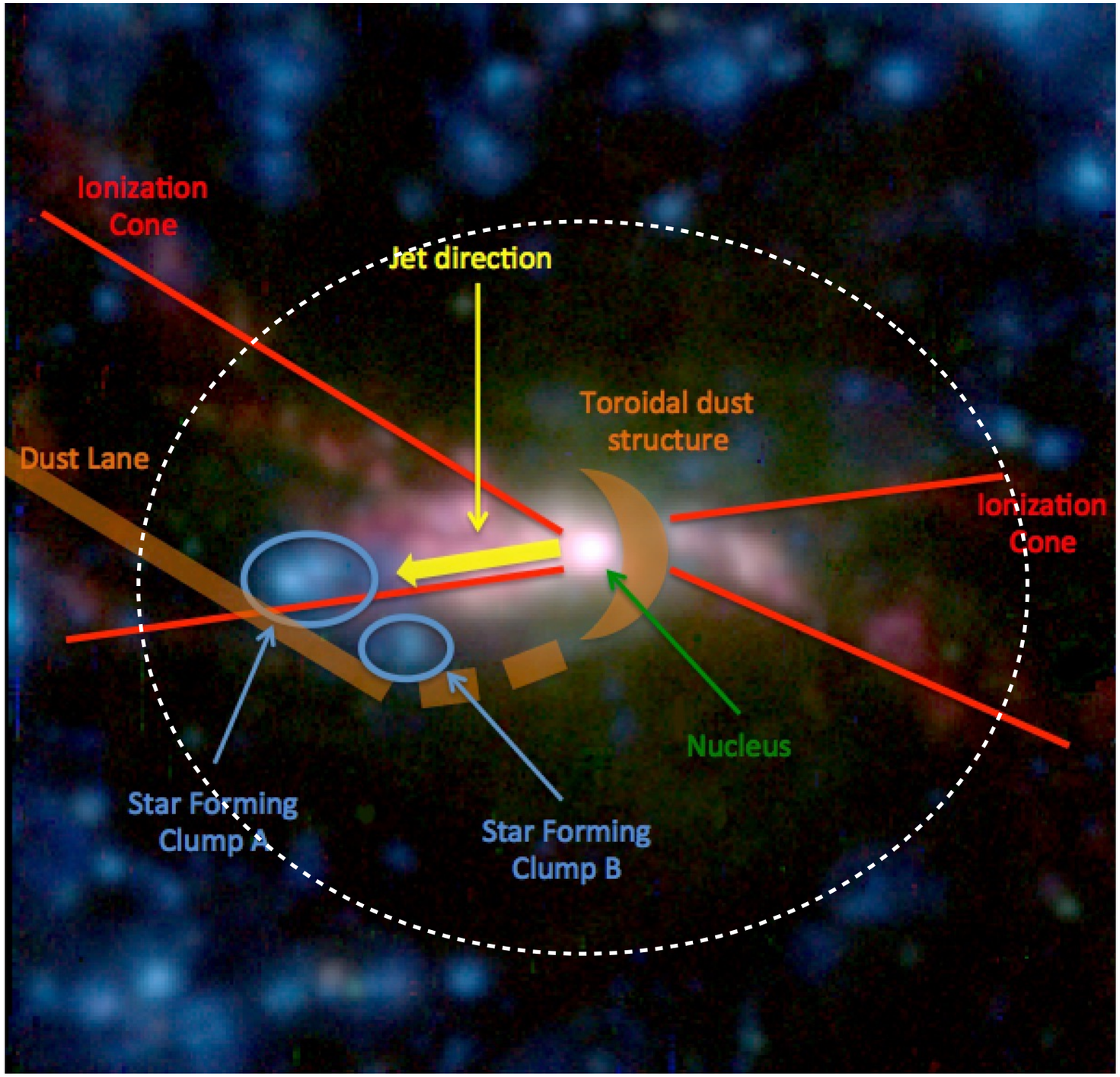


Cresci, AM et al., 2015

Positive feedback in NGC5643?

The two "*blobs*":

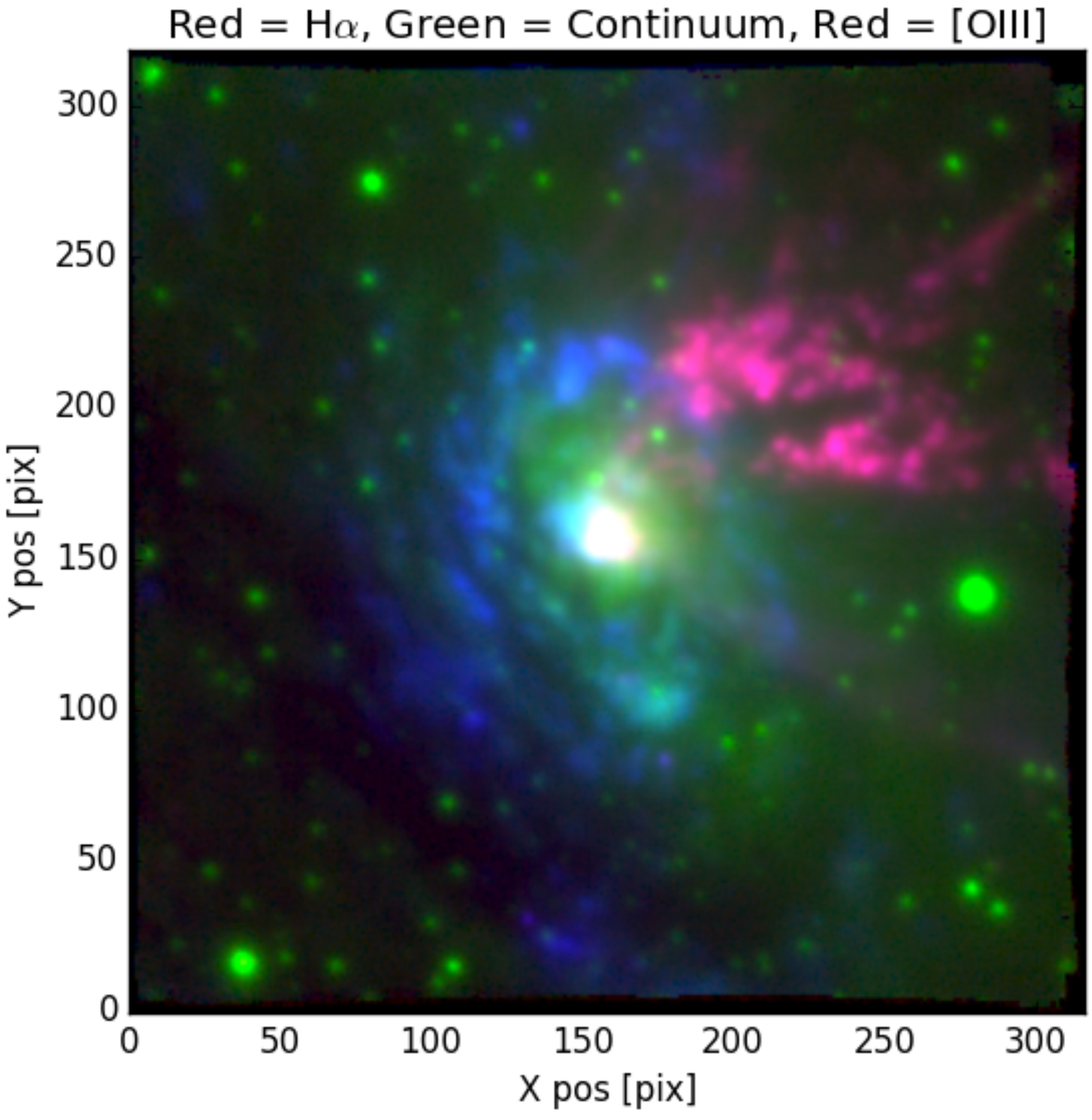
- Show SF-like line ratios
- Are on the receding side of the dust lane
- Have high EW(Hα) → young age (~10 Myr)
- Are much closer than the SF ring around the nucleus, in the ionization cone
- Are in the direction of the outflow

