



Universidade Federal de Santa Maria - UFSM
Centro de Ciências Naturais e Exatas - CCNE
Departamento de Física



Feeding vs. Feedback in AGN probed with NIFS: recent studies

Rogemar A. Riffel

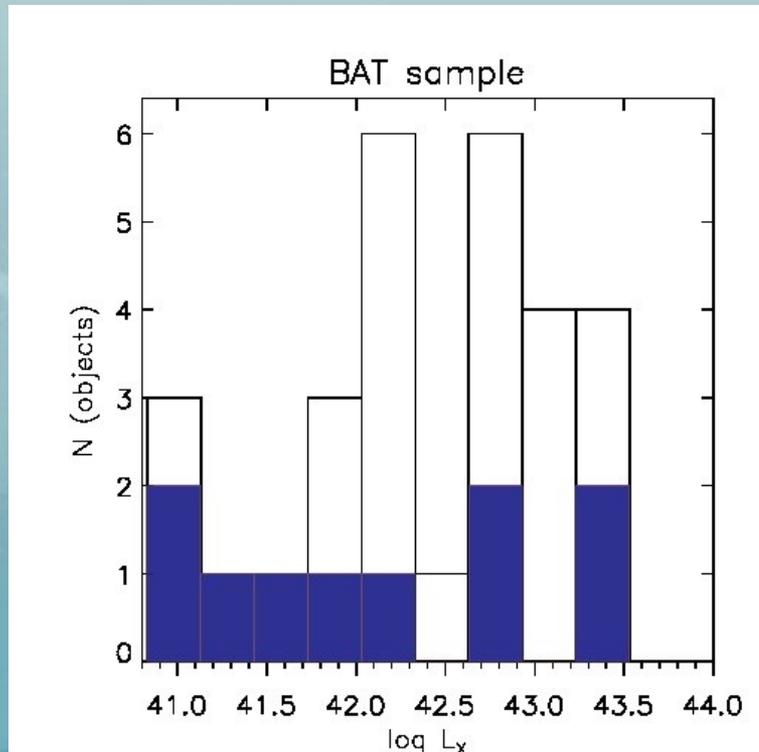
NIFS survey of feeding and feedback processes in nearby Active Galaxies

⇒ **PI:** Storchi-Bergmann, T. (UFRGS)

⇒ **Co-Is:** Riffel, R. A. (UFSM), Riffel, R. (UFRGS), Diniz, M. (UFSM),

⇒ Schonell Júnior, A. (UFRGS), Dametto, N. (UFRGS)

⇒ **Goal:** observe a complete sample of nearby AGN to study feeding & feedback



⇒ Selected from the Swift-BAT 60-month catalogue to have:

→ $L_{X(15-195\text{ keV})} > 10^{41.5} \text{ erg/s}$

(measures direct emission from the AGN)

→ $z < 0.015$

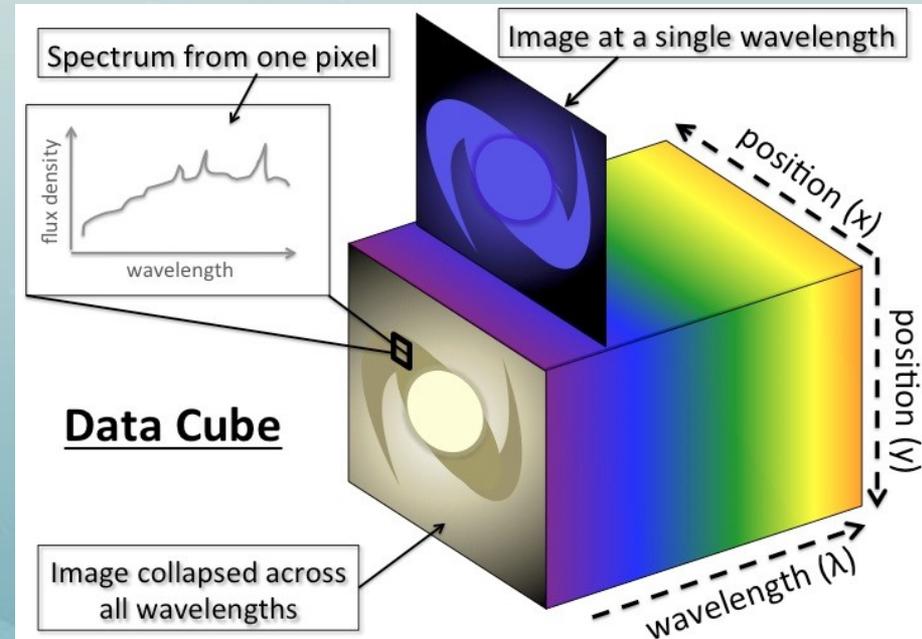
→ *Observable with NIFS*

→ *Extended [OIII] emission*

(to assure that the galaxies have extended line emission)

Motivation

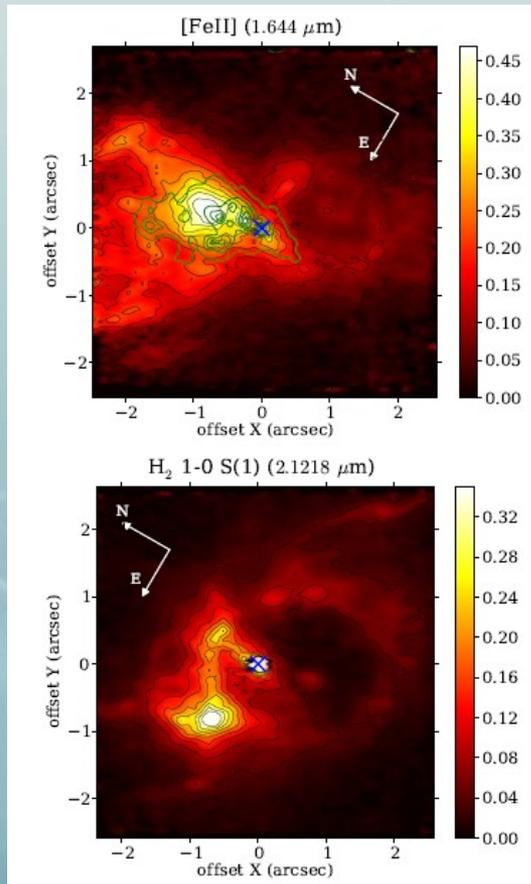
- **Why IFS?** Provides the *spatial resolution and coverage* and *spectral resolution* needed to map the inner region of active galaxies in details.
- **Why the near-IR?** In the near-IR we are able to map the gas emission from very distinct ionization degrees (from molecular to high ionization) and map the stellar kinematics (using the CO bands)
- **Map the AGN feeding and feedback**



