

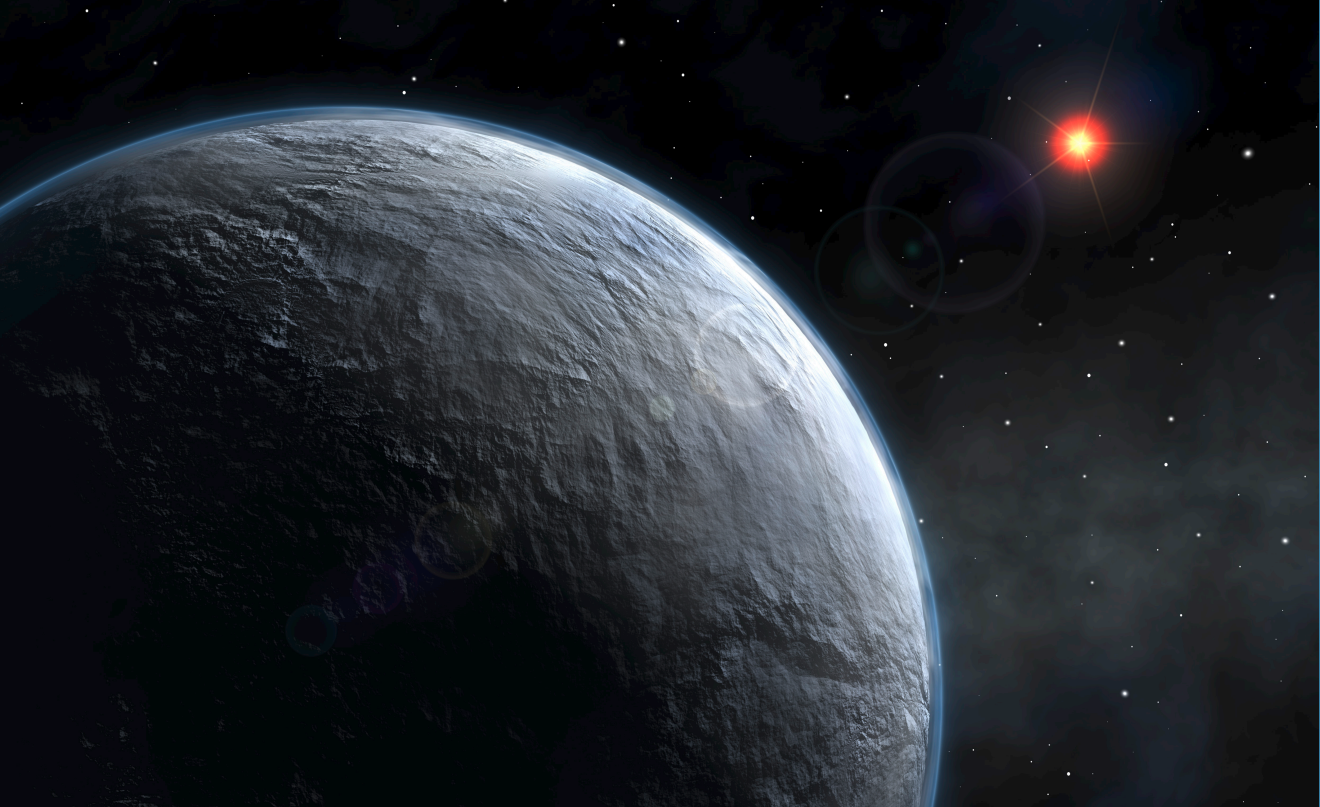


**2017**

# ANNUAL REPORT



INSTITUT DE RECHERCHE  
SUR LES EXOPLANÈTES  
INSTITUTE FOR RESEARCH  
ON EXOPLANETS



03

Objectives and Mission

05

Research

07

Our Team

09

Outreach

11

Publications

12

Funding and Organisation





# Objectives and Mission

**WE ARE LIVING AT A PIVOTAL MOMENT IN THE HISTORY OF HUMANITY, ONE IN WHICH TECHNOLOGY IS CAPABLE OF ANSWERING ONE OF THE GREATEST QUESTIONS OF ALL: ARE WE ALONE IN THE UNIVERSE?**

This debate alone justifies the multi-billion dollar investments seen in the robotic exploration of our Solar System and the construction of powerful astronomical observatories, both on ground- and space-based.

