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Magnetar Bursts Scanner (MagBurstS)

Yogesh Maan[(1)]
(1) National Centre for Radio Astrophysics (NCRA - TIFR), Pune, India, e-mail: ymaan@ncra.tifr.res.in

A significant fraction of the transient radio sky is composed of short timescale transient phenomena. These transient phenomena point to systems with most extreme physical parameters, such as energies, magnetic field strengths, gravitational fields, and densities, in the universe. The galactic sources of the majority of such transient phenomena are known to be a variety of neutron stars: radio and high energy pulsars, magnetars, etc. The fast transients of extra-galactic origin are known as fast radio bursts (FRBs) — milliseconds-wide highly luminous radio transient events of extra-galactic origin. Magnetars are a small subset of the known neutron star population, but with extremely high magnetic fields, young ages, highly variable high-energy emission, and sometimes transient radio emission. The spontaneous field decay in these objects with unusually strong magnetic dipole fields ($10^{14} - 10^{15}$ G, hence the name "magnetar") is thought to provide the energy source for the observed anomalously high X-ray luminosities (Duncan & Thompson, 1992). Given the huge magnetic energy reservoir, magnetars also form the basis of a number of models to explain the origin of FRBs. The recent detection of exceptionally strong radio bursts from the magnetar SGR 1935+2154 (e.g., FRB 20200428D and FRB 20221014A, Bochenek et al., 2020; CHIME/FRB Collaboration et al., 2020; Dong & Chime/Frb Collaboration, 2022; Maan et al., 2022) has provided a strong observational support to some of these models. Establishing an observation link between magnetars and FRBs is of utmost importance to (a) understand the origin and emission mechanism of FRBs, (b) study the lower energy end of the FRB distribution which is otherwise undetectable by the current generation of radio telescopes, (c) predict and study the high-energy (optical/X-rays) counterparts of FRBs, as well as (d) understand the magnetar population in other galaxies. However, establishing and studying such a link would require detecting a statistically significant number of bright bursts (say, with fluence >1 kJy ms) from a variety of Galactic magnetars. The current detection of only a few such bright bursts, that too only from one of the Galactic magnetars, indicates the rarity of such events as well as the lack of dedicated observations and optimal strategies to catch these rare events.

To optimally probe the observational links between magnetars and FRBs, we are currently developing MagBurstS* — Magnetar Burst Scanner — a dedicated, real-time transient search and classification instrument utilizing the NCRA 15-m dish. MagBurstS will facilitate continuous monitoring of the Galactic magnetars and active repeating FRBs over long timescales, and search for radio bursts with fluences of the order of 0.1 kJy ms or more in real-time. In this talk, I will provide a detailed account of recent scientific findings that motivated the MagBurstS developments, followed by a detailed description of the underlying instrument and algorithms as well as the current status and findings.

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2. Bochenek, C. D., "A fast radio burst associated with a Galactic magnetar", Nature, vol. 587, no. 7832, pp. 59–62, 2020. doi:10.1038/s41586-020-2872-x.
3. CHIME/FRB Collaboration, "A bright millisecond-duration radio burst from a Galactic magnetar", Nature, vol. 587, no. 7832, pp. 54–58, 2020. doi:10.1038/s41586-020-2863-y.
4. Dong, F. A. and Chime/Frb Collaboration, "CHIME/FRB Detection of a Bright Radio Burst from SGR 1935+2154", ATel 15681, 2022.
5. Maan, Y., Leeuwen, J. van ., Straal, S., and Pastor-Marazuela, I., "GBT detection of bright 5 GHz radio bursts from SGR 1935+2154, coincident with X-ray and 600 MHz bursts", ATel 15697, 2022.

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