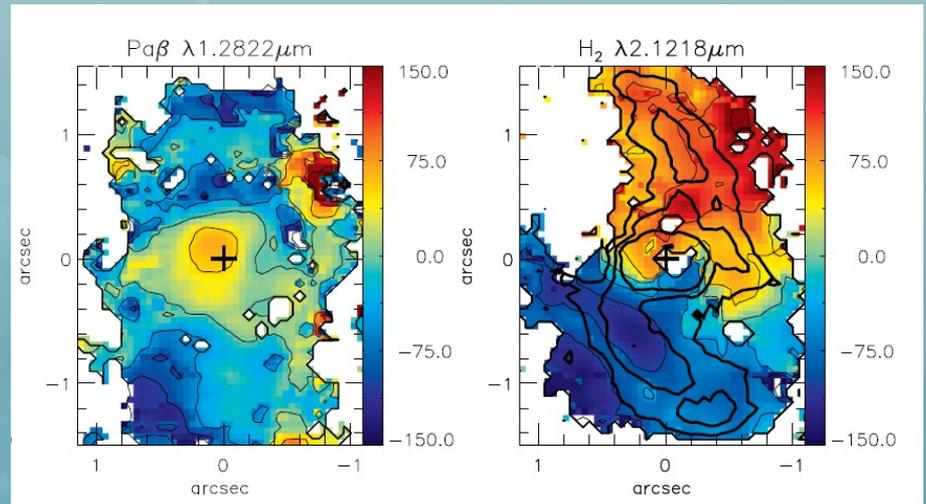
Credit: C. Harrison

Previous results

- **Molecular hydrogen and ionized gas have distinct flux distributions and kinematics;**
- **H₂ emission** is dominated by gas in **rotation** at the plane of the galaxies, with **inflows** seen for some cases;
- The **ionized gas** shows **outflows** (sometimes associated to radio jets) plus a component from the **disk**



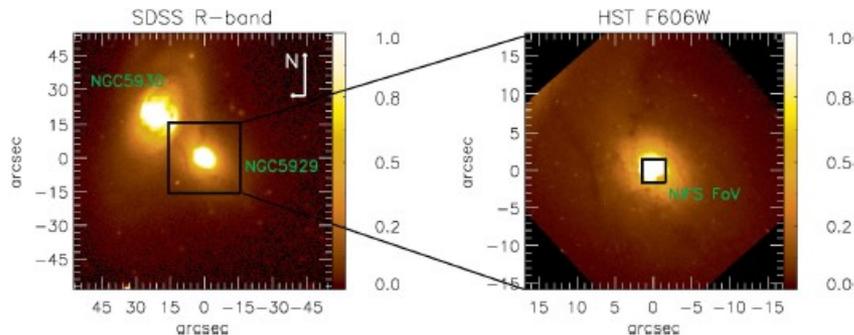
[FeII] and H₂ flux
distributions for the Sy2
NGC1068 - Riffel+ 2014



Pa β and H₂ velocity fields for the Sy1 **Mrk79** - Riffel+ 2013

NGC 5929

Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015

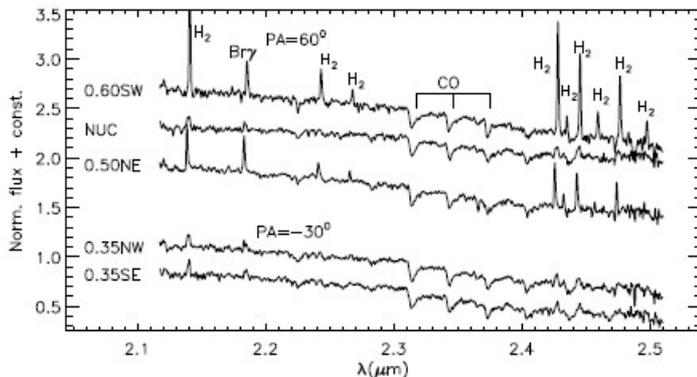
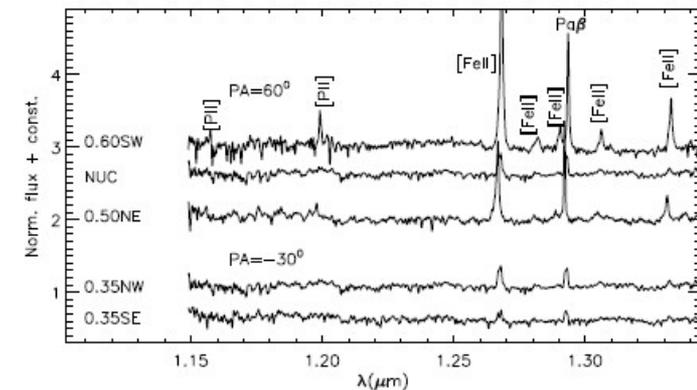


- Has a companion (NGC5930)
- Seyfert 2 nucleus
- Distance: 35.9 Mpc (1 arcsec = 175 pc)

- J and K band NIFS observations
 - **FoV:** 3"x3" = (525 x 525 pc²)
 - **Spatial resolution:** 20 pc
 - **Velocity resolution:** 40 km/s

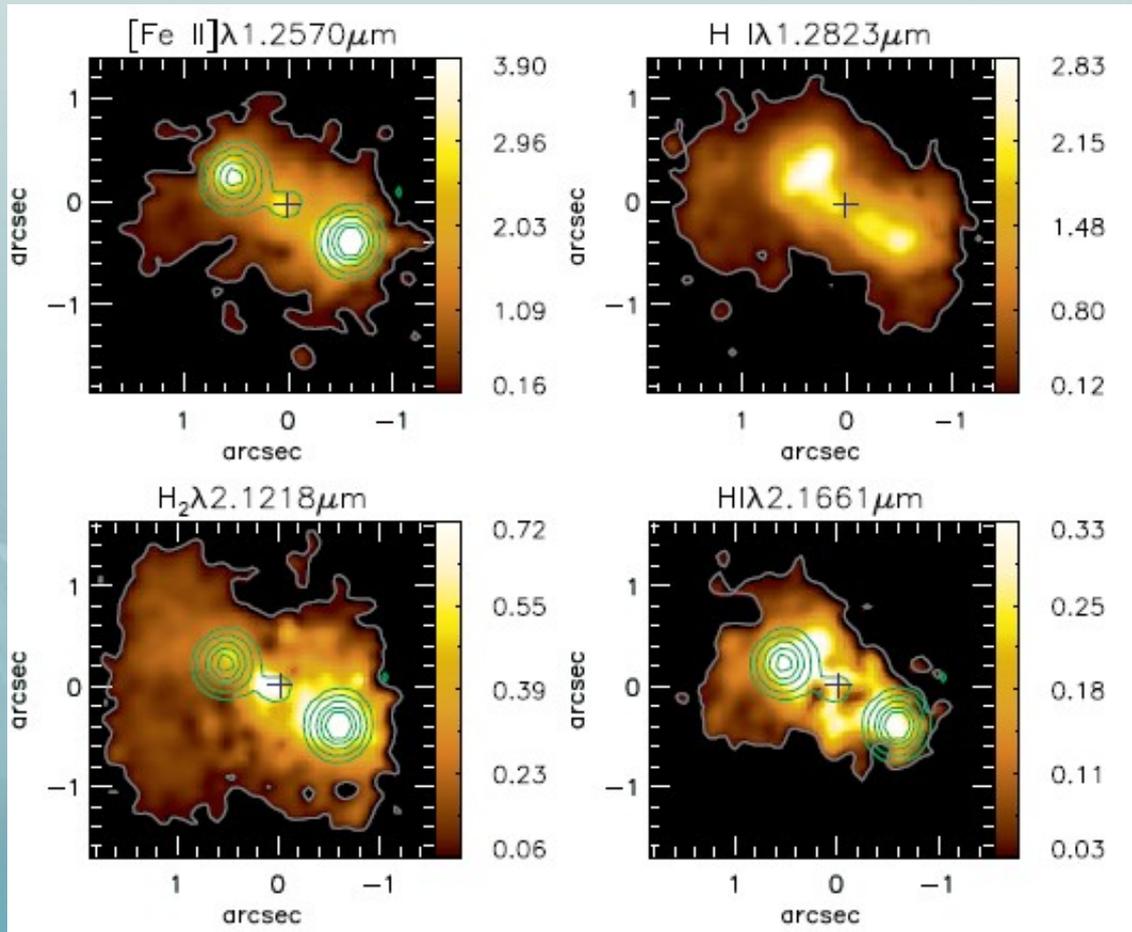
- **Emission lines:** Flux distributions and gas kinematics

