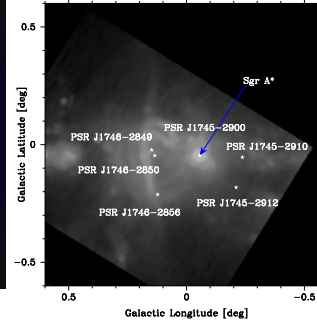
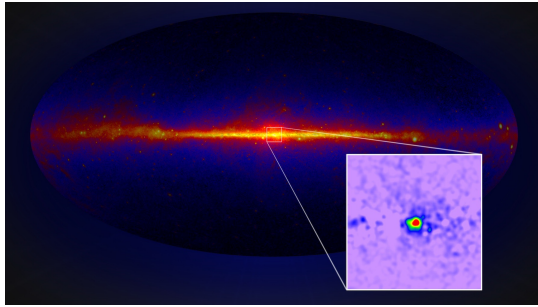


Searching for Neutron Stars in the Dense Stellar Cluster at the Center of the Galaxy

Principal Investigator: Walid Majid (335); Co-Investigators: Thomas Prince (Caltech), Karishma Bansal (NASA, AMES)

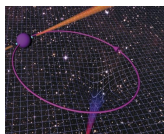
Program: FY21 R&TD Strategic Initiative

Strategic Focus Area: The Galactic Center, Dark Matter, and Millisecond Pulsars



Abstract

- The physics of the dense star clusters in the vicinity of the central black holes of galaxies is a topic of great interest in astrophysics.
- Our own Galactic Center (GC) contains the closest massive black hole and is the only nuclear star cluster that we can study in detail.
- Millisecond pulsars (MSPs) have exquisite timing stability and are considered to be precision cosmic clocks
- Finding one such MSP in orbit about the Galactic Center black hole would be a signature discovery
- The DSS-43 antenna of the DSN offers one of the best capabilities of any telescopes for high-frequency detections of MSP in the GC
- The GC harbors a radio loud magnetar, a rare class of neutron stars, offering a window into the magneto-ionic environment of dense stellar clusters



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Objectives

K-band Pulsar Survey of the GC

- Multipath scattering in the interstellar medium broadens pulses with sharp frequency dependence
- We have built a state-of-the-art pulsar backend that operates at K-band (17-27 GHz) in Canberra
- DSS-43 is the most sensitive single dish radio telescope in the southern hemisphere
- We are carrying out a survey of the inner few arcminutes around the GC region

High Frequency Observation of Magnetars

- Magnetars are a rare class of neutron stars with very high magnetic fields, providing the main engine for intense high energy outbursts
- Magnetars have flat radio spectra and are best studied at high radio frequencies, where the effects of interstellar medium are greatly reduced
- We are carrying out observations of active magnetars following high energy outbursts

Novel Detection Algorithms

- Searching for pulsars in binary systems with orbital periods longer than the duration of observations has been a computationally prohibitive task due to the large phase space, consisting of Keplerian parameters
- We are working on developing novel coherent search techniques that are capable of carrying out pulsar searches with higher derivative terms
- We plan to test and validate coherent search techniques by searching for pulsars in globular clusters, where a large number of MSPs have been identified

Publications

[A] Pearlman, A. B., Majid, W. A., Prince, T. A., et al., "Bright X-ray and Radio Pulses from a Recently Reactivated Magnetar", Submitted for publication in Nature Astronomy, arXiv:2005.08410.

[B] Bansal, K., Pearlman, A. B., Majid, W. A., Prince, T. A., et al., "Simultaneous Radio and X-ray Observations of Radio Magnetar J1818-1607", in prep (2021).

Results

Multi-frequency Observation of Magnetars

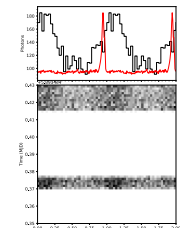
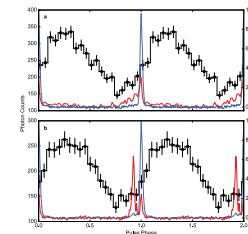
- Detailed study of single pulses from XTE J1810-197 in both radio and X-ray
- Post-outburst studies of the new member of the radio magnetar class, Swift J1818

Carried out K-band survey of the GC using DSS-43 before long downtime

- We have obtained 95 hrs of K-band data on the GC, including surrounding region
- Data quality problems persisted at DSS-43
- Developed a suite of tools aimed at cleaning and removing instrumental artifacts from the data
- Large computation cost with some degradation of sensitivity due to data quality issues

Development of novel search techniques

- Efficient sub-band search technique for single bright, but narrowband pulses
- Dynamic programming method for pulsar searches in binary systems with high-order terms



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