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CORDIS Results Pack on
exoplanets

A thematic collection of innovative EU-funded research results

November 2019

The race to find new planets and life beyond our solar system

Research and Innovation

Contents

Editorial

For many years exoplanets, planets beyond our solar system, existed merely in theory and science fiction storylines. While there were those who believed in their existence, there were no means of detecting planets light years ahead. This, however, changed radically over the last two decades with advances in technology and capabilities in observation, both on Earth and in space. With these advancements, exoplanets were no longer an idea or part of a story, they were real; and this CORDIS Results Pack will highlight some of the most exciting EU-funded research in the ongoing hunt for planets beyond our solar system.

Today, exoplanetary research is developing at a startling rate. There have been more than 4 000 exoplanets discovered outside our solar system, illustrating just how diverse the planets in our galaxy are. There is an ongoing race to discover extra-solar 'Earth-like' planets where some form of life may have evolved and could therefore, feasibly, host life one day in the future.

In the pursuit of exoplanets discovery

Horizon 2020, the EU's EUR 77 billion research and innovation funding programme for the period 2014-2020, supports scientific excellence in Europe and has contributed to high-profile scientific breakthroughs such as the discovery of exoplanets as seen with the SPECULOOS project, covered as part of this pack. Whilst larger consortiums on exoplanet research are less common, there are many smaller projects being led by young, passion-driven astronomers through the European Research Council (ERC) and Marie Skłodowska-Curie Actions, for example, who are making large contributions to our understanding of exoplanets and our galaxy.

A focus on the projects

This CORDIS Results Pack focuses on seven projects funded by the EU within Horizon 2020 that put a spotlight on exoplanets. The ABISSE project set out to gain an understanding of exoplanets beyond the solar system and whether they can host life. Another project, DISCO, emphasised the importance of determining the composition of gas and dust surrounding a newly formed star.

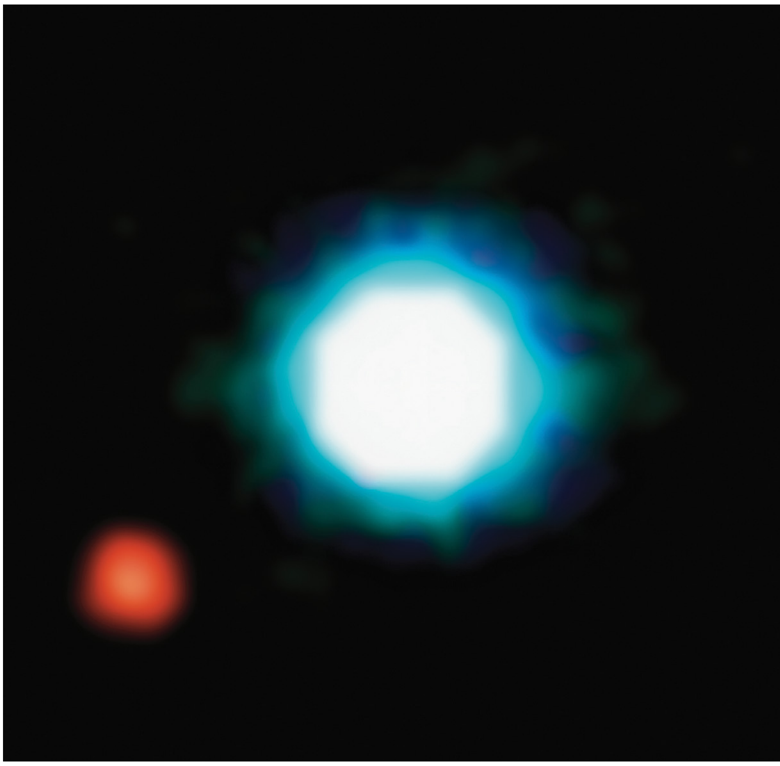
The DiskTorqueOnPlanets project shed light on the role of cosmic dust in defining the architecture of planetary systems. ExoLights worked towards answering fundamental questions of what exoplanets are, the causes for observed diversity, and whether their formation history can be tracked back from their current composition and evolution. Meanwhile, ExTrA used new telescopes to boost their search of habitable worlds nearby cool stars.

The SPECULOOS project helped create a network of pioneering ground-based telescopes. In fact, this project made global headlines when it helped find a planetary system containing seven Earth-sized planets revolving around a small red ultracool dwarf star named 'TRAPPIST-1'. Finally, the vortex project advanced new vortex coronagraph instruments, enabling astronomers to get closer to the realm of short-period planets.

Can planets beyond the solar system support life? Numerical models tell us

Over 4 000 exoplanets have been discovered outside our solar system, most of which are between one and two times as big as Earth. An EU initiative has set out to gain a better understanding of these so-called super-Earths to determine whether they can host life.