- **CO absorption bands:** Stellar kinematics



NGC 5929

Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015



⇒ **Emission line flux distributions from single Gaussian fits**

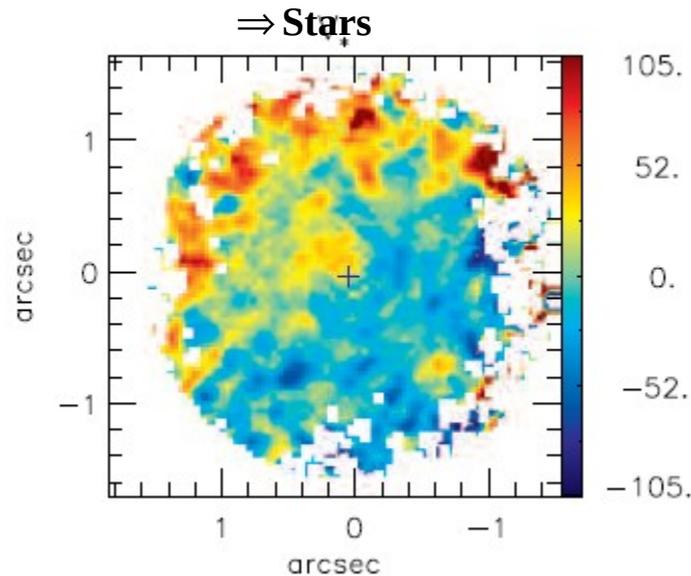
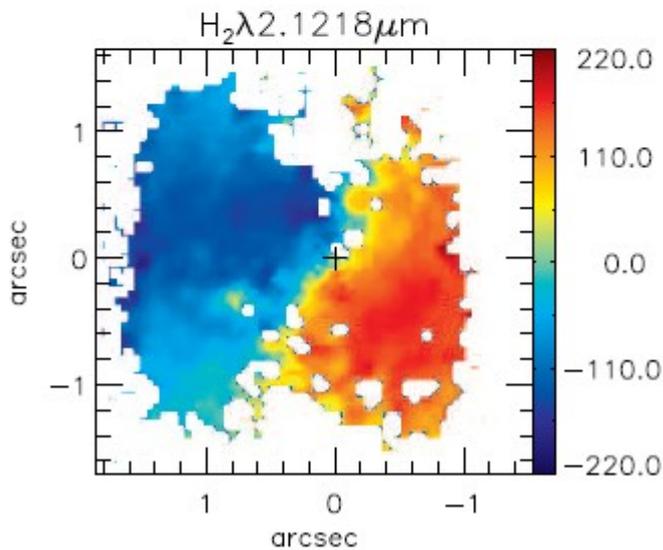
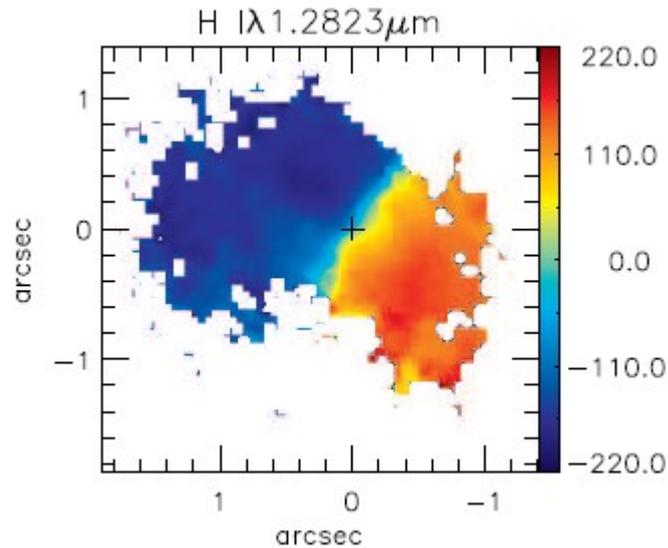
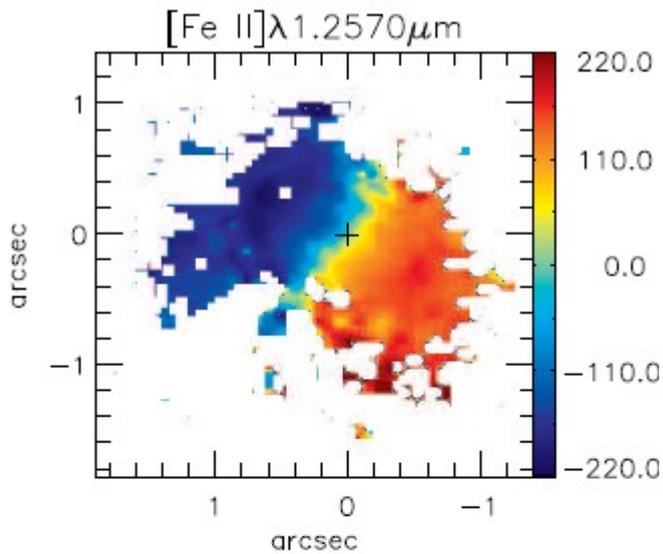
⇒ **Highest intensities:** correlation with radio emission (green contours)

⇒ For the **ionized gas**, the peak of the emission is observed associated to the NE radio hotspot

