



# Physics of Magnetars: Highest Magnetic Field Objects in the Universe

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**Program:** Spontaneous R&TD

## PROJECT OBJECTIVE

- Obtained ToO observing time with NICER to study the magnetar emission right after its recent activation
- Make use of the unique opportunity to observe the magnetar in radio and X-ray simultaneously while in active state
- Characterize the broadband emission properties of the magnetar
- Study the time evolution of the X-ray emission
- Search for correlations in emission properties on a rotation by rotation timescale



## BACKGROUND

- Magnetars are young neutron stars with extremely strong magnetic fields:  $B \sim 10^{13} - 10^{15}$  G
- Long rotational periods and large spin down rates
- Primarily powered by the decay of their magnetic fields, serving as the energy source for their transient emission
- Of 29 known magnetars, only 4 have been active in the radio band
- XTE J1810-197 is the prototype transient magnetar
  - $P_{\text{spin}} \sim 5.54$  s;  $\dot{P} \sim 10^{-11}$  s/s;  $B \sim 2-3 \times 10^{14}$  G
- Significant flux increase in radio was observed in December 2018

## BENEFITS TO NASA & JPL

- Characterization of individual X-ray pulses with respect to their TOA, duration, pulse height, energy, and number of components
- Comparison of the time of arrival of pulses in radio and X-ray
- Study the variable nature of hot spots
- Connection between magnetospheric emission and magnetic reconnection on the surface of the star

## PUBLICATIONS

- *Majid, W., Pearlman, A., Prince, T., et al., "High Frequency Radio Observations of the Reactivated Magnetar XTE J1810-197", The Astronomer's Telegram, No. 12353.*
- *Pearlman, A., Majid, W., Prince, T. et al., "Bright X-ray and Radio Pulsations from a Recently Reactivated Magnetar", to be submitted to Nature Astronomy.*

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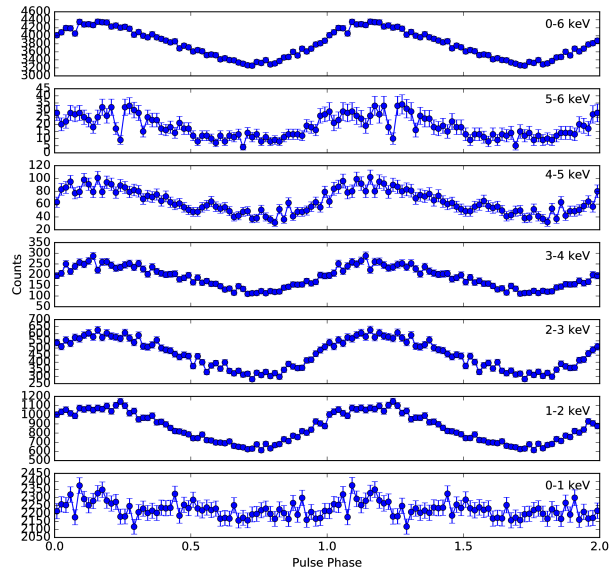
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## X-ray pulse profiles of XTE J1810-197 in different energy bands



## NICER X-ray Observatory onboard the ISS & the DSN



## Broadband single pulses in radio and X-ray

