

# Brazilian Large and Long Program (BrLLP) LP002

## Progress Report - March 2018

### Title: AGNIFS - NIFS survey of feeding and feedback processes in nearby Active Galaxies

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#### 1. Executive summary

We have been awarded 82.5 hours (spread over 6 semesters) to complete NIFS+ALTAIR observations in the J and K bands of the inner few hundred parsecs of a distance limited sample of 20 nearby Seyfert galaxies drawn from the Swift-BAT 60-month catalogue and selected to have 14-195 keV luminosities larger than  $10^{41.5}$  erg/s, redshifts  $z < 0.015$  and being accessible to NIFS ( $-30^\circ < \delta < 73^\circ$ ). Our goal is to map the ionized and hot molecular gas distributions and kinematics, as well as the stellar population and kinematics in order to answer the following questions: (i) How much mass is available for accretion; (ii) what mechanisms bring gas to the environs of the SMBH and (iii) what are the mass inflow rates? (iv) How do outflows interact with the interstellar medium, (v) what are the mass outflow rates and kinetic power? (vi) Can the outflows strip the ISM away from around the BH? (vii) What is the role of star formation in the process? Can we find signatures of recent star formation in the vicinity of the AGN -- a signature of co-evolution of the bulge and SMBH? (viii) How are the measured properties related to the luminosity of the AGN?

In order to complete the observations of the sample of 20 nearby Seyfert galaxies, we need to observe 16 galaxies in the J and K bands plus one galaxy, NGC2110, only in the J band, as we have previous NIFS observations of 4 galaxies of the BAT sample. We have estimated we need 5 hours per galaxy, thus a total of 82.5 hours for the completion of the observations, which we estimated could be observed in 6 semesters: 2015A, 2015B, 2016A, 2016B, 2017A, 2017B. Unfortunately, due to the problem that happened with Altair in 2016B, since that semester we have had no observations, even though we were awarded the time. In summary, we received data only for 6 objects and are thus still missing observations of 10 objects.

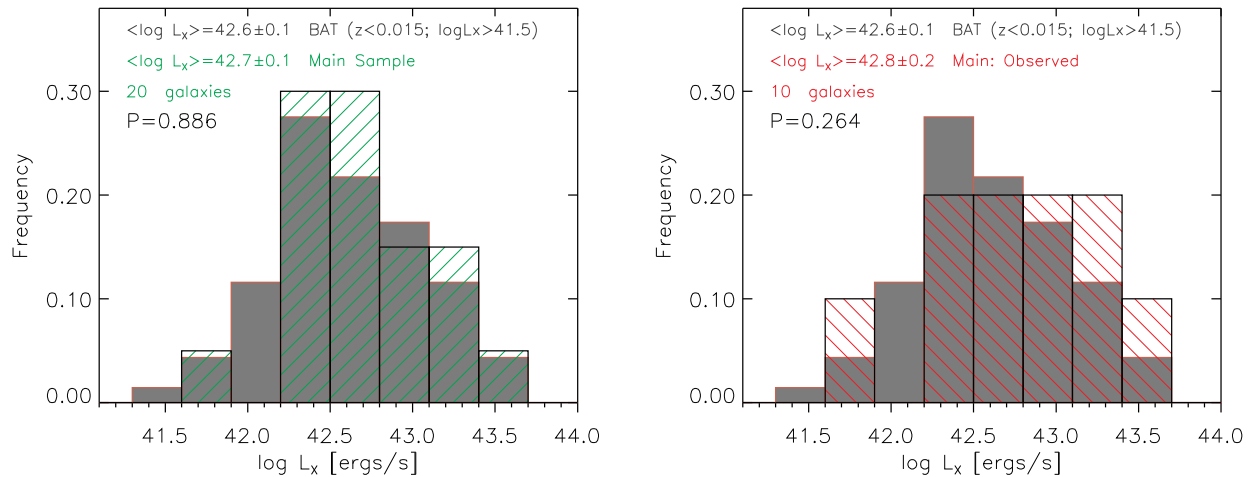
In 2017A and 2017B we did not receive any NIFS data, mostly due to the failure of Altair. Observations of other 5 galaxies are in the 2018A queue (GN-2017A-Q-4, rollover and GN-2018A-Q-106). According to the Gemini North schedule, NIFS will be on the telescope on April, May and July. We expect to get the 5 galaxies observed to have 75% of the sample concluded. We hope to get observations of 4 more galaxies in the next semester to have 19 of the 20 galaxies of our sample observed.

**Project site and Data Release:** We have built a site with the results of the project obtained so far: <https://sites.google.com/view/agnifs>. We are planning to make available, via this site, two data releases (DR) containing reduced data cubes: the DR1 is planned for when 75% of the observations are concluded, while DR2 will be released when the full sample (or at least 90% of it) is observed. But if desired by the NTAC, we can make available right away to the Brazilian Astronomical community the reduced data cubes of the 6 galaxies observed with the LLP, e.g. via e-mail contact with the PI.

The raw data is already available in the Gemini archive.

## 2. Answers to the comments and questions raised by the NTAC:

We have kept the histograms below from the last report to emphasize the need of more data for us to be able to conclude the project, as we have so far only 37.5% of the data we have requested in the LLP2.



*Figure 1: Distribution of the BAT-AGN sample in terms of the X-ray luminosity of the AGN (filled histogram) as compared with the distribution for the whole LLP sample of 20 AGN (green hatched histogram, left panel) and with the distribution of the 10 AGN (red hatched histogram, right panel) so far observed (6 from LLP2 and 4 from previous observations).*

Comments from the NTAC: "In particular, the scientific justification is clear – the topic is of importance. The NTAC recommends that this LLP continue as programmed.

The only drawback is that they mention that they still plan to make the data available and, at this point, the data should be already available, at least the raw data.