⇒ The **molecular hydrogen** shows its emission peak at 0.6" SW from the nucleus

NGC 5929

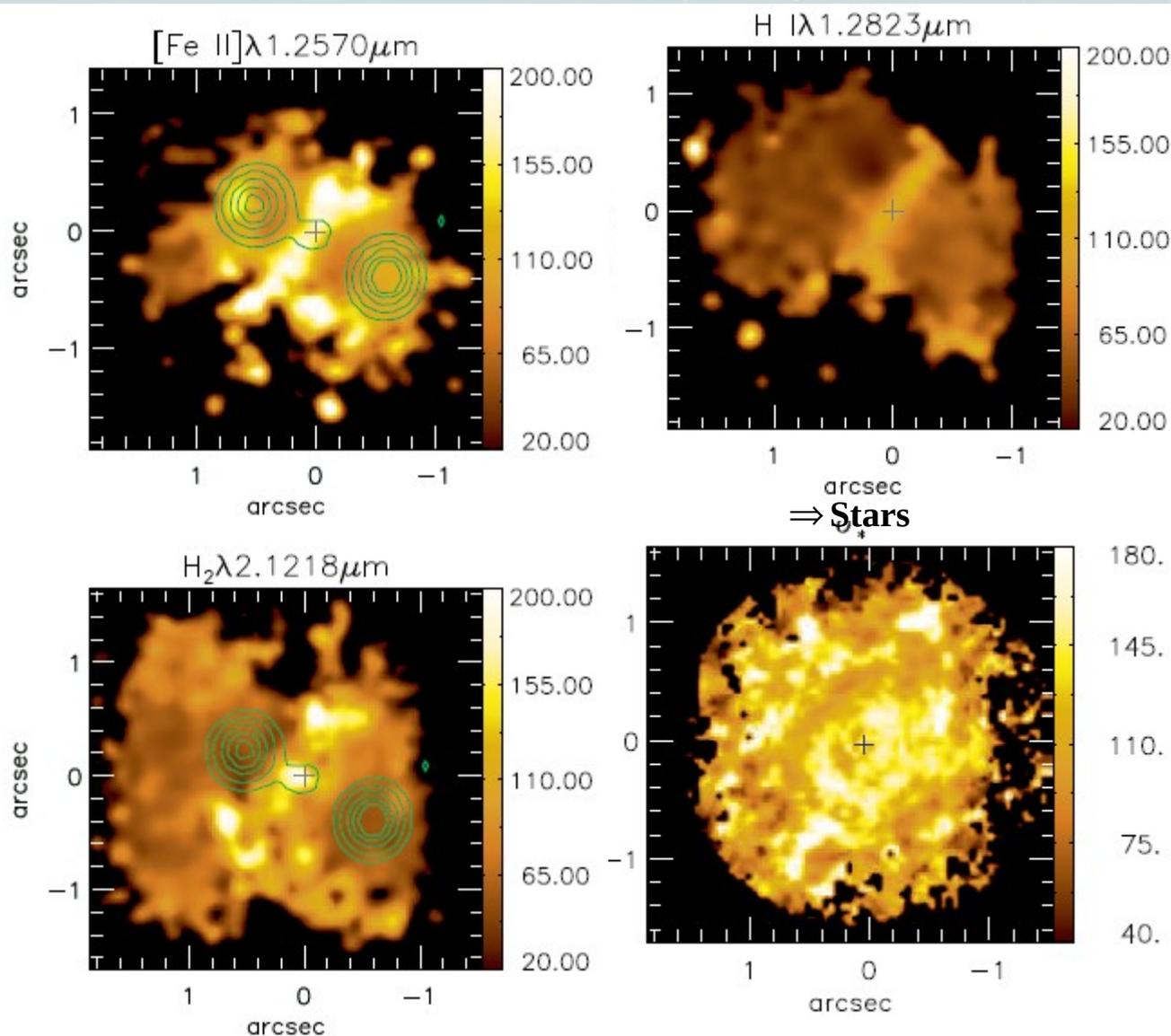
Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015



- **Velocity Fields**
- **Counter rotation of the gas, relative to the stars**
- Same disk inclination
- Same orientation of the line of nodes
- Distinct velocity amplitude
- **Effect of the interaction with NGC5930**

NGC 5929

Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015

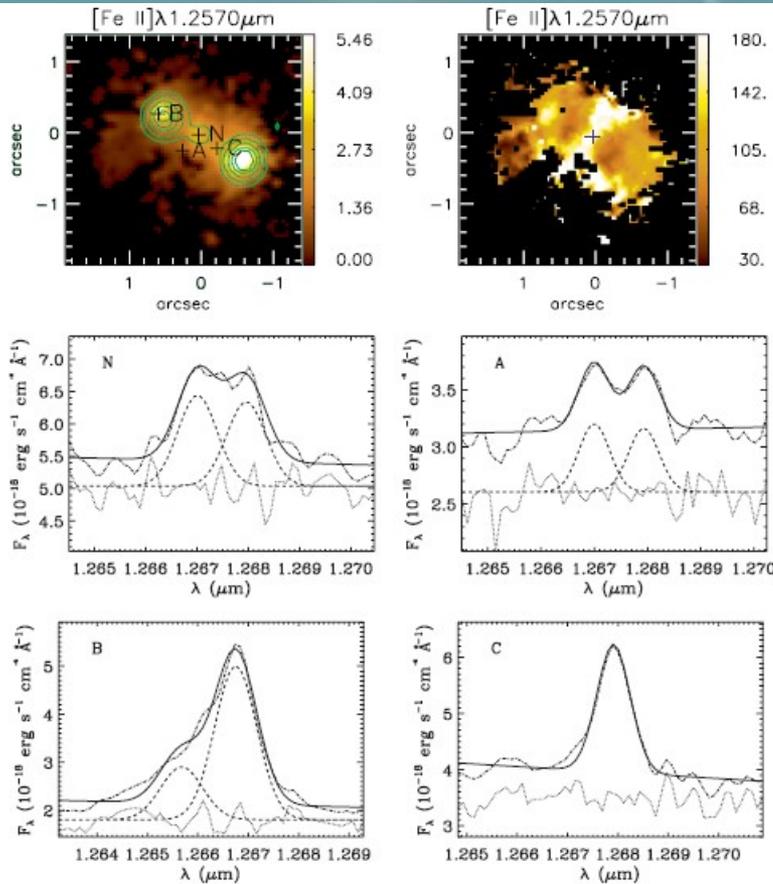


Velocity dispersion maps

- Stars: low-sigma ring associated to intermediate-age stellar population(?)
- Gas: Structure perpendicular to the radio jet with high sigma values
 - Width: ~50 pc
 - Sigma: ~200 km/s

NGC 5929

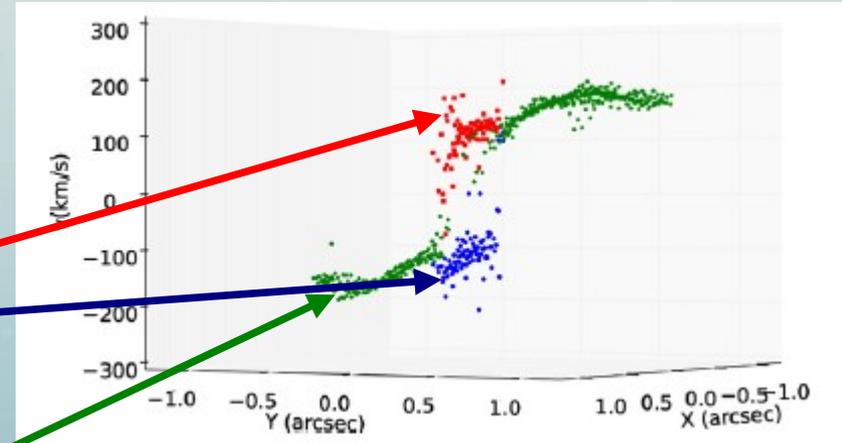
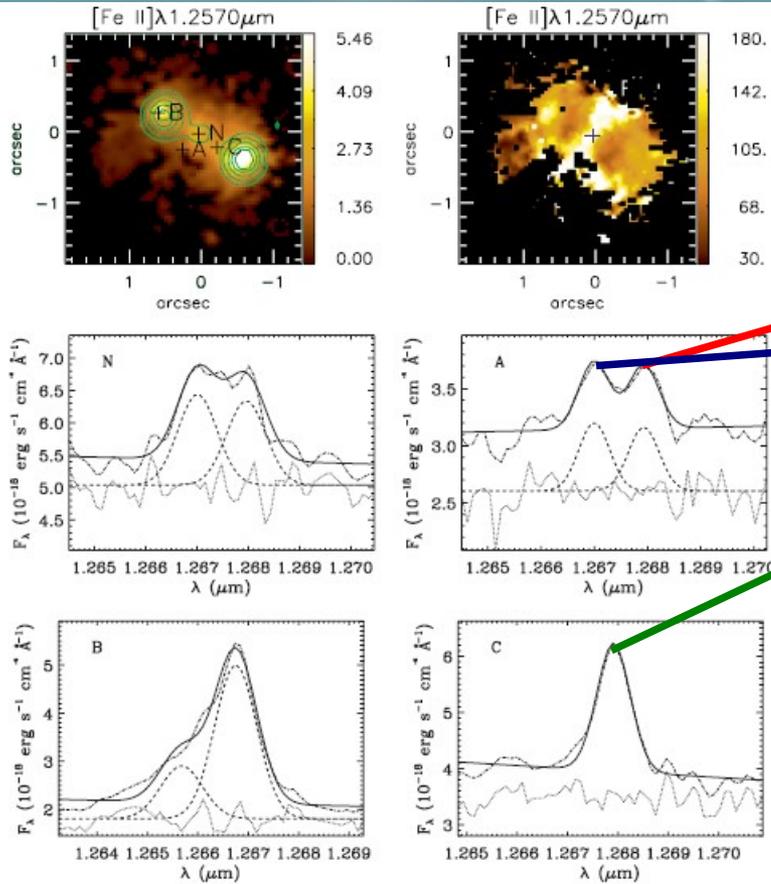
Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015



