02
Research Highlights

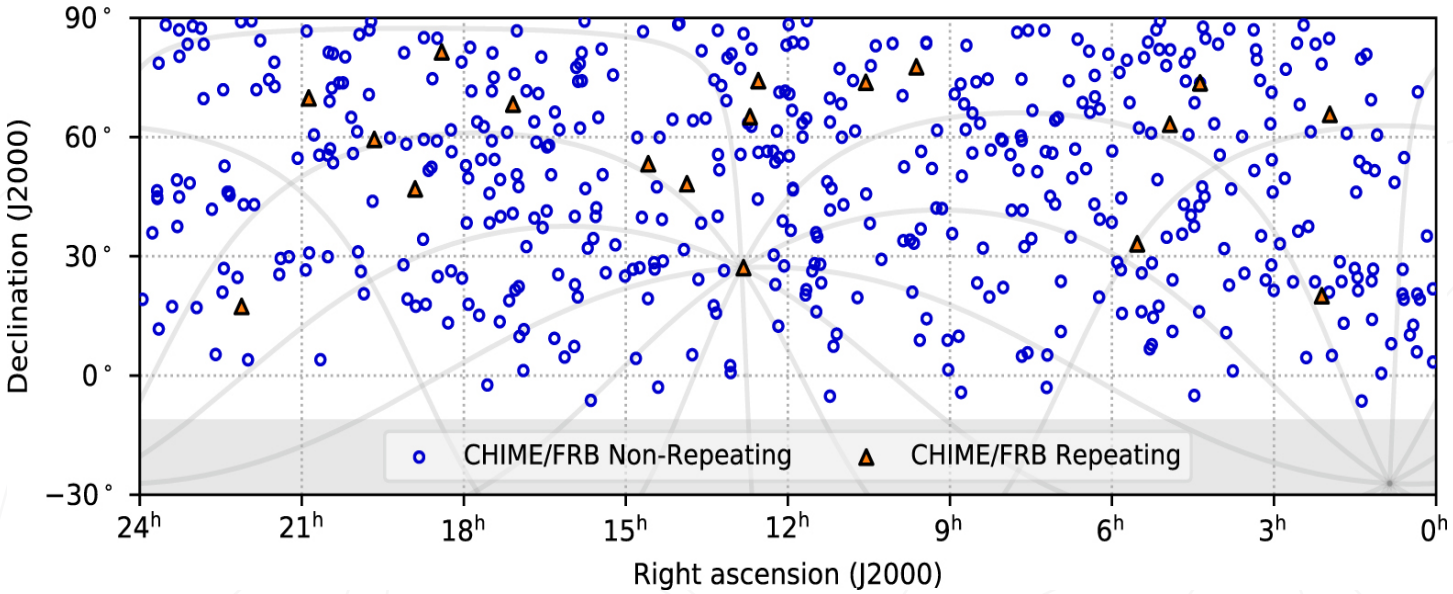
The First CHIME/FRB Fast Radio Burst Catalogue

The CHIME/FRB Collaboration is led by McGill and involves nearly two dozen MSI undergraduates, graduate students, postdocs and staff, led by MSI Professors Vicky Kaspi and Matt Dobbs.

The CHIME telescope, located near Penticton, BC, consists of four cylindrical reflectors oriented North-South. They have no moving parts and observe the full Northern sky daily at radio frequencies between 400 and 800 MHz. CHIME's large collecting area, bandwidth, and field of view make it a superb transient detector, a capability made real by the CHIME/FRB Project.

The CHIME/FRB Project uses CHIME to detect Fast Radio Bursts in real time at a rate of roughly 3 per day -- orders of magnitude greater than any other telescope. The CHIME/FRB software pipeline, developed in large part thanks to MSI students and postdocs and first operational in mid 2018, allowed for the detection of over 500 FRBs by mid July 2019. This sample, by far the largest ever collected, constituted the First CHIME/FRB Catalog of Fast Radio Bursts. The sheer number of FRBs in this catalog has already enabled many detailed analyses of the FRB population by both the CHIME/FRB team, as well as by the FRB community worldwide.

Top: the CHIME telescope (Credit: the CHIME Collaboration).



Sky distribution of 18 repeating sources and 474 sources that have not been observed to repeat (Source: CHIME/FRB Collaboration, 2021).

In the Catalog paper itself, the team was able to do the first statistically meaningful comparison between repeating and apparently non-repeating FRB properties, showing their sky and dispersion-measure distributions appeared consistent with arising from the same underlying distribution, within the current uncertainties. The team also used the sample to determine the log N/log S distribution of FRBs, showing they are consistent with being from a non-evolving population distributed in Euclidean space, consistent with the CHIME/FRB sample originating mainly from redshifts less than 1.

Additional studies done by the CHIME/FRB team were enabled by the Catalog. For example, MSI PhD student Alex Josephy led an analysis using the Catalog to demonstrate the sky distribution of the CHIME/FRB sample is consistent with being isotropic, as expected from a cosmological population. MSI postdoc Masoud Rafiei-Ravandi further showed that the CHIME/FRB First Catalog sample locations show statistically significant correlations with Large Scale Structure Then MSI PhD student Pragya Chawla (now a postdoc at ASTRON in The Netherlands) studied the dispersion measure and scattering properties of the CHIME/FRB sample, showing that FRBs are likely found in local environments that have much more extreme properties than HII regions and supernova remnants like those known in our Milky Way galaxy. Finally, then MSI PhD student Ziggy Pleunis (now a Dunlap Postdoctoral Fellow at University of Toronto) used CHIME/FRB Catalog data to show there is a very significant difference between the morphologies and the spectra of repeating and apparently non-repeating FRBs, which may signal a difference in emission mechanism between the two populations. Ziggy was awarded the 2021 J. S. Plaskett Medal of the Canadian Astronomical Society for the top astronomy PhD thesis in Canada for this work, along with the Division D PhD Prize of the International Astronomical Union.

Citation: "The First CHIME/FRB Fast Radio Burst Catalog", CHIME/FRB Collaboration (2021), ApJ Supplement 257, 59.

Why this is important?

Fast Radio Bursts (FRBs) are a relatively newly discovered astrophysical phenomenon. This first CHIME/FRB Catalog of Fast Radio Bursts contains over 500 FRBs detected during CHIME's first year of operations (mid 2018 to mid 2019). The sheer number of FRBs in this catalog has already enabled many detailed analyses of the FRB population by both the CHIME/FRB team, as well as by the FRB community worldwide.