"We strongly suspect that these super-Earths are rocky and made mostly of oxygen, silicon, magnesium, iron and nickel," says François Soubiran, a Marie Skłodowska-Curie fellow, undertaking research at France's École Normale Supérieure of Lyon under the supervision of Razvan Caracas as part of the EU-funded ABISSE project. "On average, almost every star has a super-Earth, which means they are very common and we might find life on one or more of them." However, little is known about these giant-size versions of Earth.



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Can super-Earths generate life-saving magnetic fields?

Using sophisticated numerical simulations, ABISSE is characterising the properties of materials inside a super-Earth and determining if such properties can lead to the production of magnetic fields. "For a planet to produce a magnetic field, it needs to have a conducting fluid in a convective motion – the convection is what happens when you heat up water in a pan," Soubiran explains. Inside Earth, the magnetic field is produced by a portion of the iron core that is in a liquid state. "Inside super-Earths, the iron core may very well be fully crystallised, making a dynamo process impossible there." ABISSE is committed to finding where such a process could occur.

Project partners have made considerable progress on two aspects. The first concerns the mantle – a region of the Earth's interior between the crust and core. It had been suggested that molten silicates electrically conduct, and that an enrichment in iron could also significantly increase conductivity. They worked together with two experimental teams to provide numerical support in analysing the data. These experiments investigated the properties of silicates with and without iron under very high pressures. "Preliminary results allow us to conclude that super-Earths' deep magma oceans conduct enough for a dynamo process," says Soubiran.

Probing the mysterious depths of super-Earths

The second key finding raises several questions. The ABISSE team discovered that nickel and iron do not mix well together at high pressure. Calculations show that the two also tend to separate at low temperature, primarily because of magnetic effects. The team is not yet aware how temperature will influence behaviour. One hypothesis is that the cores of super-Earths will be separated in iron- and nickel-rich sections. "This is a completely new idea that needs to be thoroughly examined," he adds.

Many of the soon-to-be-discovered planets are super-Earths, and the challenge of finding life urges us to characterise them as best we can.

Researchers are currently working with modellers to implement the results of the calculations in their models. In doing so, they will be able to determine the key parameters in characterising these exoplanets and finding the right conditions for habitability.

"Many of the soon-to-be-discovered planets are super-Earths, and the challenge of finding life urges us to characterise them as best we can," concludes Soubiran. "Numerical simulations are a great tool to understand these planetary objects that we can't explore directly – yet." This research was undertaken with the support of the Marie Skłodowska-Curie programme.

PROJECT
AB Initio Simulations for Super-Earths

COORDINATED BY
École Normale Supérieure de Lyon in France

FUNDED UNDER
H2020

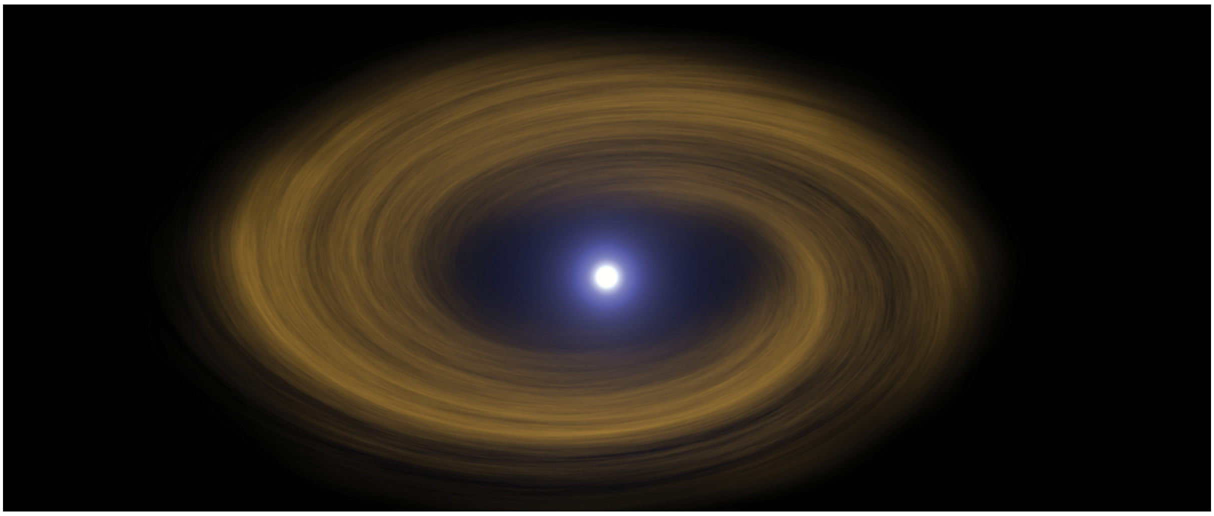
CORDIS FACTSHEET
cordis.europa.eu/project/id/750901

PROJECT WEBSITE
N/A

Chemical fingerprints of stars give clues to exoplanet make-up

A lot of headlines and research around exoplanet composition focuses on measurements of their atmosphere. Although this is a good starting point for whether or not they can sustain life, determining the composition of gas and dust surrounding a newly formed star – the birthplace of planets – is key to understanding the planet's full chemical composition.

