Long Wavelength Astrophysics

by

Liam Dean Connor

A thesis submitted in conformity with the requirements
for the degree of Doctor of Philosophy
Graduate Department of Astronomy and Astrophysics
University of Toronto

Abstract

Long Wavelength Astrophysics

Liam Dean Connor

Doctor of Philosophy

Graduate Department of Astronomy and Astrophysics

University of Toronto

2016

Acknowledgements

Contents

List of Tables

Chapter 1

Introduction

1.1 Digital Telescopes

1.2 Time-domain Sky

1.2.1 Dispersion

1.2.2 Scattering

1.3 Fast Radio Bursts

The discovery of fast radio bursts has captivated the attention of astronomers for two reasons: their origin is a genuine mystery, the likes of which had not been seen in transient astrophysics in decades; and the problem appears to be tractable on timescales of years to a decade. There is good reason to think that with the right survey one could at least determine their approximate radial distance, as well as the nature of the burst source, if not specific details. This is not true of the tensor-to-scalar ratio, r, in inflationary cosmology, or the deviation of dark energy's w from -1, which one might constrain with arbitrary improvements without ever making a detection.

The first FRB was discovered in 2007 by Lorimer et al. (2007), and has since been called the "Lorimer Burst". Its Galactic latitude ($b = -41.8°$) and large dispersion measure (DM= 375 pc cm^{-3}) implied that the ∼10 millisecond burst was extragalactic (Lorimer et al., 2007). However, in the years immediately following, no fast transients were seen with DMs exceeding the expected Galactic contribution. This lead to skepticism about the celestial nature of the Lorimer Burst and suspicion that it was terrestrial interference (Burke-Spolaor et al., 2011).

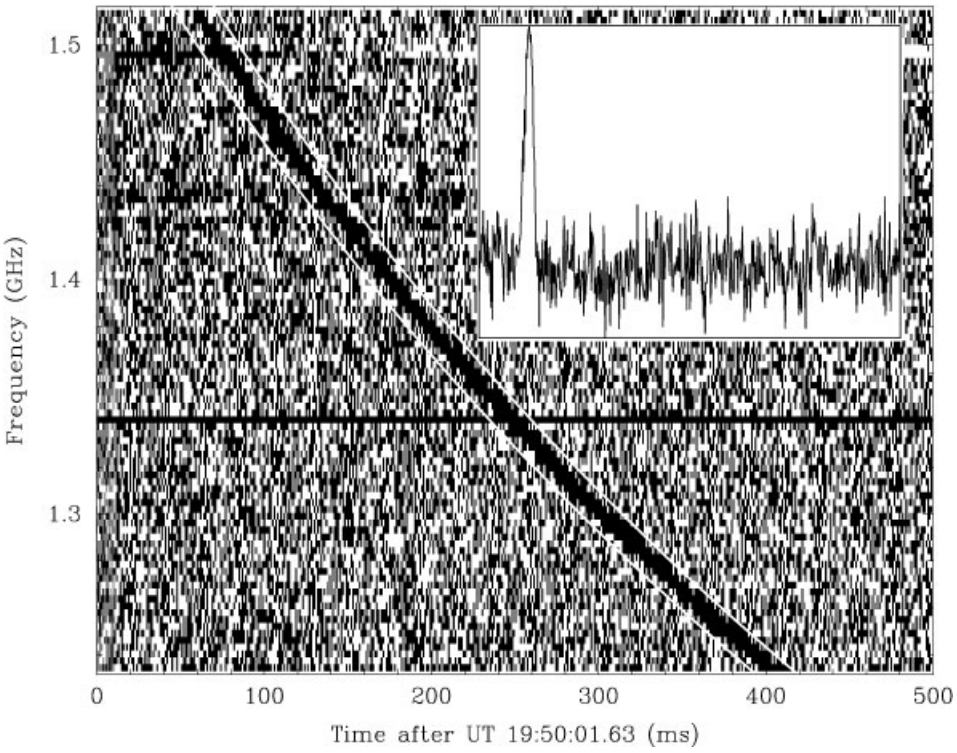

Figure 1.1: Figure reproduced from (Lorimer et al., 2007) of the so-called Lorimer Burst, which is the first known FRB.

Suspicion that this was a one-off event was relinquished with the discovery of four more FRBs in 2010 in the High Time Resolution Universe (HTRU) survey (Thornton et al., 2013). Though their detection made a much stronger case for the extraterrestrial

nature of FRBs, it was not unequivocally accepted. This is because until the discovery of FRB 121102 in Arecibo's Pulsar ALFA (PALFA) survey, all FRBs had been found with the Parkes radio telescope and in its 13-beam receiver. At Parkes, an unexplained "class" of transients were found in high time resolution data that appeared to be dispersed with hundreds of pc cm^{-3}, and which lasted for ten to a few hundred milliseconds (Burke-Spolaor et al., 2011; Bagchi et al., 2012). These pulses were given the name "Perytons", named after a mythological hybrid animal.

While an astronomical origin for Perytons was excluded early on due to their multi-beam detections, it was not obvious if they were being emitted in the earth's atmosphere naturally, or by something human-made (Katz, 2014; Dodin & Fisch, 2014; Danish Khan, 2014). It was later found by Petroff et al. (2015) that Perytons were likely caused by an on-site microwave oven. The microwave's magnetron was found to mimic the sweeping λ^2 dependence of truly dispersed sources when the oven's door was opened prematurely (Petroff et al., 2015).

1.3.1 Models

1.4 Pulsar thing

1.5 Thesis Outline

Bibliography

Bagchi, M., Nieves, A. C., & McLaughlin, M. 2012, MNRAS, 425, 2501

Burke-Spolaor, S., Bailes, M., Ekers, R., Macquart, J.-P., & Crawford, III, F. 2011, ApJ, 727, 18

Danish Khan, M. 2014, ArXiv e-prints, arXiv:1404.5080

Dodin, I. Y., & Fisch, N. J. 2014, ApJ, 794, 98

Katz, J. I. 2014, ApJ, 788, 34

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

Petroff, E., Keane, E. F., Barr, E. D., et al. 2015, MNRAS, 451, 3933

Thornton, D., Stappers, B., Bailes, M., et al. 2013, Science, 341, 53