**Answer:** As since 2016B we haven't obtained new data, the raw data are already available in the Gemini Science Archive as public. Considering the final reduced data, we have included a new link in the website of the project (<https://sites.google.com/view/agnifs>) pointing to the Data Release 0 (DR0), which includes the J and K-band cubes of 9 galaxies (most from previous observations but that obey the criteria for the scientific goals of the project, and thus included in the total sample). After the acceptance of the Schönell et al. submitted paper, we will include the data of more 5 galaxies.

## 3. Progress of the work

### 3.1 – Updates from semester 2016B:

In 2017A and 2017B we did not receive any NIFS data, as in the previous and present semester, mostly due to the failure of Altair. We have had only 6 galaxies observed in the LLP, in three semesters: 2015A, 2015B and 2016A. The observations of other 5 galaxies are in the 2018A queue (GN-2017A-Q-4, rollover and GN-2018A-Q-106). According to the Gemini North schedule, NIFS will be on the telescope on April, May and July. We expect to get the 5 galaxies observed to have 75% of the sample observed.

In 2018A, Marina Bianchin has joined the project as a PhD student at UFSM.

In 2017B, two PhD theses were presented based on data of the LLP.

1. Diniz, M. R., 2017: "Estudo de populações estelares em galáxias ativas a partir de cubos de dados no infravermelho próximo", UFSM. Supervisor: Rogemar A. Riffel

2. Schonell, A. J., 2017: "Estudo da alimentação e Retro-alimentação de núcleos ativos de galáxias a partir de observações no infravermelho próximo", UFRGS. Supervisor: Thaisa Storchi-Bergmann

Since the last report, we have published one paper:

*Riffel et al. 2018, MNRAS, 474, 1373: Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: II - The sample and surface mass density profiles.*

One paper is submitted since 2017B and we are working in the implementation of the referee's comments.

*Schönell et al. 2017: Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: III - Gas distribution and excitation.*

The following papers are still "in progress":

(1) *2D Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: IV – Gas emission and Stellar Populations in NGC2110*, by Diniz, M. R. et al.; this paper presents a study of the gas excitation and kinematics, as well as the distribution of the stellar populations in NGC2110. This paper is being finalized and will be submitted to MNRAS soon.

(2) *Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: V - Resolved 2D stellar populations in the inner kiloparsec*, by Diniz, M. R. et al.; this paper applies the methodology developed in the paper number 1 above and contains many of the results of Diniz PhD Thesis.

(3) *Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: V - gas kinematics*, by Bianchin, M. et al.; this paper presents and discuss the gas kinematics of six galaxies. It will be part of the Marina Bianchin PhD Thesis.

(4) *Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: VI - 2D stellar population of the inner 500 pc of NGC 4151*, by Riffel, Rogerio et al.; this paper provides the mapping of the stellar population ages and nuclear continuum of this well known and nearby Seyfert 1.5 galaxy

(5) *Probing the AGN-SB connection in the Near-Infrared*, by Dametto et al.: this paper is will be the main paper of Dametto's Thesis, to be presented in second semester of 2018.

(6) *2D Panchromatic stellar populations in Seyfert galaxies*, by Hahn et al.: this paper will be the main paper of Luis D. Hahn Thesis, to be presented in 2019.

### Summary of previous semesters:

In 2015A we received only ~60% of the approved observations. The project was awarded 20 hours: 15 hours in Band 1 under the project GN-2015-Q-3 and 5 hours in Band 2 under project GN-2015A-Q35. We received **11.5 hours** for the observations of the galaxies **NGC3516** and **NGC5506** in both the J and K bands, 1.5hrs more than requested because they had difficulty in the acquisition of NGC5506. We received also 2 (0.2 hrs) of 10 requested exposures for NGC4388

and no data for NGC4939.

In 2015B we received ~50% of the approved observations. We were awarded a total of 15hrs in project GN-2015B-Q-29: 2.5hs to observe NGC2110 in the J-band, 10 hours to observe J and K bands of Mrk9 and NGC788, and 2.5hrs to observe the K-band of NGC3081, but only observations in the J-band for **NGC2110** and in the J and K bands of **NGC788** were obtained. We did not receive any data for Mrk9 and NGC3081.

In 2016A we were awarded 15hrs to observe three galaxies in project GN-2016A-Q-6: NGC3227, NGC4235, J-band NGC4388 and NGC4939, but received only 59% of the awarded time, comprising observations of **NGC3227** and **NGC4235**.

In 2016B we were awarded 15hrs to observe three galaxies in the project GN-2016B-Q-26: NGC1125, NGC2992 and NGC3081 but received no data, receiving instead the following remark regarding this project: "This program is in band 1 and has been accepted for rollover into semesters 17A and 17B if not completed in 16B." Thus we were expecting to observe these three galaxies in 2017A and/or 2017B.

In 2017A we were awarded 15hs to observe three galaxies in the project GN-2017A-Q-4: NGC3393, NGC 3786 and NGC5728. As pointed out above, these galaxies can be observed with NGS, but no observations were obtained.

In 2017B, we also did not receive any data (although we had a 2016B program in rollover), as NIFS was not available. In 2018A, the observations of other 5 galaxies are in the queue (GN-2017A-Q-4, rollover and GN-2018A-Q-106).

For 2018B, we are requesting observations of 4 galaxies (NGC3035, NGC1194, NGC4388, NGC1125), as in 2017B we requested the observations of only 4 galaxies (instead of the 3 originally planned). The availability of the LGS facility in 2018B is pending of its successfully commissioning in 2018A. If the LGS mode is not available, we propose to use NIFS without AO. In this case, although the angular resolution will be worse than those of previously obtained data, we will still be able to probe tens of parsecs scales in the galaxies, enough to properly map the gas and stellar kinematics and distributions. To observe these 4 galaxies in the J and K band we request 20 h in 2018B. In addition, the PIT includes more 5 h as Night Basecal Time.

