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A nanosecond-duration radio burst generated by a defunct satellite

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1 Extended Abstract

Astronomy — and in particular the study of transient sources — is increasingly affected by spacecraft–borne interference. This can originate due to both intentional and unintentional transmission, but little is known about the properties of satellite-borne interference at very short (sub-millisecond) timescales.

Here, we report the detection of an intense burst of radio emission on 2024 June 13$^{\text{th}}$ 05:13:09.035 UTC, over a 695.5 MHz–1031.5 MHz bandwidth by the Commensal Realtime ASKAP Fast Transients Survey (CRAFT) coherent detection system, CRACO, on the Australian Square Kilometre Array Pathfinder, ASKAP. We find that the observed burst dispersion measure of $2.26 \cdot 10^{-5}\,\mathrm{pc\,cm^{-3}}$ (69.7 TECU), rotation measure of $1.5\,\mathrm{rad\,m^{-2}}$, arrival direction, and reconstructed near-field distance of 4500 ± 80 km are all consistent with the burst arriving from the Relay 2 satellite, which was decommissioned over 50 years ago.

The application of coherent de-dispersion enabled us to limit the burst width to be at most 30 ns, with an average flux density of at least 300 kJy, as shown in the left panel of Figure 1. However, the width and magnitude of the burst peak are limited by our time resolution and dynamic range, respectively, and we infer a peak flux density of at least 3 MJy over a timescale of 3 ns. As shown in the right panel of Figure 1, we find the burst to be almost 100% linearly polarised, except for two narrow bands of circularly polarised emission.

We consider a fast electrostatic discharge (ESD) from a charged spacecraft surface or a plasma cloud generated by a micrometeoroid impact to be potentially plausible explanations for the observed radio emission, and examine each scenario. Neither is wholly satisfactory: ESDs from solar panels on geostationary satellites have previously been observed with the Arecibo radio telescope, but with durations of microseconds not nanoseconds, while laboratory simulations of micrometeoroid impacts also suggest a much longer emission timescale and lower peak frequency.

These unexpected results

1. open new possibilities for the remote sensing of spacecraft-threatening ESDs (potentially requiring just a few square metres of collecting area); and
2. reveal a new source of spurious foreground events for observations of astrophysical transients in general and astroparticle detection experiments in particular.

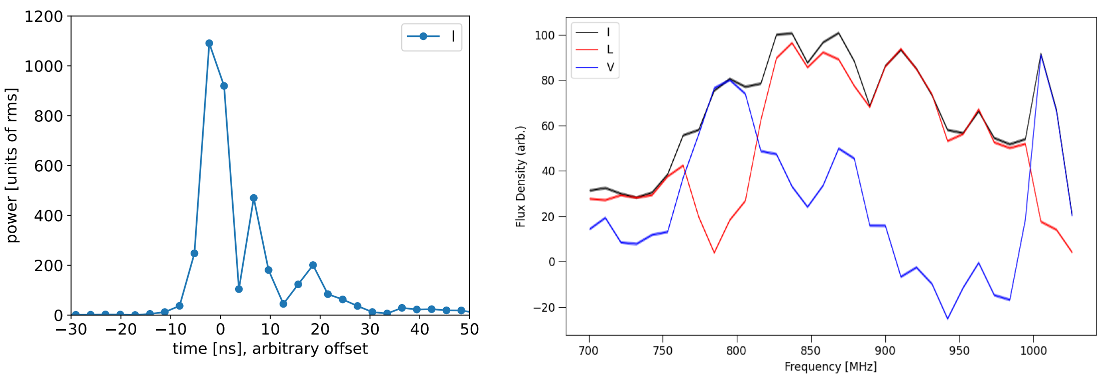

Figure 1. Left: The dedispersed burst. Total burst power at Nyquist resolution (marked with points — connecting line is to guide the eye only) after dedispersion and coherent summation. 19 antennas were beamformed using a nearfield delay model. We emphasise that the 1-bit sampling precision of the recorded antenna voltages limits the accuracy of the signal reconstruction, in particular the peak amplitude. **Right: Polarisation properties of the burst.** Total power (I), total linear polarisation (L), and total circular polarisation (V) flux densities are plotted in arbitrary units as a function of frequency.