Stars are born in a maelstrom when massive, cold clouds of gas and dust collapse and ignite a star. Leftover material in a disk gives rise to boulders ranging up to metres in size. Eventually, large clusters of such boulders will be incorporated into planets that orbit the star. At the same time, a bewildering network of chemical reactions gives rise to complex organic molecules that are trapped in the icy boulders around the star, and are eventually transported to the planets.



"Deciphering the chemical ingredients of material that give birth to planets will reveal the bigger picture of the origin and diversity of planets. Currently, a wealth of research is dedicated to measuring the atmospheric composition of exoplanets as well as planets of our solar system. Although this makes sense, those planetary characteristics are just a springboard for discussions around the habitability of exoplanets, which is ultimately determined by their birth material," notes Mihkel Kama, coordinator of the EU-funded project DISCO.

Using stellar 'contaminated material' as a probe for planets

Hitherto research has given a preliminary understanding of oxygen and carbon abundance in protoplanetary disks. The primary goals of DISCO were to add several more elements to the toolbox of chemical composition analysis to improve understanding of how planets, and specifically habitable environments, originate.

Researchers pioneered a new approach called the 'Contaminated A-stars Method' (CAM) which applies to stars slightly bigger than our Sun. "The chemical element budget of planet-forming material close to a star is very hard to measure directly, so we were looking for innovative new methods to do this. While solar-type stars have churning convection zones, more massive stars are more quiescent. As a result, any material falling onto such a star, like blobs of planet-forming material or gas ejected from a hot close-in planet, would not mix into the star's interior but would rather sit on its surface. This makes it easy for astronomers to measure their spectra and analyse the chemical imprint of the accreted material on their surface," explains Kama.

New chemical elements detected for the first time

Researchers studied several planet-forming disks surrounding young stars. Previously, the focus had been on carbon and oxygen, which was of limited use for understanding the composition of planets. Their research has led to impressive results. In particular, they succeeded in teasing out the precise fraction of sulfur atoms that were locked in solid particles prior to planet formation. This information, which is hard to obtain with any other means and can now be obtained for almost any element using CAM, provides a crucial input to planet-formation models used to predict the elemental composition of planetary solid cores and gaseous atmospheres.

Deciphering the chemical ingredients of material that give birth to planets will reveal the bigger picture of the origin and diversity of planets.

The team has also tracked sodium, zinc, iron and magnesium particles locked in solid particles. "These are elements astronomers have been desperately trying to track down and characterise in planet-forming environments. We hope that this work is going to bring a breakthrough in understanding the properties of Earth and planets around other stars," concludes Kama.

PROJECT
Decoding planetary compositions using observations and modelling of planet-forming disks

COORDINATED BY
The Chancellor, Masters and Scholars of the University of Cambridge in the UK

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/753799

PROJECT WEBSITE
N/A

Dusty disks act as a nursery for nascent planets

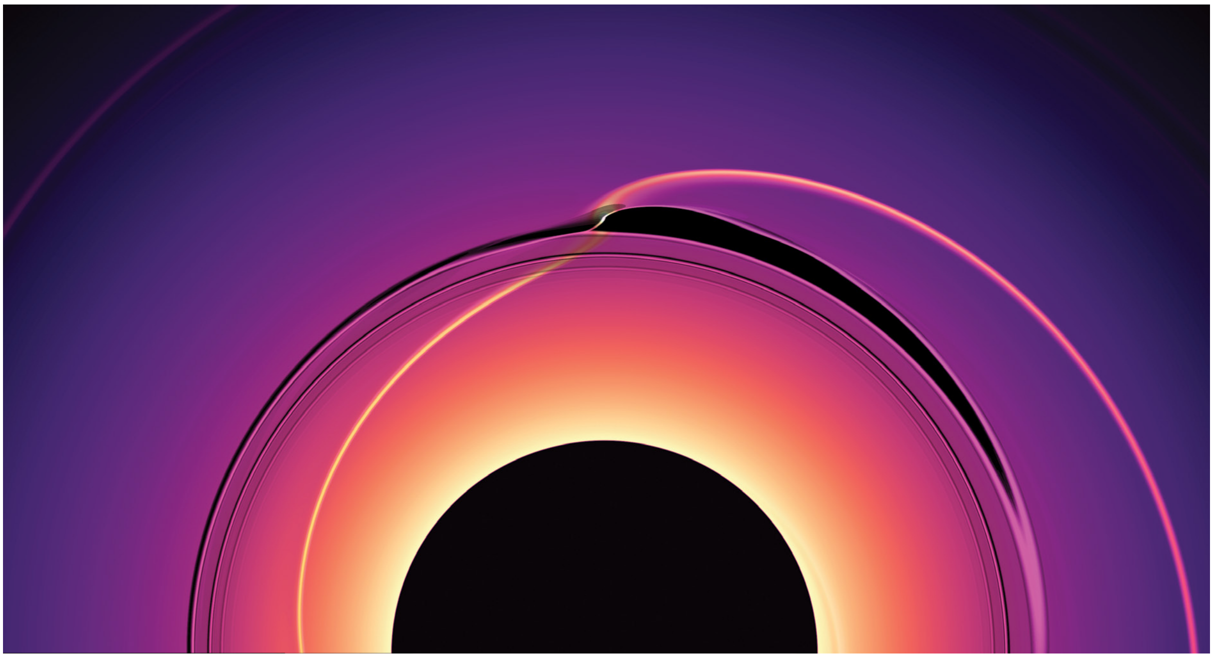
Looking up at the magical canopy of stars on a clear night, what you cannot see is the multitude of young stars nurturing the growth of new planets and planetary systems. EU-funded researchers have shed new light on the role played by cosmic dust in shaping this process.

