Annual Report 2021

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Danish National Research Foundation

Technical University of Denmark
DTU

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Contents

The Launch of the James Webb Space Telescope. Image obtained from NASA

The Cosmic Dawn Center

Directors' Statement

Sune Toft — Center Director (photo taken by Guarn Nissen)

On Christmas day 2021, the Cosmic Dawn Center and the rest of the world got the best possible scientific present: the successful launch of the James Webb Space Telescope (JWST) from the European Spaceport in French Guiana. After years of careful preparation and multiple delays, a highly anticipated milestone was finally reached. The perfect launch of JWST meant that the telescope saved significant amounts of fuel — fuel that will now be used to extend its lifetime from a guaranteed five years to potentially beyond a decade.

This is great news for many reasons. For example, there will be more overlap and synergy with future space telescopes like the ESA's Euclid mission and NASA's Roman Space Telescope. Both telescopes will survey large parts of the sky to find thousands of the rarest distant galaxies that may hold the key to understanding galaxy formation but can only be studied in detail by James Webb. There will also be overlap with the next generation of ground-based telescopes, such as the European Extremely Large Telescope (ELT), which will nicely complement the infrared observations from James Webb with observations at optical wavelengths.

Thomas Greve — Center Co-Director (image obtained from DTU)

While we would have preferred fewer delays for the JWST, we at DAWN have taken advantage of the extra time to build up the infrastructure, expertise and preparatory survey work needed to lead Cosmic Dawn science from the time the first images are transmitted to our computers.

Over the last years, DAWN has led the development of the latest version of the influential COSMOS survey. The culmination of this work so far was the publication of the new official COSMOS source catalog, led by DAWN PhD student John Weaver. The catalog maps the positions, distances and properties of more than one million galaxies over most of cosmic history. We presented the catalog to the COSMOS team at an online launch party and made it immediately available to the world, along with specialized tools to read and analyze it. To date, hundreds of scientists have downloaded the catalog and are using it for their future research. The COSMOS catalog paper is co-authored by 18 DAWN team members ranging from first-year students to professors who all made important contributions and is thus a textbook example of what is possible in a center of excellence. It has already been an important component in winning numerous observing programs with the world's largest telescopes (including JWST), and a suite of scientific papers is under review.

We have spent the previous years putting the expertise and experience developed at DAWN (as part of the COSMOS work) to work on preparing and laying the grounds for a James Webb data center and source database. The ambition is to homogeneously process data from all DAWN's programs as well as from large public surveys together and make the data products and derived quantities easily accessible to all researchers at the center and to the whole community. This will ensure maximal scientific exploitation of the James Webb telescope from the beginning and consolidate DAWN's position as a world hub for the expected breakthrough. The past year gave many examples of the scientific excellence that DAWN scientists achieve. Several high-visibility discoveries, often led by our students and associates, were published in the most impactful journals.

The launch of JWST created headlines worldwide, including in Denmark, where both local and national media picked up the story in a big way. With its involvement and leadership of many JWST programs, DAWN was in high demand by journalists. DAWN scientists made numerous appearances on TV, radio and print media to explain to the public the fascinating science that the JWST will do and the Danish involvement in the mission.

Nobody would have enjoyed the launch of JWST more than our dear colleague, Hans Ulrik Nørgaard-Nielsen, who tragically and unexpectedly passed away on the 3rd of September 2021. For more than 20 years, Hans Ulrik was involved in the James Webb Space Telescope, specifically the MIRI team. It is in great part thanks to his work that DAWN and Danmark are heavily involved in the first MIRI science observations. Hans Ulrik looked forward to seeing the first JWST data of the most distant galaxies. He will be greatly missed.

A key aspect of DAWN's mission is to attract and develop young scientists who will become future leaders in the field. We are thrilled to have welcomed several new postdocs and students to DAWN in the past year. As in previous years, 2021 was a successful year for our young and early career scientists at DAWN in terms of winning grants. For example, Kasper Heintz won a Carlsberg Reintegration Fellowship, which will allow him to continue his research at DAWN on fast radio bursts as tracers of baryons across the cosmic web. Shuowen Jin won a Marie Curie Fellowship to work on extremely dusty early galaxies at DAWN. Seiji Fujimoto won the prestigious NASA Hubble Fellowship, which he will take to the University of Texas at Austin this fall. Seiji's achievement is particularly noteworthy in that it is the first time that a postdoc based in Denmark has won a Hubble Fellowship. Francesco Valentino won the ESO Fellowship at the European Southern Observatory headquarters in Germany. Congratulations to Kasper, Shuowen, Francesco, and Seiji!

DAWN is buzzing with excitement over the expected arrival of the first JWST data, which we have waited and prepared for since the start of the center. 2022 promises to be a monumental year for DAWN.

Annual Highlights 2021

Galaxies Running out of Gas

One of the great questions in astronomy is how some galaxies, after having spawned billions of stars at a continuous rate, suddenly cease to form new stars. Since stars are made of gas, we expect the reason for this quenching to somehow be associated with the galaxies' gas supply being exhausted. In the present-day Universe, where galaxies have had billions of years to slowly use up their gas, this is perhaps less puzzling. But until recently it had not been confirmed observationally in the early Universe, where galaxies have had much less time to evolve.

We were therefore excited to report the detection of a small sample of galaxies, seen as far back in time as 10–12 billion years ago, which are clearly seen to have run out of gas. The study, led by Kate Whitaker, specifically targeted galaxies lying behind massive galaxy clusters, the immense gravity of which helps magnify their light.

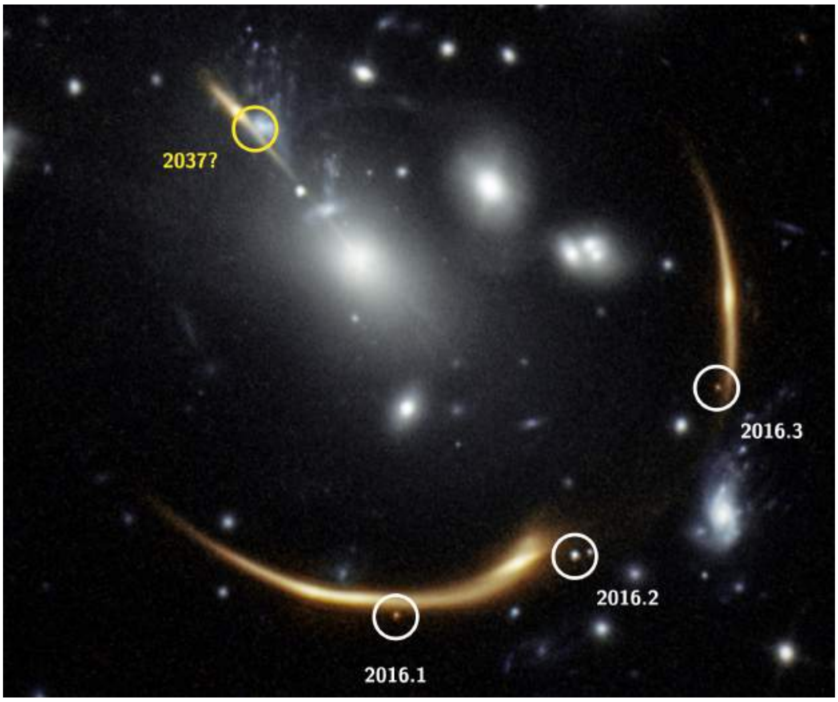
What physical processes led to the depletion of gas is still unknown. But with the recent successful launch of the James Webb Space Telescope, we are optimistic that follow-up observations will reveal the cause for the early quenching of galaxies.

