Join Us!

Dunlap offers many free events to the public each year. Please visit our website or check us out on social media to find out about our next celebration of space!

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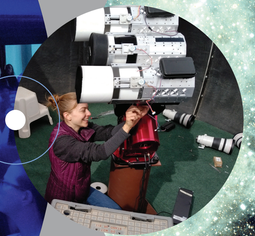
DUNLAP INSTITUTE
for **ASTRONOMY & ASTROPHYSICS**



Dunlap Institute for Astronomy & Astrophysics
UNIVERSITY OF TORONTO

2018-2019
A YEAR IN REVIEW

Who We Are

The Dunlap Institute for Astronomy & Astrophysics at the University of Toronto is an endowed research institute with over 50 faculty, students, postdocs, and staff.

What We Do

At Dunlap, we design and build innovative technology like telescopes, spectrographs and supercomputers, and 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.

What We Study

Our team studies infrared and radio instrumentation, dark energy, large-scale structure, the cosmic microwave background, the interstellar medium, galaxy evolution, cosmic magnetism, and time-domain science.

Our Commitment

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

Cover: Graduate Student Deborah Lokhorst sets up the Dragonfly telescope's namesake subthinker. Also on the cover: a false-colour image of Galactic cirrus, as seen through the Dragonfly telescope. Photo credit Shany Danieli, Yale University.

This page: A view of the Milky Way, behind the 46m radio telescope at the Algonquin Radio Observatory. Credit: Jing Santiago-Luo, Postdoctoral Fellow, Canadian Institute for Theoretical Astrophysics, University of Toronto

Director's Message

Prof. Bryan Gaensler

At the Dunlap Institute, we have an unrelenting desire to learn more about the Universe. Over the last year, we've made groundbreaking discoveries on supernova explosions, plasma lenses, gamma-ray bursts, cosmic magnetism, globular clusters, intergalactic gas and more, with the unquestioned highlight being the flood of fast radio bursts that we found using the CHIME radio telescope. Through big new projects like GIRMOS and CIRADA, we're also building world-leading hardware and software to measure and study the cosmos in innovative new ways.

Our program of training and professional development continues to grow, with huge numbers of young scholars and students coming to the Dunlap Institute to learn how to become successful scientists. This year, as always, our marquee event was our Instrumentation Summer School, where world-leading experts explain the details of how telescopes collect and manipulate light.

Thousands of people, from across Toronto and beyond, participated in our outreach and education events, culminating in our massive annual Planet Gazing Party, held under wonderful clear skies at the end of the summer.

The Universe is an exciting place. We're thrilled to be studying it, and to be sharing our excitement and our discoveries with you.

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ASTROPHYSICS

Pictured Above: Dunlap faculty, fellows, postdocs, associates, students, and staff at the 2019 Annual Retreat

Our Research

At Dunlap, our astronomers seek ground-breaking answers to fundamental questions. We collaborate with researchers from around the world, and work with some of the most advanced telescopes on Earth and in space.

We are also committed to training the next generation of astronomers, by providing opportunities for students starting out in the field to partner with our scientists. These partnerships often lead to amazing new discoveries – like the research of 2018 Summer Undergraduate Research Program (SURP) student Shaziana Kaderali. Shaziana is the lead author on a recent research paper about globular clusters, called "Rediscovering the tidal tails of NGC 288 with Gaia DR2."

Globular clusters are old compact groups of stars that have been orbiting the Milky Way galaxy for billions of years. Although they are tightly bound by gravity, interaction with the rest of the galaxy can slowly strip off the outer stars into thin 'tidal tails' that can stretch far across the sky. However, there are some clusters that do not appear to have any tails. One proposed explanation is that they are even more tightly bound by gravity than the observed stars would suggest, hinting at the presence of a high fraction of dark matter.

Shaziana and Dunlap Fellow Jason Hunt analysed a simulation of cluster NGC 288, and found that the angle at which we observe the cluster leads to the simulated tails being very compact, and hard to detect. They then used data from the European Space Agency's Gaia mission to locate stars that moved as a coherent tidal tail. Their discovery of such tidal tails shows NGC 288 to be a perfectly normal globular cluster, without any unusual levels of dark matter.

Until this research result, scientists had been looking for more exotic explanations for why this cluster didn't have tidal tails, but actually, they were just hard to see!