Protoplanetary disks are flattened, rotating disks of dust and gas found around almost all low-mass stars soon after their birth. Although dust grains are a relatively minor constituent, they are the raw material from which planets are made. Thus, understanding their role in planet formation is crucial.

EU-funded scientists working on the DiskTorqueOnPlanets project are beginning to unravel the largely unknown role that cosmic dust plays in defining the architecture of planetary systems as we observe them today.

Interactions between the dust mass and the forming planet

As project coordinator Martin Pessah explains: "One of the processes that may play an important role is the so-called planetary migration due to the mutual gravitational interaction between the planet and the disk that accelerates the planet and makes it move."



Undertaken with the support of the Marie Skłodowska-Curie programme, DiskTorqueOnPlanets set out to characterise the mechanisms involved in determining the speed and direction of this migration with a focus on the dust in the protoplanetary disk.

Dust properties matter

Simulating dust dynamics requires huge computing power for detailed models. To achieve this goal, the team exploited the power of the graphics processing units available at the High Performance Computing Centre at the University of Copenhagen.

The state-of-the-art, and publicly available, numerical code FARGO3D, developed by fellow Pablo Benítez-Llambay, was extended in a unique way within the scope of the project to address challenging problems in dusty disk dynamics.

A key outcome was a robust numerical algorithm to account for the drag force produced between the gas and dust particles in a protoplanetary disk. According to Pessah: "The tools developed in this project have enabled us not only to discover and systematically study for the first-time gravitational forces arising from the dust component in protoplanetary disks, but also to expand our research to other fundamental questions related to dust growth and dust dynamics in these disks."

Project members successfully demonstrated that dust-particle dynamics are mainly affected by the degree of coupling of dust particles with the gas in the disk, and that depends on the particle size. "We have shown that self-consistent dust dynamics including multiple particle-sizes seem to be crucial to understanding not only how planets form, but also how they move within the disk," Pessah explains.

Poised to support pioneering observations

The Atacama Large Millimeter/submillimeter Array (ALMA) is the result of an international collaboration of institutions united in their endeavour to understand our cosmic origins. It is the most powerful astronomical observatory ever built on Earth.

ALMA has enabled the direct imaging of never-before-seen details of the formation of planets. DiskTorqueOnPlanets tools will help scientists collecting this revolutionary data make sense of it and begin to unravel the processes that shape planetary systems.

In summary, Pessah says: "We have built a framework to solve dust dynamics for an arbitrary number of dust species in numerical simulations, opening the door to the study of a broad range of processes critical to our understanding of planet formation and evolution. By making the tools publicly available, this project supports the global scientific effort to explain the history and evolution of both our own solar system and exoplanetary systems elsewhere in the universe."

We have shown that self-consistent dust dynamics including multiple particle-sizes seem to be crucial to understanding not only how planets form, but also how they move within the disk.

PROJECT
New Frontiers in Modeling Planet-Disk Interactions: from Disk Thermodynamics to Multi-Planet Systems

COORDINATED BY
University of Copenhagen in Denmark

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/748544

PROJECT WEBSITE
N/A

Big Data helps solve some exoplanet mysteries

Among the 4 000 exoplanets known so far in the Milky Way, there is little resemblance to the ones around the sun. An EU initiative has explored exoplanets' characteristics and what makes them so different.

Characterising exoplanet atmospheres represents the next major advance in this new field. This is because the atmospheric chemical composition can provide valuable clues into the formation and evolution processes considered responsible for exoplanets' diversity in our galaxy.