### **Assessment of the data:**

We have reduced all the data received so far: J and K-bands observations of NGC3516, NGC5506, NGC788, J-band observations of NGC2110, J and K-band observations of NGC3227 and NGC4235. The reduction effort was led by Rogemar Riffel.

### **Calibrations:**

The data has good quality, but we have had a few problems with calibrations when there are observations of the same target in two different nights. We have been solving these problems via calibrated long-slit cross dispersed spectra both from previous and new observations obtained by the student Luis Gabriel Hahn at IRTF (InfraRed Telescope Facility, NASA, Hawaii) and at the Blanco telescope instrument ARCoIRIS.

### **Data analysis:**

(1) We have been using a Butterworth filter to reduce the noise in the data, and remove instrumental fingerprints.

(2) We have been using the program PROFIT (Rogemar Riffel) for the measurement of the emission lines via the fit of one or more Gaussians or Gauss-Hermite polynomials.

(3) We are using the program Starlight (Cid Fernandes 2004) adapted for observations in the near-IR by Rogério Riffel for the study of the stellar population, as well as black body components (to account for the contribution from the dusty torus) and a power-law continuum (to account for the AGN continuum).

(4) Stellar kinematics: We have obtained the stellar line-of-sight velocity distribution (LOSVD) of each galaxy by fitting the spectra within the range 2.26–2.40  $\mu\text{m}$  (rest wavelengths), which includes the CO absorption band-heads from 2.29 to 2.40  $\mu\text{m}$  using the library of near-IR stellar spectra of Winge, Riffel & Storchi-Bergmann (2009). The fitting of the spectra was performed using the penalized Pixel-Fitting pPXF method (Cappellari&Emsellem 2004), that finds the best fit to a galaxy spectrum by convolving template stellar spectra with a given LOSVD, under the assumption that this distribution is well represented by a Gauss-Hermite series.

(5) We are modeling the stellar and emission line kinematics. In the case of the gas kinematics, we fit rotation models that, when subtracted from the measured kinematics, allows the isolation of non-circular motions, where we investigate the signatures of feeding (via inflows) and feedback (via outflows).

### **Software development:**

Dr. Rogério Riffel and his students have developed a tool, called "MEGACUBE", with an initial goal to fit the continuum via spectral synthesis over the whole data cube (using different stellar population bases, continua and varying fitting parameters) to produce maps of the star formation history, mean ages, mean metallicities in a uniform way for all the datacubes obtained in the LLP. These maps will be stored in the MEGACUBE together with the reduced data. A recent development is to include also in the MEGACUBE maps for the gas flux distribution and kinematics as well as the stellar kinematics.

### **Collaborations:**

We are collaborating with the group of Dr. Richard Davies from the Max Planck Institute for Extraterrestrial Physics, in the analysis of some X-Shooter data for a similar sample of nearby AGN as well as of a control sample. The control sample is important mainly for the analysis of the stellar population, and he agreed to collaborate with us allowing us to use their control sample.

### **Conferences:**

Some of the results shown below as well as those from previous targets from the BAT sample were presented by Thaisa Storchi-Bergmann in invited talks at: (1) the IAU General Assembly, August 2015, Meeting #29, #2286157, entitled "Active Galactic Nuclei in 3D: feeding and feedback processes"; (2) at the conference "The Interplay between local and global processes in galaxies", that took place in Cozumel, Mexico, in April 11-15, 2016; (3) at the European Week of Astronomy and Astrophysics in Prague, in June 2017, entitled "Observational constraints on outflows from Active Galactic Nuclei". Rogemar A. Riffel presented results of the LLP2 at the conference "Chemical abundances in gaseous Nebulae" in Campos do Jordão, in November 2-5, 2016. The PhD students Natacha Dametto and Luis Dahmer Hahn presented results of their work based on LLP2 observations in two scientific meetings: "International Workshop on Stellar Libraries in Campos do Jordão" in Feb. 2017 and Natacha Dametto further presented these results in the meeting "Nebulaton" (May 2017) and "Escola de Inverno do Observatório Valongo" (May 2017).

## 4. Sample results

We present below sample results from our papers.

### *Stellar kinematics:*

In an effort led by Rogemar Riffel, we have measured and analyzed the stellar kinematics of the 16 galaxies listed in Table 1 (the 4 previously observed + 6 galaxies observed via the LLP of the main sample plus other 6 -- non-BAT -- galaxies from previous observations) via the program pPxf (Cappellari & Emsellem 2004), that finds the best fit to a spectrum by convolving template stellar spectra with a given LOSVD, under the assumption that this distribution is well represented by a Gauss-Hermite series. Results from these measurements as well as from the fit of a circular rotation model and its subtraction from the LOSVD is shown in Fig. 2 for the galaxy NGC788. A paper with the results for the 16 galaxies listed in Table 1 is now published: Riffel, R. A. et al. 2017, MNRAS, 470, 992.