- Two components along the NW-SE strip
- Single component at most locations
- Wings at the locations of the radio hotspots

NGC 5929

Riffel, R.A.; Storchi-Bergmann, T. & Riffel, R., 2014, 2015



Interpretation: rotating disk + equatorial outflows

Equatorial outflows: e.g. Hönig+ 2013, Elitzur, 2012

NGC 5899

Riffel, R.A. et al., in prep.



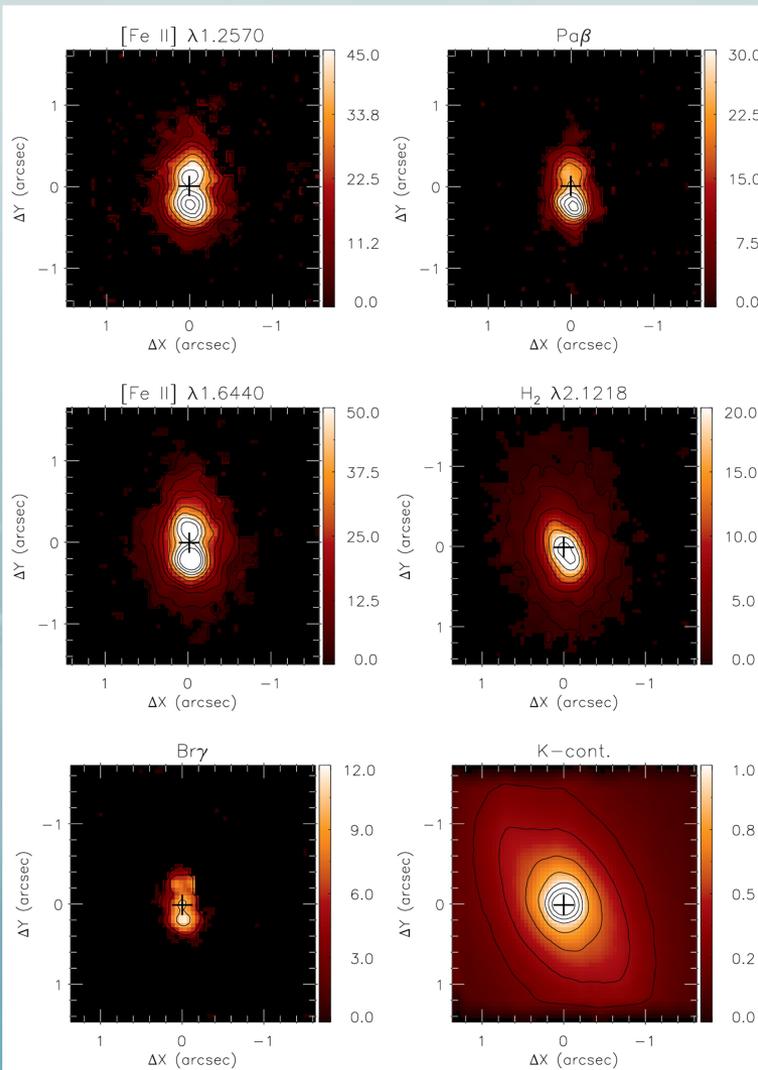
- Hubble type: SBc
- Seyfert 2 nucleus
- Distance: 36.8 Mpc
- 1 arcsec = 180 pc

- J, H and K band NIFS observations
 - **FoV:** 3" x 3" = (540 x 540 pc²)
 - **Spatial resolution:** 25 pc
 - **Velocity resolution:** 40 km/s

⇒ Emission line flux distributions

⇒ **Ionized gas:** Two emission blobs along the N-S direction

⇒ **H₂:** Peaks at the nucleus and follows the distribution of the continuum image

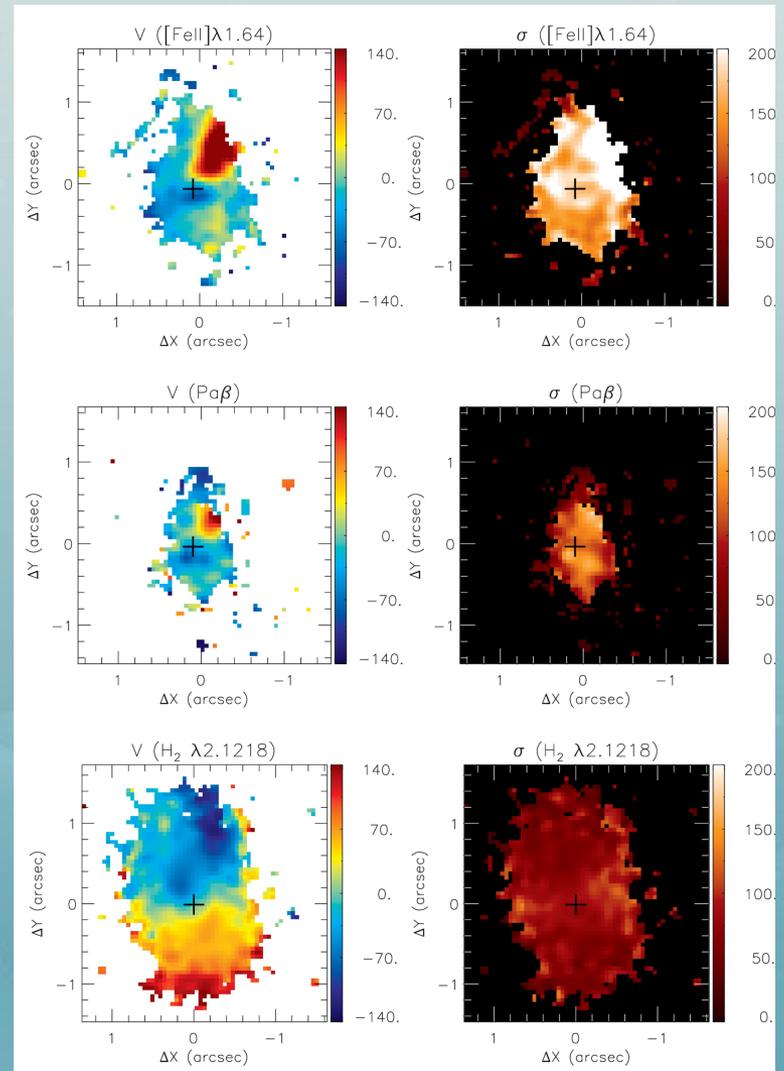
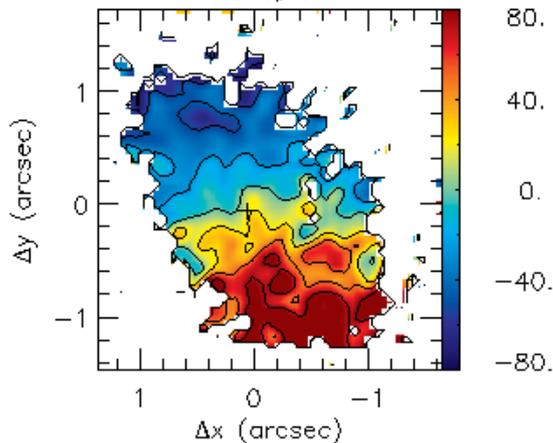


NGC 5899 Riffel, R.A. et al., in prep.

