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Unveiling the Spectro-temporal Behavior of Repeating Fast Radio Bursts at High Radio Frequencies

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Fast radio bursts (FRBs) are transient pulses of radio emission that have observed temporal widths ranging from microseconds to milliseconds and fluences between ~0.01-1,000 Jy ms. To date, multiple radio bursts have been detected from 22 out of 137 sources, which apparently distinguishes them from the so-far non-repeating FRB population. The radio bursts from repeating FRBs display a wide variety of complex time-frequency structures that encode valuable information about the source's local environment, underlying emission mechanism(s), and the intervening media along the line of sight. In particular, their bursts are often narrowband and sometimes display peculiar spectral behavior, such as bursts with subpulses that drift downwards in frequency with time (the "sad trombone" effect). Simultaneous, broadband multifrequency observations of repeating FRBs are therefore crucial for quantifying their emission behavior and distinguishing between intrinsic and extrinsic effects.

We present results from a long-term multiwavelength radio monitoring campaign of two repeating FRB sources, FRB 121102 and FRB 180916.J0158+65, with the NASA Deep Space Network (DSN) 70-m radio telescopes (DSS-14, DSS-43, and DSS-63). We observed FRB 121102 simultaneously at 2.3 and 8.4 GHz for 33.0 hr between 2019 September 6 and 2020 February 11. We detected a total of 8 bursts that were visible in the 2.3 GHz frequency band, but no emission was detected at 8.4 GHz, despite the larger bandwidth and greater sensitivity in the higher frequency band. We also observed FRB 180916.J0158+65, which displays a 16.35 d periodicity in the arrival times of its radio bursts, for 101.8 hr between 2019 September 19 and 2020 May 14. Our observations of FRB 180916.J0158+65 spanned multiple activity cycles during which the source was known to be active and covered a wide range of activity phases. Several of our observations occurred during times when bursts were detected from the source between 400-800 MHz with the Canadian Hydrogen Intensity Mapping Experiment (CHIME) radio telescope. However, no radio bursts were detected from FRB 180916.J0158+65 at any of the frequencies used during our observations with the DSN radio telescopes. We find that FRB 180916.J0158+65's apparent activity is strongly frequency-dependent due to the narrowband nature of its radio bursts, which have less spectral occupancy at high radio frequencies (> 2 GHz). We also find that fewer or fainter bursts are emitted from the source at high radio frequencies. In this talk, we will discuss these results and their implications on possible progenitor models of repeating FRBs.