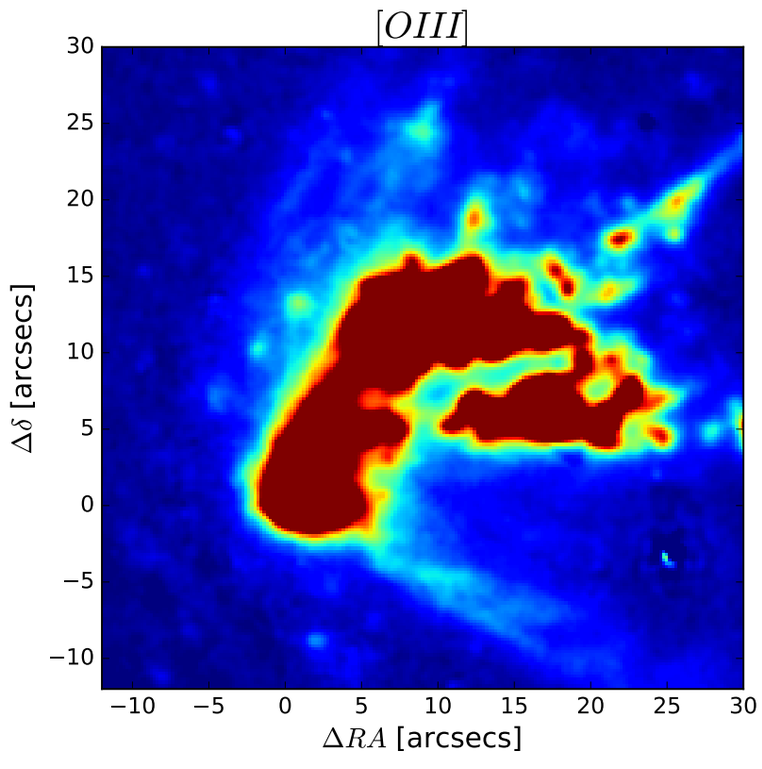


Cresci, AM et al., 2015

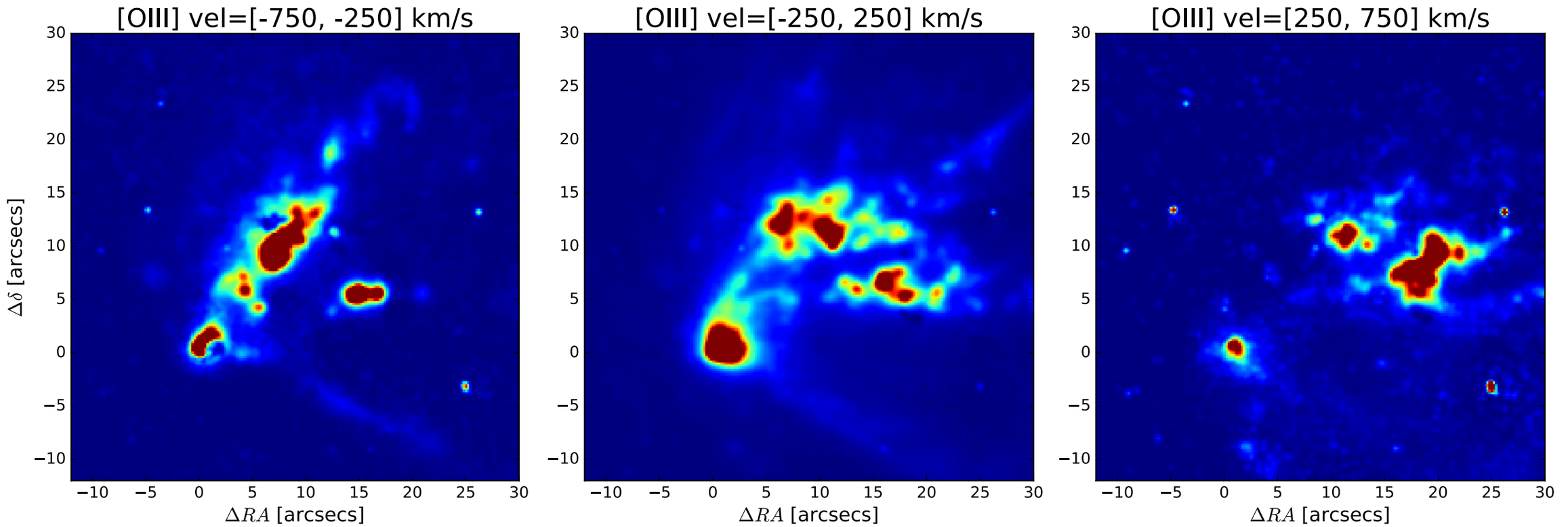
Positive Feedback?

Circinus galaxy

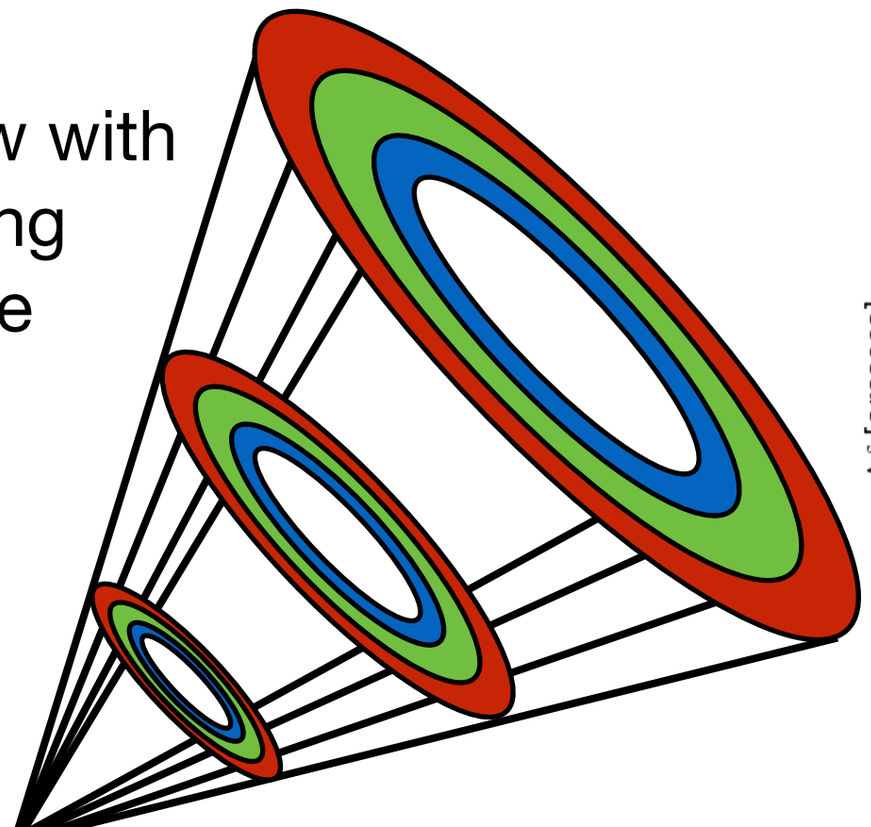


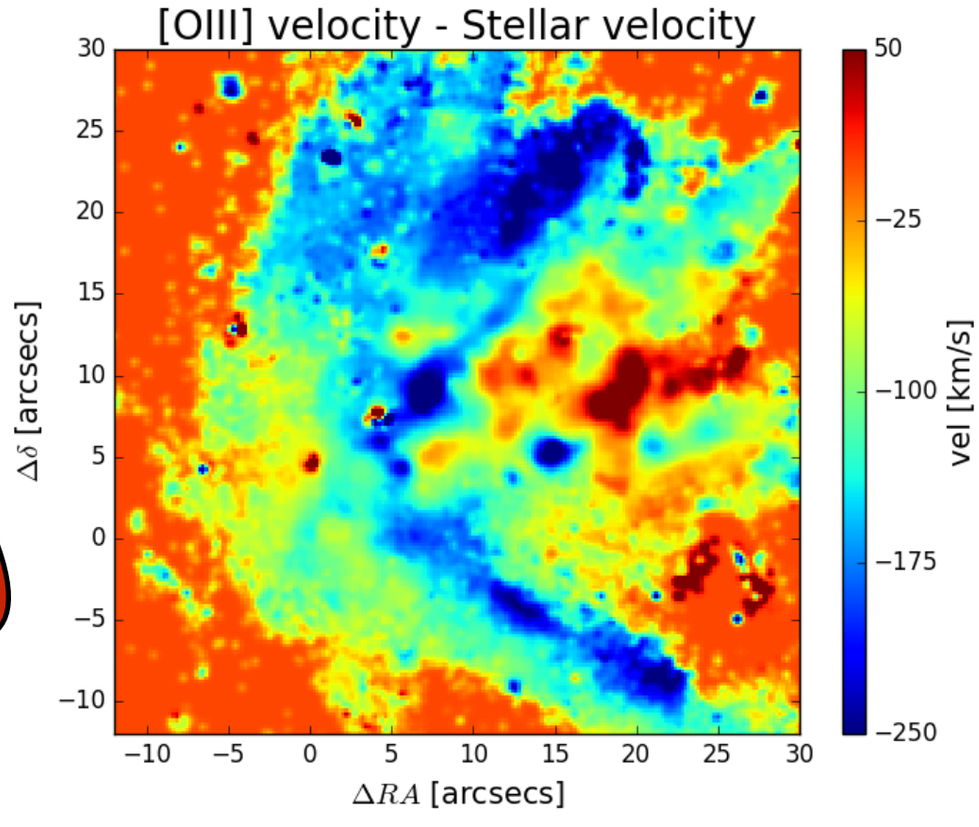


Kinematical structure in cone

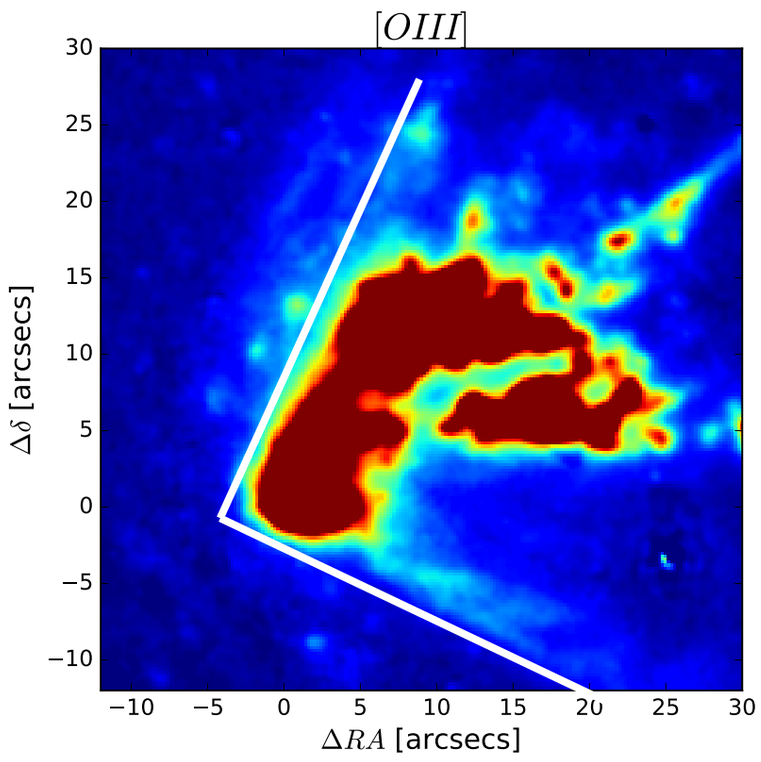


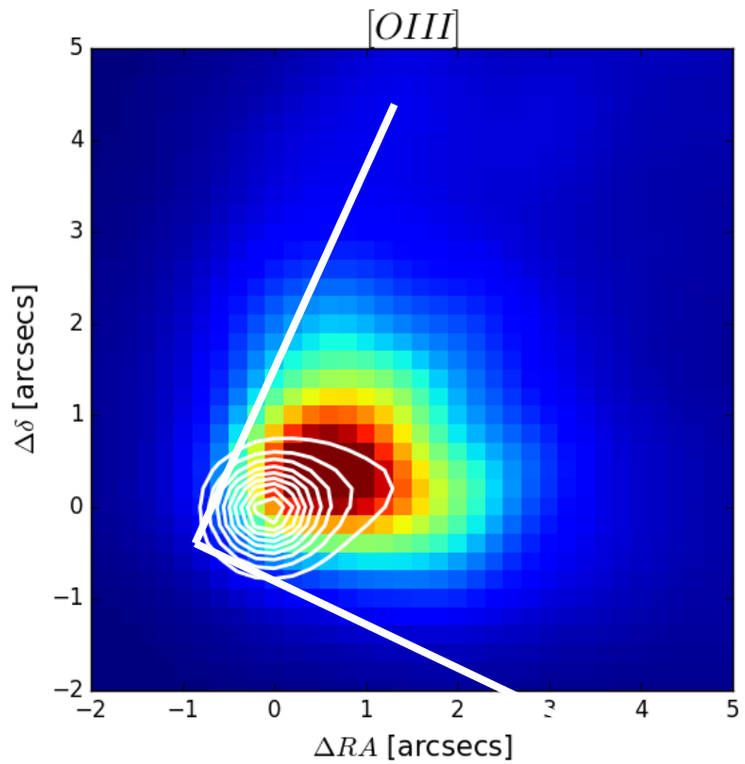
A conical outflow with velocity increasing towards the cone axis?

