“Plenty of Room at the Bottom”: Fast Radio Bursts in our Backyard

Abstract & Self-Introduction for Emmanuel Fonseca (WVU)

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Title: FRB Morphology as a (Possible) Indicator of Multiple Populations

Abstract: The increasing population of repeating fast radio burst (FRB) sources continues to highlight striking emission behavior. Specifically, repeating-FRB sources often exhibit band-limited, “downward-drifting” features in their dynamic spectra that appear to be distinct from known Galactic pulsars and magnetars. With many hundreds of FRBs now observed, it is gradually becoming clear that the FRB population can be delineated based on morphologically “simple” and “complex” structure, with all confirmed repeating-FRB sources falling into the latter category. This circumstance poses a series of interesting questions regarding the existence of multiple populations, choices in characterization of FRB morphology, morphology-based classifications of source types, and the weighting of follow-up observations of possibly repeating FRB sources.

Pleunis et al. (2021, ApJ, 923, 1) performed a comprehensive morphological study of the first source catalog produced by the Canadian Hydrogen Intensity Mapping Experiment (CHIME) FRB project. All FRBs in the first CHIME/FRB catalog were modelled assuming a running power-law form for the spectral energy distribution, as well as an intrinsically Gaussian temporal shape. While arbitrary, this parameterization is flexible to burst shapes that reflect either power-law or Gaussian spectral energy distributions. The best-fit estimates of spectral parameters and burst widths yield phases spaces that show statistically significant separations between confirmed repeating FRBs and apparently non-repeating FRBs. A summary of these differences is shown in Figure 1 below.

While instrumental biases and off-center detections can impact the observed morphology, these selection effects impact all signals detected by CHIME/FRB and thus the observed differences in distributions are believed to be astrophysical in origin. Whether the variations in morphology reflect differences in source environments, progenitor types, or orientation is the subject of debate.

The growth of the overall FRB catalog and discovery of new repeating FRBs, each with extreme morphological and polarimetric properties, have only strengthened the apparent differences in parameter distributions. Concurrently, recent FRB results have generated interest in searching for Galactic analogs of FRB sources. While the existing pulsar literature has pointed towards simple power-law forms of the spectral energy distribution, renewed probing of single-pulse morphology in various Galactic environments may bare

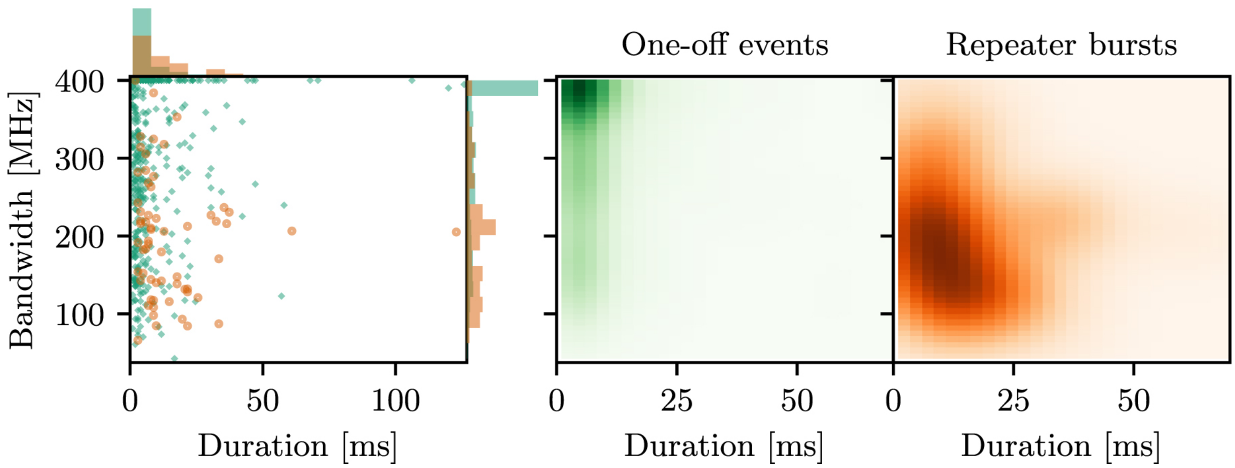

Figure 1: The distribution of FRB widths in time and frequency as evaulated for CHIME/FRB detections, which are performed in the 400-800 MHz range.

fruit in possible morphological associations with FRB sources. Galactic sites of recent interest include magnetars, pulsars within supernova remnants, binary pulsars with main-sequence companions, and "rotating radio transients."

In my talk, I will describe FRB morphology from an observational perspective and initially compare historical analyses of noted pulsars with current FRB results. I will then describe the methods used by the Canadian Hydrogen Intensity Mapping Experiment (CHIME) FRB collaboration to characterize morphology in a uniform manner. Finally, I will highlight student-led results that collectively yield features in spectro-temporal phases spaces that may be used for a variety of observational and theoretical purposes.

Self-Introduction: I currently work as an assistant professor at WVU, specializing in observational pulsar and FRB astrophysics as well as telescope instrumentation. Prior to joining WVU in late 2021, I worked as a postdoctoral researcher in Prof. Vicky Kaspi's group at McGill University in Montréal, Québec, Canada, from late 2016 till early 2021; during these years, I helped create the software and hardware that comprise the CHIME/Pulsar and CHIME/FRB backends. I previously attended the University of British Columbia from late 2010 to late 2016, where I obtained my Ph. D in astronomy under the mentorship of Prof. Ingrid Stairs; I joined the North American Nanohertz Observatory for Gravitational Waves (NANOGrav) during my graduate career, and continue to work with NANOGrav colleagues on a variety of efforts. Before moving to Canada, I attended the Pennsylvania State University for my baccalaureate studies, from 2006 till 2010. I was born and raised through the public education system in Malden, Massachusetts, to where my parents immigrated from Bogota, Colombia. I love listening to, playing, and creating music, and enjoy learning about the histories of conflict and progress.