Since the discovery of the first planet orbiting a star other than the Sun in 1995, astronomers have confirmed the existence of several thousand more exoplanets. Thousands of other candidates have also been listed, including Earth-like rocky planets. Over the next decade, the new generation of telescopes and instruments will, for the first time, probe the atmosphere of extrasolar planets similar to our own for water vapour and possibly, bio-signatures such as oxygen, ozone or methane.

The Institute for Research on Exoplanets – iREx – brings together the best researchers and their students to take full advantage of major observational projects, both in progress or upcoming, with the ultimate goal of finding life elsewhere in our Universe.

**“ THE INSTITUTE FOR RESEARCH ON  
EXOPLANETS, EXPLORING NEW  
WORLDS, SEARCHING FOR LIFE. ”**

# Director's Message

This first annual report of the Institute for Research on Exoplanets (iREx) is a brief overview of impressive expansion of our institute and team during their first few years. Created three years ago (2014) by a dozen astrophysicists from the Université de Montréal (UdeM), the iREx is in full growth and now rallies over 40 researchers (professors, students, researchers) from UdeM, McGill University, Université Laval and Bishop's University, all specialised in the study of extrasolar planets, also commonly known as exoplanets. The creation of this institute came about through the leadership of researchers in Quebec in this exciting field of research, and it is with great pride that I lead this impressive team.

It is now well established that exoplanets are very common in our galaxy and that at least a quarter of all stars in solar neighbourhood likely has a rocky planet similar to the Earth with surface conditions possibly conducive to the development of life. The iREx's mission is to explore these new alien worlds and to position itself as one of the main international players in this great quest for life outside the Solar System.

In just a few years, and thanks to the generosity of our donors and the commitment of universities hosting our members, the iREx has quickly positioned itself not only as the leading group of exoplanet researchers in Canada, but also as one of the largest in the world. Collectively, our researchers bring together a wide range of expertise and are figureheads in leading international research projects to detect and study new exoplanets. Our team is leading the development of new instruments fine-tuned to detect and study exoplanets, for example, with the Canadian instrument on board the future James Webb Space Telescope, which includes a specialised observing mode to study the atmosphere of exoplanets.

The iREx is certainly a world-class research institute, but it is also public-facing. Our team is actively involved in various outreach activities, whether it be talks given in schools of all levels or media interventions across Canada on any topics related to astronomy. The study of the Universe and its mysteries is a joy that belongs to all, and the iREx makes it a duty to share it with the Canadian and international public thanks to the backing and vision of its supporters. I can hardly imagine the discoveries that await us in the near future, and cordially invite you to be part of this great adventure!