Supernova Déjà Vu

One of the galaxies from Whitaker's study is seen as a huge, red arc circumscribing a foreground cluster (see the figure on the adjacent page). The odd shape arises because the light from the galaxy follows different paths around the cluster. While co-authors Gabriel Brammer and Sune Toft were inspecting the image, taken with the Hubble Space Telescope in 2016, they noticed a little red dot. Curiously, the dot was missing from images of the same field, taken three years later.

The dot — or rather dots, because it is seen in three different places on the sky due to the lensing effect — turned out to be a supernova; the death explosion of a star that ended its life over 10 billion years ago. With a physical model of the gravitational field of the galaxy cluster, they were able to make a remarkable prediction:

In addition to the three images appearing in 2016, the light should also take on a fourth and slightly longer path, resulting in the reappearance of the supernova in 2037. More than just a curiosity, the exact delay — observed with upcoming facilities such as the 39 meter European Extremely Large Telescope — will enable us to accurately measure the expansion rate of the Universe.



This massive galaxy cluster, dubbed MACS J0138, acting as a gravitational lens paved the way for two astonishing results in 2021: The big, red arc is a distant galaxy that stopped forming new stars due to the lack of gas. In addition to leading to this clue on the reason for early quenching, it hosted a supernova that was detected in three places in 2016 and is predicted to appear again in 2037 (±a few years). Credit: S. Rodney (U. of S. Carolina), G. Brammer (DAWN), J. DePasquale (STScI), P. Laursen (DAWN).

Image credit: Gabriel Brammer

Organization

Hiring Plan

In 2021 we welcomed two new tenured Associate Professors to DAWN's core group in Denmark. Charlotte Mason arrived in August, started her tenure and established her Villum Young Investigator group. Pascal Oesch joined us in January on a 20/80% split position with Geneva. It is also with great pride that we announce DAWN's Co-Director Thomas Greve was appointed a full professor at DTU Space.

Recruitment & Gender Strategy

In spite of the COVID 19 pandemic, DAWN experienced growth in every area throughout our center. Our recruitment strategy continues to uphold simplicity while focusing on attracting and recruiting the top candidates from around the globe regardless of gender, ethnicity, or cultural background. Postdoc and PhD positions are offered yearly through wide, open international calls with deadlines for applications, rounds of interviews, offers and acceptance deadlines following the international academic hiring cycle.

In 2021, DAWN hired a total of five postdocs, three female and two male, who are nationals of Denmark, United States, India, South Korea and China, and arrived from institutes in Denmark, United States, Spain, United Kingdom, Sweden and Germany. We dedicated our efforts on hiring outstanding, independent fellows with a broad range of diverse backgrounds to our flagship DAWN postdoctoral fellowship.

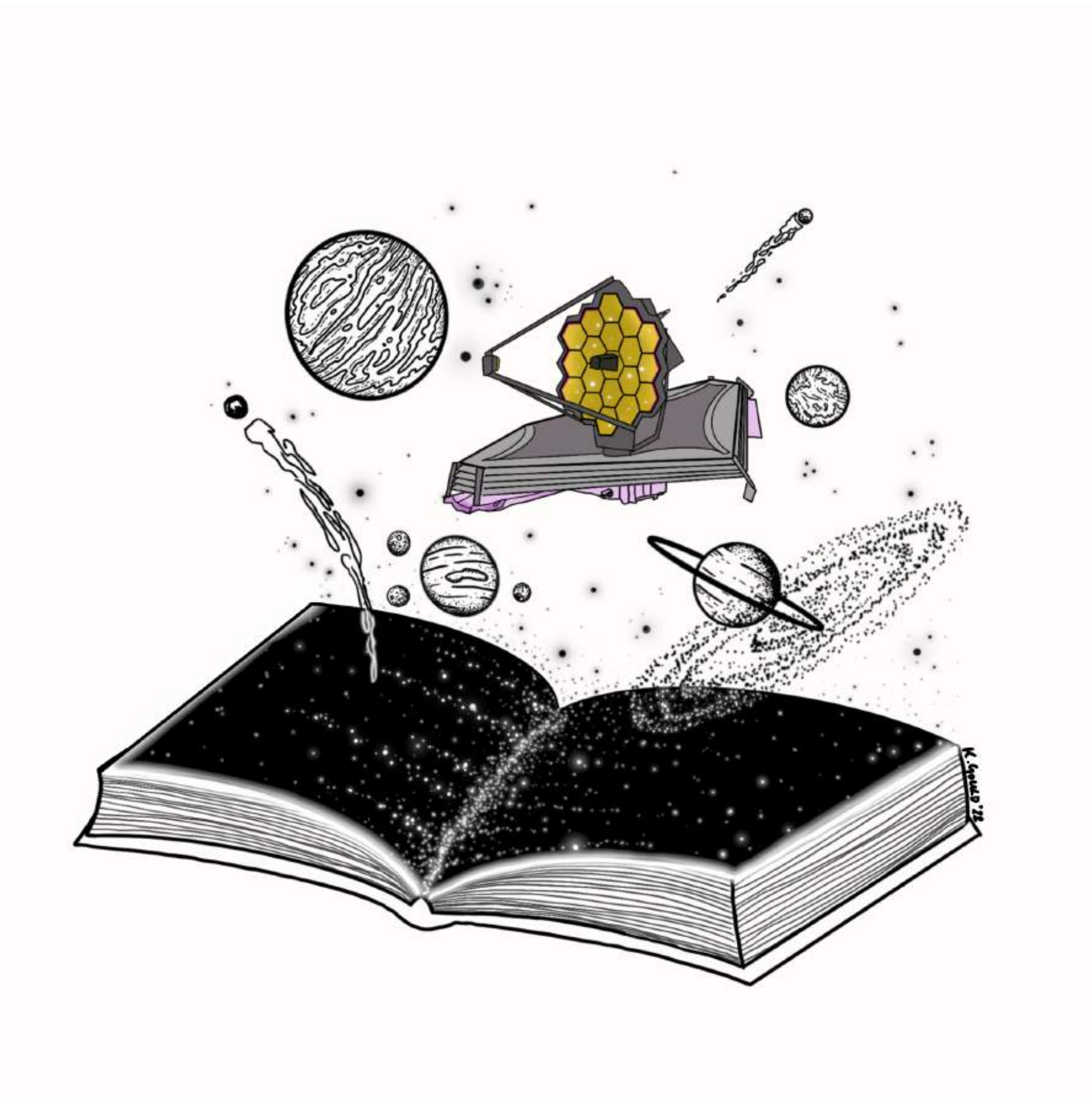
Through our PhD fellowship program, we hired six new PhD students — two female and four male — from the United Kingdom, Spain, Chile, China, Finland and Taiwan.

