Astrophysics Sector, Department of Physics and Astronomy (DIFA) of the Alma Mater Studiorum - University of Bologna, Italy
Via Piero Gobetti 93/2, 40129 Bologna Italy
Marie Skłodowska-Curie Innovative Training Networks, Early Stage Researcher (H2020-MSCA-ITN-2019)
Deadline for applications: April 1st 2020
Expected starting date: November, 1st 2020
Supervisor: Prof. Marcella Brusa
Job duration: 36 months
Main research field: Astrophysics, Physics

Job description:
The job is a full time position for an early stage researcher (ESR) in the field of Galaxies and AGN co-evolution — **Feedback and Outflows: The effects of AGN on their host galaxies.** The title of the project is: *"Incidence and energetics of AGN winds in the distant Universe".* Our goal is to develop machine/deep-learning methods that use multi-wavelength photometric properties to select AGN with strong winds among X-ray populations and constrain AGN outflow physics.
The appointed ESR will be enrolled in the PhD program (36 cycle) and submit the thesis within the period of employment. Training activities involve PhD courses, participation to seminars/workshops/conferences. The supervisor will be **Prof. Marcella Brusa** (University of Bologna).

Project description
The main goal of the project is to develop machine and deep-learning methods that use multi-wavelength photometric properties to select supermassive black holes with strong winds among X-ray populations, dissect the interaction of AGN winds with the interstellar medium in high-redshift galaxies and constrain AGN outflow physics.

The project is divided in 3 parts:
1. We will explore the incidence and detection of outflows in few tens to hundreds of AGN up to z~2, using public and proprietary XMM-Newton observations (to sample winds at the accretion disc scale) and Integral Field Unit (IFU) of X-ray AGN in optical-mm regime (to sample the winds at the galaxy scale), in conjunction with exquisite multiwavelength information available in the deep extragalactic fields (COSMOS, XXL, STRIPE82) and within the SUBWAYS program. This part of the project envisages a secondment at University of Durham under the supervision of Prof. Dave Alexander.
2. We will adopt novel deep-learning based approaches (like Convolutional Neural Network, CNNs) to explore the multi-parameter space of outflow signatures and properties (as derived above), star-formation rate, morphology, gas content. The main goal is to search for trends in wind properties as a function of, e.g., star-formation rate, AGN luminosity, gas fractions, to reveal the fundamental relations among these parameters and to explore direct and indirect signatures of AGN winds. We will apply these methods to data from the eROSITA satellite, obtained within the eROSITA_DE consortium. We will complement this approach using cutting-edge Bayesian inference and Monte Carlo techniques to account for selection effects. This is the numerical part of the project and will be accomplished thanks to a secondment to BASF.
3. We will compare the results on the dependence of outflows on AGN luminosity and host galaxy properties with zoom-in simulations that use different AGN feedback recipes (e.g. EAGLE). State-of-the-art, zoom-in hydrodynamic simulations inclusive of AGN feedback and radiative transfer will generate full synthetic galaxy-AGN images and spectra creating the ideal baseline to properly train the CNNs. This will be accomplished with a secondment at University of Leiden, under the supervision of Prof. Schaye.

The project is open in the framework of **BiD4BEST (**Big Data for Black hole Evolution Studies; GA 860744; Coordinator: Dr. Francesco Shankar, University of Sothampton), a H2020 Marie Sklodowska-Curie Innovative Training Network (MSCA-ITN-ETN) that offers an innovative and intersectoral research training programme for 13 PhD students in one of the most visible areas of astrophysical research: *the formation and evolution of supermassive black holes in galaxies.*

A coordinated research training effort in this field has been established to mobilise the community in Europe and prepare a core group of young scientists in anticipation of new observational data in the early/mid 2020s from future space missions with strong European involvement. These data will have the quality and volume to yield transformational science on the formation of black-holes in galaxies, as long as the necessary expertise and synergies among observation, theory and data analytics exist within the European astronomy community. BiD4BEST brings together leading scientists in observational and theoretical studies of black holes and galaxies, industrial experts in cutting-edge big-data technologies, and professionals in science dissemination. The 13 doctoral research projects available in the network combine state-of-the-art observations, numerical simulations and innovative analytic tools to compare theory with observation and shed light on the physics of black hole formation in the context of galaxy evolution. The training on expertise from different research areas (observational astronomy, theoretical astrophysics) and sectors (academic, industrial) will be achieved by carefully designed secondments, mixed doctoral supervisory committees (academia, industry), well coordinated events for team communication and interaction, as well as network-wide courses on astrophysics and transferable skills. The proposed research training programme aspires to generate individuals that in addition to academic competences, master big-data analytics and have the capacity to apply these technologies to solve problems in different sectors (research, industry, non-academic) by developing innovative products and services. Further information can be found at https://wwwmpa.mpa-garching.mpg.de/~kdolag/ BiD4BEST/index.html and https://cordis.europa.eu/project/id/860744

Institution description and working place:

The Department of Physics and Astronomy (DIFA) of the Alma Mater Studiorum - University of Bologna, is one Department of the Science School and one of the most scientifically productive Physics Departments of Italy, internationally well-well-known for its activities in a wide range of research fields.

The Department is a teaching site of the University and provides lectures in all fields of astronomy and astrophysics at all academic levels. Furthermore, it is one of the only four institutions in Italy to offer an international PhD program fully dedicated to Astrophysics. The Department has its own scientific libraries, several meeting rooms that host regular weekly seminars from highly renowned scientists from the whole world, as well as smaller regular meetings and several informal talks of the different research groups. Moreover, DIFA will deploy and install in spring 2020 a High Performance Computing cluster called "Matrix" with 896 virtual cores and 4 GB RAM/core, equipped with 240 TB of disk storage space, used both for DIFA research activities in the context of the Open Physics Hub project, and for innovative teaching courses.

