A new kind of radio transient: ERBs

Douglas Scott* and Ali Frolop†

Dept. of Physics & Astronomy, University of British Columbia, Vancouver, Canada

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We describe the discovery of a new kind of radio transient, which we call “early-riser bursts” or ERBs. We found this new class of source by considering traditional radio searches, but extending into the complex plane of dispersion measure. ERBs have the remarkable property of appearing before they are searched for. We provide suggestions for the most likely origin of this new astronomical phenomenon.

I. INTRODUCTION

Time-domain astronomy is exploding. It used to be that progress happened in a uniform and continuous way, but increasingly in the past few decades we have seen abrupt eruptions of activity, with new science ideas cropping up unexpectedly.

An obvious example of this is the sudden appearance of models of transient events in the radio sky [1]. Some of these ideas have even been accompanied by empirical evidence for the existence of such events, e.g. “fast radio bursts” or FRBs.

Originally discovered using data from the Parkes Observatory, FRBs are now being routinely detected using the CHIME instrument [2]. This year, for the first time there are probably more individual FRB events than different theories to explain them [3], and so it is time to consider whether there may be entirely new classes of transient source to discover.

II. DETECTION OF FRBS

Knowing that FRBs were originally found by broadening the parameter space in searches for pulsars, we want to further extend how transient events are found in radio data to see if we can uncover something new.

A key phenomenon to consider for the detection of FRBs is that the radio waves are dispersed by the plasma through which they travel, so that high frequencies arrive earlier than low frequencies. The time delay depends on a quantity called “dispersion measure”, usually given the variable name “DM” [4]. The delay between frequencies $\nu_{\text{low}}$ and $\nu_{\text{high}}$ is then

$$\Delta t \propto (\frac{1}{\nu_{\text{low}}} - \frac{1}{\nu_{\text{high}}}) \times DM.$$  \hspace{1cm} (1)

One has to correct for this effect in order to optimise the signal-to-noise ratio of the burst. However, FRBs are detected with a wide set of values of dispersion measure and hence it is necessary to search over a range of DM when looking for transient signals that are dispersed according to frequency.

Several algorithms exist for performing this search task, e.g. direct dedispersion [5], brute-force dedispersion [6], tree dedispersion [7], subband dedispersion [8], subversion dedispersion [9] and cast-aspersion dedispersion [10]. We have developed a new approach for undoing the effects of dispersion, which we just call “spersion”. We then used this method to search for new kinds of radio transient.

It is well known that the first FRB, the Lorimer Event, was discovered when a search was mounted over a wider range of DM than normally considered [11]. Inspired by this, we decided to search the radio archive for sources with negative DM values. This would be a natural signal for alien intelligences to send to us, since it is not something that the interstellar medium can make naturally. Inspired by recent suggestions [12] that unusual astronomical signals might have their origin in extraterrestrial civilisations [13], we used spersion to perform a search into the negative DM region.

Unfortunately this investigation was unsuccessful, and we found no obvious evidence of bursts of this kind produced by intelligent aliens. However, undeterred, we then extended our net further and found something even more remarkable.

III. DETECTION OF ERBS

Most dedispersion methods use intensity data, i.e. the incoherent signal, coming from the square of the electric fields. It is possible instead to directly examine the coherent data. Dedispersion then corresponds to multiplying the $E$ field signal by a (frequency-dependent) pure phase. By extending the phase factors into the full complex plane we can broaden the scope of dedispersion patterns that are applied to interferometric signals. We specifically found that it is interesting to explore imaginary DMs, in analogy with the use of “imaginary time” in certain approaches to special relativity and quantum mechanics, i.e. we are considering a Wick rotation in the DM complex plane [14].

Carefully searching through the data archive in this way, we discovered the first example of an entirely new class of source. We call these “early-riser bursts” or

*Electronic address: docslugtoast@phas.ubc.ca
†Electronic address: afrolop@phas.ubc.ca
ERBs. This kind of event is even more unexpected than we expected. Because of the complex dedispersion applied to the finite-time window of the radio data sets, these ERBs literally happen just before you look for them. This behaviour explains why they had previously escaped attention. Such a phenomenon is not unknown to science, with the ERBs behaving in a similar way to the properties of “thiotimoline”, described more than half a century ago in chemistry [15].

IV. WHAT ARE ERBS?

There are several possibilities for the origin of these early-riser bursts, which we now examine in turn.

1. ERBs are just the tail of the distribution of FRBs. This seems the least likely explanation.

2. ERBs arise from some systematic or instrumental effect, perhaps a local household appliance masquerading as burst signals. This kind of explanation has no precedent and is thus also very unlikely.

3. ERBs are related to a mild form of Lorentz violation. All that is required is that the signal in one special direction appears to be going faster than the speed of light. Surely no one would suggest such a thing to explain puzzling experimental data.

4. This leaves the most plausible ERB explanation being fabrication by hyper-intelligent aliens. Conventional FRBs have already been claimed to be of alien origin [16]. Moreover, when the object ‘Oumuamua passed through the Solar System there were suggestions that it might be an artificial structure [17], after which efforts were made to look for SETI-like signals from it [18]. The null results of these experiments are easily explained by the fact that no one thought to look for ERBs that would appear before the search even started.