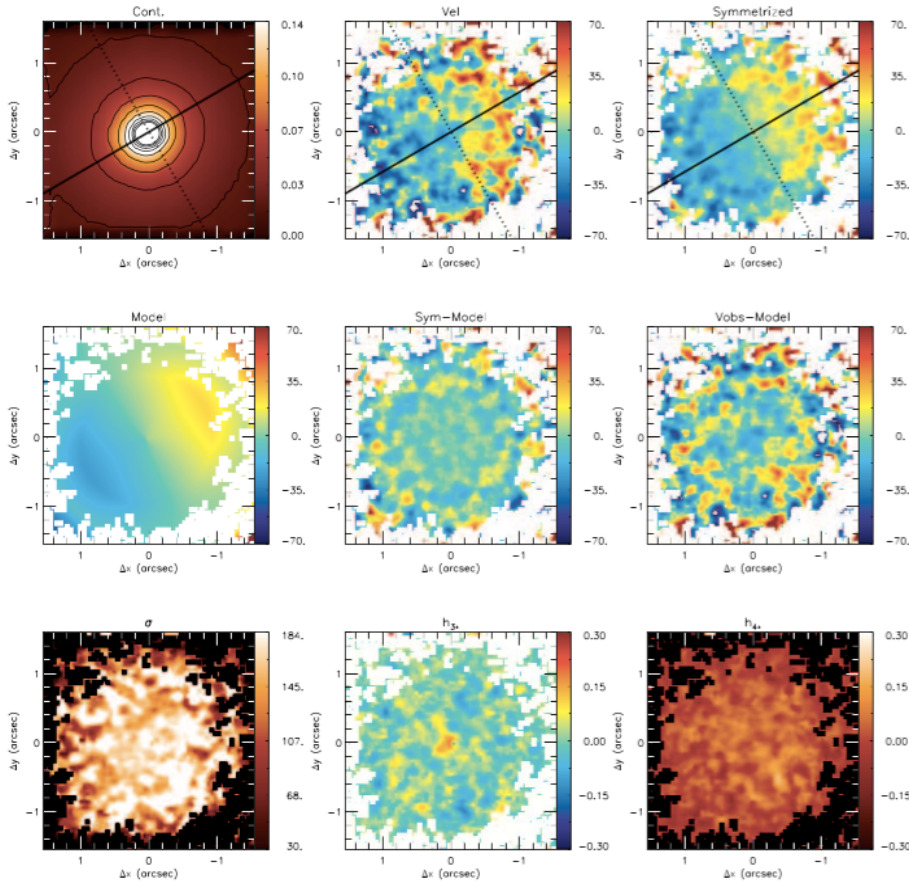


Figure 2. Stellar kinematics of the inner 3''x3'' of NGC 788: Top-left: K-band continuum image obtained by averaging the spectra, with the color bar shown in units of  $10^{-17} \text{erg cm}^{-2} \text{s}^{-1}$ ; top-center: stellar velocity field; top-right: symmetrized velocity field; middle-left: rotating disk model; middle-center: residual map for the symmetrized velocity field; middle-right: residual map for the observed velocity field; bottom-left: stellar velocity dispersion; bottom-center: h3 Gauss-Hermite moment and bottom-right: h4 Gauss-Hermite moment. White regions (and black regions in  $\sigma$  and  $h4$  maps) are masked locations and correspond to regions where the signal-to-noise ratio of the spectra was not high enough to allow reliable fits. The continuous line identifies the orientation of the line of nodes and the dotted line marks the orientation of the minor axis of the galaxy. North is up and East to the left in all maps. The color bar for the velocity field model, residual maps and  $\sigma$  show the velocities in units of  $\text{km s}^{-1}$  and the systemic velocity of the galaxy was subtracted from the observed velocities.

### *Stellar Population*

The stellar population is being analyzed by the PhD students Marlon Diniz under the supervision of Rogemar Riffel and by Luis Gabriel D. Hahn under the supervision of Rog rio Riffel. While Marlon is focusing on the NIFS data only, Luis Gabriel is combining NIFS and GMOS data (when available for the same galaxies) to perform a panchromatic study of the stellar population. NIFS maps for



the stellar population distribution as well as that of a Featureless Continuum and Black Body contribution attributed to a dusty torus are shown in Fig. 3 for NGC3516, and are part of the PhD Thesis of Marlon Diniz. A paper with the results of the stellar population for Mrk573 obtained using the same method is already published (Diniz, M. R. et al., 2017, MNRAS, 467, 3286).

An update of the results from the analysis of the data on the galaxy NGC1052, lead by Luis Gabriel D. Hahn follows. We have mapped the gas excitation and kinematics, and the stellar population properties in both the optical and in the J and K near-Infrared bands. Emission-line flux distributions reveal, besides a rotation component, two regions wit double-peaked profiles along the radio jet. The optical flux-ratios show extended LINER emission throughout the 5.0"x3.0" field of view. These regions are found to be compatible with inflows/outflows. Principal component analysis (PCA) reveal an unresolved broad line region centered at the nucleus, consistent with a low luminosity active galactic nucleus (LLAGN). This scenario is compatible with the X-ray source located in the same point. In the near infrared, the emission lines are much weaker, with only the [FeII] and H2 lines displaying extended emission. Also, for the first time in the literature, we combine optical and NIR datacubes and perform stellar population synthesis. By using the optical alone, we find only contribution from old stellar populations. When adding the NIR, on the other hand, we detect a featureless continuum at the nucleus, associated with the LLAGN and compatible with the PCA results.

