Unidentified FRBs in archival data

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FRB 010312

Recently Zhang et al. (2019) reported the discovery of FRB 010312. This event occurred during a survey of the Magellanic Clouds and surrounding regions wherein the first fast radio burst, FRB 010724, was discovered (Lorimer et al. 2007). The reported signal-to-noise ratio (S/N) of FRB 010312 is 11, for a pulse width of 24(1) ms. Examining the data[1] with DESTROY[2], and performing no RFI mitigation, we confirm the burst detection and obtain a S/N= 12 with a pulse width of 37^{+17}_{-8} ms, at the reported dispersion measure. This implies a peak flux density of ~ 150 mJy and specific fluence of ~ 5.6 Jy ms if the signal occurred at boresight. As Zhang et al. point out, their detection brings this survey more in-line with other expectations for the FRB rate (Champion et al. 2016; Bhandari et al. 2018).

WHY MISSED?

Much more interesting than the above minutiae is why and how this event was missed in the previous analyses of these data. The survey was originally searched (Crawford et al. 2016) using SEEK from the SIGPROC[3] software suite. This algorithm uses down-sampling and smoothing processes in searching a time series, that can result in under-estimated S/N values; these steps were initially motivated as a time saving measure to overcome computational constraints that now no longer exist. The upshot is that the S/N values reported by SEEK can be degraded by as much as a factor of $\sqrt{2}$ (Keane & Petroff 2015). For FRB 010312, this exact scenario occurred and the detection S/N determined was 8 and based on this the candidate was dismissed as sub-threshold.

RE-PROCESSING ARCHIVAL DATASETS

Several archival datasets have only been searched using this and other pipelines that perform similarly or worse. Without re-processing these data with something optimised[4], in the worst case the true detectable population of FRBs in a dataset could, in a Euclidean Universe, be $2^{3/4} \approx 1.65$ times larger than one might initially estimate, i.e. a 10σ threshold would in fact be a 14σ threshold. Reprocessing these same data sets in search of radio pulsars as ever more sophisticated search techniques are developed, as RFI mitigation procedures improve and as computational constraints disappear has been successful over and over again (see Knispel et al. 2013 and references therein). This was, of course, true for the original FRB discovery and the same is likely true for FRB searches generally. As well illustrated by FRB 010312, there is potentially a large number of missed FRBs in datasets that have already been searched. The situation may even be more stark when we consider how difficult it is to mitigate radio frequency interference and that all FRB searches ever performed have looked for temporally symmetric broadband flat-spectrum pulses, and most FRBs do not look like that. We encourage further work using multiple search codes, where possible, and also searching a broad DM and pulse width range.

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[1] The relevant survey pointing is SMC018_034.
[2] https://github.com/evanocathain/destroy_gutted
[3] http://sigproc.sourceforge.net/
[4] For example HEIMDALL, a GPU-based single pulse search code — https://sourceforge.net/projects/heimdall-astro/

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