**René Doyon**  
**Director, iREx**  
**Professor, Université de Montréal**



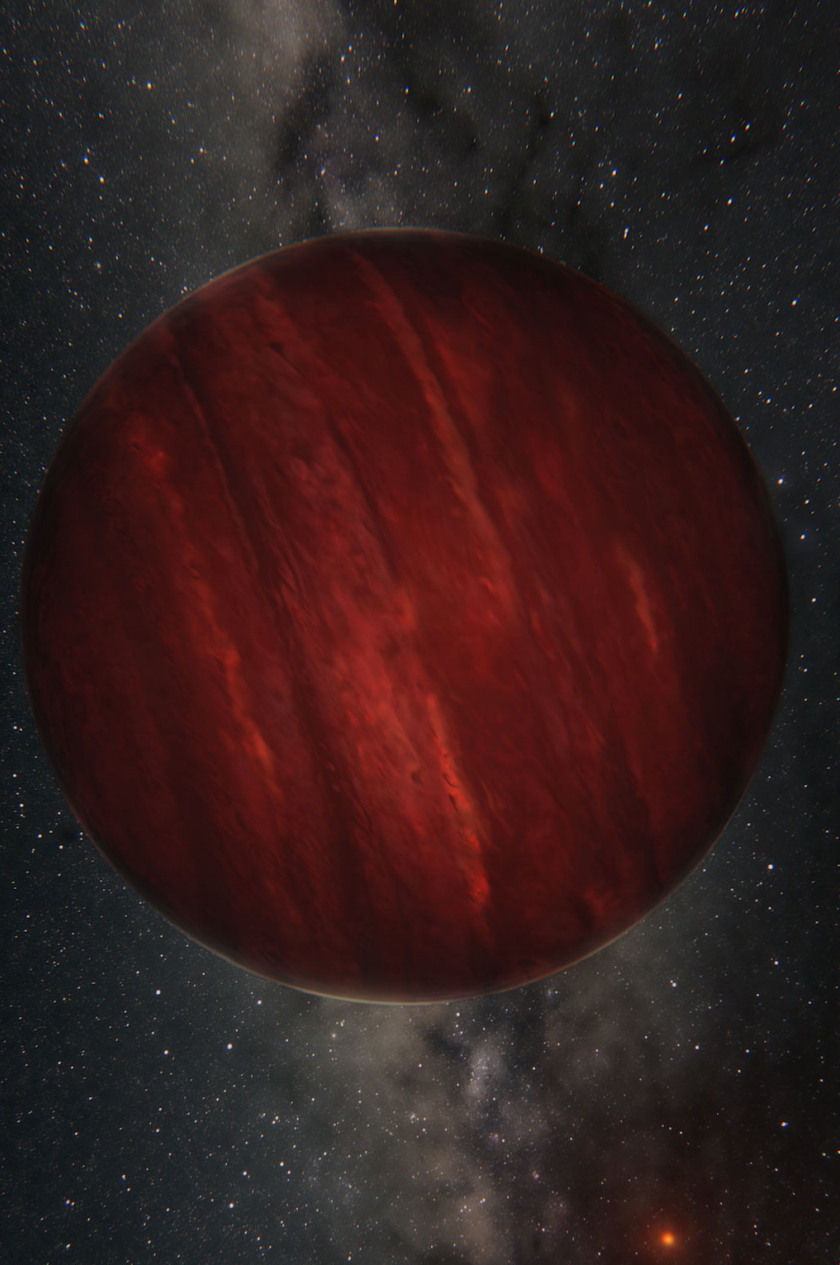
# Research

## THEORY AND OBSERVATIONS

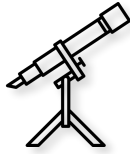
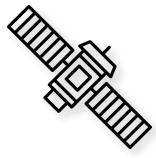
Since its beginnings, dating back to ancient times, astronomy has always been a science of observation. While theoretical descriptions of astrophysical objects remain an important part of the field, these efforts only have meaning to the extent that they can be confirmed using observations.

The study of exoplanets is certainly no exception to this rule; this field of research was only truly born with the first few discoveries made in the 1990s. Today, various methods are used to detect exoplanets directly and indirectly. The observations made by the institute's researchers can be categorised in a few types :

- ✓ **High-contrast imaging:** A technique allowing the direct detection of massive exoplanets found at large distances from their star.
- ✓ **High-precision infrared velocimetry:** A technique allowing the detection of a star's motion due to the presence of a planet orbiting it.
- ✓ **Transit spectroscopy:** A technique that allows the study of an exoplanet's atmosphere as it transits in front of its star.
- ✓ **Brown dwarfs and exoplanets:** Brown dwarfs, with masses between those of stars and massive planets, can teach us many things about exoplanets.
- ✓ **White dwarfs and exoplanets:** White dwarfs, which are stellar remnants, can sometimes contain traces of the planetary systems they once possessed.
- ✓ **Planetary formation and evolution:** Allows the study of how exoplanets of different masses formed and evolved to have the characteristics we now observe.

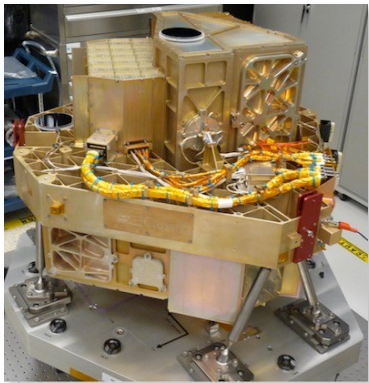


GU Piscium b, discovered in 2014 via direct imaging, is one of the exoplanets with the largest distance from its star known: 2,000 times the Earth-Sun distance from of its own star, a red dwarf.