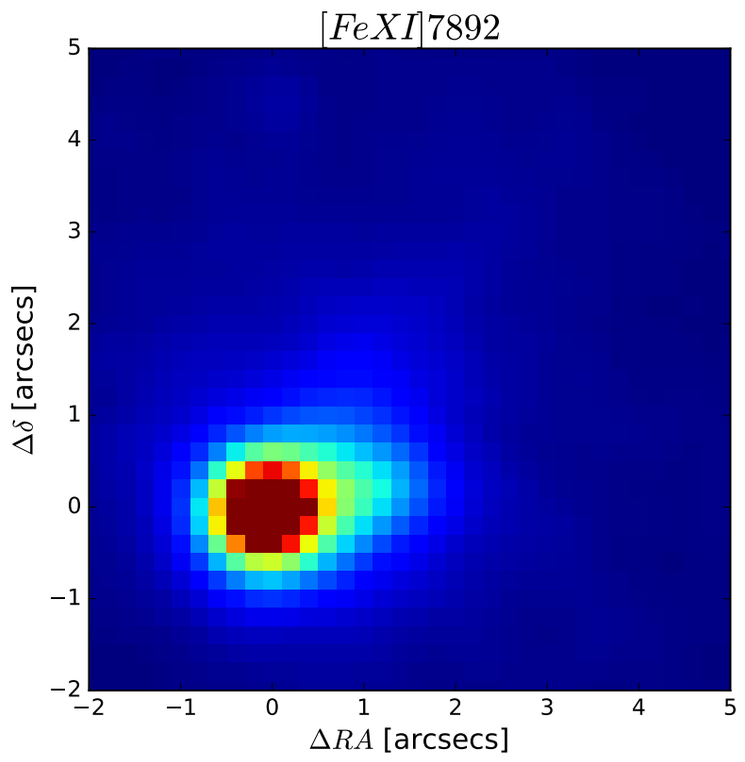


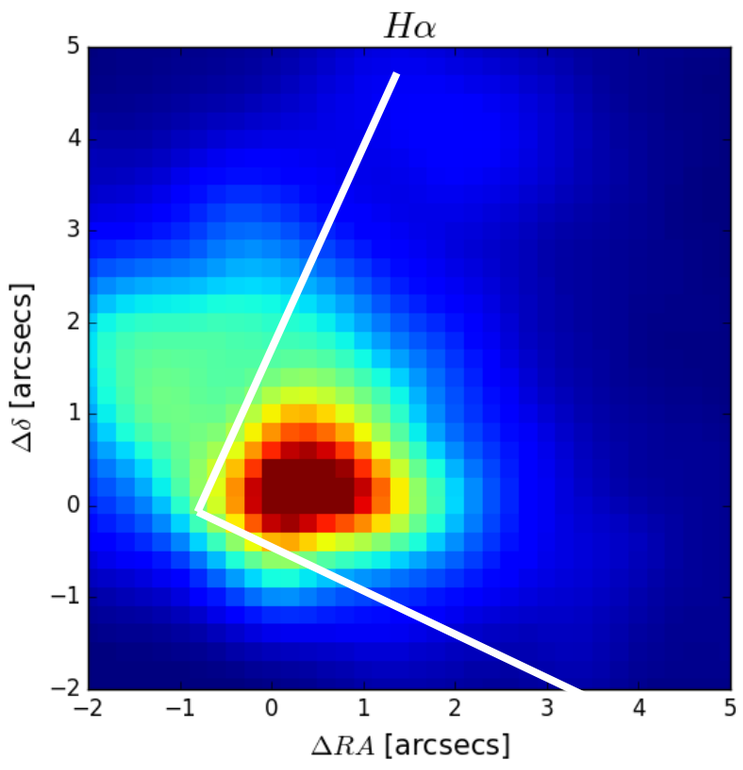


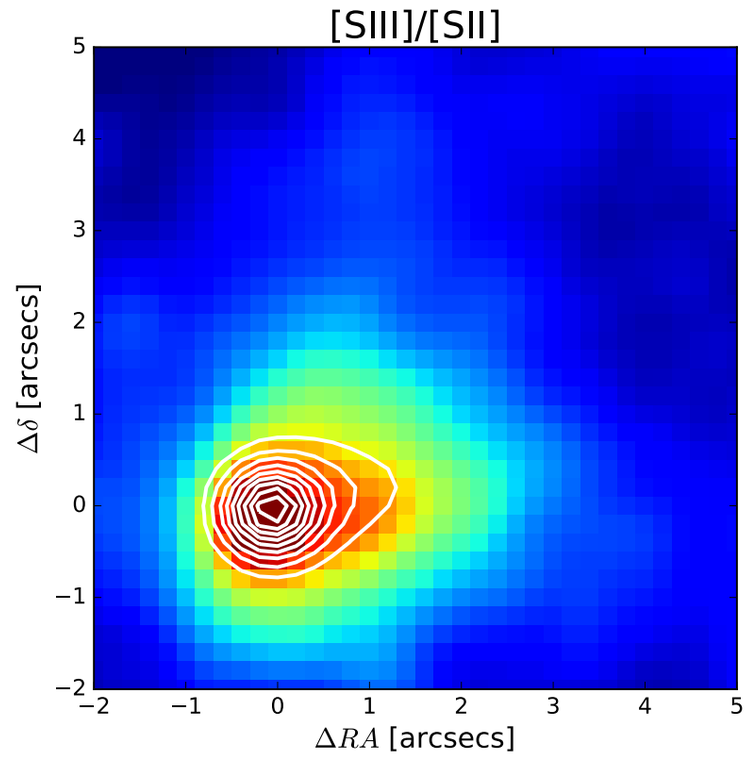
Ionisation structure in cone

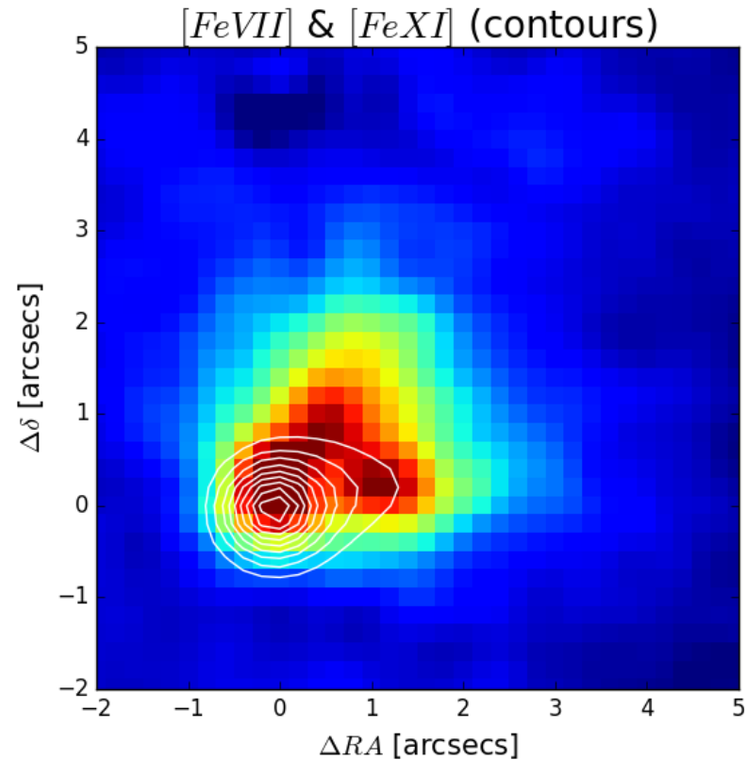






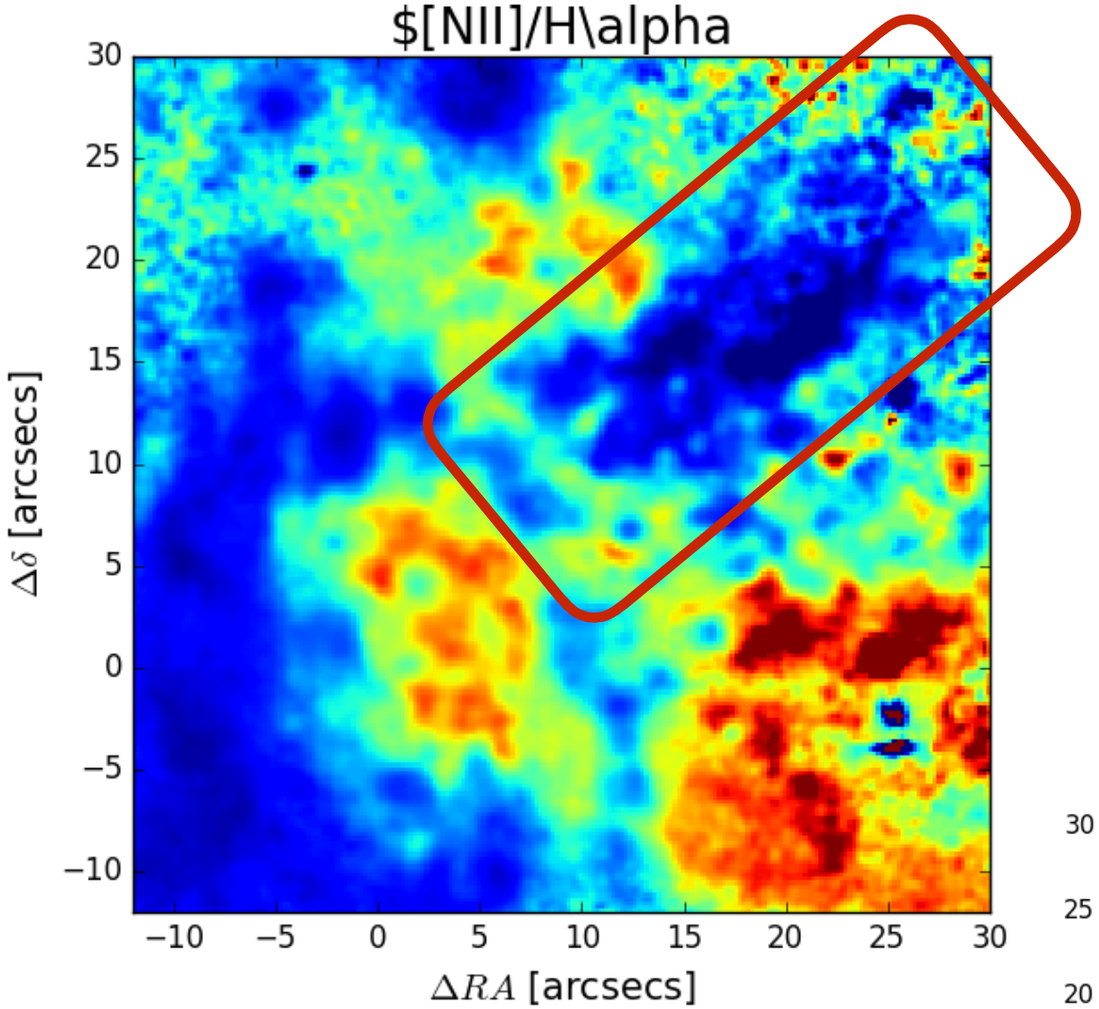


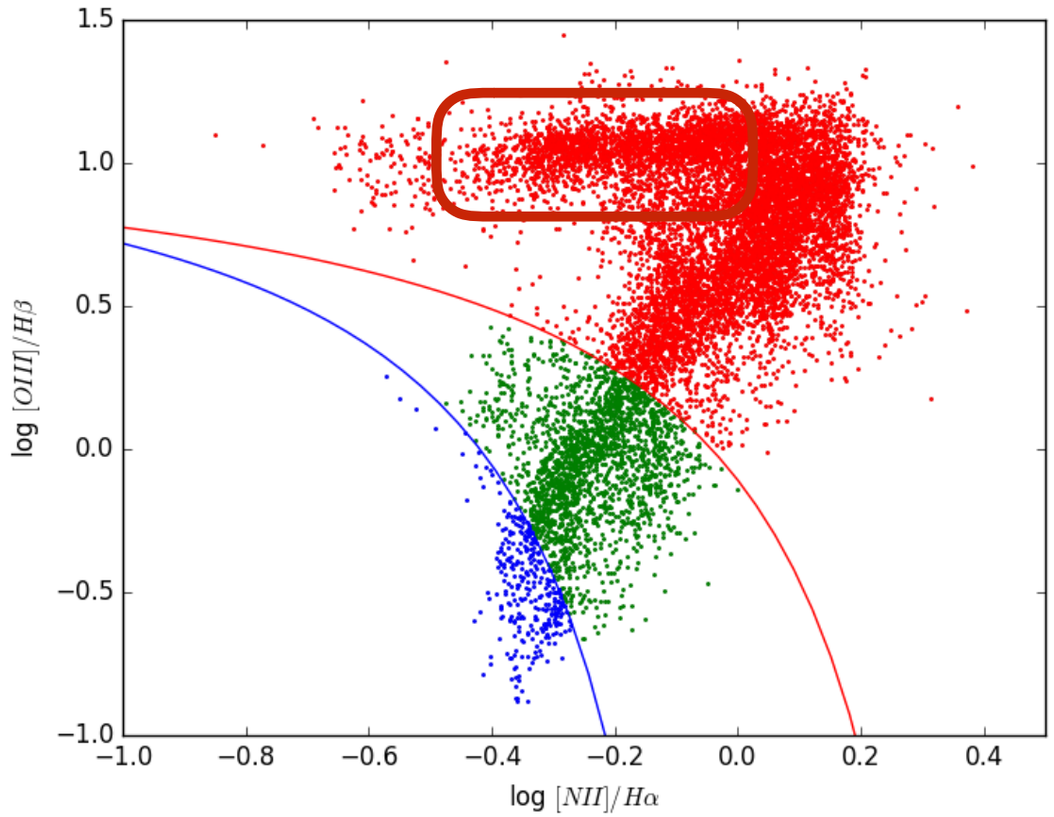


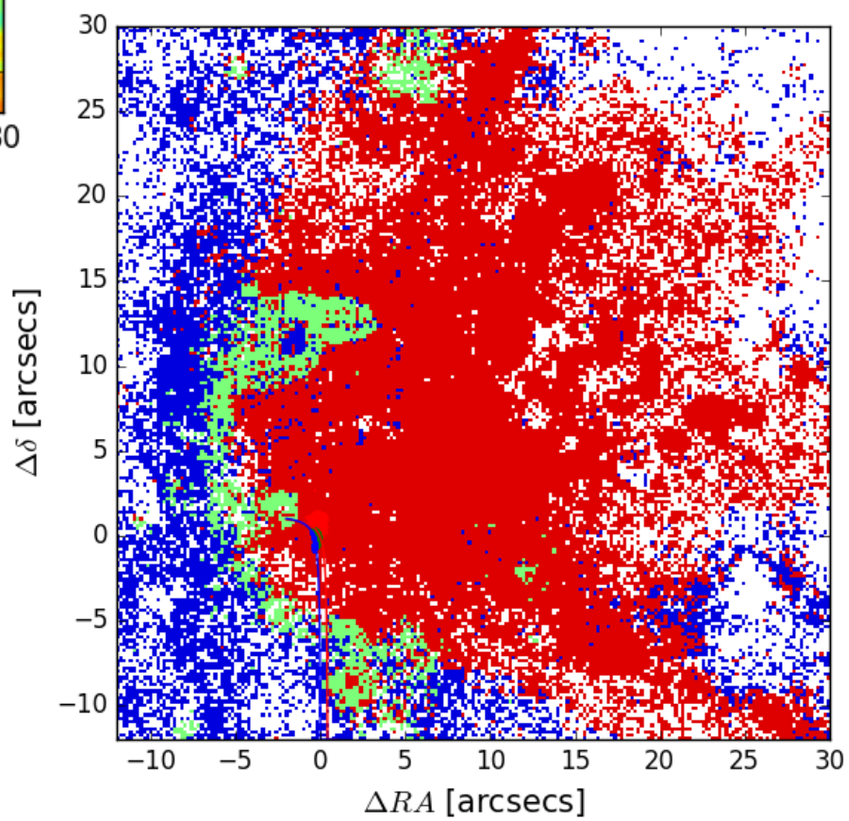


Marconi et al. 2016, in prep.

Matter bounded clouds?