Before the EU-funded ExoLights project, work in exoplanet atmospheric spectroscopy had been undertaken piecemeal with one or perhaps two spectra over a narrow wavelength range being studied at any one time. "This approach is inadequate to provide answers to key exoplanetary science questions," says coordinator Giovanna Tinetti. "It's only by performing a comprehensive spectral survey of exoplanets in a wide variety of environments that we'll answer these fundamental questions."

ExoLights created an open-source infrastructure to observe, analyse and interpret the atmospheres of exoplanets, thus enabling the study of a very large and diverse sample for the next 10 years.

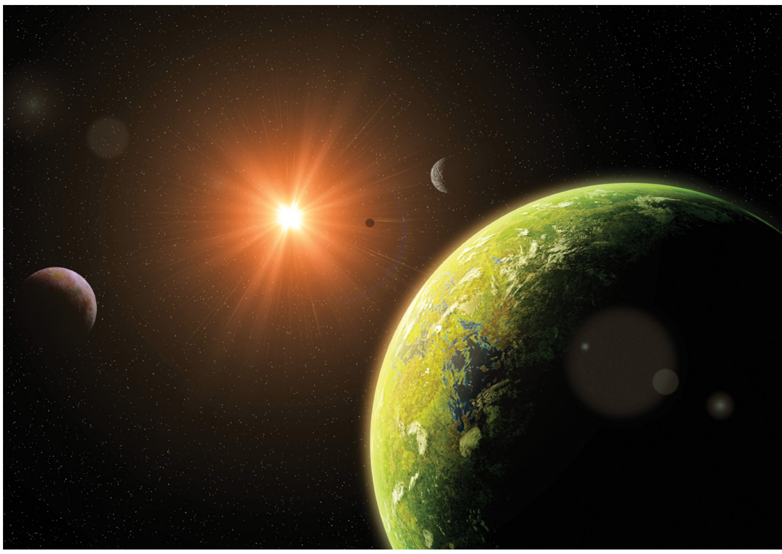
Enter the big data era for exoplanet characterisation

The ExoLights team delivered several breakthrough scientific discoveries and an infrastructure of open source numerical codes to observe and interpret a large population of exoplanet atmospheres. In 2018, team members published the first catalogue of 30 exoplanet atmospheres being studied at any point. "This work has shifted the entire field of exoplanet atmospheres from the investigation of individual planets to the characterisation of populations," notes Tinetti. "This focus on population analysis and infrastructure to monitor and process big data has been driving the entire exoplanet characterisation field towards these goals."

The scientists have obtained some high-impact results. One is the first analysis of an exoplanet's atmosphere around a super-Earth. Another is the first water vapour detection in the atmosphere of a super-Earth, specifically in its parent star's habitable zone.

Understanding exotic exoplanet worlds at a new level

Research findings indicate that a statistically significant number of planets – approximately two orders of magnitude larger than the sample expected to be observed with future general-purpose facilities – needs to be observed systematically to fully test models and determine the relevant physical parameters. "This requires observations of a large sample of objects, generally on long timescales that can only be performed with a dedicated space



instrument, rather than with multi-purpose telescopes not often optimised for the specific application," explains Tinetti.

The project initially conceived and investigated dedicated space missions and observatories like ARIEL and Twinkle. "ExoLights has been leading the effort to plan and carry out such missions in Europe," she adds. "They will benefit the global planetary and exoplanetary community over the next decade."

ExoLights also carried out public engagement as well as several educational activities. The ongoing Original Research By Young Twinkle Students is an innovative and highly successful educational programme, enabling secondary schools to work on original research linked to the Twinkle space mission under the supervision of PhD students and other young scientists. Launched in 2019, the ARIEL Data Challenge Series gathered professional and amateur data scientists. They used machine learning to remove noise from exoplanet observations caused by star spots and instrumentation. Over 100 international teams participated in the ARIEL Data Challenge Machine Learning competition in 2019.

"ExoLights created an open-source infrastructure to observe, analyse and interpret the atmospheres of exoplanets, thus enabling the study of a very large and diverse sample for the next 10 years," concludes Tinetti. "The open-source tools developed, the space missions designed and currently being implemented, and the scientific advances published will be the project's legacy."

