1. PHD PROJECT DESCRIPTION (4000 characters max., including the aims and work plan)

Project title: Study of the population of radio transient sources

1.1. Project goals

The overall goal is to establish which physical mechanisms and scenarios give rise to the observed burst of radio activity in different groups of Active Galactic Nuclei (AGN) and what is the impact of the new-born radio jets on the surrounding interstellar medium.

1.2. Outline

It has been already discovered based on optical/UV and X-ray studies that active galactic nuclei (AGNs) may go through short phases of activity. Last reports say that they change their spectral type, and some of them do so even more than once. These ‘changing-look AGNs’ loose and regain broad emission lines in their optical spectra and often show large changes in the optical photometry probably as a result of variable obscuration by irregularly shaped torus or change of the accretion rate onto a central black hole. In the second case, which is related to the source's activity state, the name ‘changing-state AGNs’ is rather used.

It is beyond doubt, that these extraordinary ‘changing-state AGNs’ are extremely useful for studying the evolution of AGNs but also can help us understand the radio jet production process. However, in the radio range, such observations were until recently very modest. New possibilities were brought only by the modern radio time-domain surveys such as Caltech-NRAO Stripe 82 Survey (CNSS) and the ongoing Very Large Array Sky Survey (VLASS).

Using the mentioned surveys, we discovered a group of objects that appeared as new radio sources after >5-20 years of absence. They are transient phenomena with respect to the previous radio surveys and after the significant increase in the radio luminosity have been classified as radio-loud objects. We plan to conduct further comprehensive multi-epoch and multi-wavelength study of them to achieve the goals set in this work.

1.3. Work plan

- More precise definition of individual groups of objects and their observation plans.
- Writing scientific observational proposals for radio (VLA, VLBA), optical (Keck) and X-ray (Chandra) instruments.
- Reduction of the acquired data and their analysis including: fitting the radio spectra with different models of absorption; looking for correlations between radio spectral properties, luminosities, redshifts and host galaxy properties; interpretation of the life cycle of different groups of AGNs.
- Publication of the results.

1.4. Literature (*max. 10 listed, as a suggestion for a PhD candidate*)

- Urry, M. & Padovani, 1995, PASP, 107, 803
- O'Dea, C. P. & Saikia, D. J. 2021, A&A Rv, 29, 3
- Kunert-Bajraszewska at al., 2010, MNRAS, 408, 2261
- An and Baan. 2012, ApJ, 760, 77
- Czerny, B., et al. 2009, ApJ, 698, 840
- Nyland, K., Dong, D. Z., Patil, P., et al. 2020, ApJ, 905, 74
- Kunert-Bajraszewska, et al. 2020, ApJ, 897, 128
- Wołowska, A., et al. 2021, ApJ, 914, 22

1.5. Required initial knowledge and skills of the PhD candidate

PhD student should be familiar with the subject of AGN science and know the basics of radio interferometry.

Programming skills, especially in PYTHON are welcome. Phd student should be ready to learn how to reduce data from various instruments.

1.6. Expected development of the PhD candidate's knowledge and skills

The PhD student will deepen their knowledge about the physical processes responsible for radio emission and the shape of the spectrum of radio-loud AGNs and gain experience in modeling this emission. Additionally, PhD student will learn data reduction from various radio interferometers and instruments observing in other ranges of the electromagnetic spectrum. The obtained knowledge and skill set will allow the student to work as an independent scientist creating his own research projects in the future.