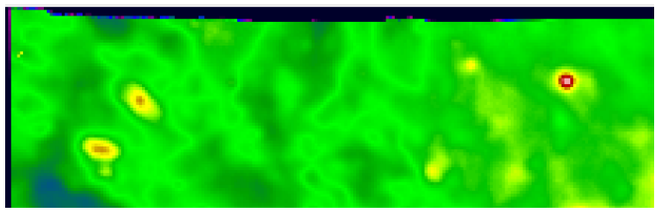


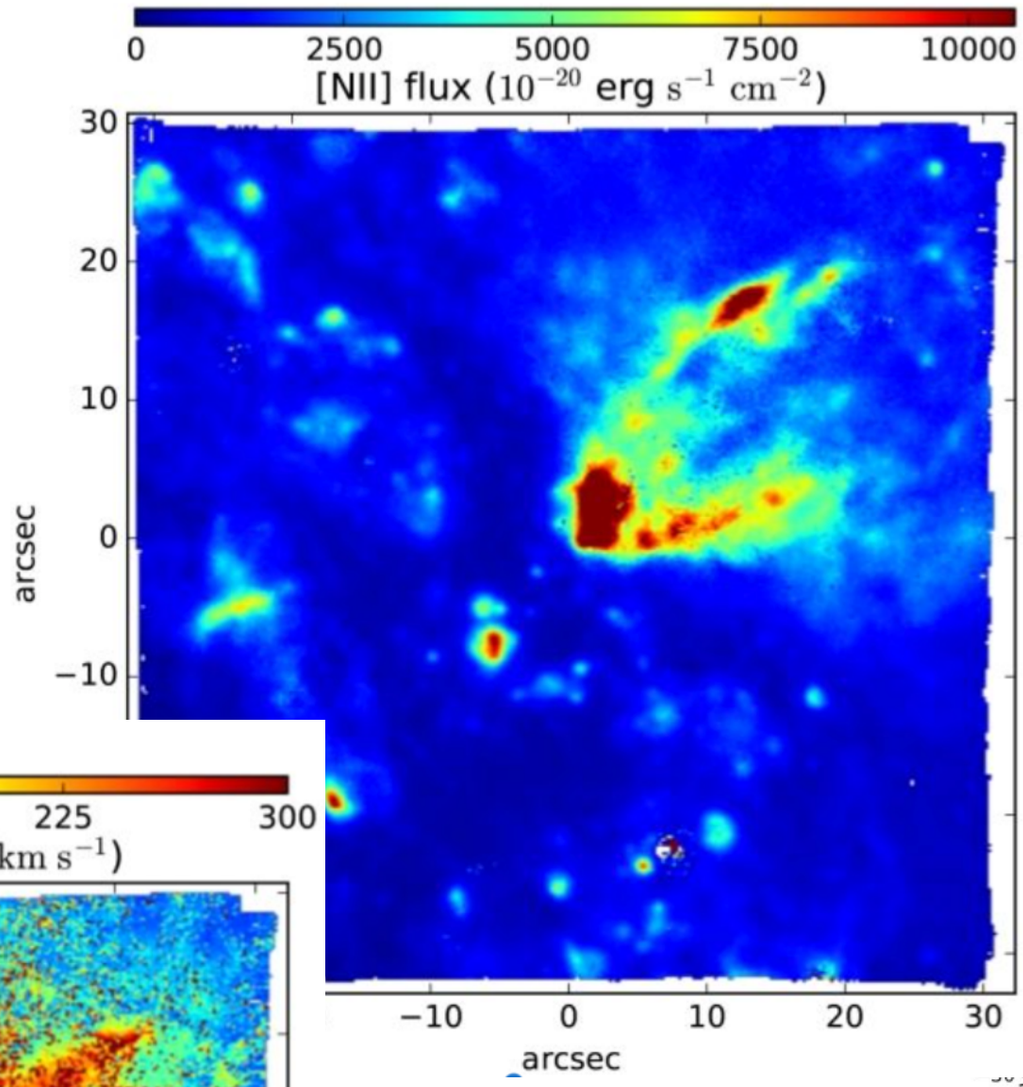


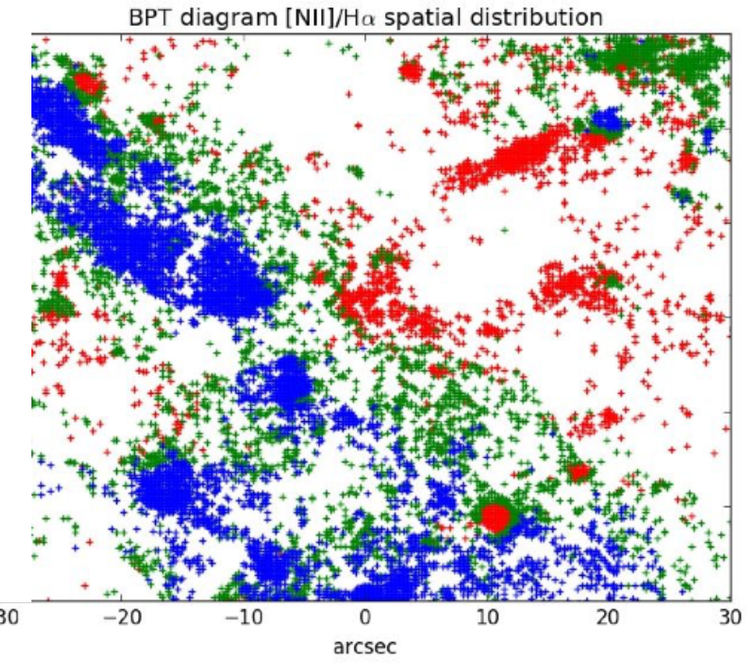
Marconi et al. 2016, in prep.