PROJECT
Decoding Lights from Exotic Worlds

COORDINATED BY
University College London in the United Kingdom

FUNDED UNDER
H2020

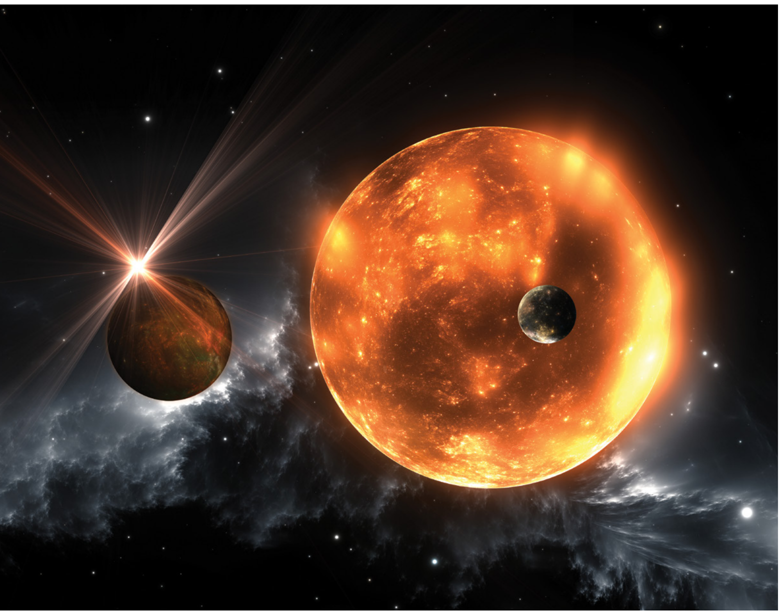
CORDIS FACTSHEET
cordis.europa.eu/project/id/617119

PROJECT WEBSITE
N/A

New telescopes boost search for habitable worlds nearby cool stars

A new facility housing three telescopes in the Chilean desert will soon be on the hunt for cold objects such as forming Earth-sized planets orbiting nearby red dwarf stars. Its innovative design and infrared-sensitive 'eyes' will aid in the detection of potentially habitable worlds.

One of the most exciting discoveries in astronomy over the recent decades has been the identification of planets orbiting stars outside our solar system. So far, more than 4 000 exoplanets are known; the largest percentage are significantly larger than Earth, comparable with the dimensions of the gas giant Jupiter. While this may not reflect the real conditions in space, smaller planets are harder to detect.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ExTrA is a new facility at the ESO's La Silla Observatory in Chile, which is funded by the European Research Council and the French National Centre for Scientific Research. ExTrA's telescopes will dramatically improve the detection and atmospheric characterisation of Earth-sized planets. They are specially aimed at planets that transit their star. During their motion, exoplanets cause a slight dip in the brightness of the star and cast its shadow on the telescopes. By measuring this periodic dimming of light, astronomers can infer the atmospheric physics and the bulk composition to determine what the planet is predominantly made of.

Observing in the near-infrared

The ExTrA facility is using technology that can boost the power of a traditional technique known as differential photometry (where the brightness of a star is assessed by comparing it to other stars in the image). Originally, it would be difficult to spot smaller, Earth-sized exoplanets using this method. However, researchers are developing novel methods to measure the brightness of red dwarfs in the near-infrared where they appear brighter.

"Currently, there is a host of small telescopes that scan red dwarf stars for signs of exoplanets. Running similar surveys in the infrared would make observations of small and cool exoplanets much more efficient, as red dwarfs emit most of their light in the infrared," says project coordinator Xavier Bonfils. As infrared cameras are relatively expensive, the ExTrA telescopes are using fibre optics. The light collected from the three telescopes is transmitted through optical fibres and run through an infrared detector. A robot positions the fibres in the right location to receive the light from stars. That is how ExTrA can record photometry in the infrared.

This should be the most sensitive survey for Earth-sized planets transiting bright nearby stars.

Researchers have also taken into account that infrared radiation is strongly absorbed by water. This creates a large amount of systematic errors when observing a star at different air masses. To this end, the optical fibres of all three telescopes lead to the same spectrograph – an instrument that disperses starlight – so that the astronomers can select the spectral bands that are free of water transition lines.

Water – a key ingredient for life beyond Earth

ExTrA will look for transiting planets around cool stars in the hopes of detecting Earth-sized planets in their habitable zone. In this region around a star, a planet can have surface temperatures consistent with the presence of liquid water. The prime factor determining the planet temperature is its distance from the host star.

"This should be the most sensitive survey for Earth-sized planets transiting bright nearby stars," says Bonfils. "That means we expect to be able to identify and analyse dozens of exo-Earths, and by characterising their atmospheres, we will be able to identify those that are potentially habitable."

PROJECT
Exoplanets in Transit and their Atmosphere

COORDINATED BY
French National Centre for Scientific Research in France

FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/337591

PROJECT WEBSITE
N/A

The hunt for life on other planets is ultracool and getting warmer

The existence of life beyond our solar system is the stuff dreams are made of. A novel ground-based telescope network is detecting habitable planets and making a list for newly commissioned spectroscopic telescopes seeking signs of life.

Ever since the historical first discovery of a planet orbiting another sun-like star in 1995, more than 4 000 such exoplanets have been detected at an ever-increasing rate. They include gas giants similar to Jupiter (so-called hot Jupiters) and terrestrial ones, the real attention-grabber when it comes to exoplanets that could support life.

