National Aeronautics and Space Administration

FY24 Topic Areas Research and Technology Development (TRTD)

Breakthrough Science with Hybrid Radio/Optical DSN Tracking Antenna

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Objectives:

- Conduct simultaneous long-term radio and optical monitoring observations of Fast Radio Bursts (FRB) using the new hybrid radio/optical receivers on DSS-13.
- Several classes of FRB emission models predict prompt multiwavelength counterparts on the timescales of the radio burst.
- These observations will enable precise measurements of the relative optical to radio energy flux of the bursts, a key observable for discriminating between the various proposed progenitors (e.g., magnetars, binary star systems) and emission mechanisms for FRBs (e.g., prompt, afterglow).

Background:

- Fast radio bursts (FRBs) are bright, millisecond duration, radio pulses of unknown origin.
- FRBs are extragalactic phenomenon with enormous energy outputs > 10^{39} erg in the radio band alone.
- As neither the progenitors nor their emission mechanisms are known, simultaneous multi-wavelength studies of repeating FRBs across vastly different wavelengths can constrain emission models.

Technical Approach and Results:

- Successful installation and integration in RFO camera box.
- Developed acquisition pipeline with two readout modes: sustained and triggered
- Burst detection pipeline
- Commissioning of the instrument is on-going, including observations of the Crab pulsar
- Conducted science campaign with observation of several nearby and active FRBs

Significance of Results; Benefits to NASA/JPL:

- Unique scientific capabilities: simultaneous radio/optical, high time resolution, large FoV, ease of scheduling, sensitive instruments.
- Excellent sensitivity in both radio and optical, key to new discoveries in an emerging and exciting field in astronomy and astrophysics.

Acknowledgements:

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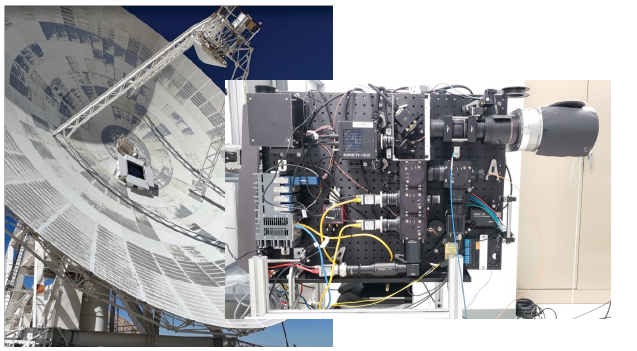
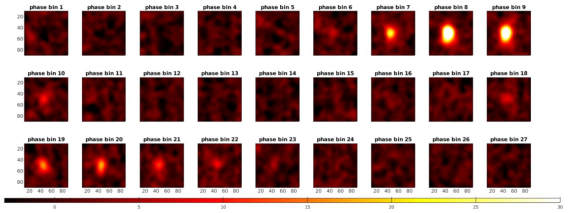
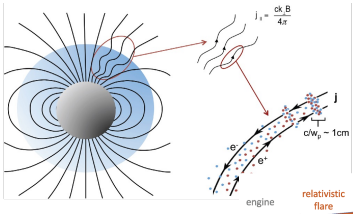


Left panel: RFO's Segmented aperture and camera box installation on DSS-13 at DSN's Goldstone complex in CA. Right panel: RFO camera box.



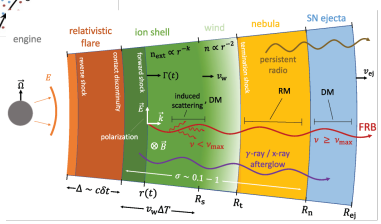
Phase-resolved millisecond imaging of the Crab pulsar: The Crab pulsar spins with a rotation period of roughly 33 milliseconds. The light from the pulsar is binned over one cycle of rotation, showing both the main-pulse (panels 7-10), and inter-pulse (panels 18-22). Since the pulsar is spinning down, the precise rotation period of the pulsar was obtained from contemporaneous radio observations.

Proposed FRB Emission Mechanisms:
Near versus Far



Kumar & Bosnjak 2020

Metzger+ 2019



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