

Detection of Multiple Repeating Fast Radio Bursts

Fast Radio Bursts (FRBs) consist of short (few ms) bursts of radio waves, which arrive at Earth from far outside our own Galaxy, and likely from cosmological distances. Their origins are unknown, although leading models involve compact objects, either neutron stars, or objects interacting with black holes. FRBs are notoriously difficult to study, as although they are ubiquitous, where and when one arrives cannot in general be predicted.

The Canadian Hydrogen Intensity Mapping Experiment is a new Canadian radio telescope designed and built to study the accelerating Universe. Consisting of 4 100m x 20m cylindrical reflectors with no moving parts, CHIME is a "digital" telescope that can "see" over 200 square degrees of the sky at any one time -- an orders-of-magnitude larger field-of-view compared with conventional radio telescopes. So large a field-of-view is very useful for studying a transient phenomenon like FRBs, as CHIME's chances of "seeing" an FRB is larger than for other telescopes. Major components of CHIME's correlator "brain" -- which handles the signals from CHIME's 1024 antennas -- were built in Prof. Matt Dobbs' McGill Cosmology Lab. Subsequently, a special-purpose Fast Radio Burst detector was added to CHIME by teams led by Profs. Vicky Kaspi and Matt Dobbs, to study the transient FRB phenomenon.

In 2019, the CHIME/FRB project "burst" onto the FRB scene in two adjacent papers published in *Nature*, the first announcing the detection of FRBs down to radio frequencies of 400 MHz (the lowest that had yet been seen), along with the discovery of only the second ever "repeating" FRB source. The result was highlighted on the cover of the January edition of *Nature*. The CHIME/FRB team quickly followed up these discoveries with the 2019 announcement of the discovery of an additional 8 repeating sources, effectively revolutionizing the FRB field and enabling astrophysicists worldwide to begin to study this newly recognized astrophysical source class.

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**.

Why this is important

Fast Radio Bursts (FRBs) are one of the most interesting puzzles in modern astrophysics. Consisting of few-millisecond-duration bursts of radio waves, FRBs are arriving from far outside our Milky Way galaxy over 1000 times per day across the full sky, demonstrating they are ubiquitous in the Universe. Their origin is unknown. Studying them is challenging as they are unpredictable and transient. Canada's new CHIME radio telescope is a world-leading FRB detector and began full operations in 2019.

Right: The CHIME Telescope (Credit: CHIME Collaboration). Bottom: Waterfall plots for some of the repeating FRBs detected by CHIME. (Source: CHIME/FRB Collaboration (2019), <https://arxiv.org/abs/1908.03507>)