## INSTRUMENTATION

Through its collaborations with the Observatoire du Mont-Mégantic (OMM), the iREx is one of the only teams with access to such a wide range of high-performance scientific instruments dedicated to the observation of exoplanets. Its researchers are studying, developing and improving data analysis techniques and pushing the institute to the top of the pack in exoplanet research.



✓ **NIRISS / FGS** is one of four scientific instruments on Webb, whose mission is to find and study the weakest and farthest astronomical objects in our Universe. Prof. Doyon and his team have specially designed NIRISS to probe the thin atmosphere of exoplanets as small as Earth, to determine their composition, and to perhaps detect the presence of water vapour, CO<sub>2</sub>, or potentially even bio-signatures such as methane or oxygen.



✓ **SPIROU and NIRPS** are two comparable spectrographs that will perform radial velocity measurements on low-mass stars with sufficiently high accuracy to detect Earth-sized planets in the habitable zone of low-mass stars. SPIROU will be installed at the Canada-France-Hawaii Telescope in 2018, while NIRPS will be at ESO in Chile in 2019.



✓ **GPI** is an instrument capable of detecting infrared light emitted by giant gas planets, similar to Jupiter, which are orbiting their Sun, similarly to the gas giant planets of our own Solar System during its formation. It has been installed in Chile on the Gemini-South 8m telescope since 2015.

✓ **PESTO** is an optical camera, equipped with an EMCCD, fully optimised to measure the timing of exoplanet transits and installed at the OMM.



The James Webb telescope, which will be launched in May 2020, hosts four instruments, including NIRISS/FGS, for which Prof. René Doyon is the Canadian Principal Investigator.

# Our Team

**Since its creation in 2014, the iREx team has continued to grow and welcomes the best researchers from around the globe.**

Our strength is our researchers. The iREx's goal is to grow its team over the years leading up to the launch of JWST (Spring 2020) and beyond to meet the challenges created by the huge amount of data this telescope will generate. The iREx's value also lies in the diversity of these researchers. Since 2015, the iREx has seen its staff grow from approximately 15 researchers to over 45, not only due to the commitment of experienced researchers, but also and especially through the recruitment of numerous students of all levels.

The iREx now has a solid core of experts and has trained a new generation of scientists that will be able to meet its objectives in the coming years.





" Being part of a research group like iREx allows us to work alongside experts who are experts in all areas of exoplanet research. It is an enriching experience that gives us the opportunity not only to develop as a specialised researcher, but also to open our horizons to other topics related to the search for exoplanets. "