Housing of the Center

University of Copenhagen has sublet part of the completed Niels Bohr Building on the north-west side of Jagtvej where the Cosmic Dawn Center is located. The office spaces are modern and appealing, but DAWN has already outgrown our allocated space and DAWN eagerly awaits the result of the institute's pursuit of more building space. Additional space is urgently needed in order to house all the new researchers and long-term guests who are scheduled to arrive in 2022. Currently access to meeting facilities is also very limited and we look forward to gaining access to meeting rooms large enough to have talks and social gatherings for the whole center.

The DAWN center at DTU is located within DTU Space, at the Technical University of Denmark in Lyngby. All DAWN offices are on the 2nd floor, except for one office on the 1st floor. The offices are contemporary and welcoming and there is plenty of lounge space available. However, sufficient office space for long-term visitors — several are scheduled to arrive in 2022 — remains a challenge. The center shares two spacious meeting rooms with the rest of DTU Space.

The Niels Bohr Building (left) and the DTU Space Building (right)



Drawing by DAWN PhD student Kate Gould

Science Progress & Research Updates in 2021

Research Integrity

DAWN is committed to the highest levels of research integrity. We continue our commitment to open access to our research products via arXiv.org and open access peer-reviewed scientific journals. This also includes the use of public research data repositories. DAWN is also committed to the principles of the FAIR framework for sharing and stewardship of research data, with procedures to ensure that these data are Findable, Accessible, Interoperable, and Reusable (Wilkinson et al., 2016). These principles are particularly important for extragalactic astronomy research that increasingly relies on large surveys and distributed datasets from a wide variety of space- and ground-based observatories. At DAWN this includes the development of the Cosmic Dawn Survey and public release of associated data products (Euclid Collaboration et al., 2022) and a research-ready repository of archival data from the Hubble Space Telescope that enabled, for example, the Supernova deja-vu" discovery described above (Rodney et al., 2021).

Research Plan

Research Themes & DAWN's 2021 Discoveries

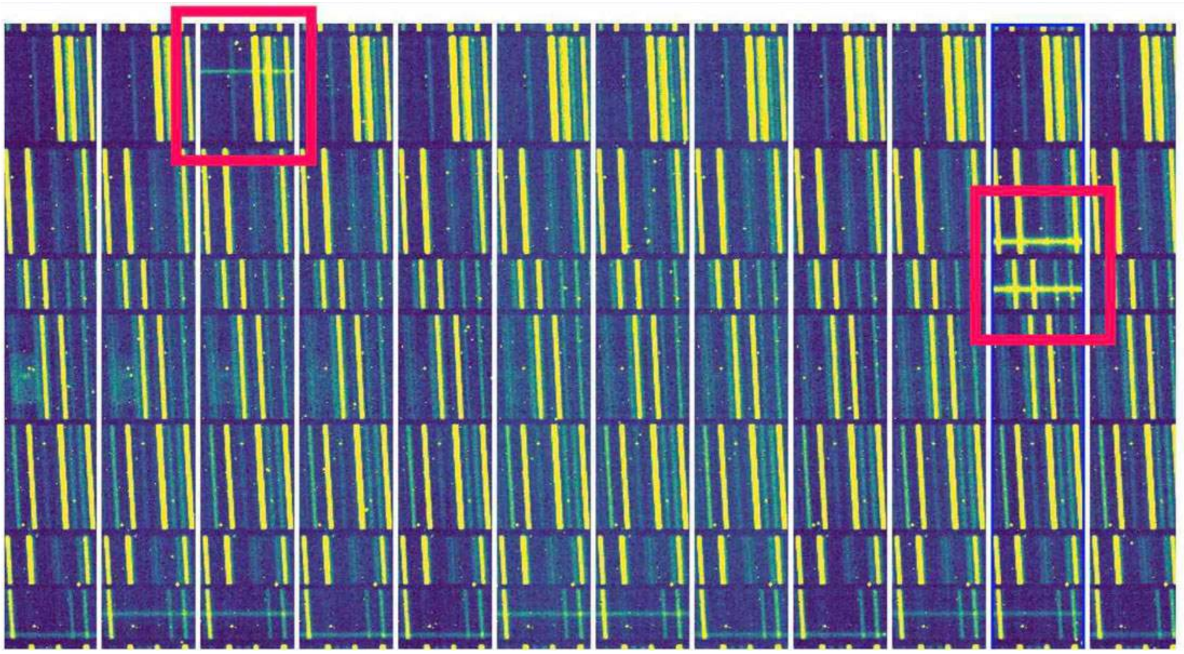
Last year was the final year without James Webb data, but as the previous years DAWNers did not lie idle and continued our research in our five main themes of interest: The birth, the evolution, and the eventual "death" of galaxies, their interior, and their exterior. The following five sections describe some of the discoveries we published in 2021.

First galaxies

The farther away a galaxy is, the more time its light has spent on its journey toward us. Hence, to learn about the first galaxies, born a few hundred million years after the Big Bang, we aim to observe the most distant galaxies.

The current record-holder for the most distant galaxy, observed by DAWN's Pascal Oesch and Gabriel Brammer back in 2016 and dubbed "GN-z11", is seen when the Universe was 400 million years old. That very galaxy became the object of attention last year, not only in the astronomical community but also in the public eye, when a team of Chinese astronomers Jiang et al. (2021) reported the detection of a possible gamma-ray burst, the most violent explosion in the Universe. The existence of a gamma-ray burst in such early epochs of the history of the Universe would have major implications for our understanding of its formation timescales.

Alas, a more bland explanation turned out to be much, much more plausible, when Steinhardt et al. (2021a) demonstrated that the observed burst was at least ten billion times more likely to be the glare of a piece of space junk one of the more that 100 million pieces of metal debris orbiting Earth. Shortly after, this conclusion was backed up by a paper by Michalowski et al. (2021) who identified the piece as the upper stage of a Russian Proton rocket.



An arbitrary collection of (2D) spectra, taken with the MOSFIRE spectrograph on the Keck I telescope in Hawaii. Roughly one in $1,000$ *to* $10,000$ *— exemplified by the ones marked by a red square — show a spurious transient flash caused by debris from artificial satellites. The relatively common appearance of this phenomena demonstrates that a UV flash spotted close to the most distant known galaxy, GN-z11, was most likely* not *the earliest gamma-ray burst ever detected, but simply a piece of space junk. Credit: Steinhardt et al. (2021a).*

With the recent successful launch of James Webb, the distance record of GN-z11 is expected to be broken soon. There are strong theoretical grounds to believe that the first galaxies formed between 100 and 200 million years after the Big Bang. Naturally, we will be on stranger tides in this hitherto unexplored epoch. Theoretical predictions are therefore essential, such as the ones provided by Steinhardt et al. (2021b) who investigated expected uncertainties and, in particular, how to deal with them.

