Deciphering the Origins of FRBs using Local Universe CHIME Bursts

Fast radio bursts (FRBs) are energetic radio pulses of high brightness temperature ($\sim 10^{35}$ K) and millisecond duration. In spite of the fact that more than 1000 FRBs have been discovered to date, their nature continues to be a subject of intense debate, owing in part to a limited sample of localized FRBs. To unveil the nature of FRB sources, identification of FRB multi-wavelength counterparts as well as detailed analyses of their hosts and local environments are promising approaches. However, due to the limited sensitivity of current telescopes, these approaches are best suited for local Universe FRBs.

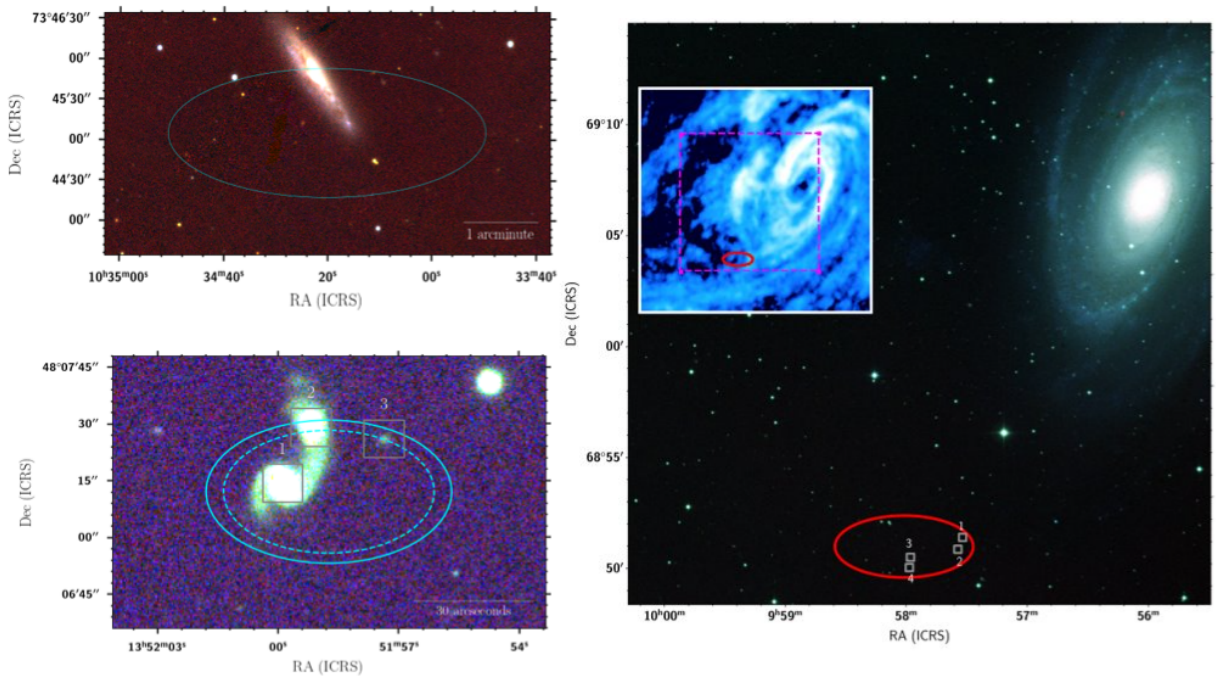

Figure 1: Low-DM CHIME FRBs: The figure shows a subset of localized low-DM CHIME FRBs: (top left) FRB 20181030A host (NGC 3252; 20 Mpc), (bottom left) FRB 20190303A host (Merging pair, [PA2008] 207.996573+48.12472; z = 0.064), and (right) FRB 20200120E host (M81; 3. Mpc). In each plot, a solid ellipse represents a 90% confidence localization region.

The Canadian Hydrogen Intensity Mapping Experiment (CHIME)/FRB project has been detecting FRBs since July 2018, and many of them have sufficiently low dispersion measures (DMs) suggesting a nearby origin. Even better, the localization of low-DM FRBs to a few arcminutes precision using the CHIME/FRB baseband system can result in a reliable host association for nearby FRBs. These local Universe FRBs have made a significant contribution to our understanding of FRB origins. FRB 20200120E, for example, which was discovered as part of the low-DM CHIME/FRB project, is located in a globular cluster of M81, which is a conglomeration of very old star populations. It is one of the last places we expected to find FRBs because the most prevalent FRB model invokes young highly magnetized compact objects (like Galactic mag-

netar SGR 1935+21) produced via prompt formation channels like core-collapse supernovae, long gamma-ray bursts, and superluminous supernovae. This discovery provides the strongest evidence yet for the existence of multiple FRB formation channels. Moreover, multi-wavelength follow-ups of these local Universe CHIME FRBs have enabled stringent limits to be placed on high-energy counterparts than for more distant FRBs, which are the majority of the FRBs localized to a host galaxy to date.

In my talk, I will report on the CHIME/FRB discoveries of several local Universe FRBs (three are shown in Figure 1) and the constraints we derived on different proposed FRB source and emission models. These local Universe FRBs are found to bridge the gap between Galactic (radio-loud) neutron stars and the much more distant extragalactic FRBs in the radio transient ($\sim$GHz) phase-space. I will also discuss the constraints we derived on the distribution of hot ionized baryons in the circumgalactic medium of the Milky Way using the localized nearby CHIME bursts, and how we can combine them with halo gas probes in the UV and X-ray bands. Finally, I will discuss the application of Local Volume galaxies in order to understand the nature of the FRB luminosity function.

About the Author

Mohit Bhardwaj is currently a McWilliams postdoctoral fellow at Carnegie Mellon University, USA. He received his bachelor's degree in electronics and electrical engineering and has an integrated master's degree in Physics from BITS Pilani (India). He will soon receive his PhD in Physics from McGill University. His research interests include astrophysical transients, interstellar medium, astrostatistics, observational cosmology and radio instrumentation. Mohit is a member of the CHIME/FRB project. Within the CHIME/FRB collaboration, he is leading the multi-wavelength follow-up and host association of local Universe FRBs. In his PhD work, he used local Universe CHIME bursts to decipher the origins of FRBs. FRBs, he believes, can provide a unique view into the aftermath of some of the Universe's most violent events. In addition to solving the FRB origin problem, he wants to use FRBs to map the cosmic web. Finally, he is always on the lookout for unexplored enigmas of the Universe. So, if you know of any, don't hesitate to contact him.