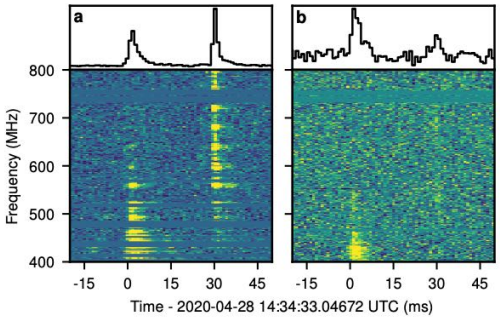
CHIME/FRB detects most powerful radio burst ever seen from a magnetar

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 a relatively newly discovered astrophysical phenomenon. These short duration radio bursts are known to be coming from far outside our Milky Way galaxy, but are of unknown origin. The CHIME/FRB Project is making significant progress toward identifying the nature of these sources, and also laying groundwork for their great potential as probes of structure in the Universe.



On April 28, 2020, the newly constructed CHIME radio telescope and its Fast Radio Burst (FRB) instrument detected by far the most powerful radio burst ever seen from a magnetar. FRBs were first reported in 2007 but until recently were a major astrophysical mystery. Consisting of few-millisecond bursts coming from cosmological distances, FRBs must be titanic radio explosions. Yet astronomers have been baffled regarding their origins. For a while, in spite of their inferred ubiquity, models for FRBs outnumbered detected sources! Published theoretical ideas ranged from merging neutron stars to primordial black hole evaporation to cosmic string cusps to disk debris near the event horizon of a supermassive black hole.

The CHIME/FRB Project turned on in 2018 and has been discovering hundreds of FRBs, thanks to the telescope's enormous size (equivalent to five hockey arenas), unique cylindrical design and powerful correlator which digests some 13 Tb per second, enabling observations of over 1000 independent positions or "beams" on the sky. The FRB instrument carries out this search in real time, thanks to a powerful software search engine designed and implemented by students, postdocs and programmers at McGill, U. Toronto, UBC and the Perimeter Institute.

Unexpectedly, on April 28, 2020, during routine operations, CHIME/FRB detected two closely spaced radio bursts so powerful they lit up several dozen of its sky beams at once. The source of the event was immediately identified not as coming from a cosmological distance as with previously observed FRBs, but rather from our own backyard here in the Milky Way. The source was the previously known Galactic magnetar SGR 1935+2154, which had never before been seen to emit radio bursts, much less explosions far more powerful than any radio burst yet seen from a magnetar. Simultaneously, a subset of the CHIME/FRB team from U. Toronto detected the same event at a small 10-m telescope being used as a testbed in the Algonquin Park in Ontario.

The CHIME/FRB discovery demonstrates that magnetars are capable of producing radio bursts of brightness comparable (though still somewhat smaller than) those of some FRBs. This provided a "smoking gun" to prove that at least some FRBs are magnetars. This discovery was identified by both Nature and Science magazines as among the most important scientific discoveries of 2020.

However, the discovery does not prove that all or even most FRBs - particularly the most luminous - are magnetars. The SGR 1935+2154 burst, though intense, was still at least a million times less luminous than those from the most distant known FRBs. Only time will tell whether FRBs represent a variety of source classes, or whether the April 28 event was the Rosetta Stone for the entire class.

Top: The double burst from Milky Way magnetar SGR 1935+2154 , shown both in time and in radio frequency, as observed on April 28, 2020 by (a) CHIME/FRB and (b) the 10-m radio telescope in the Algonquin Provincial Park, Ontario (Credit: CHIME/FRB Collaboration, 2020, Nature, 587, 54-58). Bottom: the CHIME telescope ((Credit: the CHIME Collaboration).