Galaxy formation is not an instantaneous event, taking place at a specific moment. Rather, it is a continuous build-up of large systems from smaller clumps. We have yet to discover a truly primordial collection of stars, but we are continuously pushing the limits. To detect some of the first galaxies, the Atacama Large Millimeter Array — an array of radio telescopes in the Chilean desert — has proved very successful, among other things enabling us to accurately determine the temperature of dust (Bakx et al., 2021), and — with the aid of gravitational lensing (see information box above) — perform extremely high-resolution observations of the interstellar gas (Fujimoto et al., 2021), both in galaxies seen less than a billion years after the Big Bang.

> **Gravitational Lensing**
>
> As predicted by Einstein's theory of relativity, massive objects such as black holes, galaxies, or clusters of galaxies warp spacetime to the extent that they may deflect light. If a massive objects lies between us and a light source, it can act as a cosmic lens, distorting and amplifying the distant source.
>
> This marvelous effect is popular among astronomers studying the distant Universe — specifically here at DAWN — enabling us to exploring details not otherwise accessible to us.

Galaxies form and grow by accreting gas from the surrounding intergalactic medium. But in order to condense, that gas must cool, or else the gas particles will be too energetic, and escape. In this cooling process, the gas is expected theoretically to emit a certain kind of ultraviolet light called "Lyman-α". Typically, the emitted Lyman-α will be dominated by star formation rather than cooling, but Kimock et al., 2021 demonstrated, using high-resolution computer simulations, that every massive galaxy should go through such a phase, and that fluctuations in both processes can sometimes make the effect of cooling comparable to that of star formation.

The emitted Lyman-α cooling radiation is, however, after all very faint, and has yet to be convincingly verified, observationally. Nevertheless, using one of the world's largest telescopes, Keck I at Mauna Kea, Hawai'i, Daddi et al., 2021 presented the observations of Lyman-α radiation from three filaments of gas, one million lightyears across, accreting onto a galaxy group in the early Universe. Although other interpretations are possible, the authors argued that the most plausible explanation is indeed the long-sought-after Lyman-α cooling radiation.

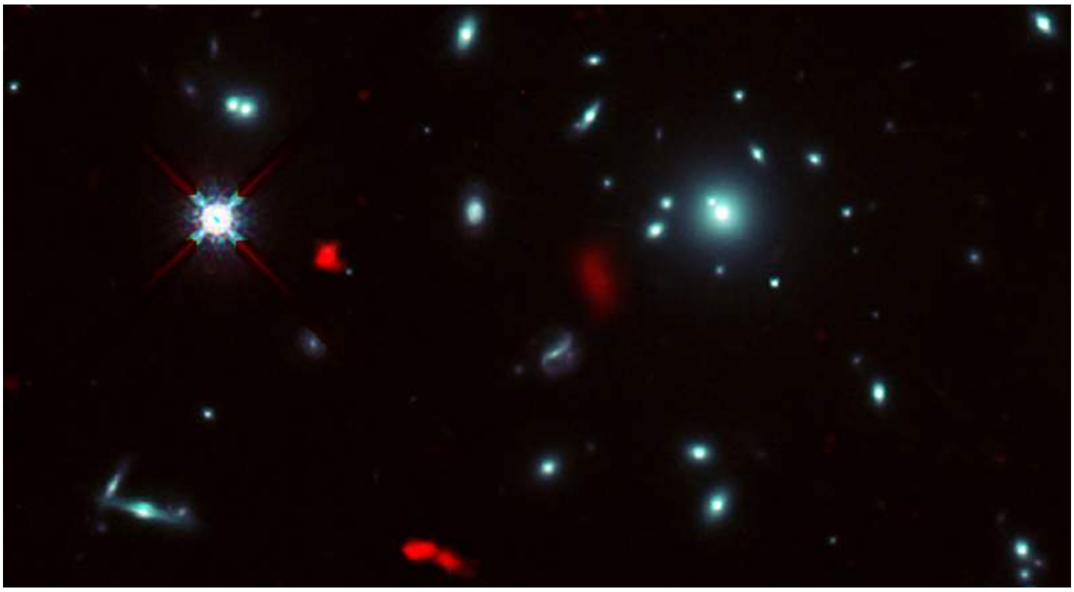
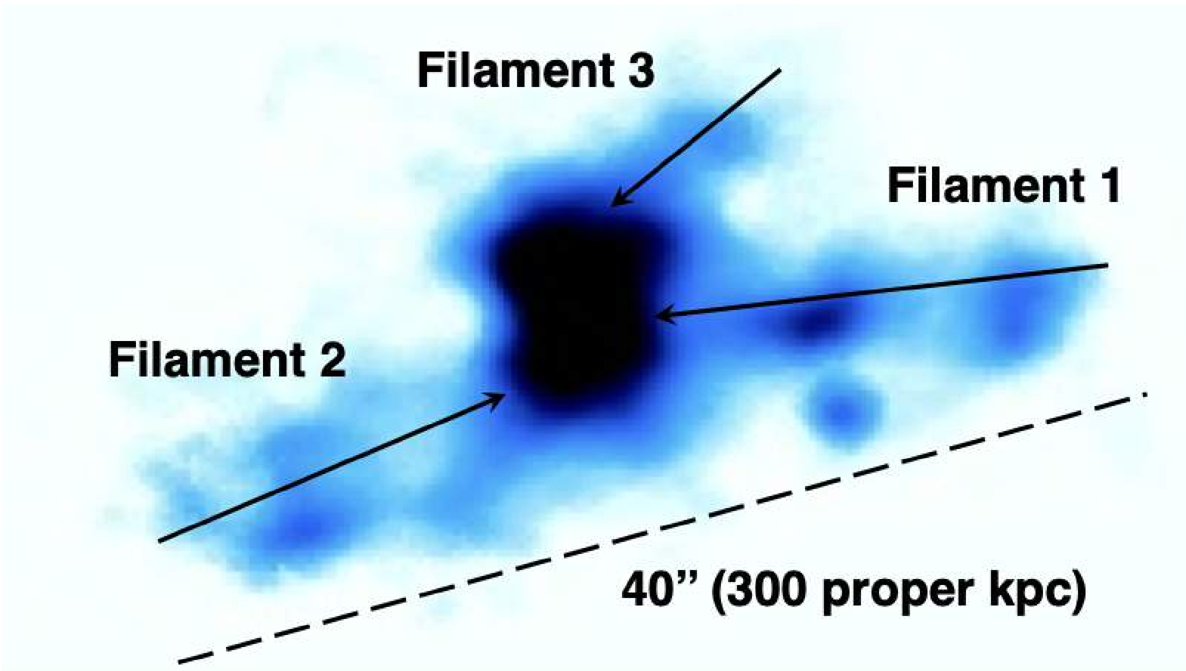


Image of the galaxy cluster RXCJ0600-2007 taken by the NASA/ESA Hubble Space Telescope, combined with gravitational lensing images of the distant galaxy RXCJ0600-z6, 28 billion lightyears away, observed by ALMA (shown in red). Due to the gravitational lensing effect by the galaxy cluster, the image of RXCJ0600-z6 was intensified and magnified, and even appeared to be divided into three or more parts. This allowed Seiji Fujimoto and his collaborators to detect galaxies that were seen to be rotating already when the Universe was 7% of its current age. Credit: ALMA (ESO/NAOJ/NRAO), Fujimoto et al., NASA/ESA/HST.