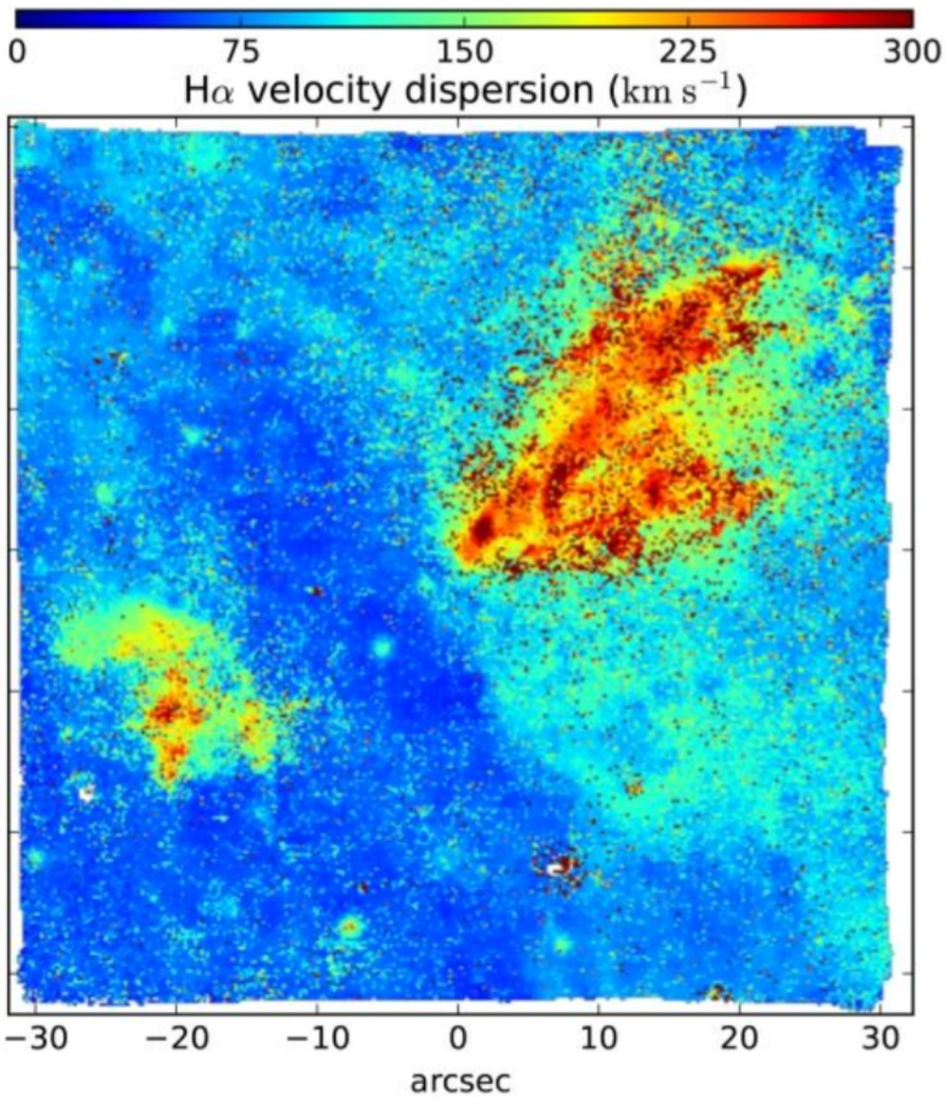
NGC 4945

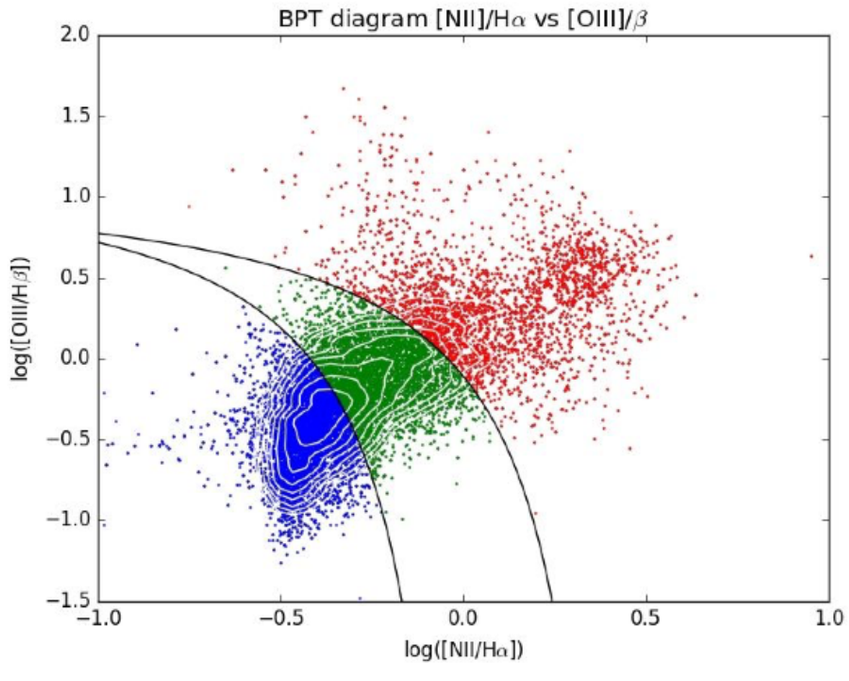
A strong starburst
& a hidden AGN…



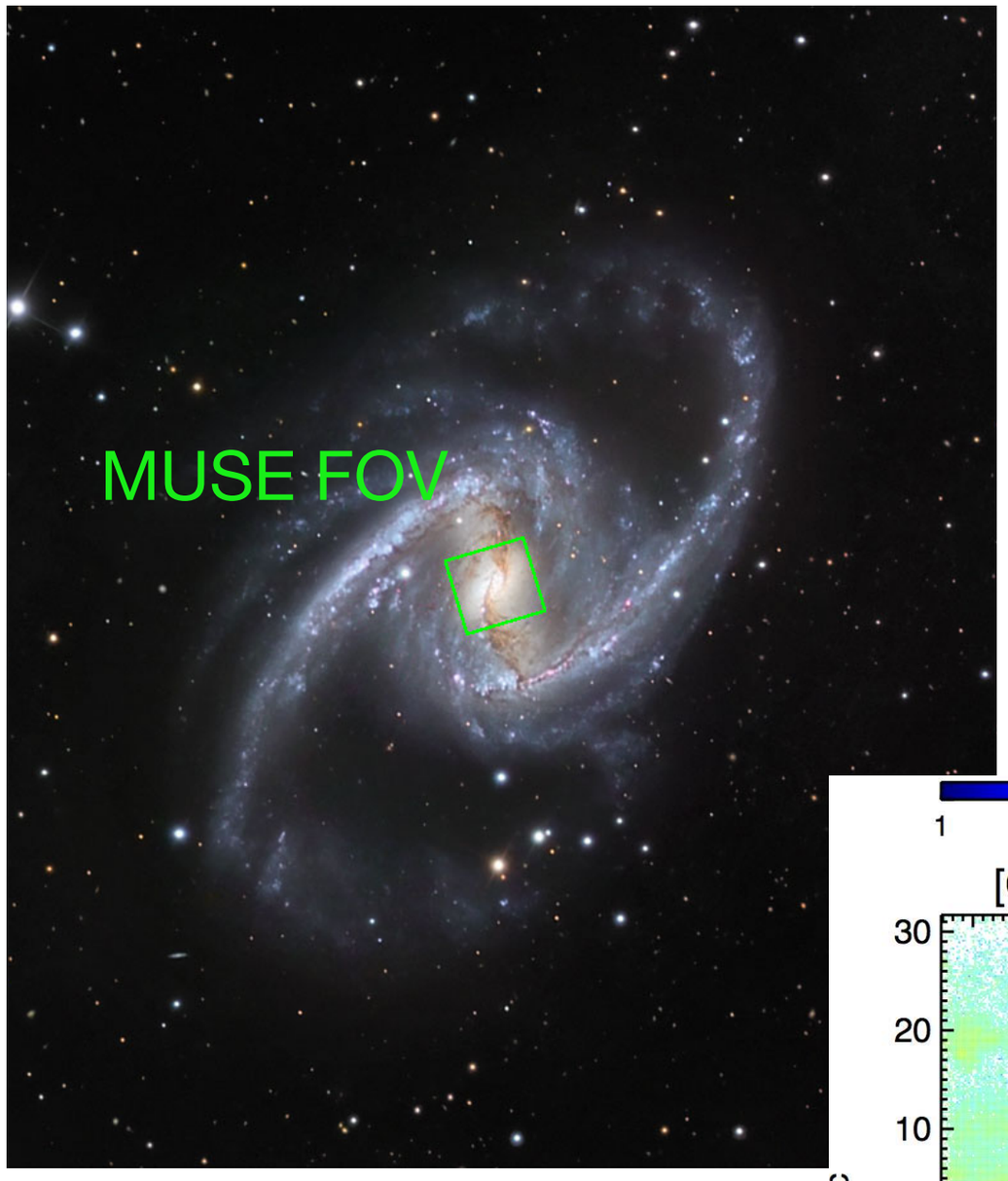


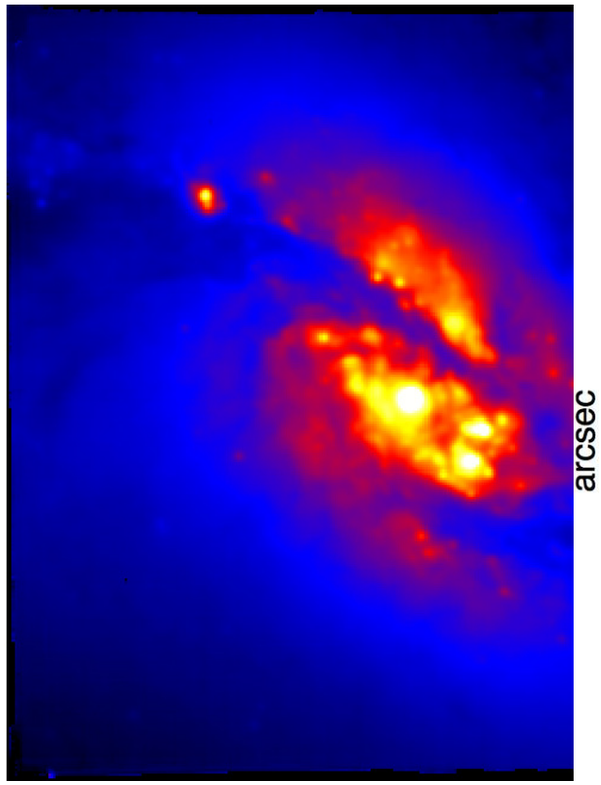


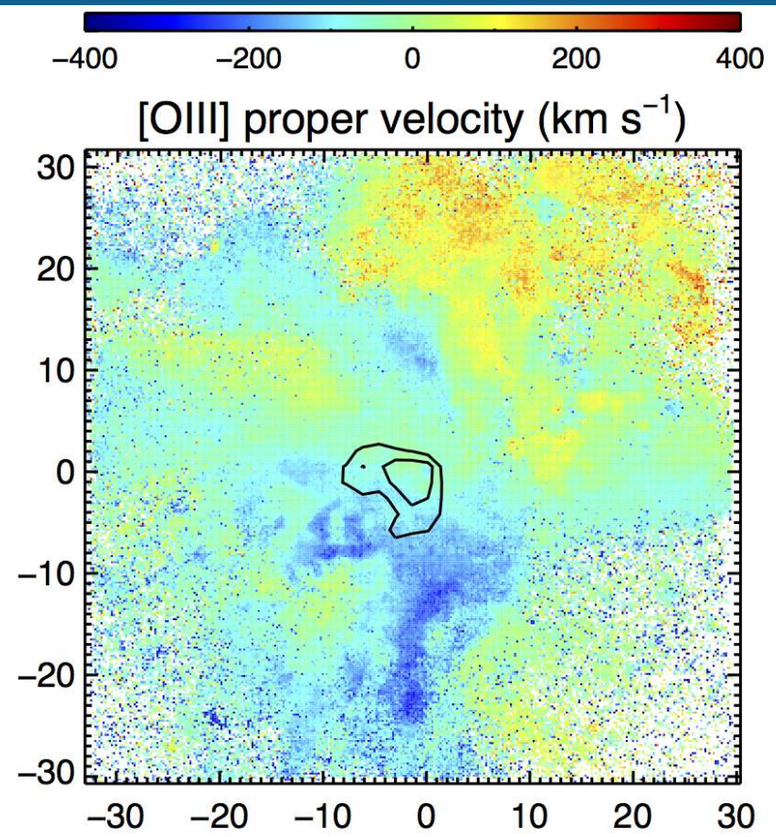


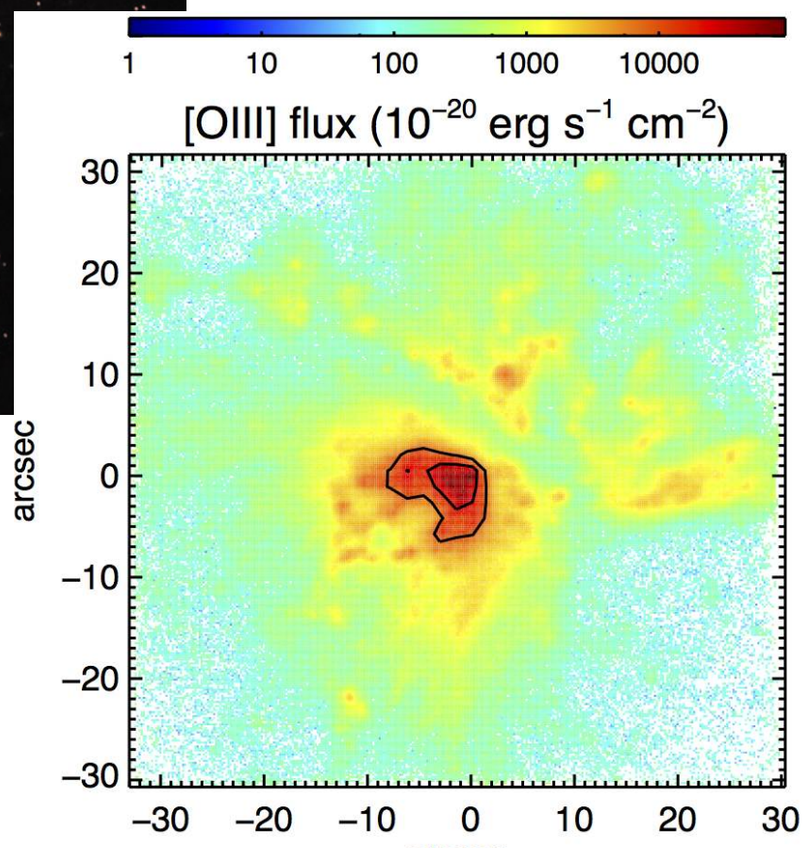


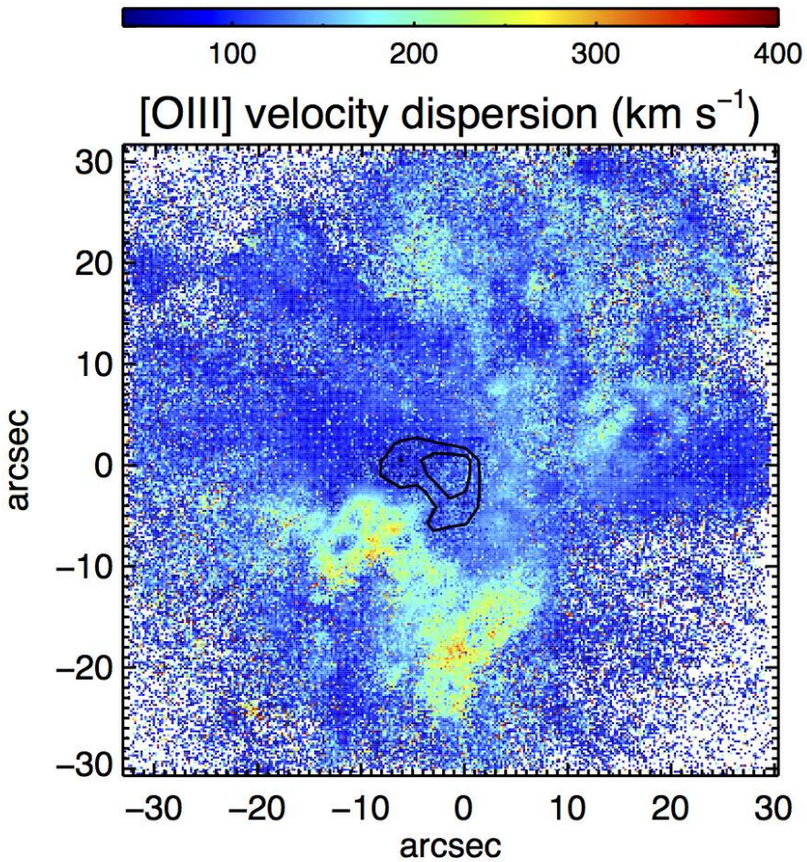
NGC 1365





