Some members of the Dragonfly team beside the Dragonfly array in Mayhill New Mexico, in November, 2022. Credit: The Dragonfly team.

OUR TECHNOLOGY Dragonfly

In 2022, the Dragonfly team completed 70% of its ultrawide survey, which will map out the full footprint of the Sloan Digital Sky Survey when complete. A large expansion to the array called the Dragonfly Spectral Line Mapper (DSLM) is currently underway, consisting of an additional 120 lenses with ultra-narrow bandpass filters. Currently 10 out of 120 lenses of DSLM are on sky, with the commissioning of the first of four 30 lens arrays upcoming.

In 2022, the team wrote three papers on Ultra Diffuse Galaxies, one paper on the stellar halos of the Dragonfly Edge-on Galaxies Survey, and three SPIE proceedings on the DSLM and Dragonfly instrumentation.

SuperBIT

Through 2022, SuperBIT has been preparing to launch a super-pressure balloon in the Spring of 2023 from Wanaka, New Zealand, for a 100-night flight at 35 km above sea level.

On this mission, SuperBIT will measure the dark matter distribution of 100 galaxy clusters, allowing us to better understand the nature of dark matter and dark energy in the Universe.

Through this past year, the SuperBIT team has been taking part in the pre-flight instrument integration campaign at the NASA Columbia Scientific Balloon Facility in Palestine, Texas.

CIRADA

The Canadian Initiative for Radio Astronomy Data Analysis (CIRADA) is a \$10M program intended to create sophisticated new software products and catalogues for studying the sky at radio wavelengths. In 2022, CIRADA released an image cut-out server for the new Rapid ASKAP Continuum Survey (RACS), new software to efficiently correct radio data for ionospheric Faraday rotation, and new standardized formats and associated toolkits for sharing radio polarization data. In 2023, we will produce science-ready products for the first full data sets from the Very Large Array Sky Survey (VLASS), and will release sky-monitoring data, polarization maps and absorption spectra produced by the Canadian Hydrogen Intensity Mapping Experiment (CHIME).

WHO WE ARE

The Dunlap Institute for Astronomy & Astrophysics at the University of Toronto is an endowed research institute with over 80 faculty, students, postdocs, and staff.

WHAT WE DO

At Dunlap, we design and build innovative technology like telescopes, spectrographs and supercomputers. We pursue ground-breaking astronomical research using these facilities.

We also provide world-class training to students, and we run science and astronomy outreach events to engage the public across the Greater Toronto Area and beyond.

Background Photo: Star field taken from Las Campanas Observatory, Chile. Credit: Anna O'Grady.

WHAT WE STUDY

Our team studies optical, infrared and radio instrumentation, dark energy, large-scale structure, cosmic magnetism, time-domain science, galaxy evolution, the early Universe, and more.

OUR COMMITMENT

The Dunlap Institute is committed to making science, training, and outreach productive and enjoyable for everyone.

Cover Picture: Webb's First Deep Field, the first operational image taken by the James Webb Space Telescope. Credit: NASA, ESA, CSA, STScl.

Smaller Cover Picture: Some members of the JWST CANUCS team in Halifax, July 2022.

Back Cover: John Fowler on Unsplash.

Smaller Back Cover: SuperBIT balloon borne telescope and SuperBIT team member, Ajay Gill. Credit: Jonathan Qu and Kevin Li,

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Dunlap Institute for
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UNIVERSITY OF TORONT

2022 A YEAR IN REVIEW



DUNLAP INSTITUTE for ASTRONOMY & ASTROPHYSICS

> Some Dunlap members gather for the 2022 Dunlap Institute Annual Retreat. Credit: Kara Manovich.



Prof. Bryan Gaensler

DIRECTOR'S MESSAGÉ

The Dunlap Institute has emerged from the pandemic with a sense of purpose and excitement. We have recently welcomed our newest faculty member, Prof Juan Mena-Parra, who consolidates our leadership in the CHIME and CHORD projects. Our other flagship instrumentation projects such as GIRMOS, Dragonfly and SuperBIT have all also made exciting progress, while our Dunlap Fellowship program has attracted some outstanding new hires working on infrared spectrographs and adaptive optics. We also continue to provide national leadership on data platforms and processing, through both the ongoing CIRADA project and the ambitious "CanDIAPL" proposal that is now under review.

Yes and

Our researchers have produced break-through results in the past year on stellar streams, fast radio bursts, and globular clusters, the latter showcasing the spectacular capabilities of JWST. We have also been appointed to lead a new research alliance between the University of Toronto and the Hebrew University of Jerusalem on cosmic explosions and collisions.

On the outreach front, our online content continues to build a loyal following, and in November, we were pleased to reintroduce our first in-person event in three years — Astronomy on Tap. We have grown our partnership with Discover the Universe / À la découverte de l'univers, with new focuses on the 2024 solar eclipse and on Indigenous Astronomy.