**Frédérique Baron, Ph.D. student at iREx**

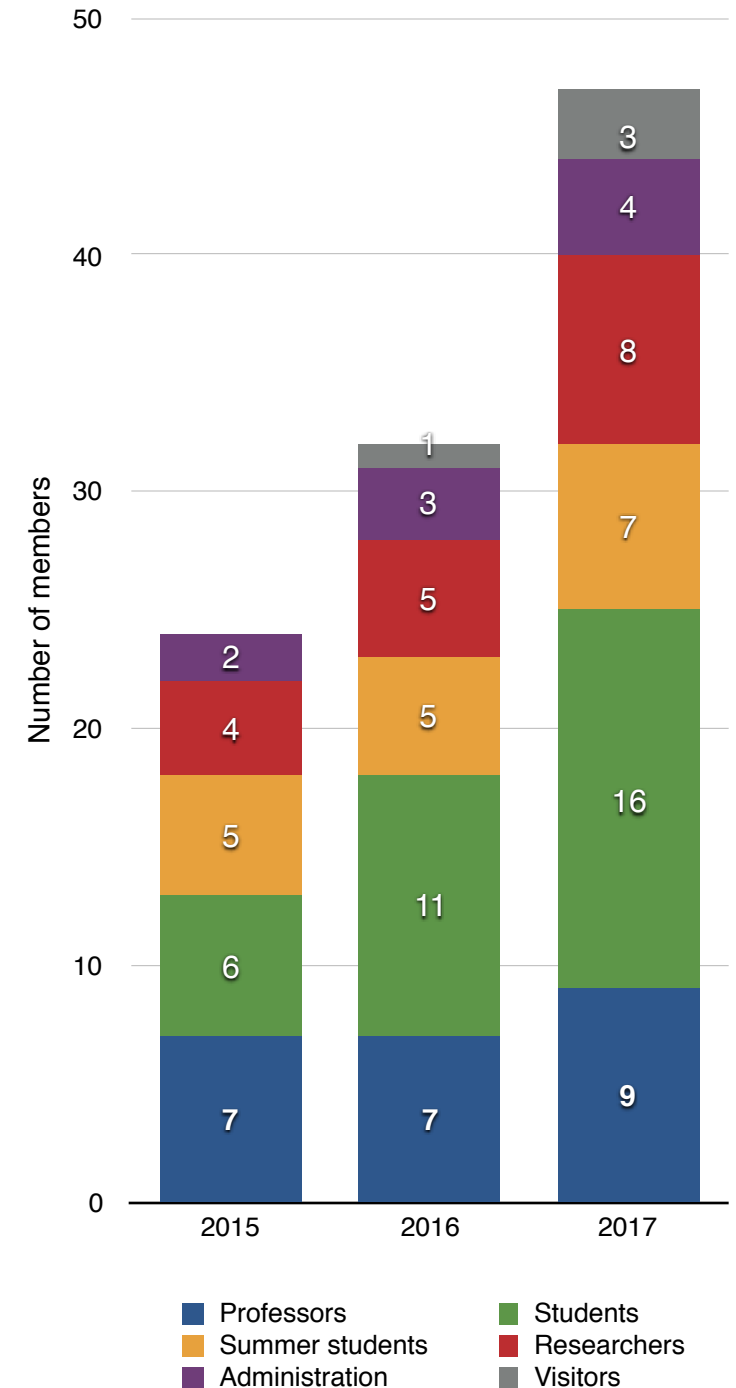
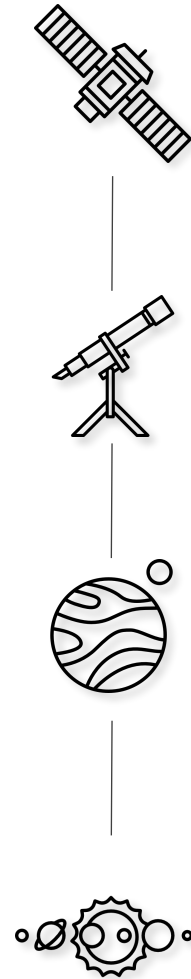
" Research is a team effort. It is very reassuring to be able to ask questions to experts in a field in which you are still a novice. The summer project I worked on was very interesting and I am very pleased to have achieved a significant scientific result. "

**Laurent Jacob, Trottier summer intern 2017 at iREx and Université de Montréal student**

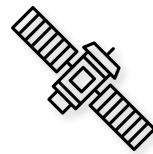


" I feel so blessed to belong to a community of people who are working to solve fundamental questions like "How do planets form?" and "What makes the Earth special?". The iREx is an exceptionally collaborative and social environment where all students, researchers and teachers interact regularly. "

**Lauren Weiss, Trottier postdoctoral researcher at iREx**



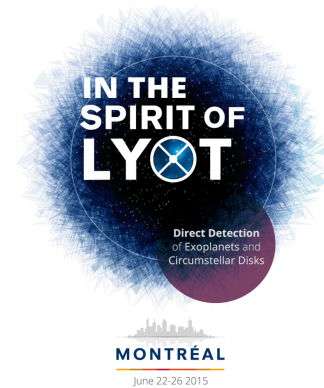
# Outreach



## TALKS AND OTHER ACTIVITIES

Through its knowledge translation mission, the iREx offers a range of activities such as international scientific conferences, general public talks and fun and out-of-the-box micro-conferences.