Three filaments of gas accreting from intergalactic space onto a central galaxy group and emitting Lyman-α radiation, likely from cooling (Daddi et al., 2021).

Galaxy Evolution

As outlined above, galaxy *formation* and galaxy *evolution* are not two distinct phases, overlapping considerably. Describing how galaxies evolve is different from most other evolutionary studies, in that a given galaxy will never be seen to evolve: The involved timescales are simply too long for humans, typically occurring over some 100 million years.

Observationally, astronomers then take on a more statistical approach: Gifted with the unique ability to look back in time, we can study the "average" physical properties of a large sample of galaxies at a given epoch in the history of the Universe, and compare these properties to those of the large sample of galaxies, observed during *another* epoch.

One such study was led by DAWN PhD student Mikkel Stockmann, who investigated how massive galaxies that had all stopped forming stars — so-called *quenched* galaxies, discussed in the next section — evolved from 10 billion years ago, till today (Stockmann et al., 2021). From this study we learned how the progress is a mixture of "passive" evolution due to internal processes, and "active" evolution due to accretion of smaller galaxies.

A popular diagnostic when studying galaxies are *distribution functions*, describing how some quantity such as galactic masses or luminosities is distributed. That is, how many small/faint galaxies there are, vs. how many massive/bright galaxies. This tool was used by Stefanon et al., 2021a to show how the ratio between the stellar mass and the dark matter mass does not evolve significantly in the first billion years of their lives, and by Bouwens et al., 2021 to investigate the evolution in luminosities. Such studies take a lot of effort in making sure that the methods used to detect and select the various populations of galaxies do not result in non-comparable samples.

Gravitational lensing allowed Caputi et al., 2021 to analyze rapidly growing galaxies in the early Universe, as well as Rizzo et al., 2021 to conclude that galaxies in the early Universe are much less turbulent than expected and predicted by models. More locally, Rusakov et al., 2021 studied the star formation history in the dwarf galaxy Fornax, showing how bursts of star formation can be induced by tidal forces each time it comes too close to a massive galaxy.

Quenching — The Death of a Galaxy

Stars are made of gas. The more massive they are, the faster they burn, and the faster they recycle their gas to the "interstellar medium", the extremely dilute space between the stars in a galaxy. Some galaxies, like our own Milky Way, are able to continuously form new stars for billions and billions of years. Others, however, at some point almost completely cease to form new stars.

Why is this? What makes them stop? Which physical processes are responsible, and when and how fast does it happen? A clear answer to at least some of these cosmic deaths was given by Whitaker et al., 2021a who showed that six galaxies in the early Universe had simply run out of gas; they had been quenched. What made them lose their gas is still an open question e.g. was it exhausted, or was blown out by an active galactic nucleus (see information box below) but the galaxies were further analyzed by Man et al., 2021 who showed that the process must have been very fast (cosmologically speaking). The observations were facilitated by gravitational lenses, one of which allowed Rodney et al., 2021 to predict the appearance of a supernova explosion in the year 2037.

To come closer to a theory of how gas is depleted, Magdis et al., 2021 quantified how the fraction of gas in such quiescent galaxies evolves. Interestingly, the conditions for quenching seem to be rather universal across most of the history of the Universe.

On the theoretical side, clues to the quenching of galaxies came from Whitaker et al., 2021b, who predict that quiescent galaxies should have a much higher ratio between the masses of molecules and dust; a prediction which can be tested in the near future. In another suite of simulations, Nelson et al., 2021 show that galaxies may be quenched in an inside-out manner by the energetic feedback of active galactic nuclei.

Active Galactic Nucleus

In the center of most galaxies reside so-called "supermassive black holes" — black holes millions or billions times as massive as our Sun.
From time to time, gas or even stars whirl into these black holes. In this process, some of the matter will avoid its bleak destiny, instead being expelled as extremely energetic particles and radiation. These systems are called *active galactic nuclei*, and they may have a profound impact on the rest of the galaxy and its surroundings.

The Interstellar Medium — Dust and Gas Between the Stars

As described above, the space between the stars is not completely empty, but filled with an extremely dilute mixture of atoms, molecules, and dust. This so-called interstellar medium plays a pivotal role in both the formation, evolution, and death of galaxies, and is hence crucial to study and understand.

In a large sample of galaxies, Gillman et al., 2021 showed how the amount of heavy elements in the gas decreases with distance from the center of a galaxy, and how this relation evolves with time. Meanwhile, Valentino et al., 2021 studied the effect that active galactic nuclei may have on the gas and dust, finding e.g. that a large fraction of the infrared light from a galaxy may be due to the dust being heated by the active galactic nuclei.

The most abundant element in the Universe is hydrogen. Detecting hydrogen becomes impossible with current telescopes, however, once a galaxy is too far away. Instead, we may rely on observations of "proxies" such as carbon monoxide (CO), as explored by Heintz et al., 2021a. That is, observing light from CO tells us how much hydrogen there is. In even more distant galaxies, this becomes problematic as well, but in a novel approach, Heintz et al., 2021b found a promising similar proxy, namely ionized carbon.

Indeed, observing in details the interstellar medium in the most distant galaxies is challenging, but with the help of our pet tool, gravitational lensing which magnified a galaxy 28 billion lightyears away by a factor of around 100, Fujimoto et al., 2021 were able to resolve the fine details of the galaxy's interior. In this way they showed that the relation seen today in the local Universe between star formation and light emitted from carbon, seem to hold true also in the early Universe, meaning that we can use this relation to probe star formation in the distant Universe.

Analyzing the contents and the evolution of the interstellar medium requires sophisticated physical models. A promising tool for this task was developed by Kokorev et al., 2021 in the form of a publicly available computer code, to be used by the whole astronomical community. The authors demonstrate the use of the code by analyzing the dust mass distribution of galaxies.

In a similar FAIR spirit, Narayanan et al., 2021 published a code for simulating how light propagates through the dusty interstellar medium of simulated galaxies, and applied the code to study the relationship between galaxies' star formation and infrared luminosity.

Reionization — The Universe Becomes Transparent

Until the first stars and galaxies were formed, the Universe was neutral, meaning that all atoms had a number of negative electrons that matched the number of positive protons in their nuclei.