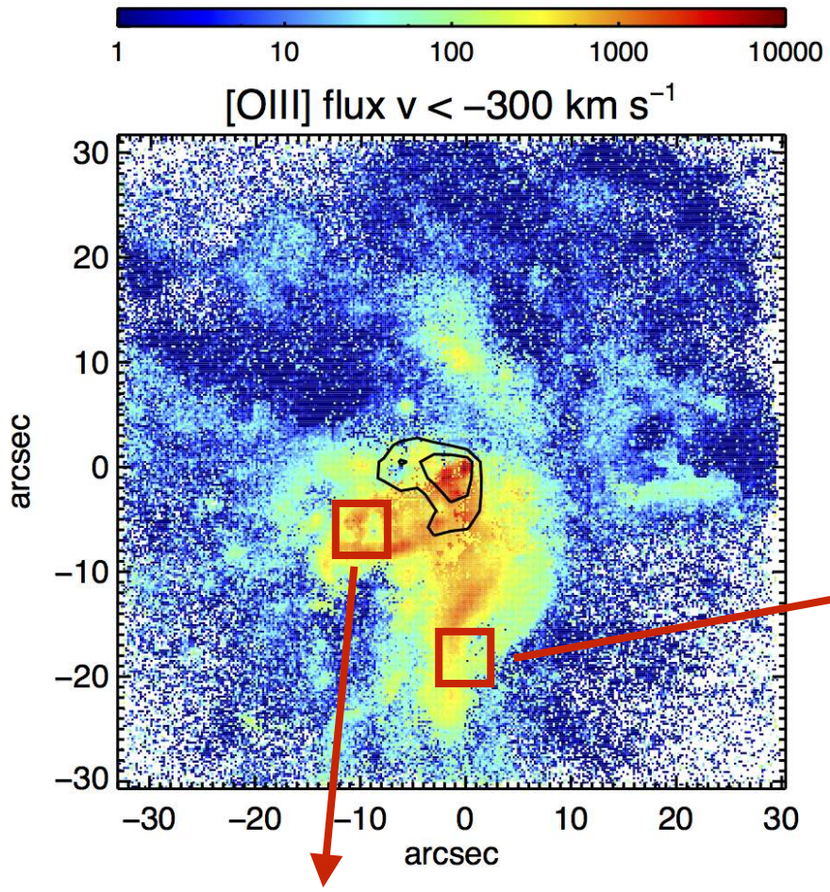


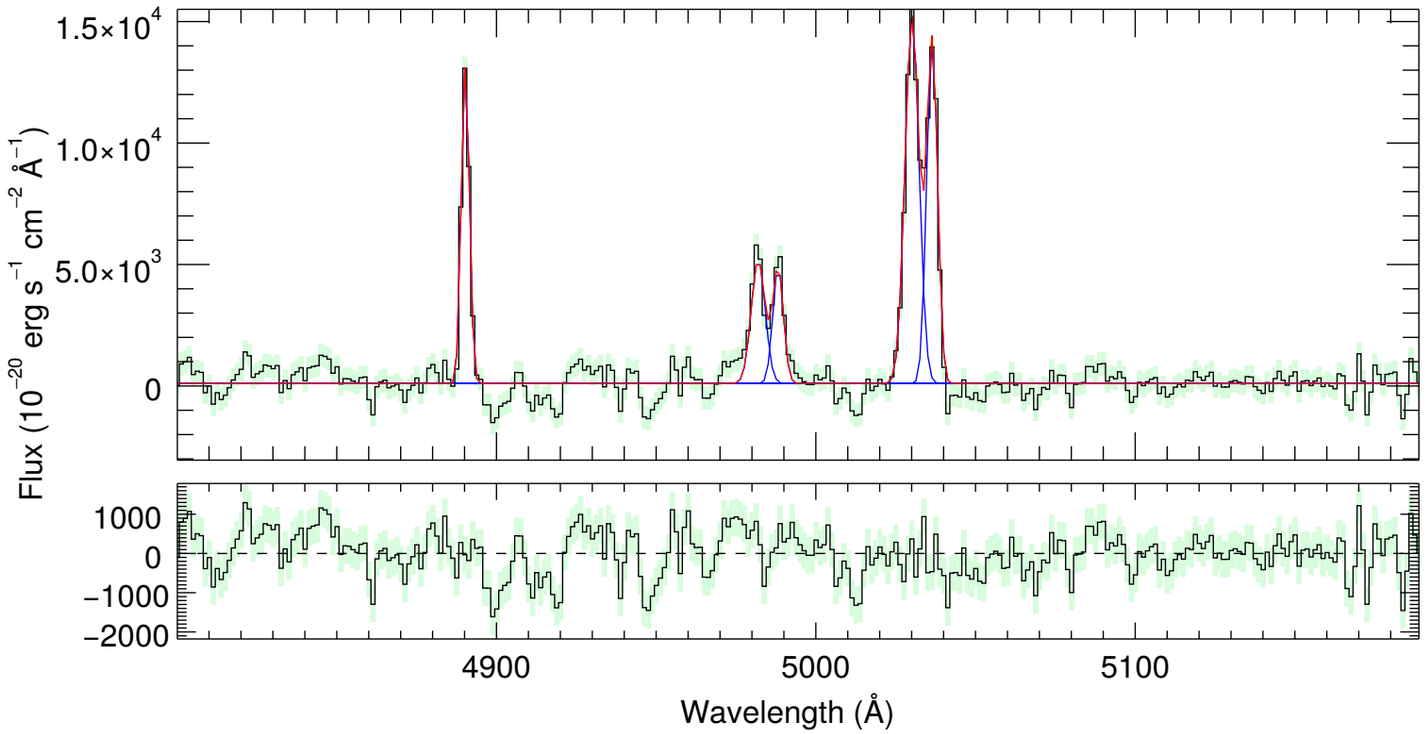


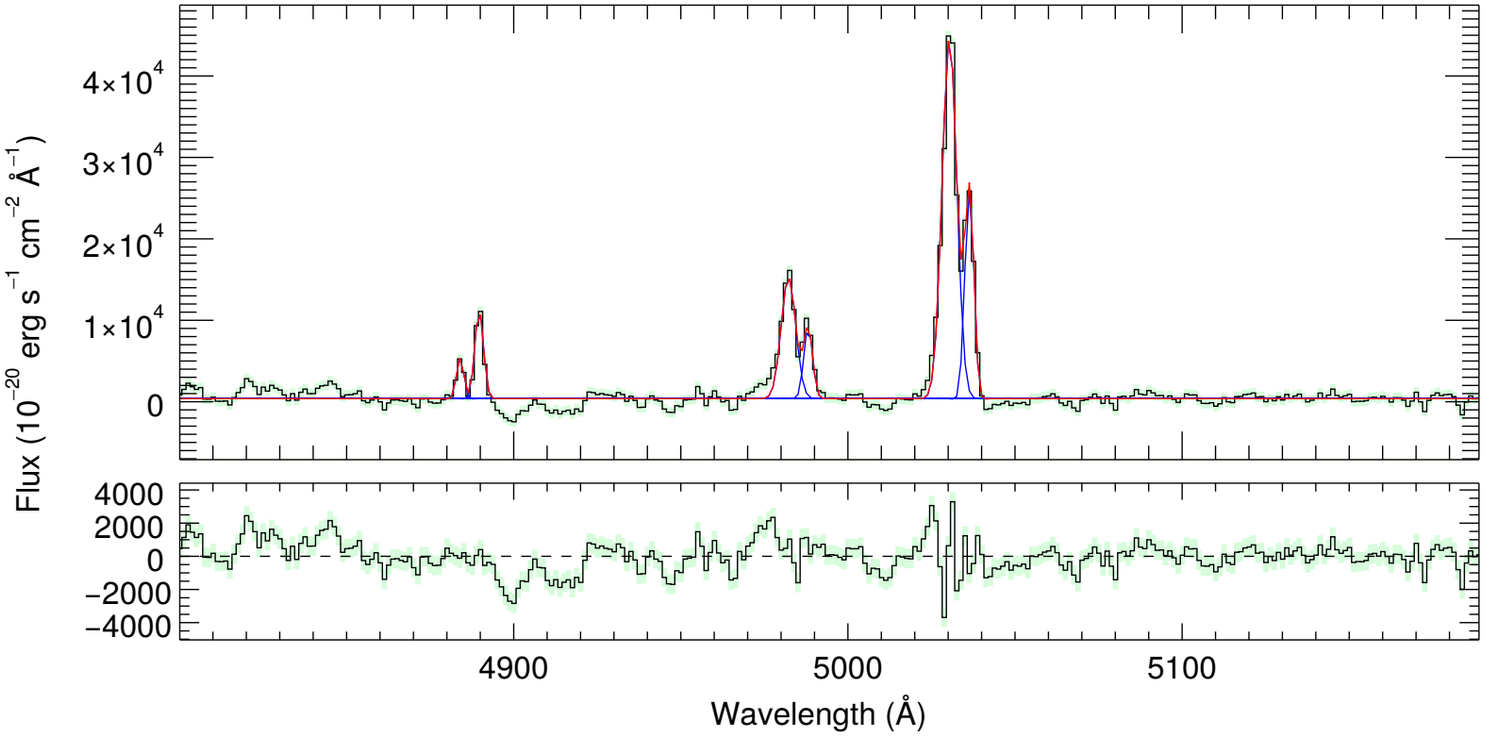


[OIII], flux, velocity, velocity dispersion

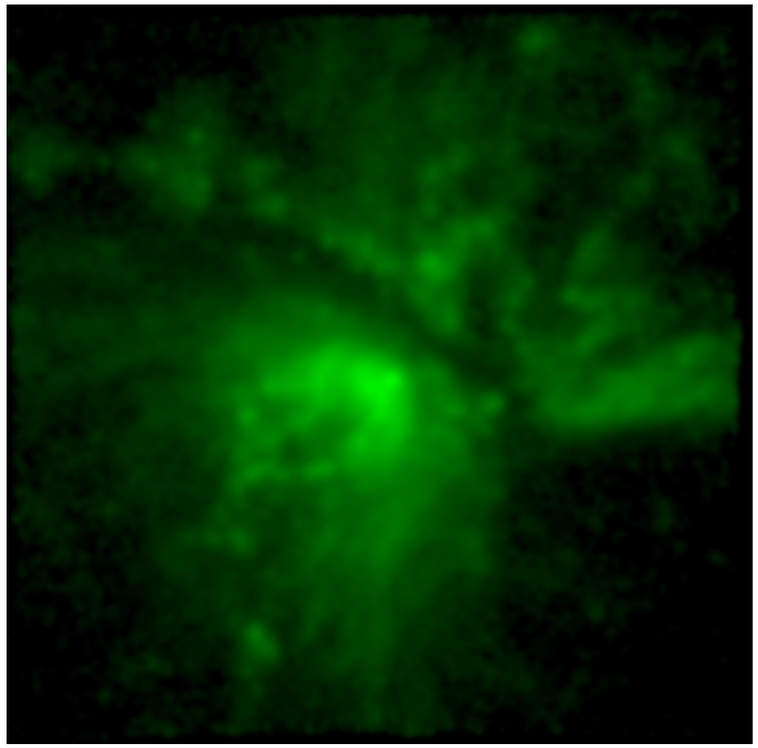
NGC 1365

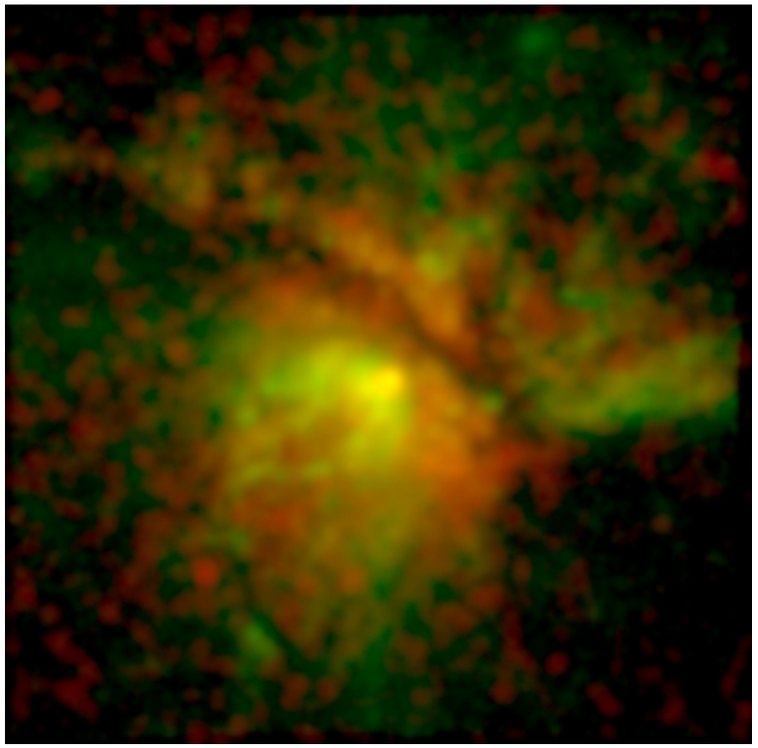




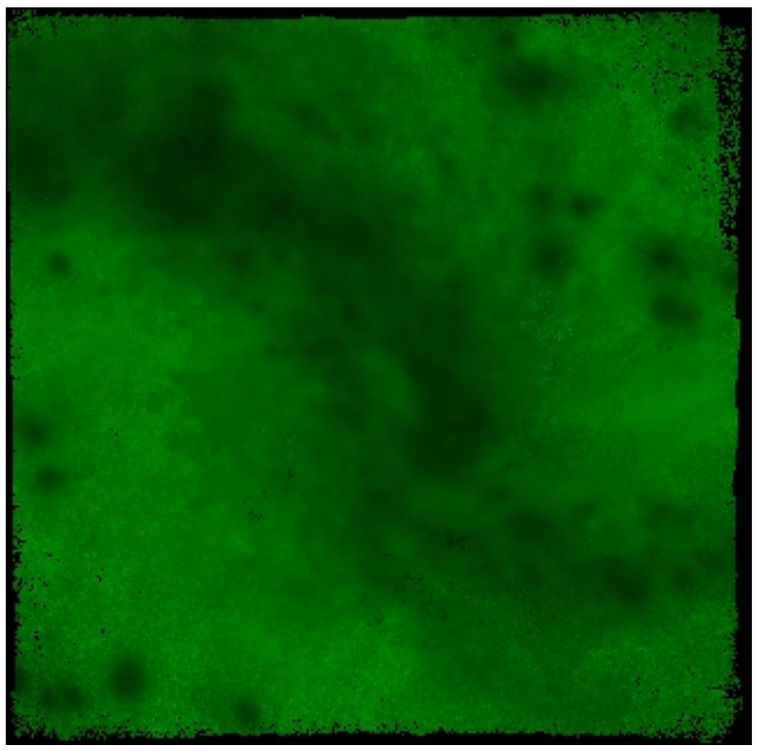


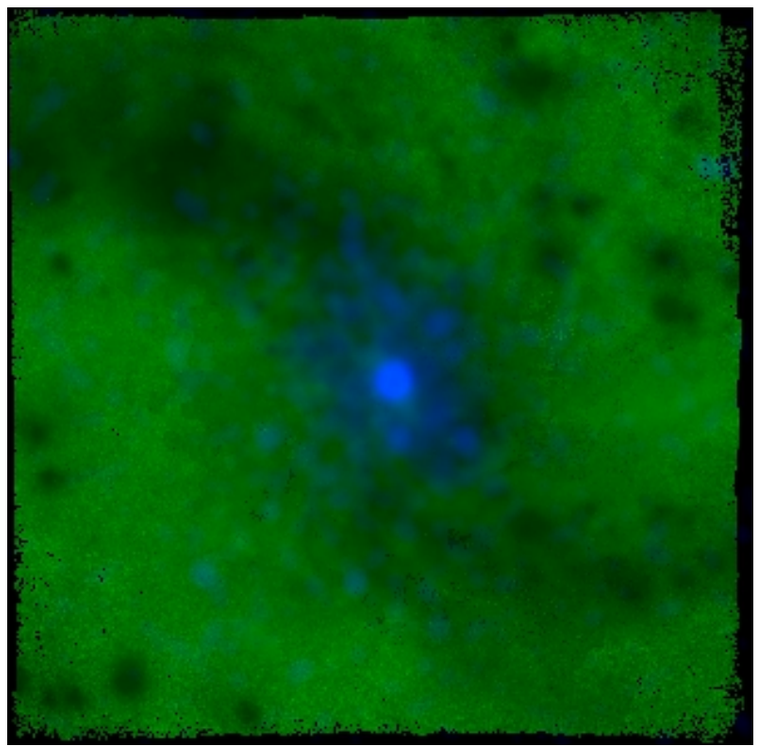
Venturi+, 2016



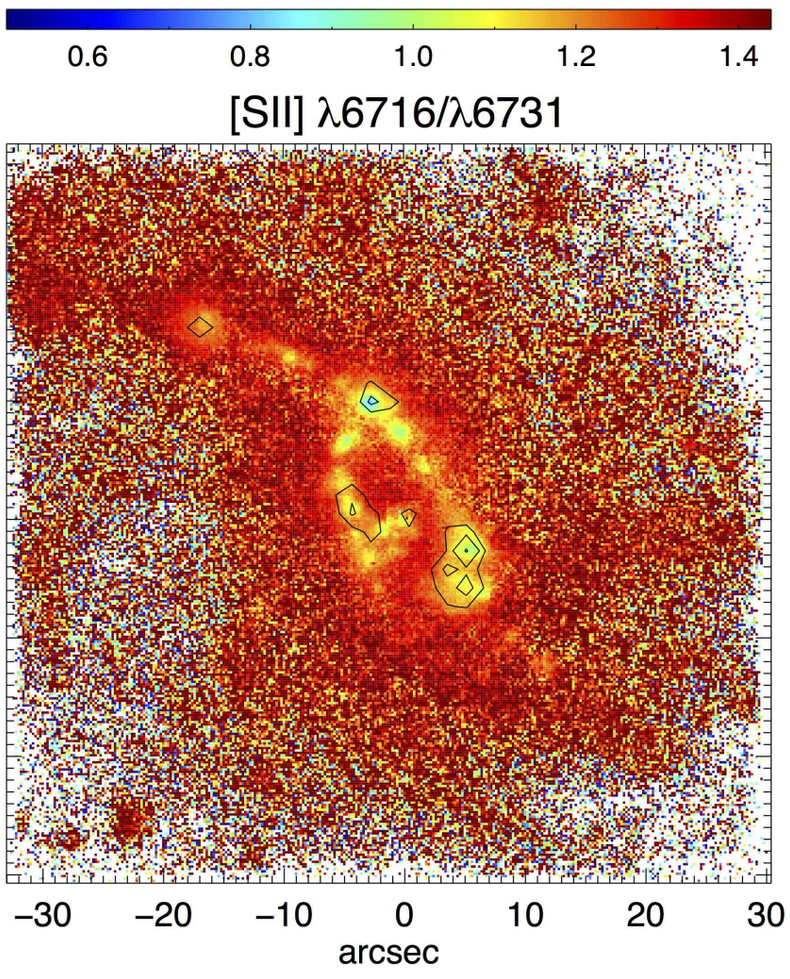


OIII 0.3-1.2 keV





NII/Hα 2-7 keV



Conclusions

- MUSE data of nearby AGN allow detailed studies of outflow structure (kinematics and ionisation):
  Velocity and ionisation structure of conical outflow in Circinus and NGC 4945

- MUSE data allow studying the relation between AGN and SF:
  Possible positive feedback in NGC 5643

- Working on detailed modelling of kinematics and ionisation
  - kinematical model to infer outflow parameters
  - photoionisation modeling for the physical properties of ionised gas

- Many complementary observations, e.g. *Chandra, XMM-Newton, Galex, HST, Spitzer, Herschel, ALMA, Radio*

- Stay tuned for results in the next few weeks!

Cresci et al. 2015, *Marconi et al. 2016, Venturi et al. 2016*