PhD name: Iván Ezequiel López
PhD Cycle: 36
Tutor: Marcella Brusa - Co-supervisor: Silvia Bonoli (DIPC, Spain)
RESEARCH PROJECT: Constraints on SMBH accretion ratio distributions from large area multi wavelength surveys

This PhD project is in the framework of BiD4BEST (Big Data Application for Black Hole Evolution Studies), an Innovative Training Network (ITN) funded by the EU under the call H2020-2019-MSCA-ITN (GA: 860744). The Network comprises 10 institutes across Europe and has the main goal of training 13 Early Stage Researchers in the field of Black Hole and Galaxy co-evolution.

The focus of this thesis is on the key questions: What galaxy and environment properties facilitate accretion onto the supermassive black holes (SMBH) and how SMBHs affect the properties of their hosts? Despite studies that show evidence of a co-evolution between them and the galaxy host, is not completely clear how the accretion affects the host. For the local Universe, there are confident measures of SMBH masses that show a relation with the stellar components from the host (for a review, see Kormendy & Ho (2013)). However, since it is more difficult to measure M_{BH} for AGN at high cosmological distances, the relationship is not too clear. Besides that, there are other physical parameters, as star formation rate (SFR) and black hole accretion rate (BHAR) that supports the evidence of a co-evolution and feedback between them up to z=3 (Aird et al. (2015a)). There are works that use different proxies to recover the intrinsic physical parameters (e.g., Aird et al. (2018)), and arrive at the expected probability distribution of accretion rate showing dependence with the type of galaxies and their stellar mass.
To try to understand better the co-evolution scenario, we need a large and unbiased sample of accretion rates distribution within different types of galaxies throughout cosmic history. So, our main goal is to determine unbiased tracers of the accretion history of supermassive black holes as a function of AGN and galaxy properties from the highest down to the lowest values of the Eddington ratios, typical of AGN in their peak and latest phases.
At the beginning of the PhD, I compiled an X-ray catalog using available data in the AEGIS field (Laird et al. (2009), Nandra et al. (2015), Liu et al. (2020)). We select our sources on X-ray because is an efficient method to look at a wide range of redshifts and can show us low luminosity AGN that are missing in other bands because the galaxy host dominates the observed flux. I crossmatched the catalog looking for photometric data in other wavelengths (Galex for UV and Wise for IR). For the optical band, I crossmatched with the miniJPAS catalog (Bonoli et al. (2020)), which has 54 narrow-band filters and thus can provide more information of features from the spectra than a broad filter catalog. I also searched for a confident redshift for these sources from DEEP2 or SDSS. After the sample was built, I did the correction of the X-ray fluxes for absorption using the hardness ratio and redshift. Our final sample has 440 sources.
To obtain the physical parameters of the AGN and galaxy host, I used two methods: spectral energy distribution (SED) fitting and spectra fitting. For the first one, I used all photometric data and redshift to construct the SED. For the fitting, I used X-Cigale (Boquien et al. (2019), Yang et al. (2020)) to model the dust, stellar, gas, and AGN emission and recover M_*, SFR, SFH, L_{AGN}, etc. Because the models fitted demanded a high capacity of RAM and computing time, I executed the fitting on the cluster of OPH at UNIBO. For the spectra fitting, I obtained the available spectra for SDSS or MMT (collaboration with Dr. Coil) and fitted the continuum, iron, and broad/narrow emission for CIV, MgII, Hβ, and Hα. With the FWHM of the broad lines, I could estimate M_{BH} for 105 sources. I used L_{AGN} and M_{BH} to compute BHAR considering if the AGN is radiatively efficient or not. With these parameters recovered, I did a principal component analysis (PCA) to find hidden correlations between them and I studied the possible bias of our sample. The PCA did not show an indicator of a correlation between M_*-M_{BH} and I know that our sample is biased on high luminosity AGN, probably because of the target selection by SDSS. Beware that, I explored other possibilities to look for M_*-M_{BH} for the sources with $M_{BH.}$ I evolved each source from the spectroscopic redshift down to z=0 with three simple modes: constant rate, variable rate following SFH, and variable rate following SFH with an energy limit. This last one is promising because it can be easily computed and can explain the observed scatter.
Now, I am working in DIPC with the JPAS team and co-supervisor Dr. Bonoli, trying to understand better how to extract the best quality from the available data. In the next months, we will wrap all the results in a first paper.

WORKSHOPS, CONFERENCES & MEETINGS

06 June 2021 - Journal Club Universidad Nacional de La Plata (UNLP), Argentina
- Talk: “Recovering AGN/host physical properties”

28 June - 2 July 2021 - EAS Anual Meeting
- Poster: “Looking for constraints in SMBH accretion ratio distributions”

30 June 2021 - Weekly PhD Seminars, Bologna
- Talk: “Constraints on SMBH accretion ratio distributions”

10 September 2021 - FAME, Bologna
- Talk: “Using X-Cigale and narrow-band filters to recover the AGN/host physical properties distributions”

PhD SCHOOLS

As part of BiD4BEST network member, I took part in the following mandatory PhD schools and training activities:

14-16 July 2021 – AI, machine learning and careers in Data Science by BASF
7-11 June 2021 - School on Numerical Galaxy Formation by LMU
19 April 2021 – How to read/write scientific papers by Nature Astronomy
22-23 March 2021 - Outreach Training by SISSA
13-21 January 2021 - School on Astro-statistics

INTERNAL COURSES

30 November – 2 December 2020, Bologna, Italy - “The Interstellar Medium”
19 - 23 April 2021, Bologna, Italy - “Gamma Ray Bursts: from observations to physical properties”
5-14 May 2021, Bologna, Italy - “Writing, talking and presenting Science”

ISA LECTURES

1/12/2020 - “Data in public communications” by Giuseppe Sollazo
21/09/2021 - “Monsoon Stories from Desert Trees" by Soumaya Belmecheri

RESEARCH PERIOD ABROAD

15 September - 3 December 2021 - Donostia International Physics Center, Spain. Research collaboration with Dr. Bonoli to work on JPAS data.

COMPETITIVE TELESCOPE/COMPUTER TIME ALLOCATIONS

Gemini 2021A, granted:
Program Title: Shock-excited H2 in M58: also jet-shocked?
PI: Ivan Lopez ID: GN-2021A-Q-137
Total Time Observed: 3.1 hr
Data already reduced - Related to the Master’s thesis.

OTHER RELEVANT ACTIVITIES

Coordination of Weekly PhD Seminars at Unibo.
Regular assistance to FAME, Journal Club from UNLP and Work Package Meetings from Bid4Best.

PUBLICATIONS

None