Ionized and molecular gas have distinct velocity fields and sigma maps

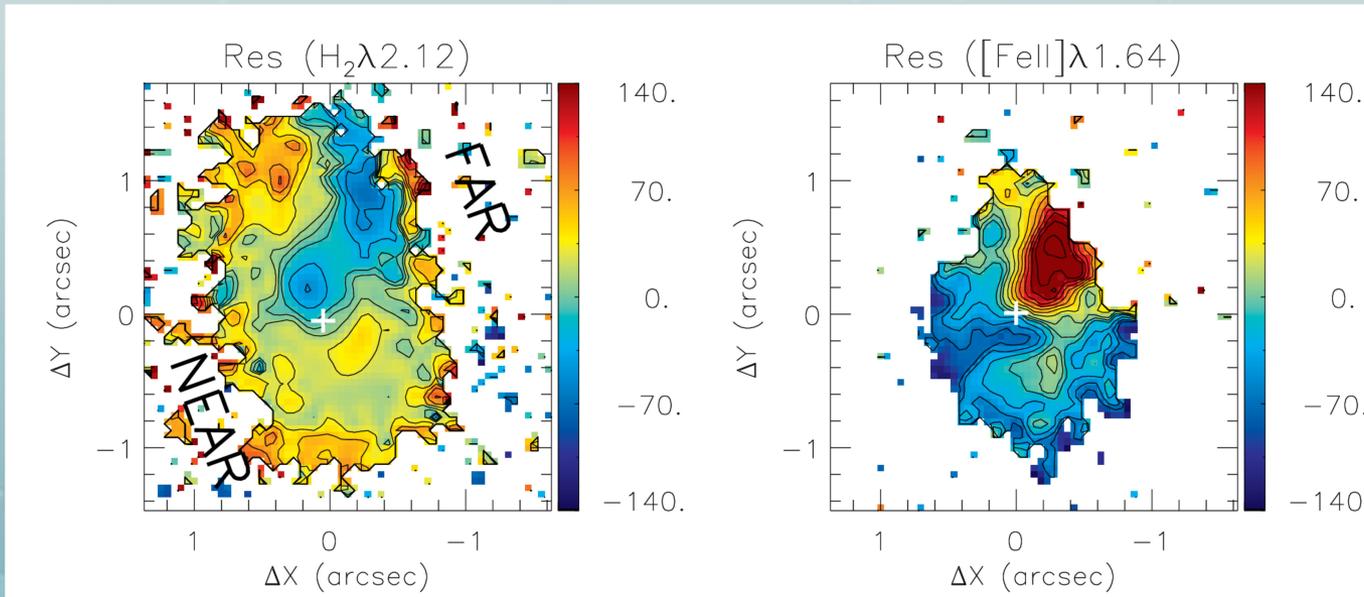
The H_2 velocity field is similar to the stellar velocity field, with **some distortions**

⇒ Stars



NGC 5899 Riffel, R.A. et al., in prep.

Residual velocity maps: observed velocities – rotating disk model



H_2 : blueshifts at the far side of the galaxy => inflows

Ionized gas: blueshifts and redshifts => outflows

CONCLUSIONS

NGC5929

Flux distributions:

- ✓ Although all lines show a correlation with the radio hotspots, **the peak of the emission for the ionized and H_2 gas is located at distinct locations**
- ✓ Additionally, the H_2 presents more extended emission.

Gas Kinematics

- ✓ (Counter)rotation
- ✓ Equatorial Outflows
- ✓ Interaction of the radio jet with the [FeII] emitting gas

NGC5899

Flux distributions:

- Ionized gas:** two emission blobs along N-S direction
- H_2 :** More extended along the major axis of the galaxy

Gas Kinematics:

- Ionized gas:** Outflows
- H_2 :** Rotation (similar to the stars)
+ inflows

Posters



Marlon R. Diniz (UFSM): Feeding Versus Feedback in AGN from Near-Infrared IFU Observations: The Case of NGC2110



Moiré G. Hennig (UFSM): A nuclear molecular ring in Mrk1066 revealed by PCA tomography



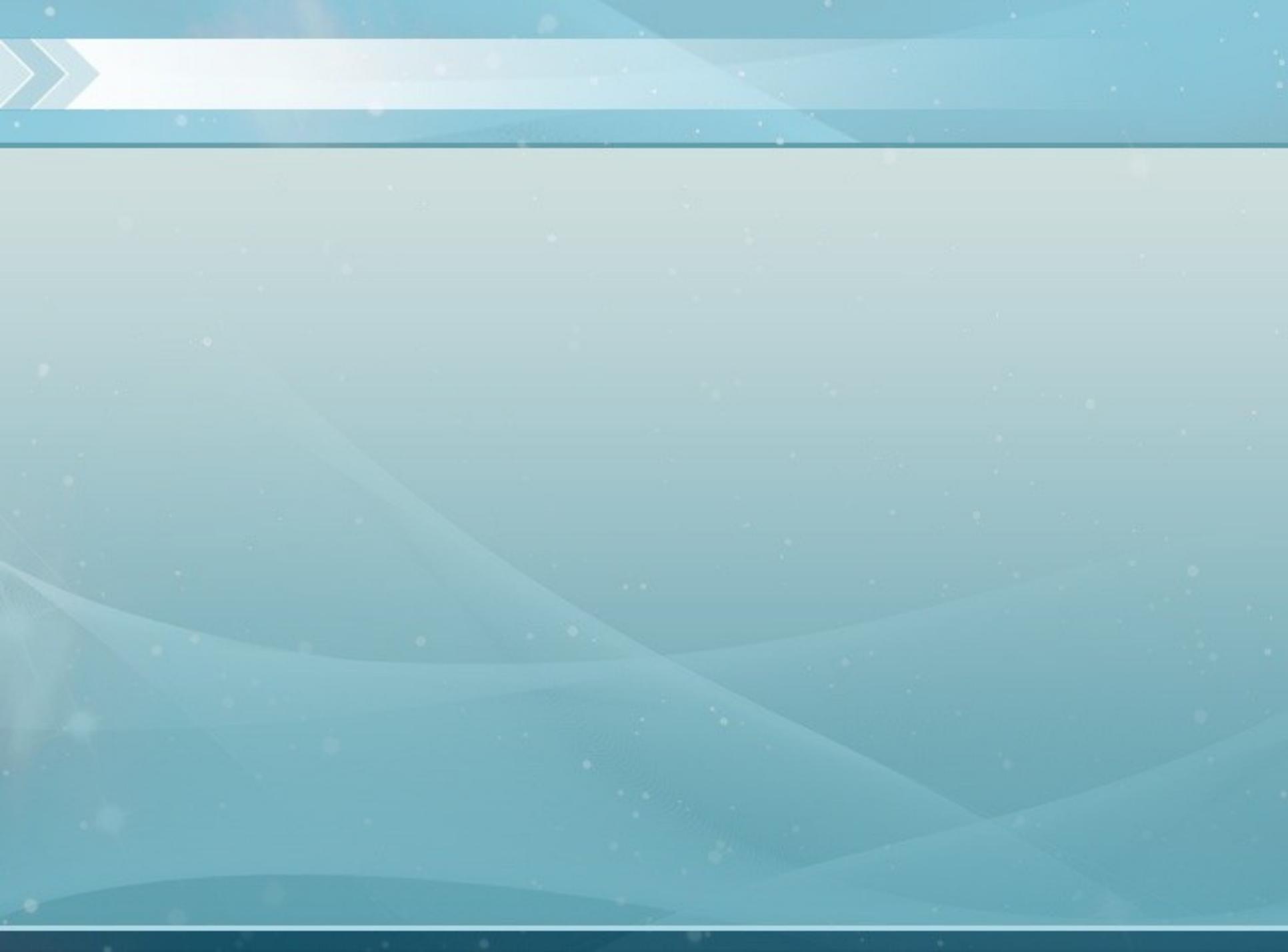
Astor J. Schönell Jr (UFRGS): Feeding and Feedback in AGN: the case of NGC 5548