EU-funding of the ambitious SPECULOOS project has helped create a network of pioneering ground-based telescopes. Discovery of life on other planets may be around the corner rather than light-years away.

When you wish upon a star

Project coordinator Michaël Gillon's lifelong dream of finding life on other planets began to solidify with initiation of the SPECULOOS prototype in 2011 at the University of Liège's TRAPPIST 60 cm robotic telescope in Chile, to monitor about 50 of the nearest and brightest ultracool dwarf stars. These stars are considered the best targets for detection of spectroscopic biosignatures with next-generation giant telescopes, among which is the James Webb Space Telescope (JWST) scheduled to launch in 2021.

It is remarkable that, after centuries of speculation, the existence of life beyond our solar system is now entering the realm of a testable scientific hypothesis. If one day we discover it, our vision of the Universe and of our place in it will change forever. In the meantime, the project will probe the diversity of terrestrial planets in the galaxy.

By 2015, the SPECULOOS prototype had found a clear exoplanet signal at one of its 50 ultracool dwarf targets. Gillon continues: "In 2016, we acquired much more data, revealing the existence of seven temperate Earth-sized planets around this tiny nearby star. Now called the TRAPPIST-1 planetary system, all of these planets could harbour water in liquid form on their surfaces. And all of them are well-suited for detailed atmospheric studies."

The revelation led to a press conference at NASA's headquarters in Washington DC, USA and a flurry of publications, including in the prestigious peer-reviewed journals Nature and Nature Astronomy.

Like a needle in a haystack

Despite the exciting successes of the SPECULOOS prototype, detecting exoplanets potentially habitable and dozens of light-years away is no easy task. Astronomers often rely on a sort of mini-eclipse, a dimming of the light emitted by the star that happens with a predictable regularity lasting a predictable length of time, indicating it is caused by an object in orbit.

Aside from the inherent technical difficulty, the relative frequency of such planets around Sun-like stars is unknown. Finding more could take time and patience.

Intensifying the hunt for habitable planets

There are about 1 000 ultracool dwarf stars close enough and bright enough to make the atmospheric study of Earth-sized planets possible with JWST. Gillon plans to follow them all.

Thanks to EU-funding and an international collaboration, he has brought to eight the total number of robotic ground-based telescopes in the network. At four different locations, they cover both the northern and southern hemispheres to ensure maximal potential for detecting exoplanets during their transit across their own stars.

Gillon reflects: "It is remarkable that, after centuries of speculation, the existence of life beyond our solar system is now entering the realm of a testable scientific hypothesis. If one day we discover it, our vision of the Universe and of our place in it will change forever. In the meantime, the project will probe the diversity of terrestrial planets in the galaxy."

PROJECT
SPECULOOS: searching for habitable planets amenable for biosignatures detection around the nearest ultra-cool stars