Three different views of a simulated galaxy, constructed from the ultraviolet, visible, and infrared light escaping through the interstellar dust cloud, calculated using the radiative transfer code POWDERDAY *(Narayanan et al., 2021).*

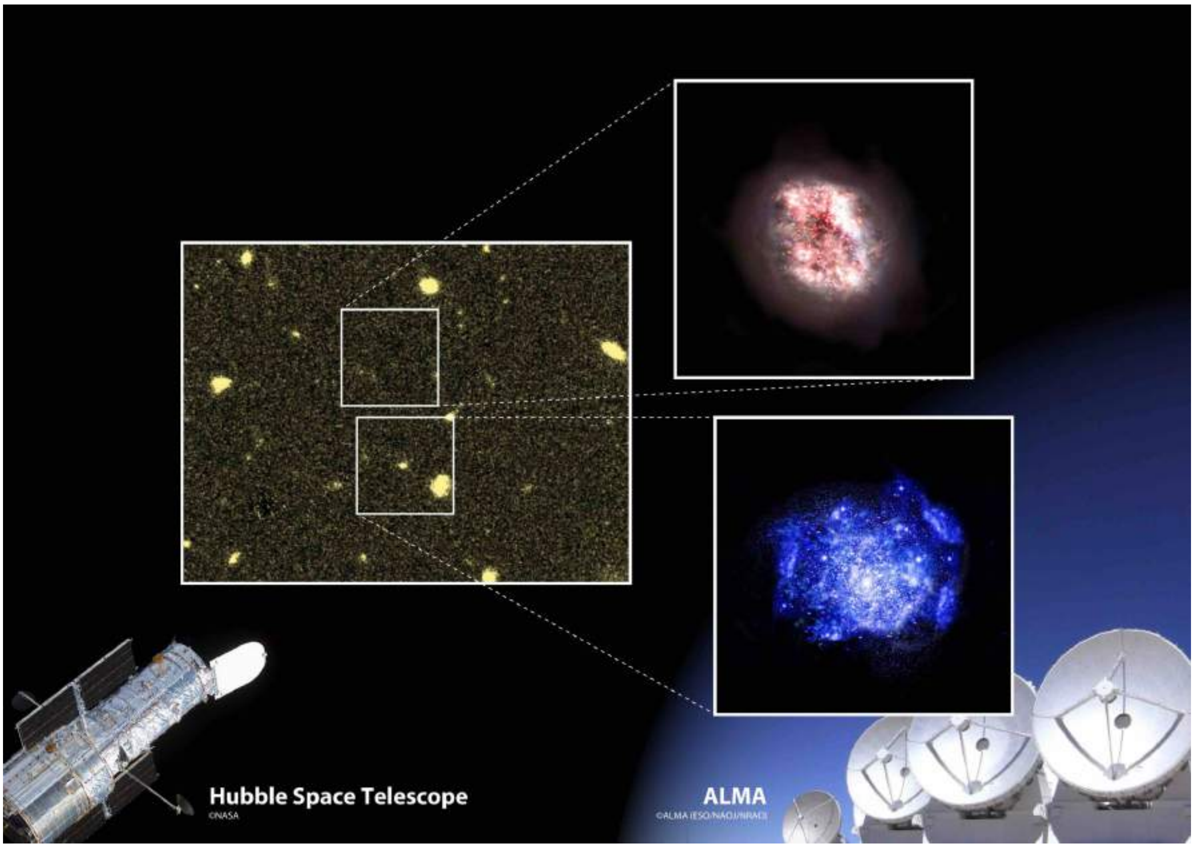
The first stars are believed to have been extremely massive, and to emit an abundance of highly energetic, ultraviolet photons. However, as soon as such a photon encounters a neutral atom it will be absorbed, severely obstructing observations of the first galaxies.

The energy of the absorbed ultraviolet photon ejects the atom's electron, so that the atom is now electrically charged — a process called ionization. Shortly after the onset of star formation, ejected electrons soon met and recombined with positive nuclei, virtually making the Universe opaque to radiation. Nevertheless, the combined ultraviolet light from copious amounts of young galaxies were able to ionize more and more of the Universe, eventually transforming the intergalactic space into a transparent plasma. This process is called *re*ionization, since in fact the gas had been ionized before, during the first few hundred thousand years after the Big Bang.

The exact conditions, duration, time, and progression of this global transition are currently unknown. We know that it ended roughly 900 million years after the Big Bang, but not exactly when it started. Much of our knowledge about this epoch comes from simulations which predict the early formation of stars and galaxies. Most such simulations do not take into account the fact that most stars are in fact born in pairs. The effect of such binary stars was investigated by Doughty and Finlator, 2021, who found that binary stars cause reionization to complete earlier and faster than without those stars.

Dust in galaxies is created from heavy elements, which were not present in the very first galaxies. However, some galaxies seen in the epoch of reionization are already dusty. In fact, some are so dusty that all their visible light is absorbed, making them basically invisible. How do we know, then? Using the Atacama Large Millimeter Array, Fudamoto et al., 2021 reported the detection of radio waves from two galaxies that were non-detected in visible light. These observations implied that as much as one in five galaxies in the epoch of reionization may be concealed by dust.

Radio observations of galaxies is a promising way to circumvent the opaqueness of the Universe in the epoch of reionization, since this radiation is not energetic enough to ionize gas and hence be absorbed. In this way, Uzgil et al., 2021 investigated the emission from ionized carbon in galaxies seen in the end of the epoch of reionization, while Jarugula et al., 2021 reported the hitherto most distant detection of water.



The "REBELS-29" field of galaxies, observed with the Hubble Space Telescope. In the upper box, no galaxies are seen, but observing the same field with the ALMA observatory revealed a galaxy completely invisible in the optical. Fudamoto et al., 2021 show how these observations imply that around one in five galaxies in the early Universe may be hidden by dust. Credit: HST/NASA/ESA/Fudamoto et al.

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Drawing by Peter Laursen.

Image credit: NASA

Feature Articles

The Status of the James Webb Space Telescope

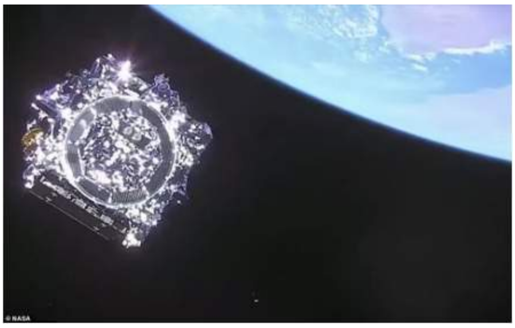
By Peter Laursen

> *"Décollage... Liftoff... from a tropical rainforest to the edge of time itself."*

With these somewhat gaudy, yet powerful words from NASA mission commentator Rob Navias, the Cosmic Dawn Center and the rest of the astronomical community could finally heave a sigh of relief when our flagship, the James Webb Space Telescope, was launched into space from French Guiana in an Ariane 5 rocket on Christmas Day 2021.

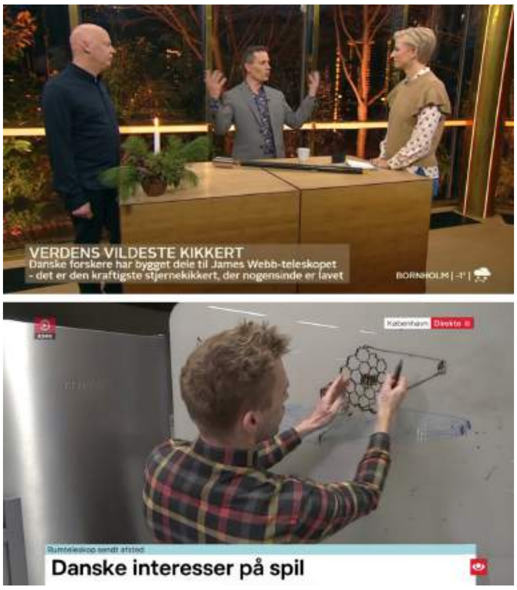
Technical challenges, new safety precautions, reduced personnel, and the Covid-19 pandemic delayed the process for years. By the end of 2021, deferrals came almost on a day-to-day basis, unfortunately obstructing a planned public live-streaming and press conference in the Planetarium.