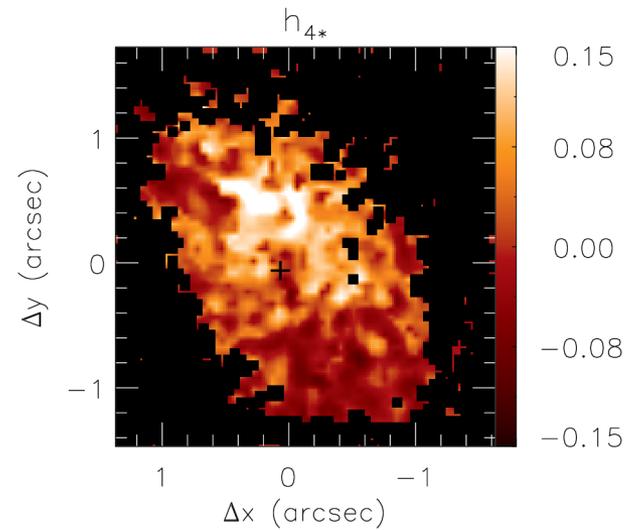
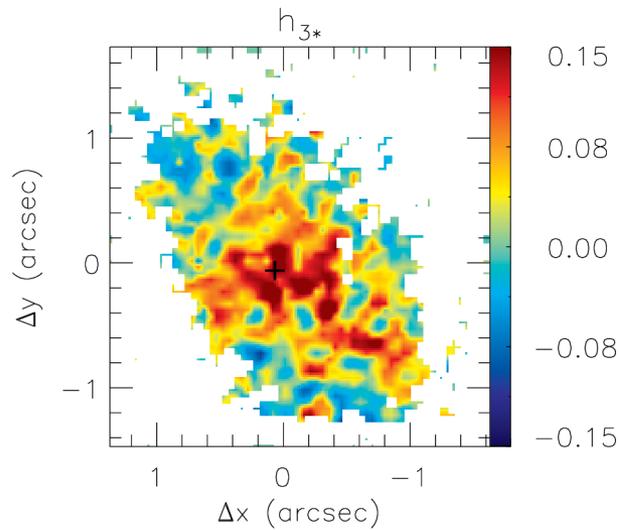
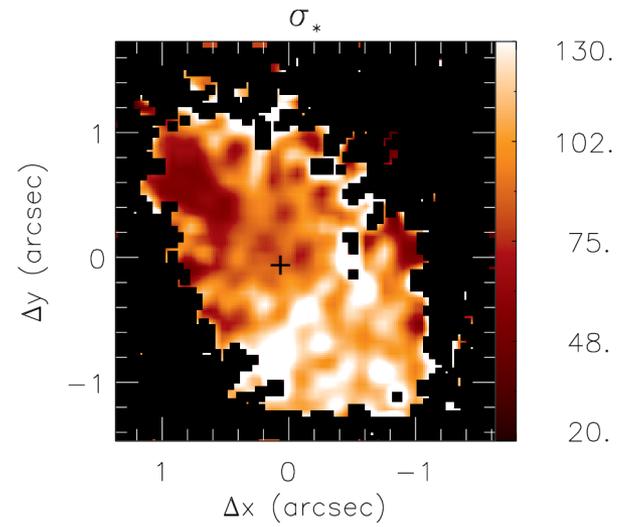
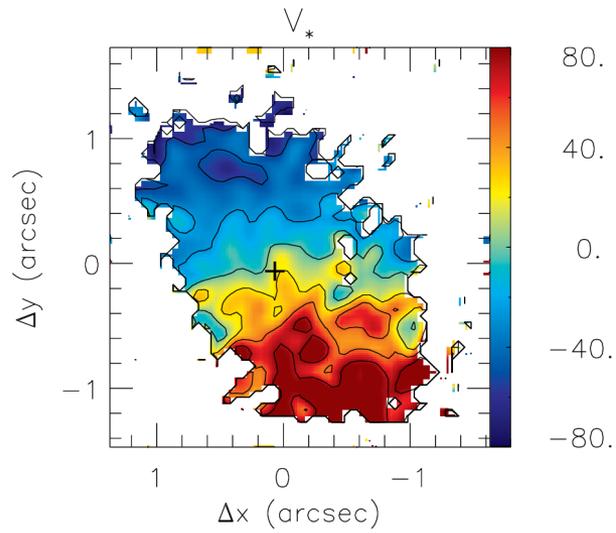
Carine Brum (UFSM): The ionized gas kinematics and distribution in the inner region of the Seyfert galaxies observed with GMOS IFU



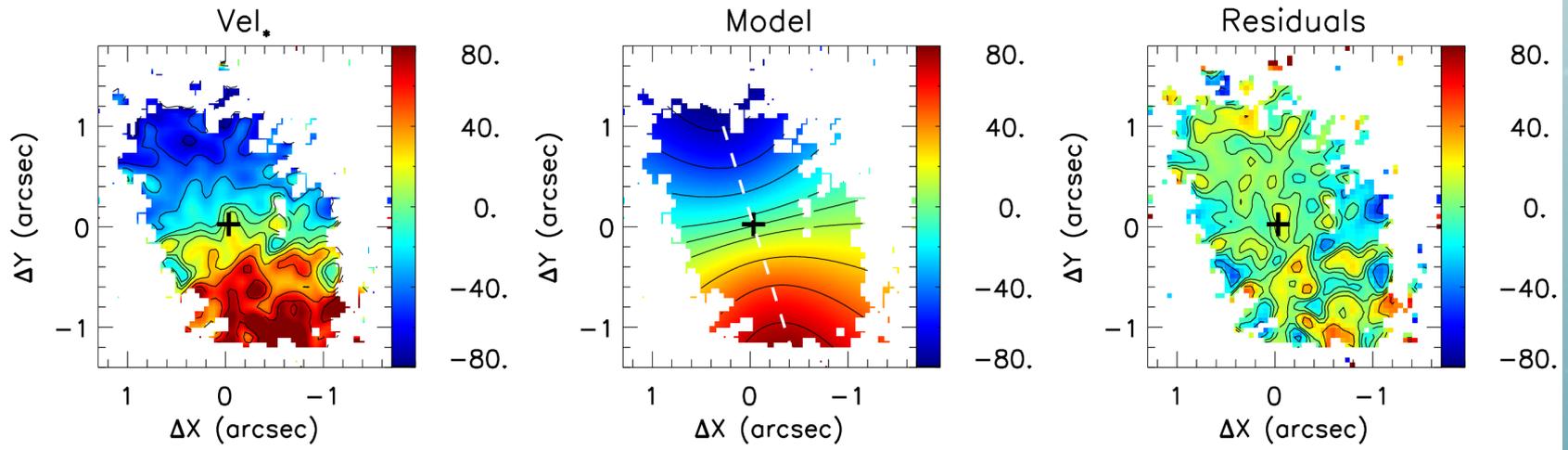
Hekatelyne P. Carpes (UFSM): GMOS IFU Spectroscopy of IRASF23199+0123



