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Revealing the Dynamic Magneto-ionic Environments of Repeating Fast Radio Burst Sources through Multi-year Polarimetric Monitoring with CHIME/FRB

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Observations of the transient phenomenon of fast radio bursts (FRBs) have provided a confounding variety of burst properties and host galaxy associations. The mechanism of their emission, the nature of their progenitor/s, the possibility of distinct subpopulations and their utility as probes all remain open questions. Repeating FRB sources offer a promising avenue for approaching some of these questions by enabling spectral, temporal and polarimetric properties to be tracked over time. However, despite a published sample of over 20 repeating sources, very little is known of the long-term behavior of repeating sources and polarimetric observations have historically been confined to a small fraction of the published sample. The FRB survey operating on the Canadian Hydrogen Intensity Mapping Experiment (CHIME) is an ideal instrument for probing this unknown domain of FRB phase space, proffering a large and rapidly growing sample of repeating FRB sources that can be studied individually as well as in aggregate.

In this talk, I report on polarized observations of nearly one hundred bursts from 14 previously published repeating sources [1, 2] using multi-year monitoring with CHIME/FRB over 400-800 MHz. The sample includes the periodically active source, FRB 20180916B [3], from which 42 bursts spanning 2018 December to 2021 November are analyzed. We find significant variations in the Faraday rotation measure (RM) from FRB 20180916B, including an apparent secular increase in RM of ~ 40 $rad\ m^{-2}$ (a fractional change of over 30%) over seven months. The absence of a substantial difference in the average RM variability of bursts occurring within and across the 16.33 day activity cycle places helpful limits on the degree to which the unknown mechanism of periodic activity probes the dynamic magneto-ionic environment of the source.

Significant RM variations are observed in many other sources of this sample, including RM changes of several hundred $rad\ m^{-2}$ in bursts from FRB 20181119A and FRB 20190303A. The erratic RM variations seen from several repeating FRB sources challenge simple models that predict more secular evolution if the RM is produced by an evolving shocked medium near the source [e.g. 4]. Combining these observations with constraints on variability in dispersion measures (DMs) enables lower bound estimates to be calculated for the average line-of-sight magnetic field strength in the local environment of each repeater. In general, repeating FRBs display RM variations that are more prevalent and extreme than those seen from radio pulsars in the Milky Way and the Magellanic Clouds, which may suggest that FRBs and pulsars occupy distinct magneto-ionic environments.

1. CHIME/FRB Collaboration, Andersen, B. C., Bandura, K., et al., "CHIME/FRB Discovery of Eight New Repeating Fast Radio Burst Sources", *ApJL*, **885**, October 2019, L24, doi: 10.3847/2041-8213/ab4a80.

2. Fonseca, E., Andersen, B. C., Bhardwaj, M., et al., "Nine New Repeating Fast Radio Burst Sources from CHIME/FRB", *ApJL*, **891**, February 2020, L6, doi: 10.3847/2041-8213/ab7208.

3. CHIME/FRB Collaboration, Amiri, M., Andersen, B. C., et al., "Periodic activity from a fast radio burst source", *Nature*, **582**, June 2020, pp. 351-355, doi: 10.1038/s41586-020-2398-2.

4. Piro, A. L., & Gaensler, B. M. 2018, "The Dispersion and Rotation Measure of Supernova Remnants and Magnetized Stellar Winds: Application to Fast Radio Bursts", *ApJ*, **861**, July 2018, 150, doi: 10.3847/1538-4357/aac9bc.