Top: Shaziana Kaderali, Former Dunlap SURP Student. Credit: Shaziana Kaderali
Below: The globular cluster NGC 288. Credit: NASA

Our Technology

CIRADA

The Canadian Initiative for Radio Astronomy Data Analysis (CIRADA) is a $10M program to create sophisticated new software products and catalogues for studying the sky. The CIRADA team met in Toronto in August 2019 for an annual project review, where we developed our first set of software tools to analyse data on magnetism and explosions. In 2020, the team expects to produce some major data releases from CHIME, including studies of gas clouds throughout a vast volume of the Universe, as well as the results of a novel experiment to detect hundreds - or even thousands - of new neutron stars.

Dragonfly

Dragonfly is an innovative, multi-lens array designed for ultra-low surface brightness astronomy at visible wavelengths. It has pioneered the study of extremely faint, complex structure around galaxies. Commissioned in 2013 with three Canon lenses, Dragonfly continues to grow in size, and as of late 2019, has 48 lenses in the main array.

In 2019, the Dragonfly team published 13 papers, including the follow-up to a previous Dragonfly discovery, the ultra-diffuse galaxy DF-44. The team's new study showed how a more nearby version of DF-44 would be an excellent candidate for determining whether dark matter is made up of axions. Dragonfly is now ears-barking on an "ultra-wide" survey to try to find an example of such a galaxy.

A successful $85,000 NSERC grant led to the commissioning of a prototype wide-field narrow-band imaging version of Dragonfly. This instrument is a harbinger for exciting developments coming in 2020, as Dragonfly evolves to become the world's most powerful narrow-band survey telescope.

CHIME

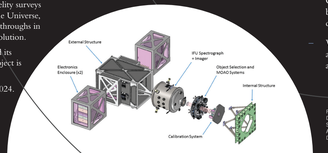
2019 was a breakthrough year for the Canadian Hydrogen Intensity Mapping Experiment (CHIME), after kicking off its search for fast radio bursts. These mysterious events have been perplexing astronomers since their discovery just over a decade ago. In its first year of searching, CHIME has discovered hundreds of new bursts, and at least nine sources of bursts that repeat, helping astronomers constrain the possible cause of this phenomenon.

GIRMOS

The Gemini Infrared Multi-Object Spectrograph (GIRMOS) will be the first adaptive-optics-fed, multi-object integral field spectrograph, bringing a one-of-a-kind capability to the 8-meter Gemini Telescope. GIRMOS will perform simultaneous high angular resolution spectroscopic measure-ments of multiple astronomical objects by taking advantage of the latest advances in adaptive optics and infrared spectroscopy. Through large, high-fidelity surveys of very distant galaxies throughout the Universe, this will enable major scientific breakthroughs in the study of galaxy formation and evolution.

In September 2019, GIRMOS passed its conceptual design review, and the project is now in its preliminary design phase.

GIRMOS is expected to deploy in 2024.



Top Right: Some members of the Dragonfly team, in front of the Dragonfly telescope in New Mexico. Credit: Pieter van Dokkum, Yale University
Middle: The CHIME telescope in Penticton, B.C. Credit: Vincent MacKay, Dunlap Institute
Bottom: A graphical breakdown of GIRMOS Credit: the GIRMOS team.

Our Training

- Our 2019 Instrumentation Summer School hosted 29 students from nine countries and five continents for a week of astrononical instrumentation training.
- For the ninth straight year, our Summer Undergraduate Research Program (SURP) brought undergraduate students from across Canada to work on astronomy research projects. This year, we launched a feature called SURP Student of the Week, to highlight the students' work.

Our Outreach

- In February 2019, we launched SpaceTime, an all-ages astronomy celebration featuring talks, games, and prizes. SpaceTime will continue into 2020.
- Throughout the year, we hosted three Astronomy on Tap events, which continue to thrive as among the largest "Taps" in the world. Several more are scheduled for 2020.
- In partnership with the Royal Astronomical Society of Canada, we held our Planet Gazing Party in September 2019, bringing over 5000 planet fans to the University of Toronto's downtown campus.
- We continue to partner with "Discover the Universe," a training program that has reached over 1500 educators across Canada to help guide them in their astronomy teaching.

From top to bottom:
Dunlap Instrumentation School students Elizabeth Bekker and Vivian Yun Yan Tan take part in an instrumentation lab.
SURP Student Kelly Werker Smith does pull tests for balloon-borne telescope, SPIDER.
A young space enthusiast answers a trivia question at a SpaceTime event.
Dunlap Professor Mike Reid presents to a full house at Daniels Spectrum, while an interpreter signs.