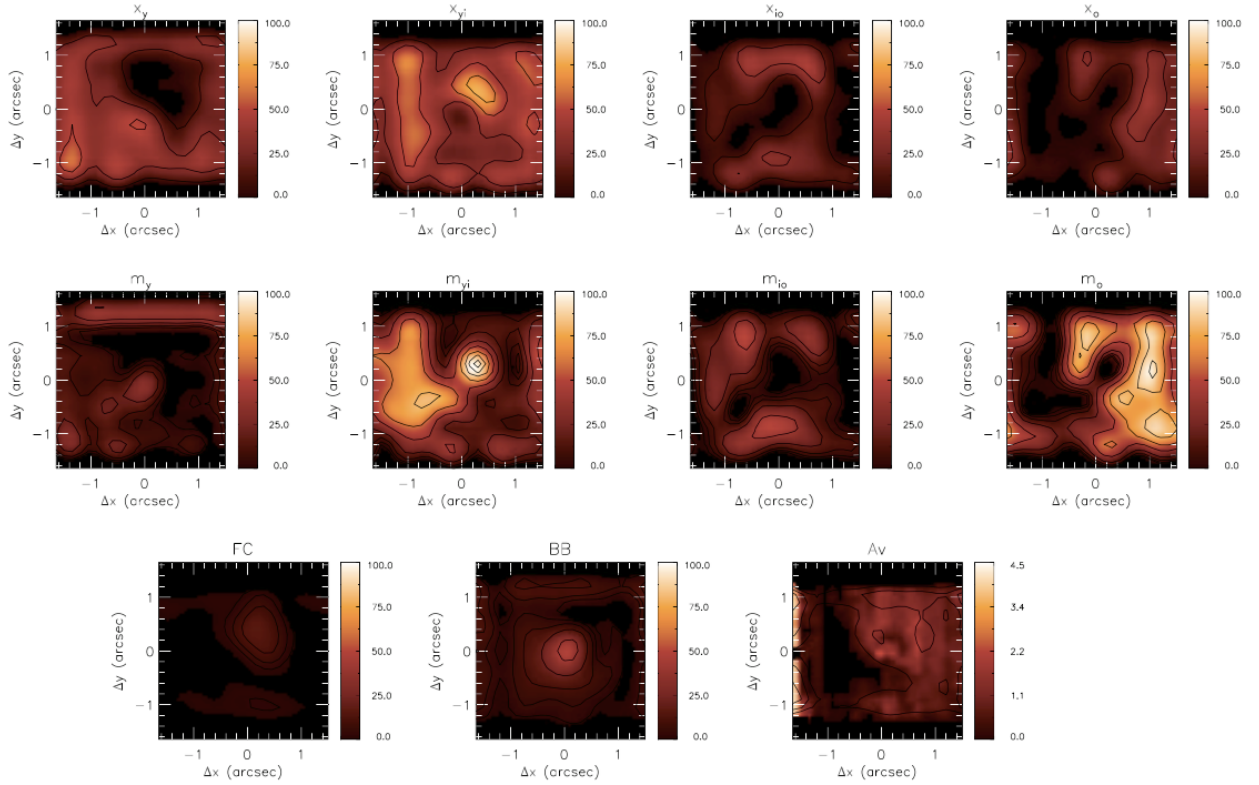


Fig. 3: NGC3516: Top row: Results of the spectral synthesis, where  $x_y$ ,  $x_{yII}$ ,  $x_{I0}$  and  $x_o$  represent the percent contribution to the continuum at  $2.2\mu m$  of stellar populations within the age bins (in yrs)  $1E3-1E8$ ,  $1.01E8-7E8$ ,  $7.01E8-2E9$ ,  $2.01E9-15E9$ , respectively. In the second row we show the percent contribution of the each age bin in mass. The bottom row shows, from left to right, the percent contribution of the featureless continuum FC, the black body component (with temperature  $T \sim 1000K$  to account for the torus contribution) and the reddening affecting the stellar population.

#### Emission line flux distributions, ratios, gas masses and kinematics:

We have obtained the gas flux distributions, excitation and kinematics in the J- and K-band emission lines for all galaxies observed, using the PROFIT routine to fit Gauss-Hermite

polynomials to the emission lines. This is illustrated in Fig. 4 below for NGC 5506, and has already been obtained for all the galaxies observed in the LLP. On the basis of these measurements and assumptions regarding the gas density, we have also calculated the gas mass surface densities in units of  $M_{\text{sun}}$  per  $\text{pc}^2$  for the ionized and hot molecular gas. We have also calculated the average gradients of these properties. This is illustrated for NGC 788 and Mrk 607 in Fig. 5 below. These results are from a submitted paper by Astor Schonell, and part of his PhD Thesis presented in 2017B.