Unlike the famous Hubble Space Telescope, which is orbiting Earth only 540 km above our heads and has hence been visited for service several times, James Webb was sent to a region in space known as "L2", 1.5 million kilometers from Earth! Moreover, because of its huge mirror, the telescope had to be folded inside the nose of the spacecraft. This made the launch and the subsequent deployment even more suspenseful, with over 300 individual steps that could go wrong.



The last picture ever of James Webb, taken by a camera mounted on the Ariane 5 rocket lifting Webb into space.

Nevertheless, our anticipation was more than fulfilled when the launch turned out to be highly "nominal" — astronomers' jargon of the best possible outcome. Thanks to a perfect trajectory insertion, the telescope correction boosters used a minimal amount of fuel. And when finally, a month after the launch, the telescope arrived at L2, the telescope only had to correct its speed by 1.6 m/s; a mere walking pace. To avoid drifting away from L2, Webb will occasionally need to adjust its orbit a little, using its boosters. Webb's instruments are built to last at least five years, with the hope of ten, and it therefore carried fuel for ten years. However, Webb's nominal launch left enough fuel to potentially extend its life to 20 years, provided the instruments last longer than expected.



DAWN's Thomas Greve and Peter Laursen commenting on the launch and the anticipated science of the James Webb Space Telescope in TV2's Go' Morgen Danmark and DR TV's news, respectively.

The many postponements did not put off the public interest, and our December calendar was booked with daily interviews in tv, radio, newspapers, and other media.

Current status

James Webb is built to observe infrared light, also known as "heat radiation". The need for being as cold as possible is the prime reason James Webb was expatriated to L2, lest its beautiful images would drown in Earth's heat. This is also the reason why Webb carries a sunshield the size of a tennis court. The last of Webb's four instruments, the mid-infrared camera and spectrograph MIRI, has recently cooled sufficiently to reach its target temperature; whereas the three other instruments, NIRSpec, NIRCam, and NIRISS, cooled passively to some 40 degrees above absolute zero, MIRI employs a cryocooler, lowering its temperature to only 7 K.

James Webb's mirror consists of 18 hexagonal segments. Over the course of several months, these segments have been aligned to focus the telescope; a procedure which involves moving and warping each segment micrometer by micrometer. The next two months will be spent calibrating the instruments until, by 27 June (as recently announced by STScI), we should be able to start using the telescope for science.

Scientific prospects

The scientific objectives of the telescope are multifarious: Because infrared light more easily penetrates the dusty clouds where stars are born, we will be able to peer through these clouds and learn about star formation in their very early stages. Meanwhile, a variety of molecules in the atmospheres of exoplanets absorb light from their mother stars at various infrared wavelengths, allowing us to search for life-favorable environments.

More appealing to DAWN, however, is the prospects of enlightening us about galaxies, in particular how the very first galaxies formed and evolved. Because we look further back in time the farther we look out in space, finding galaxies in their infancy entails detecting the most distant ones. As light travels through the expanding Universe it slowly turns redder, a process known as redshift. Light from the most distant galaxies is shifted all the way into the infrared wavelength region. With its amazing sensitivity, James Webb will reveal galaxies in hitherto unexplored epochs in the history of the Universe, possibly even some of the very first galaxies and stars.

The Cosmic Dawn Center is involved in many observational programs dedicated to investigating galaxies in the early Universe; in fact we are participating in over a third of all programs during the first year of observations with James Webb. Some programs target already known galaxies in order to analyze their interior and physical conditions in great detail. Others more blindly search regions of the sky with exposure times of hundreds of hours, unveiling progressively fainter and more distant sources with time, with the aim of painting a coherent picture of how the galaxies evolve in the earliest phases of their lives. Yet other programs intend to study the effect that galaxies have on the Universe as a whole, namely to probe the so-called Epoch of Reionization (see p. 18).

In their entirety, the programs that we will carry out with James Webb — as well as the discoveries we will certainly make but have not even had the imagination to predict — will teach us wonders about the cosmos that will absolutely make the delays worth waiting for, as we peer back to the edge of time itself.

Transitions

By Isabella Cortzen

I have always been fascinated by Astronomy since I was a child. When the moment to choose a university education after high school came, it was just a natural decision to pursue a degree in astrophysics at the Niels Bohr Institute.

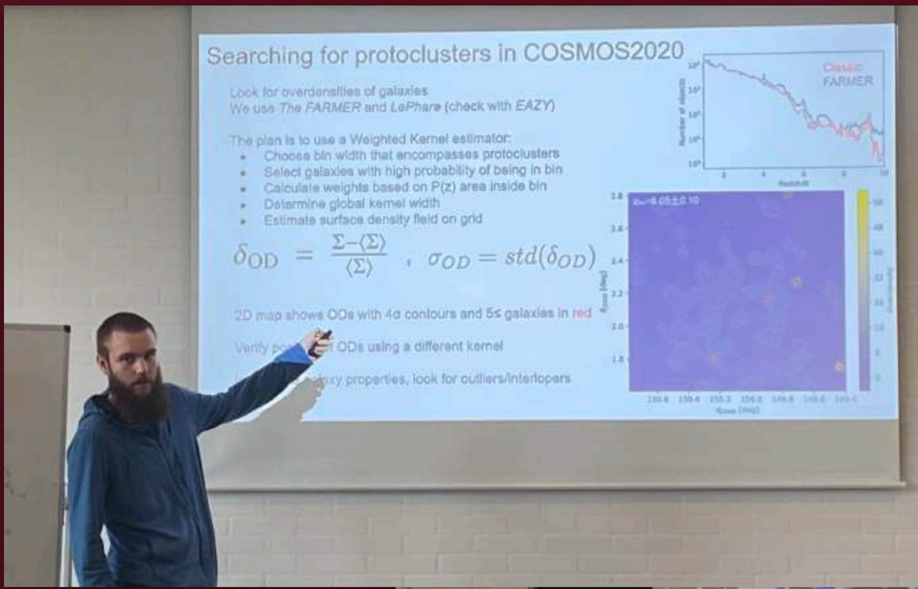
After Bachelor's and Master's theses on astrophysical topics, my curiosity kept me motivated to explore the Cosmos: thus, I decided to enroll for a Ph.D. at the Cosmic Dawn Center at the University of Copenhagen. In 2020, I finally obtained my Ph.D. under the supervision of Profs. Georgios Magdis and Sune Toft with a research project focused on the properties of the interstellar medium of galaxies. I was very happy to have achieved this important milestone in my life with the support of my supervisors and the whole Dawn crew. This effort also earned me recognition from the Instrument Center for Danish Astrophysics (IDA) that awarded my thesis the annual “Ph.D. prize in Astronomy” in 2020.