COORDINATED BY
University of Liège in Belgium

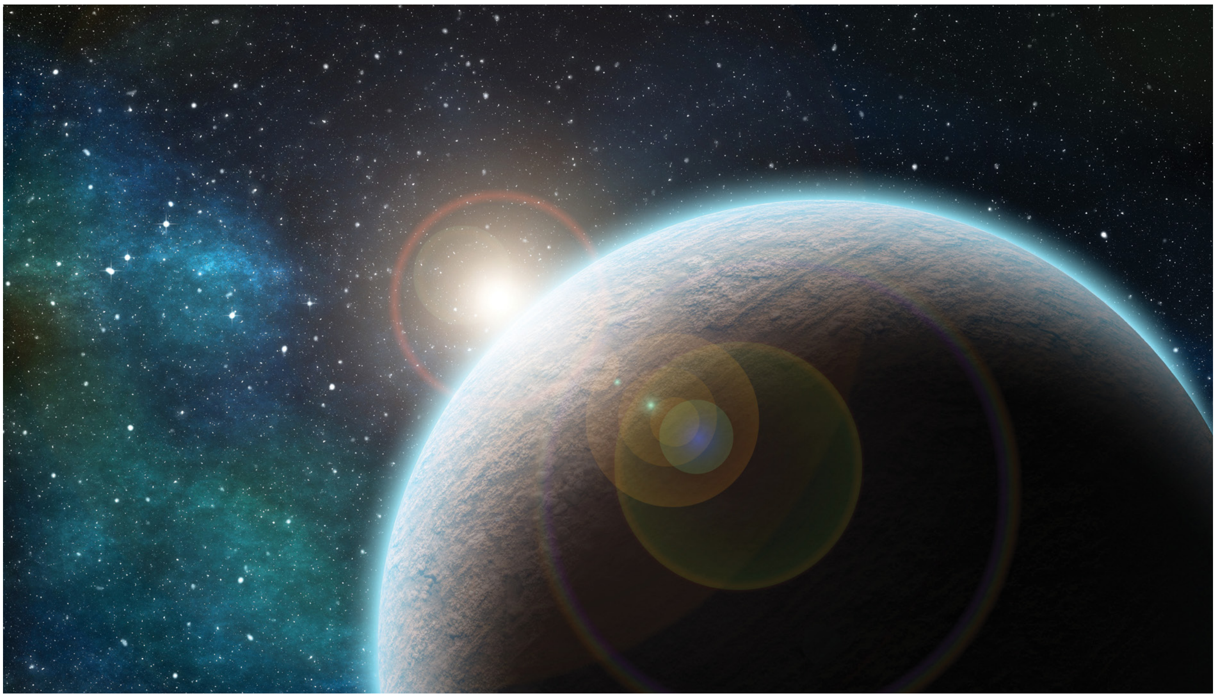
FUNDED UNDER
H2020

CORDIS FACTSHEET
cordis.europa.eu/project/id/336480

PROJECT WEBSITE
speculoos.uliege.be/

Vortex coronagraph helps spot planet formation in the act

A new device at the Keck Observatory in Hawaii has delivered its first image, showing a planet forming in the swirling gas and dust around a young star. Based on the latest vortex coronagraph technology, the device permits the direct image of distant planets closer to their host stars than was previously possible.



Young stars are often surrounded by a rotating ring of dust and gas known as a protoplanetary disk. The material in this disk can clump together, indicative of a planet in the process of forming.

A combination of dedicated high-contrast imaging equipment installed in the Keck II telescope and sophisticated image processing techniques led a team of researchers from Belgium and Sweden to take direct images of the accumulated matter around the star MWC 758. This feat has long been considered vital in the search for planets that orbit relatively close to their star just like our own.

Exoplanets galore

The study of exoplanets has seen remarkable discoveries over the past two decades. There are more than 3 000 confirmed exoplanets, but the overwhelming majority of these discoveries are a result of indirect imaging techniques. These can be either a measurement of the changing wavelength of the light the star emits, which is caused by the gravity of the orbiting planet, or the minute dimming of the star when the planet passes in front.

Direct imaging has been technically challenging: being more than a million times fainter, exoplanets are lost in the glare of their host star as seen from Earth. Although large telescopes worldwide have recently started to employ high-contrast imaging techniques, current coronagraph technology can only detect 'lonely' planets that orbit their star at a great distance. The orbital period exceeds 20 years. In comparison, all rocky planets in our solar system orbit the Sun in less than two years.

Our vortex phase masks can cancel stellar light by a factor larger than 1 000, which is the highest rejection ratio ever measured.

Taking a closer look at Earth-like planets

The EU-funded vortex project pioneered new vortex coronagraph instruments, which enable astronomers to get closer to the realm of short-period planets. The refined instruments enable high-contrast imaging of planetary systems at minute angular separations between the planet and the star. "Young stars are not close to our solar system, so we have to look farther away in the galaxy where stars and planets appear closer together. The ability of our vortex coronagraph technology to survey distant stars for planets is important for catching planets still forming," notes project coordinator Olivier Absil.

The secret behind the project success was the improvements in the existing manufacturing process for the vortex phase mask. This part of the vortex coronagraph redirects light away from the detectors by combining light waves and cancelling them out. Vortex phase masks consist of concentric microstructures that force the star light waves to swirl about the mask centre, creating the vortex singularity. Researchers etched the concentric microstructures into a diamond. "Our vortex phase masks can cancel stellar light by a factor larger than 1 000, which is the highest rejection ratio ever measured," says Absil.

Researchers built on their successful work by training a machine learning system on what to look for in the data. The aim was to discern real exoplanets from residual stellar light. This is the first time ever that researchers have applied machine learning to hunt exoplanets. Results so far show that it outperforms other data processing techniques.

Until the 1990s, planet formation theories were based on our solar system. "We now understand there is a huge variety of planetary systems out there, and so our solar system should not be regarded as an archetype," concludes Absil.

PROJECT
Taking extrasolar planet imaging to a new level with vector vortex coronagraphy

COORDINATED BY
The University of Liège in Belgium

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VAST, COMPLICATED, (DIS)ORDERLY? UNLOCKING THE SECRETS OF THE COSMOS

The night sky is not just inspiring and beautiful, it's the origin story of our very existence, and has inspired questions since humankind started walking the face of the Earth. This month's special feature looks into some of the latest EU-funded attempts to unlock the mysteries of the Universe. These efforts cover most of the Universe's story, from the Big Bang's initial gravity waves to the creation and characteristics of stars, low surface brightness galaxies, and galaxy clusters.

Check out the pack at
cordis.europa.eu/article/id/406167

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