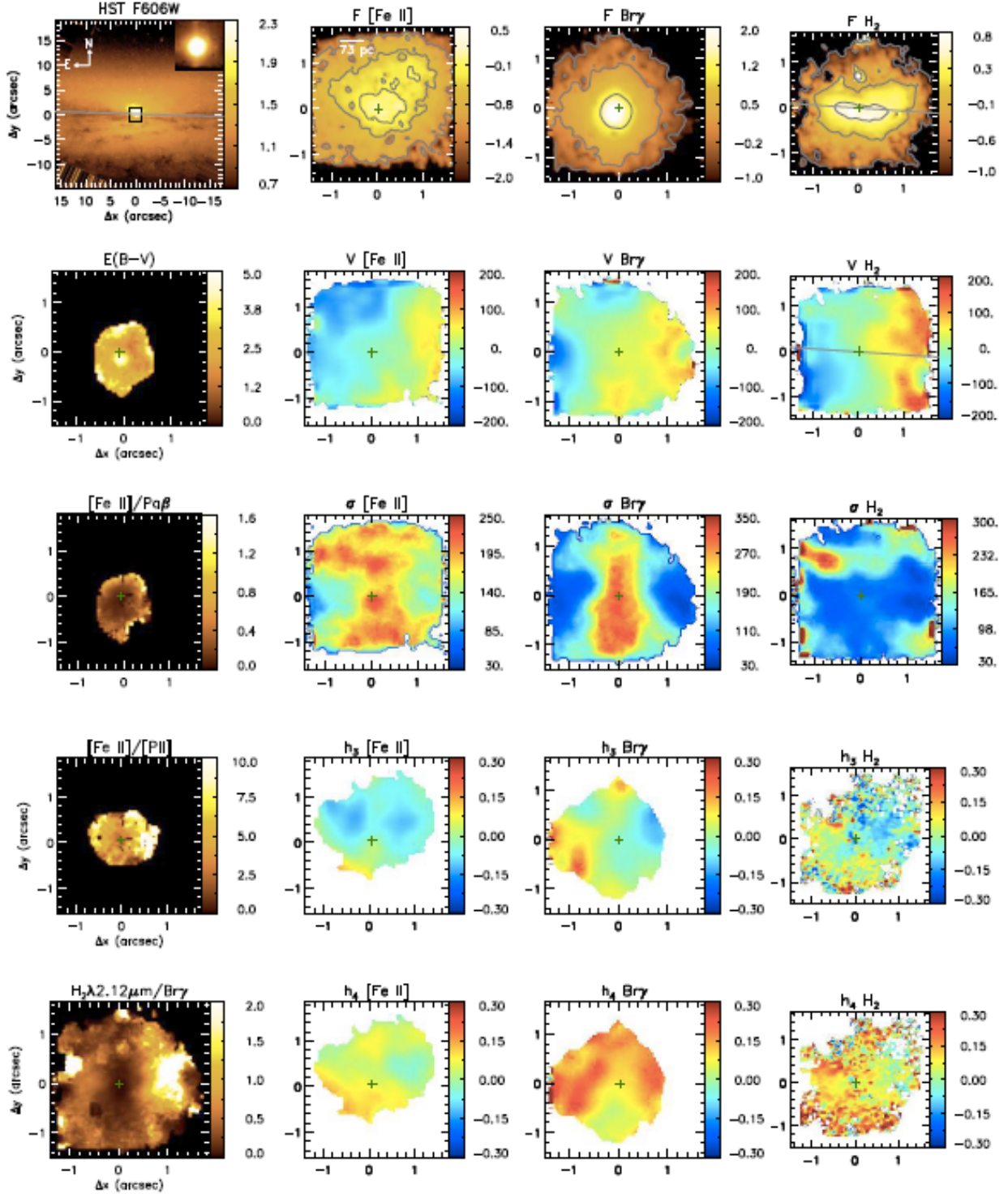


Figure 4: Top row: HST-WFPC2 continuum image of NGC5506 obtained through the filter F606W and flux distributions in the  $[\text{Fe II}]1.257\mu\text{m}$ ,  $\text{Pa}\beta$  and  $\text{H}_2 2.122\mu\text{m}$  emission lines; following rows: emission-line ratios and gas kinematics. The flux distributions are shown in logarithmic units of  $10^{-17} \text{ erg cm}^{-2} \text{ s}^{-1}$ . The LOSVD



(Vel) and velocity dispersion ( $\sigma$ ) are shown in units of  $\text{km s}^{-1}$ .  $h3$  and  $h4$  are Gauss-Hermite moments.

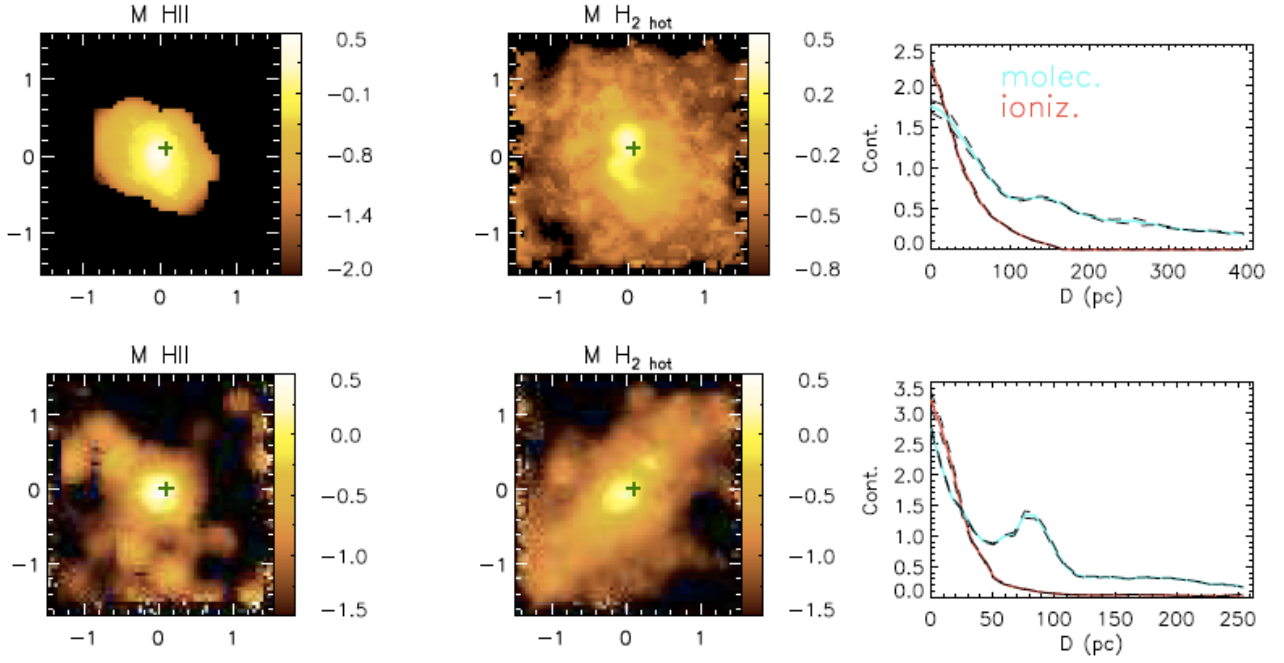


Fig. 5: Gas surface mass density distributions of NGC 788 (top) and Mrk 607 (bottom) for the ionized (left column) and hot molecular (central column) gas. Units are  $10^4 M_{\odot} \text{pc}^{-2}$  for the ionized gas and  $M_{\odot} \text{pc}^{-2}$  for the hot molecular gas. The third column shows the average radial profile of these two surface mass densities in the same units.

We have also calculated the total gas masses within the  $3'' \times 3''$  FOV and average surface mass densities, which are listed in Table 1 below for all the galaxies analyzed so far, which are also part of the PhD Thesis of Astor Schönell

Table 1 - Column (1): identification of the galaxies (including 6 galaxies from the LLP plus data from previous NIFS observations); (2) area corresponding to the emission of molecular hydrogen (in  $pc^2$ ); (3) area of ionized hydrogen (in  $pc^2$ ); (4) mass of hot molecular gas (in solar masses); (5) mass of cold molecular gas (in solar masses); (6) mass of ionized gas (in solar masses); (7) average mass surface density of hot molecular gas (in solar masses per  $pc^2$ ); (8) average mass surface density of cold molecular gas (in solar masses per  $pc^2$ ); (9) average mass surface density of the ionized gas (in solar masses per  $pc^2$ ).