The project will take place at the premises of DIFA's Astrophysics Sector (Via Gobetti 93/2 40129 Bologna Italy), located within the heart of the newly established Bologna Astrophysics Campus, which includes: INAF-Osservatorio di Astrofisica e Scienza dello Spazio di Bologna (INAF-OAS), INAF-Istituto di RadioAstronomia (INAF-IRA) and the Cerenkov Telescope Array (CTA) Headquarters, all within walking distances and shared facilities. This is the largest astrophysical center in Italy with a strong group at the forefront of the European research int he field of galaxy formation and AGN-co-evolution and key involvement in next ESA's missions Euclid and Athena.

Dedicated secondments in the University of Durham as well in Leiden University and Max Planck Institute für Extraterrestrische Physik in Garching bei München and in other non-academic partners such as BASF is planned.

Candidate profile
The candidate can be of any nationality and is required to have a master degree in Astrophysics, Physics or related fields giving access to PhD school and NOT to have any kind of PhD degree. Previous research experience (which must be no longer than 4 years) although appreciated, is not mandatory. Willingness to travel internationally for the purpose of research, training and dissemination/outreach is mandatory.

Eligibility requirements
ESR appointments are full time fixed term for 36 months. The researcher will commit to work exclusively for the action. There are strict eligibility rules associated with the recruitment of Early stage Researchers in Marie Skłodwska-Curie Innovative Training Networks, and these are:

Career: At the date of recruitment, the ESR must have a master degree giving access to PhD, shall be in the first 4 years (full-time equivalent research experience) of their research careers and have not been awarded a doctoral degree. Previous research experience, especially in extragalactic Astrophysics and galaxy evolution is appreciated but is not mandatory. A PhD degree in any field is not compatible with this ESR position.

Mobility: Trans national mobility is an essential requirement of Marie Skłodwska-Curie Training Networks. The ESR must not have resided or carried out his/her main activity (work, studies etc.) in Italy for more than 12 months in the 3 years immediately prior to the recruitment date. Compulsory national service and/or short stays such as holidays are not taken into account. Applicants must be prepared for a secondment for a total of 11 months at most in the United Kingdom, The Netherlands and Germany.

Language: A good knowledge of spoken and written English is required and will be evaluated during the selection process.

If these criteria are not fulfilled, the applications will be rejected. Candidates matching the required profile will be interviewed until a successful candidate is appointed. Candidates that do not fulfill the mobility requirement are encouraged to look in the network webpage for other open positions within the network (https://euraxess.ec.europa.eu/jobs/486901).

How to apply
Applicant should apply through the online portal (https://concorsi.unibo.it) and should provide
- An application form duly completed.
- A CV including previous technical and scientific experiences with a list of publications (if any) and/or participation to scientific meetings and research expertise. The CV should indicate all the courses attended during the master degree.
- A letter of motivation, including research interests and the reasons for applying for this programme;
- Undergraduate level certificates, including university grades and the detailed list of university courses with grades. Copies of any other scientific publication that the candidate believes significant are also welcome.
- The applicant must also provide the name and contacts of two referees.

A confirmation message will be sent.

Evaluation and interview
The selection process will consist of two different selection steps:
1. CVs and record evaluation;
2. Interview.

After the CVs and record evaluation, only the admitted candidates will be contacted for the second selection step. Candidates will be interviewed by a committee that includes at least two BiD4BEST members. The interview to assert the skills, the motivation and the fluency in English, will take place at the host institution or, for those candidates not able to travel to Bologna, via Skype. After the interview, some of the applications could be rejected. The remaining candidates will be ranked according to both their records and the interview. The candidate at the highest rank position will be offered the position. **The process is expected to finish by May 31st, 2020.** If, for any reason, the selected candidate will decline the offer or will fail to comply with the requirements for enrolment in the position, the one following in the list will be chosen.

At the University of Bologna, we value diversity and equality. The University recognises that employees may wish to have working patterns that fit with their caring responsibilities or work-life balance. Due consideration will also be given to applicants who have had career breaks for reasons including maternity, paternity or adoption leave, disability or illness.

Rights and responsibilities of researchers participating in Marie Skłodwska-CurieActions
The European Charter for Researchers is a set of general principles and requirements which specify the roles, responsibilities and entitlements of both researchers and the employers and/or funders of researchers. The aim of the Charter is to ensure that the nature of the relationship between researchers and employers or funders is conducive to successful performance in generating, transferring, sharing and disseminating knowledge and technological development and to the career development of the researchers.
It is obligatory for applicants to read and understand the detailed information regarding the rights and responsibilities of researchers engaged in a Marie Skłodwska-Curie Innovative Training Network. The European Charter for researchers can be accessed at:
https://euraxess.ec.europa.eu/jobs/charter/code

Employment contract and remuneration
The selected candidate will be appointed under a 36-months full-time employment contract with full social security and fiscal coverage, as foreseen by the Italian national legislation. The remuneration will be compliant with the rules of the H2020-MSCA-ITN-2019, as by the Marie Skłodowska-Curie Innovative Training Networks 2019, 'European Union Contribution and Applicable Rates'. The gross amount per year of the allowances includes the salary (40966 €), the mobility allowance (7200€) and a family allowance if eligible (6000€). These gross amounts include all compulsory deductions under national applicable legislation (taxes depend on the country of the host institution).
The contract includes fundings for all the travel expenses needed for the successful development of the PhD thesis (meetings, trainings, workshops, observations, collaborations, etc.).

Personal Data: any personal data will be processed in accordance with the General Data Protection Regulation 679/2016 EU (GDPR) on the Protection of Individuals.