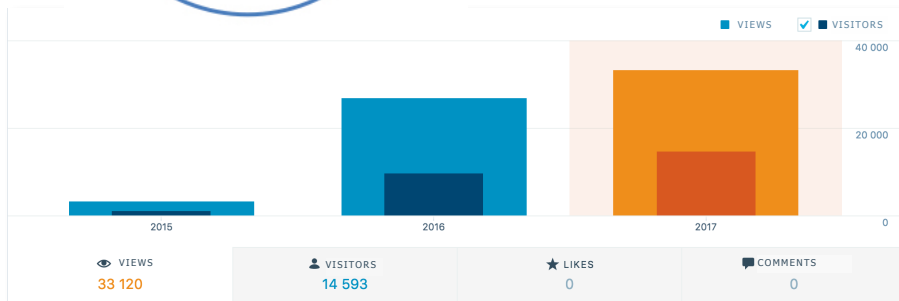
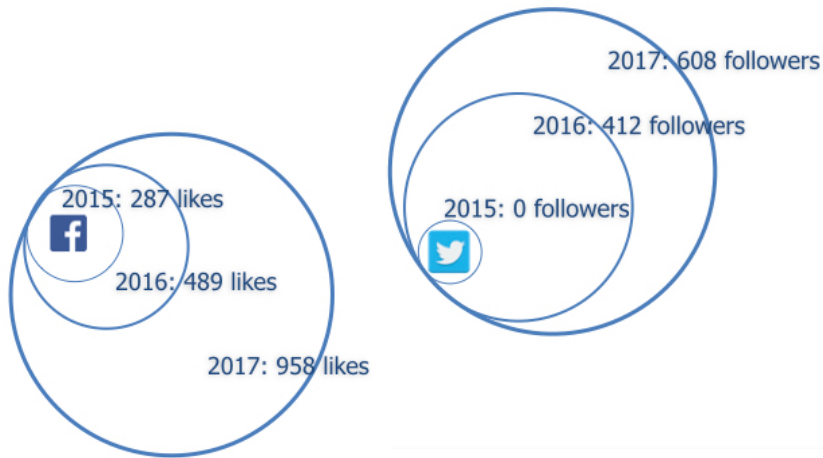
- ✓ The iREx hosted two international conferences, the **LYOT conference in 2015**, bringing together global experts in exoplanet imaging and the **JWST 2016 conference** focused on research that will be carried out with the JWST space telescope in the 2020s.
- ✓ Thanks to its pool of local and international speakers, the iREx has also enabled several thousands of people to attend **public lectures** on topics directly related to exoplanets. These conferences are offered free of charge on a regular basis in both English and French.
- ✓ Finally, the iREx, in collaboration with the Centre de recherche en astrophysique du Québec and AstroMcGill, has organized the **"Astronomie en fût"** or **"Astronomy on Tap"** evenings in bars in Montreal. These very popular activities allows our researchers to connect with the public in a more intimate and less conventional setting where we can share our passion for astronomy





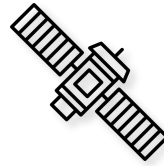
## SOCIAL MEDIA AND NEWSLETTER

Over the past three years, the iREx has been able to reach an expanding number of people through its increased presence on social media, its newsletter and its enthusiastic presence throughout Quebec primary schools, high schools, colleges, universities and even some businesses. Check out our website for all our activities, discoveries and news: [www.exoplanets.ca](http://www.exoplanets.ca).



## IREX IN THE NEWS

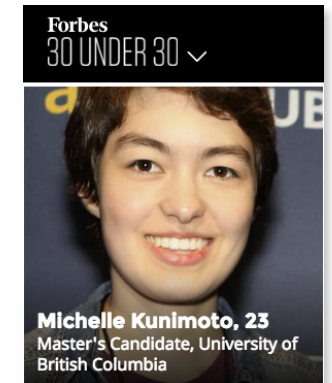
Many iREx researchers are frequently in the media, solicited for their informed and passionate commentary of everything space. The iREx is always keen to answer the call when the public wants to know more!

