New Horizons in Time-Domain Astronomy
Proceedings IAU Symposium No. 285, 2011
R.E.M. Griffin, R.J. Hanisch & R. Seaman, eds.

doi:10.1017/S1743921312001007

What To Do with Sparkers?

E. F. Keane[1], B. W. Stappers[2], M. Kramer[1,2] and A. G. Lyne[2]

[1]Max Planck Insitut für Radioastronomie, 53121 Bonn, Germany.
email: ekeane@mpifr-bonn.mpg.de

[2]School of Physics & Astronomy, University of Manchester, Manchester M13 9PL, UK.

Abstract. In 2007, the discovery of the so-called "Lorimer Burst" was announced—a single radio pulse that was so dispersed that it could only have originated outside our Galaxy. The apparently unique event, together with the large inferred distance (a redshift z ∼0.2 is required to explain its high dispersion) implies a very high luminosity. Suggested progenitors include a supernova, a binary neutron-star merger, and a black-hole annihilation event. Crude estimates of the rates of such events predict that many such bursts should already be detectable in archived pulsar-survey data, and has led to detailed searches which have had some success.

Keywords. Surveys, stars: evolution, stars:neutron, stars:supernovae:general, ISM:general

---

1. Pulsar Searches and the Lorimer Burst

Fourier-domain searches are the ones most commonly used for identifying new pulsars. However, searches for the brightest individual pulses are the best way to discover certain highly-modulated pulsars (the so-called "RRATs"; Keane & McLaughlin 2011), and perhaps the *only* way of finding extra-galactic pulsars. In 2007 Lorimer *et al.* (2007) reported the discovery of a single 5-ms 30-Jy pulse with a very high DM (dispersion measure) of 375 cm^{-3} pc, of which only 25 cm^{-3} pc is attributable to material in the Galaxy for that line of sight (Cordes & Lazio 2002). The pulse obeyed the theoretical dispersion law and showed frequency-dependent broadening consistent with interstellar scattering. It was detected in 3 of the 13 beams of the telescope receiver, as expected for a boresight signal. Despite many tens of hours of follow-up a second pulse was never observed. The interpretation of the burst was of a very bright, single event originating at a cosmological distance, with suggested progenitors including a supernova, a binary neutron-star merger, and black hole annihilation.

2. "Perytons"

Recently Burke-Spolaor *et al.* (2011) have identified a number of radio bursts in data from the on-going High Time Resolution Universe Survey; they are relatively weak, and are seen in all 13 beams of the receiver that is used. These are characteristic of radio-frequency interference (RFI), but uncharacteristically for RFI they are dispersed (although with certain "kinks" in their dispersive sweeps). It was initially reported that all of these "peryton" events were at the same DM as the Lorimer burst, raising (by association) an air of suspicion over that particular value of DM. However, the search only considered pulses in the DM range 200–500 cm^{-3} pc, and as more such signals have since been identified they are now seen to span that range. Furthermore, recent work shows that these signals, when detected, arise ∼80% through each integer second of time (UTC), with characteristic 22-second gaps (Kocz *et al.* 2011). These signals are therefore clearly terrestrial.

3. J1852−08: A Second "Sparker"?

A recent successful search of the Parkes Multi-beam Pulsar Survey for bright bursts with DM from 0–2000 cm^{-3} pc has, amongst numerous discoveries, resulted in the identification of J1852−08 (Keane *et al.* 2011). This 7-ms pulse has a lower flux density than the Lorimer burst but is strongly detected and, like the Lorimer burst, shows the theoretically-expected dispersion sweep with a DM of 745 cm^{-3} pc. According to the NE2001 model for the Galactic electron density distribution (Cordes & Lazio 2002), 222 cm^{-3} pc of that must be explained by the intergalactic medium and any putative host galaxy. The inferred redshift is $z \sim 0.1$ (or a distance of $\sim 0.5h^{-1}$ Gpc in the standard cosmological model). There seem to be two possible explanations for the nature of J1852−08. The first is that the NE2001 model is incorrect for that line of sight and so the event is actually a "giant pulse" from a Galactic pulsar. The second is that the NE2001 model is reliable, so the distance, and hence the luminosity, is too large to be due to the brightest giant pulse known from any pulsar, and that the observation was a "single event". The first possibility can be investigated readily through observation. If J1852−08 were a giant pulse-emitting pulsar (like the Crab), then since the pulse was well above our detection threshold we would expect to have observed many weaker pulses in the original 35-minute survey pointing. Those were not seen, but to exhaust the possibility a total of 16 hours of follow-up observations were performed at the Parkes Observatory, resulting in no detection. Thus, if NE2001 is incorrect then J1852−08 would also necessarily have the most extreme pulse amplitude distribution of any known pulsar. The second possibility therefore seems more likely, as even though we cannot prove that the event was unique the probability increases the longer we do not see any repetition of it. For further proof we might look for a gravitational-wave signal. However, as the event actually occurred on the 2001 June 21 it was a pre-LIGO and pre-GEO600 event so no gravitational-wave counterpart can be sought. The same holds for the Lorimer burst on 2001 August 24.

4. Outlook—What to Do with Sparkers?

The lag (of ∼10 years!) between occurrence and discovery of these two bursts means that there is no more that can be done to investigate their actual progenitors. However, as we enter the era of "real-time all-sky" monitoring, detection rates should increase dramatically. Every next-generation radio telescopes has Transients as a key science goal. With future instruments like LOFAR and (in the next decade) the SKA, it is vital to plan for "multi-messenger" confirmations; they may take the form of cross-community automated alerts and/or ATels. Such moves are essential for solving the mystery of sparkers.

References

Burke-Spolaor, S., *et al.* 2011, *MNRAS*, 416, 2465.

Cordes, J. M. & Lazio, T. J. W. 2002, astro-ph/0207156.

Keane, E. F., Kramer, M., Lyne, A. G., Stappers, B. W., & McLaughlin, M. A. 2011, *MNRAS*, 415, 3065.

Keane, E. F. & McLaughlin, M. A. 2011, *BASI*, 39, 1.

Kocz, J., Bailes, M., Barnes, D. Burke-Spolaor, S., & Levin, L. 2011, *MNRAS*, in press.

Lorimer, D. R., Bailes, M., McLaughlin, M. A., Narkevic, D. J., & Crawford, F. 2007, *Science*, 318, 777.

https://doi.org/10.1017/S1743921312001007 Published online by Cambridge University Press