V. RELATIONSHIP TO OTHER TYPES OF BURST

Other kinds of transient event are also known. Gamma-ray bursts (GRBs), were first discovered in the 1960s and determined to be extragalactic explosions after three decades of study. They are now recognised to be the most luminous electromagnetic events in the Universe. Many models have been proposed to explain GRBs [19], including that they may be signals deliberately generated by aliens [20] or perhaps extraterrestrial civilisations winking out of existence [21].

Fast radio bursts (FRBs) are now more than a decade old [22], and their origin is still largely a mystery. Nevertheless, aliens are again being invoked as the explanation.

Now we also have a third class of source, the early-riser bursts (ERBs), with non-Earth intelligence being their most likely origin.

How exactly are these different kinds of bursts related to each other and to other kinds of transient source? We would like to propose that whatever they turn out to be, the next type of burst to be discovered will be the DRBs. These will no doubt be followed by CRBs, BRBs and ultimately by ARBs. We would also suggest that if old enough data are examined carefully, then there may well be evidence for other types of transient event, such as HRBs, existing before the discovery of GRBs.

VI. CONCLUSIONS

Several recently discovered astronomical observations have their explanations in alien activity, with ERBs being just the latest example. With astronomers now embracing the idea that we are regularly seeing phenomena coming from extraterrestrial intelligence [23], we should also be considering other creative explanations for mysterious events in the sky.

The present authors would like to point to some related ideas of their own that have already been published [24]. However, we feel that further progress can only be made by being even more open-minded and imaginative. There are already serious discussions in the literature regarding ideas such as parallel universes, worm-holes, cosmic strings and variable speed of light theories. We believe that astronomers should be thinking about combinations of such explanations for celestial phenomena. For example, we should be considering explanations for GRBs that involve extraterrestrial civilizations and doomsday devices, FRB models that come from alien megastructures plus warp drives, and ERBs having their origin in ETs using time travel. In fact, perhaps the best explanations will ultimately come from multiple combinations, such as teleporting aliens from alternative realities being seen through wormholes [25].

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[2] CHIME/FRB Collaboration, 2019, Nature, 566, 230–234; CHIME, the Canadian Huge Instrument for Measuring Explosions, was given its name because when an FRB signal arrives it makes the whole interferometer ring or “chime” at radio frequencies.
[3] Platts E., et al., 2019, Phys. Rep., in press, arXiv:1810.05836 “A Living Theory Catalogue for Fast Radio Bursts”.
[4] Two letters are used here, rather than following the convention of single letter vari-
ables names, in order to avoid any ambiguity: https://www.acronymfinder.com/DM.html.

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[7] Taylor J.H., 1974, A&AS, 15, 367.
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[9] svn:dedispersion
[10] OK, we made this one up.
[11] Lorimer D.R., et al., 2007, Science, 318, 5851.
[12] Wright J.T., et al., 2016, ApJ, 816, 17, “The Search for Extraterrestrial Civilizations with Large Energy Supplies. IV. The Signatures and Information Content of Transiting Megastructures”; Matloff G.L., 2017, JBIS, 70, 210, “A Rationale for Alien Megastructures”; Wright J.T., Oman-Reagan M.P., Int. J. Astrobiol., 2018, 17, 177, “Visions of human futures in space and SETI”; Nishino Y., Seto N., 2018, ApJ, 862, L21, “The Search for Extra-Galactic Intelligence Signals Synchronized with Binary Neutron Star Mergers”; Lund M.B., arXiv:1703.10432 “Detecting the Ultimate Power in the Universe with LSST”.
[13] Some might see this as a trend for professional astronomers to admit that they mostly wanted to study aliens rather than astrophysics all along.
[14] To understand this, consider a system with cylindrical symmetry, perhaps like a candle. “Wick rotations” are those that just rotate the central part, while leaving the outer part unrotated.
[15] Krum P., Eshkin L., 1944, J. Chem. Solub., 27, 109–114, “Concerning the Anomalous Solubility of Thiotimoline”; Krum P., Eshkin L., Nile O., 1945, Ann. Synth. Chem., 115, 1122–1145 and 1208–1215, “Structure of Thiotimoline. Parts I and II”; Asimov I., 1948, Astound. Sci., Vol. 41, No. 1, 120-125, “The Endochronic Properties of Resublimated Thiotimoline”.
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[18] Harp G.R., et al., 2019, Acta Astron., 155, 51–54; Enriquez J.E., 2018, RNAAS, 2, 9.
[19] Nemiroff R.J., 1994, Comm. Astrophys., 17, 189, “A Century of Gamma Ray Burst Models”.
[20] Ball J.A., 1995, “Gamma Ray Bursts: The ETI Hypothesis”.
[21] Robinson S., 2000, “Calahan’s Key”, Bantam Spectra, New York; here GRBs are referred to as “warhols”.
[22] Lorimer D.R., 2018, Nat. Astron., 2, 860, “A decade of fast radio bursts”.
[23] Following the well-known quote from Carl Sagan: “Ordinary claims require extraordinary explanations”.
[24] See some earlier papers with related ideas: Scott D., Frolop A., 2006, astro-ph/0604011 2007, astro-ph/0703783 2008, arXiv:0803.4378 2014, arXiv:1403.8115 Ali Frolop, Ali and Frolov, Frolov A., Scott D., 2016, arXiv:1603.09703.
[25] Any aliens reading this paper who want to send comments should email the second author, Dr. Frolop.