Galaxies	A ( $H_2$ )	A (HII)	M ( $H_2$ ) <sub>h</sub>	M ( $H_2$ ) <sub>c</sub>	M (HII)	$\mu$ ( $H_2$ ) <sub>h</sub>	$\mu$ ( $H_2$ ) <sub>c</sub>	$\mu$ (HII)
MRK 1157	$2.8 \times 10^5$	$1.8 \times 10^5$	$2.3 \times 10^3$	$1.6 \times 10^9$	$5.4 \times 10^6$	$8.2 \times 10^{-3}$	5714	45
NGC 1068	$5.2 \times 10^4$	$1.5 \times 10^4$	29	$2 \times 10^7$	$2.2 \times 10^4$	$5.6 \times 10^{-4}$	384	1.4
MRK 1066	$2.5 \times 10^5$	$1.9 \times 10^5$	$3.3 \times 10^3$	$2.4 \times 10^9$	$1.7 \times 10^7$	$1.3 \times 10^{-2}$	9600	89
NGC 2110	$1.1 \times 10^5$	$7 \times 10^4$	$1.4 \times 10^3$	$9.9 \times 10^8$	$1.7 \times 10^6$	$1.3 \times 10^{-2}$	9000	24
MRK 79	$9.8 \times 10^5$	$7.8 \times 10^5$	$3 \times 10^3$	$2.2 \times 10^9$	$7 \times 10^6$	$3.1 \times 10^{-3}$	2245	9
NGC4051	$1.3 \times 10^4$	$1.4 \times 10^4$	66	$4.7 \times 10^7$	$1.4 \times 10^5$	$5.3 \times 10^{-3}$	3760	9.8
NGC4151	$2.4 \times 10^4$	$1.9 \times 10^4$	240	$1.7 \times 10^8$	$2.4 \times 10^6$	$1.8 \times 10^{-2}$	7083	125
MRK766	$3 \times 10^5$	$2.7 \times 10^5$	$1.3 \times 10^3$	$9.8 \times 10^8$	$7.6 \times 10^6$	$4.3 \times 10^{-3}$	3266	29
NGC5548	$1.7 \times 10^5$	$6.7 \times 10^5$	$2.3 \times 10^2$	$1.7 \times 10^8$	$2.2 \times 10^6$	$6.6 \times 10^{-3}$	3473	7.2
NGC5929	$1.2 \times 10^5$	$7 \times 10^4$	471	$3.5 \times 10^8$	$1.3 \times 10^6$	$3.9 \times 10^{-3}$	2966	18
NGC5506	$1.4 \times 10^5$	$1.2 \times 10^5$	$1.4 \times 10^3$	$1 \times 10^9$	$3.2 \times 10^7$	$9.7 \times 10^{-3}$	7951	244
NGC3516	$8 \times 10^4$	$6 \times 10^4$	517	$3.7 \times 10^8$	$3 \times 10^5$	$6.4 \times 10^{-3}$	6168	5
NGC788	$6.2 \times 10^5$	$5.5 \times 10^5$	1012	$7.3 \times 10^8$	$4.8 \times 10^6$	$1.6 \times 10^{-3}$	1319	8.8
NGC3227	$8.8 \times 10^4$	$4.4 \times 10^4$	1274	$9.2 \times 10^8$	$1.7 \times 10^6$	$1.4 \times 10^{-2}$	20682	39
NGC5899	$1.9 \times 10^5$	$8.7 \times 10^4$	559	$4 \times 10^8$	$4.2 \times 10^5$	$2.9 \times 10^{-3}$	4624	4.8
MRK607	$5.9 \times 10^4$	$2.3 \times 10^4$	182	$1.3 \times 10^8$	$1.1 \times 10^6$	$3 \times 10^{-3}$	5710	48

## 5. Overall status

We are now in the seventh semester of the LLP (2018A), but we got no data during 2016B, 2017A and 2017B and only ~60% of the data for semesters 2015A, 2015B and 2016A.

As we have developed a lot of expertise in this study, in order to be able to conclude it, we have proposed NGS observations for 2018A and for the next semester non-AO observations, as the remaining galaxies are close and bright enough for us to still get valuable data in order to finalize the project.

We presently have 3 PhD students and 1 Post-doc working in the project. Dr. Marlon Diniz just finished his Thesis (2017B) and is now a post-doc at UFSM. He is in charge of the analysis of the stellar population. Natacha Dametto is comparing stellar population synthesis results between the optical and near-infrared and investigating the best stellar population templates for the synthesis. Luis D. Hahn is working in the analysis of the calibration between the J and K bands, using cross-dispersed data from IRTF and Blanco, helping with the development of the MEGACUBE tasks and performing panchromatic spectral synthesis using combined data cubes GMOS-IFU + NIFS. In the present (2018A) semester, Marina Bianchin has started her the PhD at UFSM and is working with the gas kinematics in collaboration with Dr. Astor Schönell Jr. who finished his PhD in 2017B.

Reduction of data is complete, as well as the fits of the emission lines. Most "protocols" for data analysis and reduction are ready, including MEGACUBE.

## **6. Observing plan and data release**

With our LLP we aim at completing NIFS (+ALTAIR when possible) observations of a distance-limited sample of 20 Active Galaxies: 4 already observed via previous proposals plus 16 to be observed in this LLP. As already discussed in the initial part of this report, we have LLP J and K-band data for only 6 galaxies so far: NGC788, NGC 2110, NGC 3227, NGC 3516, NGC 4235 and NGC5506. We thus still need to observe 10 more galaxies in order to reach the goals of our project.

In the present semester (2018A) we hope to get observations of NGC3393, NGC3786 and NGC5728 with NGS, as rollover from semester 2017A. Although Altair will not have the Laser, all three galaxies can be observed with NGS after a change in SB conditions (from Any to SB=80%).