NGC5899



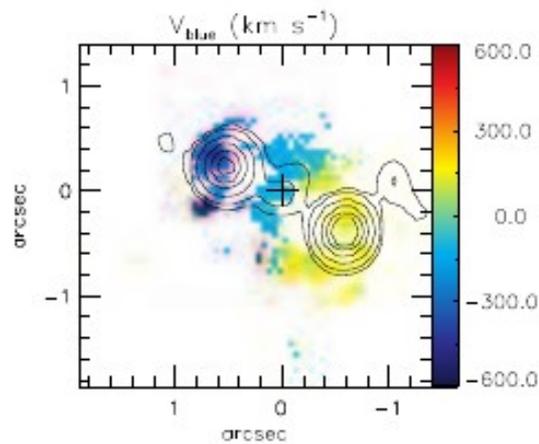
NGC5899 – Rotating disk model



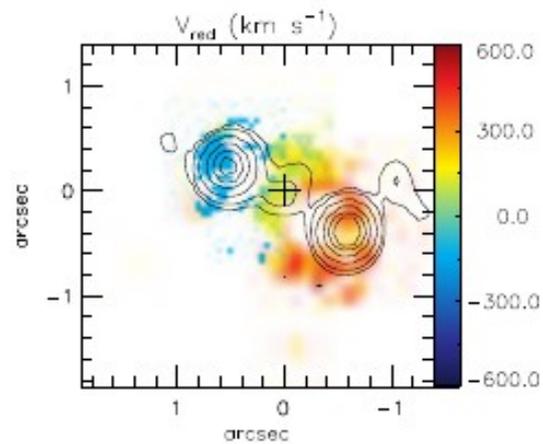
NGC5929

Velocity fields from the fitting of two components

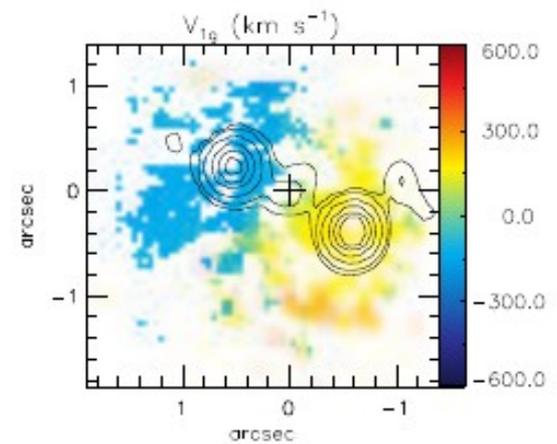
BLUE



RED

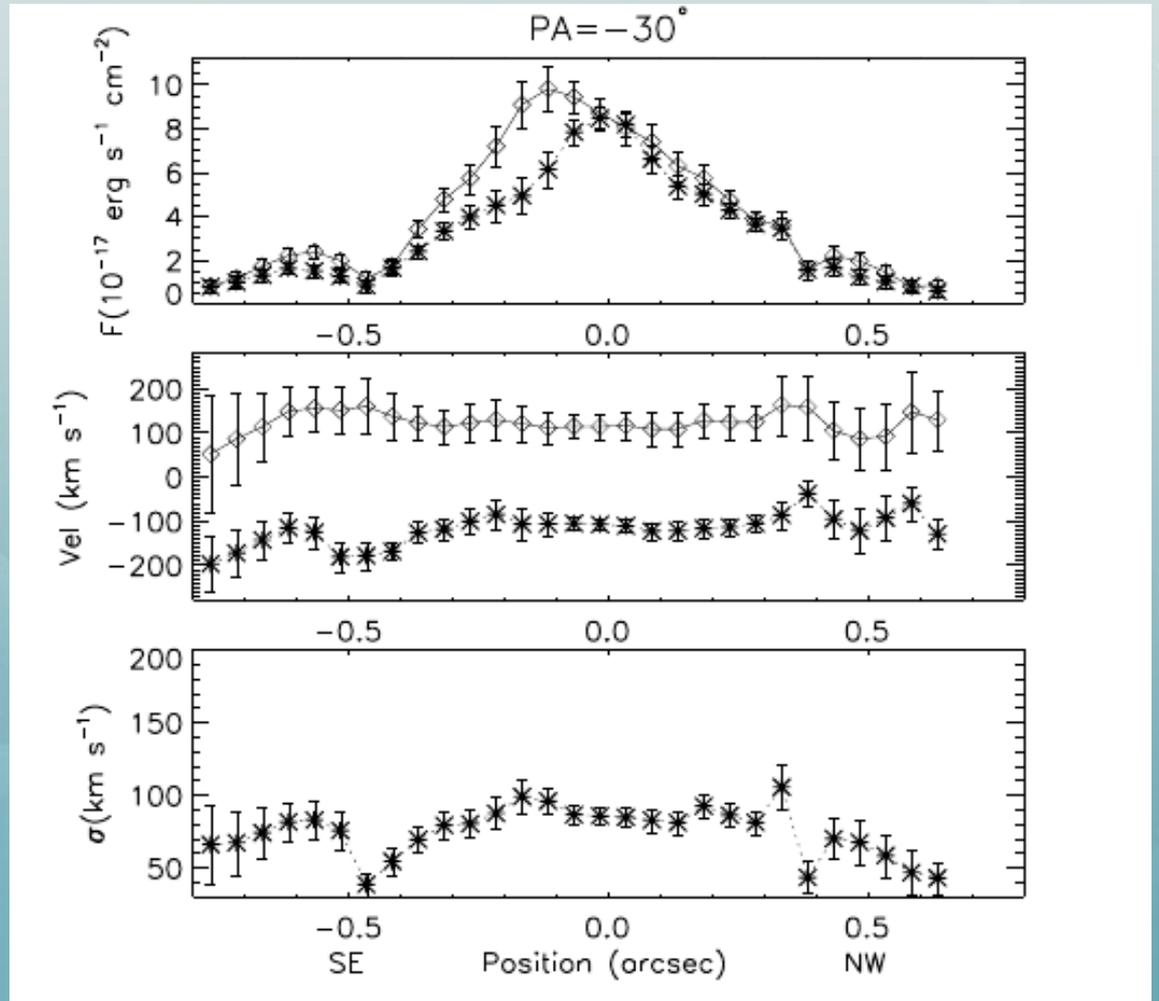


SINGLE



NGC5929

One-dimensional cuts along the NW-SE strip



[FeII]/Palpha