As we return to in-person activities, we're excited about all the ideas and projects we're about to unleash. Prepare for a slew of new discoveries in the coming year!

OUR RESEARCH

At the Dunlap Institute, our astronomers seek answers to the big, fundamental questions of the cosmos. Some of the most profound research results this year in astronomy came from data collected from the James Webb Space Telescope (JWST). Several Dunlap Institute members were heavily involved in studying JWST data, including Dunlap Fellows Dr. Lamiya Mowla and Dr. Kartheik Iyer, who were part of the Canadian NIRISS Unbiased Cluster Survey (CANUCS) team.

For Mowla, Iyer, and their fellow researchers, a big discovery came early after JWST's launch. Using the telescope's first Deep Field image, they found a distant galaxy that offers a glimpse into some of the universe's first stars.

In their analysis, Mowla, Iyer, and their team focused on a galaxy that they call "the Sparkler"



Larger photo: Pillars of Creation, as captured on the James Webb Space Telescope. Credit: NASA. dubbed as such because of the sparkling
yellow-red dots surrounding it. Using light
that has traveled for nine billion years to reach
JWST telescopes, the team concluded that those
sparkles were not only globular clusters (ancient
clusters of stars), but in fact were among some of
the oldest globular clusters in the universe.

This is the first time that astronomers have used distant globular clusters to age-date the first stars in distant galaxies. This serendipitous discovery was made possible due to a combination of JWST's incredible angular resolution, combined with the galaxy being magnified by a factor of 10-100 by gravitational lensing.

The team's research was published in September, 2022 in The Astrophysical Journal Letters.

The Gemini South telescope in Chile. Credit: Suresh Sivanandam.

CHIME & CHORD

The CHIME team kicked off 2022 with the AAS Berkeley prize, awarded in January for noteworthy progress on fast radio burst science, and bookended the year with the NSERC Brockhouse Award for Interdisciplinary Research in Science and Engineering, awarded in October. We achieved our first detection of the cosmic HI signal that motivated the design and gives the telescope its name, and provided the first proofof-concept sub-arcsecond localization of a fast radio burst using triggered Very long baseline interferometry (VLBI). The Outrigger telescopes that will make such localizations routine are nearing completion, with first light achieved this past summer on the first of three stations.

CHORD, the follow-on telescope array being built next to CHIME, is now fully funded and we recently broke ground on the on-site fabrication facility that will produce its 512 x 6m dishes. A 3-dish prototype has been operating for months now, and the 64-dish pathfinder version of the array is anticipated late in 2023.

GIRMOS

GIRMOS is being planned to be the first-light instrument for the Gemini-North Adaptive Optics upgrade project.

In the last year, the GIRMOS project reached a major milestone: the completion of its Preliminary Design Phase. This means we will be advancing to final design. Overall, this was a major effort requiring careful coordination of the distributed team across several partners and the presentation of the work to an independent expert review committee.

GIRMOS is in its final design phase, and is expected to be delivered to Gemini in late 2026. Moreover, our project has become highly integrated with the Gemini Observatory.



Prototype of CHORD feed and CHORD dishes, at the Dominion Radio Astrophysical Observatory (DRAO), near Penticton, B.C. Credit: Kit Gerodias (McGill).



OUR TRAINING

In 2022, new Associated Faculty member Josh Speagle joined as co-chair of the Training and Mentoring Committee, and the committee has grown to include staff, faculty, postdoctoral researchers and students. We put together welcome packs to welcome new postdocs and graduate students, and arranged 'Science Speed Chats' to introduce different members of the department to each other.

The mentoring program has grown now into three prongs: a program between faculty and postdoctoral researchers and fellows, a program between postdocs and graduate students, and a program between graduate students and undergraduate students. This supplements the existing 'buddy system' between graduate students. The committee is developing workshops and training sessions across a range of areas, including dealing with conflict, navigating academia, time management, careers outside of academia and more. 2023 will see a muchanticipated return of the in-person Dunlap Instrumentation Summer School. We are excited to bring students back to Toronto and to give them hands-on experience with — and training in — instrumentation.

OUR OUTREACH

In November 2022, we hosted our first in-person event in three years, Astronomy on Tap. Through 2022, we continued with some of our online outreach activities developed during the pandemic. The "Cosmos From Your Couch" YouTube series has been refined into shorter, more produced interview-style videos that highlight astronomy researchers at the University of Toronto and a topic of their choosing.

In 2022, we released 16 videos, and plan on continuing to release them on a bi-weekly schedule. Our monthly Astro Trivia nights, streamed live to YouTube, continue to attract a loyal following of players, and we have given out dozens of prizes to excited participants this year. We hope to continue this and some of our other virtual activities beyond the pandemic, in order to reach a wider audience beyond the Greater Toronto Area.

The first Astronomy on Tap event in three years, in November 2022. Credit: Dunlap Institute.