We have also requested to observe in 2018A the galaxies approved for 2017A that were not observed and that can also be observed with NGS: NGC2992 and NGC 3081.

With the observations of the above 5 galaxies, we will be covering 75% of the sample. We are proposing to obtain the observations of 4 additional galaxies in 20 hours observations being requested for 2018B.

Our effort with the MEGACUBE has the goal of storing the reduced data, together with the measurements of flux distributions and kinematic maps in each emission line, as well as the results of the spectral synthesis as extensions of the same cube. In the case of the spectral synthesis we plan to save maps of the percent contribution of each stellar population template, featureless continuum and black body (torus) contribution, as well as the reddening map. The MEGACUBE will then be made available in a data release by the end of our analysis of the data, that we estimate to happen during 2018-2019.

Table 2 shows our progress as well as the planned semesters for the forthcoming observations.

Galaxy	Activity	FWHM	Semester	Status
NGC788	Sy2	done	15B	Observed and reduced, 1 paper published and analysis on-going for additional papers
NGC1125	Sy2	0.56"	18B	
NGC1194	Sy1	Sy1	18B	
NGC2110	Sy2	done	15B	Observed, reduced, partial results in Diniz+2015.
NGC2992	Sy2	0.64"	18A	In queue for 2018A
NGC3035	Sy1	Sy1	18B	Not observed in 16B-> Proposing 2018B
NGC3081	Sy2	0.55"	18A	In queue for 2018A
NGC3227	Sy1.5	Sy1	16A	Observed and reduced, 1 paper published and analysis on-going for additional papers
NGC3393	Sy2	0.72"	18A	In queue for 2018A
NGC3516	Sy1.5	done	15A	Observed, data reduced, 1 paper published and analysis on-going for additional papers
NGC3786	Sy1.8	0.70"	18A	In queue for 2018A
NGC4235	Sy1	0.47"	16A	Observed, reduced, 1 paper published and analysis on-going for additional papers
NGC4388	Sy2	partial	18B	Only 800s in 15A -> need more time in 2018B
NGC4939	Sy1	0.68"	19A	
NGC5506	Sy1.9	done	15A	Observed, data reduced, 1 paper published and analysis on-going for additional papers
NGC5728	Sy2	-	18A	In queue for 2018A

## 7. Publications

During the years 2015, 2016, 2017 and beginning of 2018, we have finalized and published the following papers using data from the galaxies of the BAT-AGN sample: the first 4 contain data from the LLP while the others are from the same project but based on data that have been obtained in previous runs:

Diniz, M. R. et al., 2017: MNRAS, 469, 3286, Disentangling the near-infrared continuum spectral components of the inner 500 pc of Mrk 573: two-dimensional maps.

Riffel, R. A. et al., 2017, MNRAS, 470, 992: Gemini NIFS survey of feeding and feedback processes in nearby active galaxies - I. Stellar kinematics.

Riffel et al. 2018, MNRAS, 474, 1373: Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: II -The sample and surface mass density profiles.

The following is submitted since 2017B and we are working in the implementation of the referee's comments: Schönell et al. 2017: Gemini NIFS survey of feeding and feedback processes in nearby Active Galaxies: III - Gas distribution and excitation.

Previously submitted paper on the project (data from previous runs before the LLP2):

Schönell, A. J., Storchi-Bergmann, T., Riffel, R. A. & Riffel, R. 2017, MNRAS, 464, 1771: Feeding versus feedback in AGN from near-infrared integral-field spectroscopy XII: NGC5548

Diniz, Marlon R.; Riffel, Rogemar A.; Storch-Bergmann, Thaisa; Winge, Claudia, 2015, MNRAS, 453, 1727: Feeding versus feedback in AGN from near-infrared IFU observations XI: NGC 2110

Riffel, Rogemar A., Storch-Bergmann, T., Riffel, R. 2015, MNRAS, 451, 3587: Feeding versus feedback in active galactic nuclei from near-infrared integral field spectroscopy - X. NGC 5929

Storch-Bergmann, Thaisa, IAU General Assembly, Meeting #29, #2286157: Active Galactic Nuclei in 3D: feeding and feedback processes

Colina, Luis; Piqueras López, Javier; Arribas, Santiago; Riffel, Rogério; Riffel, Rogemar A.; Rodríguez-Ardila, Alberto; Pastoriza, Miriani; Storch-Bergmann, Thaisa; Alonso-Herrero, Almudena; Sales, Dinalva 2015, A&A, 578, 48: Understanding the two-dimensional ionization structure in luminous infrared galaxies. A near-IR integral field spectroscopy perspective

Riffel, Rogemar A.; Storch-Bergmann, Thaisa; Riffel, Rogério, 2015, IAU Symp. 309, 339: Near-IR Integral Field Spectroscopy of the central region of NGC 5929

Riffel, R.; Pastoriza, M. G.; Rodríguez-Ardila, A.; Dametto, N. Z.; Ruschel-Dutra, D.; Riffel, R. A.; Storch-Bergmann, T.; Martins, L. P.; Mason, R.; Ho, L. C., 2015, ASPC, 497, 459: Models Constraints from Observations of Active Galaxies  
Alf Drehmer, Daniel; Storch-Bergmann, Thaisa; Ferrari, Fabricio; Cappellari, Michele; Riffel, Rogemar A. 2015, MNRAS, 450, 128: The benchmark black hole in NGC 4258: dynamical models from high-resolution two-dimensional stellar kinematics

## **8. PhD Theses**

1. Diniz, M. R., 2017: "Estudo de populações estelares em galáxias ativas a partir de cubos de dados no infravermelho próximo", UFSM. Orientador: Rogemar A. Riffel

2. Schonell, A. J., 2017: "Estudo da alimentação e Retro-alimentação de núcleos ativos de galáxias a partir de observações no infravermelho próximo", UFRGS. Orientadora: Thaisa Storch-Bergmann

Porto Alegre, 2018 March 24

Thaisa Storch-Bergmann