PHD PROJECT DESCRIPTION
(4000 characters max., including the aims and work plan to de published online)

Project title: Bridging the Gap Between Galactic Transients and Fast Radio Bursts

1.1. Project goals

The main objective of this proposed doctoral project will be to understand the origin of, and potentially fill, the currently existing observational gap in the emission power distribution of millisecond bursts between galactic phenomena and Fast Radio Bursts (FRBs). The discovery of RRATs (Rotating Radio Transients), FRBs, and LPTs (Long-Period Transients) has demonstrated how dynamic the Universe is in the radio domain and how limited our knowledge remains regarding short-timescale phenomena.

Within the framework of the project described here, the candidate will search for FRBs in nearby galaxies, investigate the activity of galactic bursting objects (such as magnetars or RRATs), and attempt to model the distribution of dispersion measure in galactic systems depending on geometric conditions. This project aims to provide an answer to the question: Are FRB phenomena a separate group of astrophysical phenomena, or are we witnessing the tip of the iceberg of the transient radio burst luminosity distribution?

1.2. Outline

Since the discovery of Fast Radio Bursts (FRBs) in 2007 and their confirmation as an abundant extragalactic population in 2013, research into their origins, emission mechanisms, and applications has become one of the most rapidly evolving fields in astrophysics. The diverse phenomenology of these bursts (Pleunis et al. 2021), including the fact that only a relatively small fraction (>5%) of FRB sources exhibit repeating activity (repeaters; Spitler et al. 2016), suggests that multiple formation channels or emission mechanisms may exist.

Although FRBs are highly luminous, their large extragalactic distances mean that current blind surveys are strongly sensitivity-limited and therefore only detect the bright end of the luminosity distribution of potentially observable fast radio transients. Recent results indicate that repeaters (if they are young magnetars) are capable of releasing nearly all the energy stored in their magnetic fields during a single active phase (e.g. Ould-Boukattine et al. 2026).

FRBs in the local Universe (at distances of a few tens of Mpc) offer a unique opportunity to bridge our understanding of fast radio transients in the Milky Way and its immediate surroundings with the distant FRB population. The detection of FRB-like bursts from the Galactic magnetar SGR 1935+2154 (e.g., Bochenek et al. 2020), a repeater in the nearby galaxy M81 (FRB 20200120E/M81R; Bhardwaj et al. 2021; Kirsten et al. 2022), and a very bright one-off event FRB 20250316A in the spiral galaxy NGC 4141 (CHIME/FRB Collaboration, 2025) clearly demonstrates that new detections can effectively connect these 'local' bursts to the much more distant FRB population — especially since the weakest bursts from M81R have luminosities comparable to the brightest radio bursts observed from SGR 1935+2154.

This connection can be achieved through detailed characterization of their local environments (Kirsten et al. 2022), strong constraints on multi-wavelength counterparts (Scholz et al. 2020), and targeted searches for low-luminosity FRBs (Nimmo et al. 2022). Dedicated observations with medium-sized radio telescopes (such as RT4 in Piwnice) will help establish the statistics of such bursts in local galaxies. Galactic magnetars, as a possible source of FRBs, may also serve as a crucial link between local transients and "classical" luminous FRBs. For example, XTE J1810-197 is well known for its occasional radio bursting activity (e.g., Caleb et al. 2022).

Additionally, in order to better understand systematic effects (such as the structure of the interstellar medium in galaxies), a simple modelling approach will be employed. This will highlight potential gaps in the current treatment of "local" FRB studies and demonstrate the expected strong influence of these effects on the observed dispersion measure. The modelling will be based on the latest Galactic electron density model (NE 2025; Ocker & Cordes 2026) as well as radio observations of nearby galaxies of various types, compared against the preliminary estimated spatial distribution of FRBs within their host galaxies (Gordon et al. 2025).

1.3. Work plan

Analyze the collected data and publish the results of both blind and targeted L-band FRB searches (covering both Galactic and extragalactic targets). Describe the energy statistics and burst properties of XTE J1810-197 in the L- and C-bands, with particular emphasis on their possible analogues in nearby galaxies. Conduct simulations of the spatial distribution of FRB sources in galaxies of different types, utilizing current observational results. The main goal is to publish the obtained results in peer-reviewed scientific journals. Short stays in JIVE and ASTRON are planned.

1.4. Literature (max. 7 listed as a suggestion for a PhD candidate preliminary study)

Bochenek C. D., et al., 2020, Nature, 587, 59 (10.1038/s41586-020-2872-x)
Gordon A.,et al., 2025, ApJ, 993, 117 (10.3847/1538-4357/ae0298)
Kirsten F., et al., 2022, Nature, 602, 585 (10.1038/s41586-021-04354-w)
Nimmo K., et al., 2022, Nature Astronomy, 6, 393 (10.1038/s41550-021-01569-9)
Ould-Boukatinne O.S., et al., 2026, MNRAS, 546, 3 (10.1093/mnras/stag090)
Petroff E., Hessels J. & Lorimer D., 2022, A&AR, 30, a.2 (10.1007/s00159-022-00139-w)
Pleunis Z., et al., 2021, ApJ, 923, 1 (10.3847/1538-4357/ac33ac)

1.5. Required initial knowledge and skills of the PhD candidate

The candidate should have some basic knowledge about the Fast Radio Burst phenomenon and some experience with radio observations. She/he must have medium skills in using Python software and the GitHub enviroment. The analysis of the data will be carried out in IA NCU and JIVE & ASTRON (Netherlands), therefore, English is desirable.

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

The candidate will be supported by the supervisors and collaborators from JIVE & ASTRON. The data reduction process and analysis will take place mainly in IA NCU with the use of open-source software like FETCH or DSPSR (or other codes from the GitHub repositories) - support will be offered. The candidate will develop her/his knowledge about magnetars and sources of FRB in the Local Universe and in a global view. The candidate will learn how to write publications and collaborate within a recognized international scientific group.