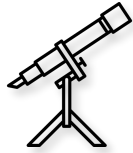


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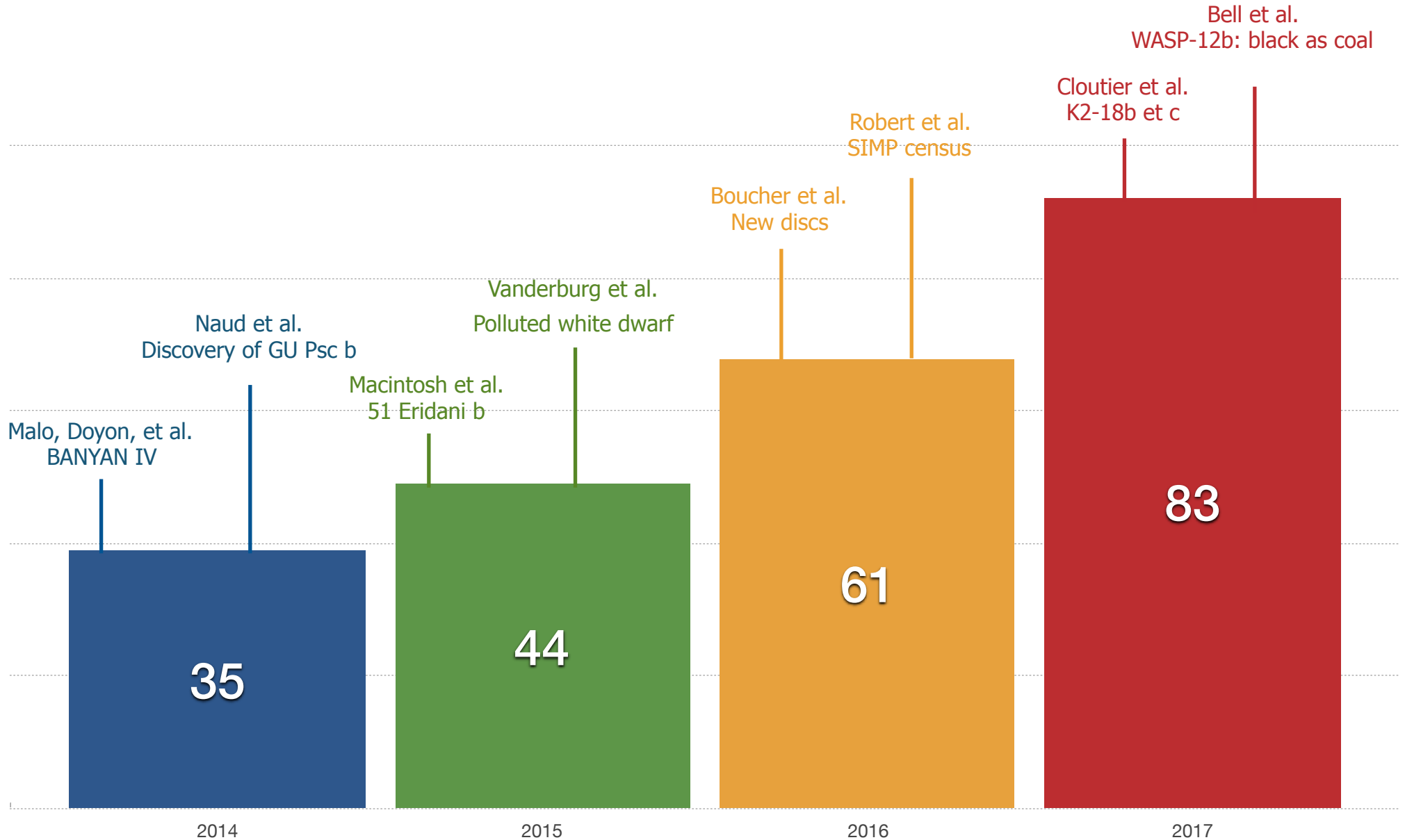


James-Webb, le télescope qui nous fera voyager dans le temps | Médium large

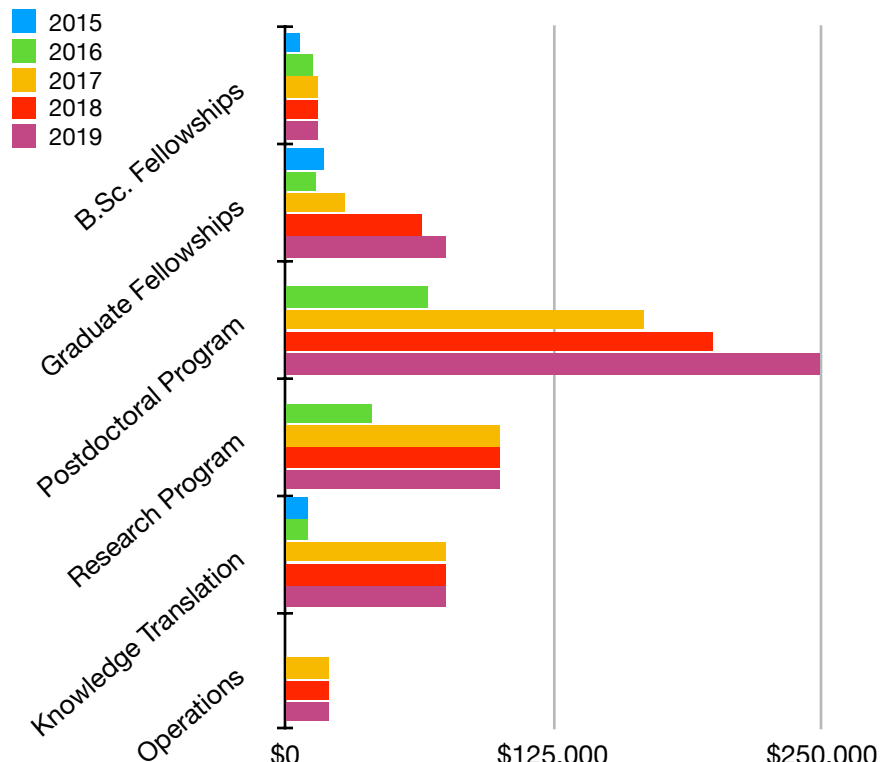




# Publications



# Funding and Organisation



## FINANCIAL OVERVIEW

The iREx's priority remains its excellence in the field of exoplanetary research. As a result, 80% of our funding goes to our research and post-doctoral programs along with our student grants. 15% of our funds are attributable to our outreach activities while our operations requires only 5% of our funds.

## ORGANISATION

### Board of Directors

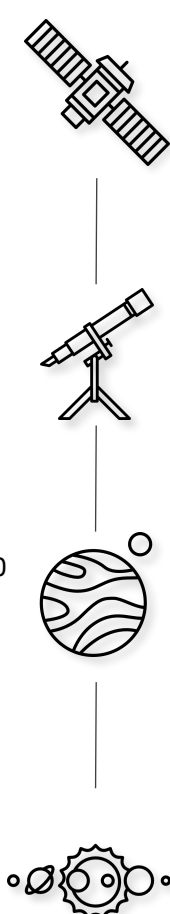
The iREx is managed by the Board of Directors, composed of the Université de Montréal's Dean of the Faculty of Arts and Science who chairs it, the Director of the Department of Physics, the iREx Director, a professor member of the iREx, a member of iREx Governing Board and a representative of the University's Office of Graduate Development and Relations as an observer. The functions of the Board of Directors - among others - are to appoint the iREx Director and members based on the recommendations of the Scientific Committee, approving the iREx scientific program as defined by the Scientific Committee and approving financial reports and predictions.

### Scientific Committee

The Scientific Committee advises the Director on the scientific development of the iREx and defines its programme of activities. It is composed of the iREx Director, the Vice-Dean of Research and Creation of the Faculty of Arts and Science, two iREx professors and an Astronomy-Astrophysics professor attached to another institution.

### Governing Board

The Director of iREx is advised by the Governing Board on all matters concerning the proper operations of the Institute, its outreach activities and its funding. The Board is made up of external representatives interested in the iREx's research area and from various backgrounds.





# **Thank you to our generous donors**

The iREx could not exist without the valuable contribution of its donors. Without their support and vision, it would be impossible for us to continue our research endeavours towards the exploration of our Universe.

We wish to thank

**Trottier Family Foundation**

**Philippe Sureau**

**Jean-François Bertrand**

**Anne Joli-Coeur**

**Marie-Hélène Paquette**

**Our other private donors**

as well as our many supporters across solar systems, near  
and far!



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