A few months after defending my thesis, I accepted a position as a postdoctoral researcher at the Institut de Radioastronomie Millimétrique (IRAM) and moved to Grenoble (France) to work on a large project aimed at investigating the nature of bright submillimeter galaxies in the Herschel fields. It was a growing experience and I had to face new challenges, such as working on a completely new research project independently and learning how to operate a large interferometer: a collection of 12 radio antennas simultaneously observing the sky from a plateau on the French Alps!

Although I am very grateful for the opportunities I was given at DAWN and IRAM and thankful for the experiences, I began asking myself whether an academic career was the right choice for me. While I enjoyed the stimulating environment of academic research, the curiosity that drives it, and being part of large international collaborations, I realized that it has always been a dream of mine to work within a field that can leave a positive and concrete imprint on the world.

In 2021, I thus decided to leave the academic world to pursue a career as a data analyst at the Police Department in Copenhagen, where I have been able to apply many of the skills I have achieved as a researcher to help create a safer society. In my current position, I provide analyses of complex data ranging from crime forecasting to optimizing case management for various sections within the organization.

Isabella Cortzen, a DAWN PhD Graduate currently a data-analyst working for the danish police force.



Searching for protoclusters in COSMOS2020
Look for overdensities of galaxies
We use The FARMER and LePhare (check with EAZY)
The plan is to use a Weighted Kernel estimator:
Choose bin width that encompasses protoclusters
Select galaxies with high probability of being in bin
Calculate weights based on P(z) area inside bin
Determine global kernel width
Estimate surface density field on grid
$\delta_{OD} = \frac{\Sigma - \langle\Sigma\rangle}{\langle\Sigma\rangle}$, $\sigma_{OD} = std(\delta_{OD})$
2D map shows ODs with 4σ contours and 5≤ galaxies in red
ODs using a different kernel
xy properties, look for outliers/interlopers
Classic
FARMER

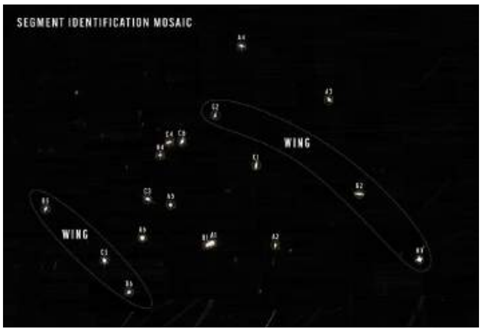
DAWN
Charlotte Mason
15 November 2021
Chasing Cosmic Dawn and Reionization
with Tommaso Treu, Andrei Mesinger, Julian Muñoz, Alexa Morales, Max Gronke, Mark Dijkstra,
Adriano Fontana, Lily Whitler, Michele Trenti, Austin Hoag, Marusa Bradac, Rohan Naidu + GLASS & BoRG teams

The journal A&A

Sharing Knowledge at DAWN

James Webb Working Group Meetings at the Cosmic Dawn Center

By Victoria Strait



Segment Identification Mosaic, image obtained from the Canadian Space Agency

The James Webb working group at the Cosmic Dawn Center is a regular meeting of faculty, postdocs, and graduate students who are interested in data from the recently launched James Webb Space Telescope (JWST). The main goals of the group are to work on both reduction of data and common science goals with public and proprietary data from JWST. In addition to our individual science goals, we would like to host a central repository for all public JWST data, reduced by us, for the purposes of doing high redshift galaxy science. The entire group meets biweekly to discuss progress, both on the scientific front and on JWSTs commissioning (see first alignment image to the left). Three instrument-specific subgroups (NIRCam/NIRISS, NIRSpec, and MIRI) meet separately for more technical discussions. At present, the groups are developing plans for answering science questions with JWST data as well as using simulated data to practice running data reduction techniques and setting up analysis tools for when the real data arrives.

Weekly Working Group Meeting for Progress Report

By Seiji Fujimoto

Since its launch, DAWN has produced numerous results, attracting people all over the world, and increasing the number of attractive students, postdocs, and senior researchers. Moreover, there are 7 DAWN associate members in overseas countries who are top-ranked researchers in the fields and closely collaborate with researchers at DAWN.

Under these circumstances, we started weekly working group meetings in November last year. The meetings aim at understanding the current trends in cutting-edge research being led by DAWN's top researchers as well as providing a platform for students to get extensive feedback on their current research from experts at DAWN. Every week, we learn about the latest research results happening around the world, discuss new proposals and project ideas, and foster new collaboration schemes.

The DAWN Journal Club

By Peter Laursen

Each day, more than 50 new articles on astronomy alone appear on the preprint server arXiv, over 25% of which is in the field of galaxies. It is custom to upload one's papers here around the same time as they are submitted to, or accepted by, a scientific journal. With such a high number of papers, keeping up with the literature is a challenging task.

To this end we try to "share the load" by taking turns on reading papers and report the contents to each other: Every Monday we meet (in person when circumstances permit) and discuss two recent papers. One DAWNer acts as the "moderator", which involves identifying in advance two papers relevant to DAWN's research, finding two DAWNers to present these papers (in time for them to prepare), and moderating the presentation and subsequent discussion during the Journal Club session.

DTU Astronomy & Atmospheric Physics Seminars

By Steven Gillman

Around one-third of DAWN researchers are based at DTU-Space, as part of the Astronomy & Atmospheric Physics (A&A) group which embodies astronomers, physicists, and space engineers. To interconnect these different research areas, in late 2021 we initiated a monthly seminar series at DTU for both A&A members and the wider Copenhagen astronomy community.

The seminars are given by well-established leading experts in their research field, covering all areas of astronomy, from galaxy evolution to exoplanets. For 2022 we have a full schedule of speakers from January through June, see the DTU webpage for further details. In the coming year, covid permitting, the speakers will visit DTU-Space for an in-person seminar, thus further enabling engagement and collaboration with DAWN researchers.

DAWN Cake Talks

By Kate Gould

The DAWN "Cake Talks" tradition originally began in 2018 as a chance for visiting researchers (usually early career) to share their research in a 20 minute talk over cake. One advantage of the pandemic is that researchers are able to give talks remotely, and the DAWN Cake Talks are now held weekly, with speakers from all over the world.

In 2021, DAWN held 29 talks, 18 of which were by speakers outside of DAWN. Speakers from 16 institutes, in 7 different countries, on 3 continents, visited DAWN virtually and in person to talk about their research. One special Cake Talk slot was used for the DAWN-IRES student symposium, where 5 visiting students from the USA presented their work from the summer.

Recently, we have opened the Cake Talks for self-nomination via google form as well as nomination by researchers at DAWN. This is advantageous not only for early career researchers outside of DAWN to share their research, but also for DAWN to increase its global reach and forge new connections. This has been highly successful so far, with 39 speakers nominated in the first call.

Inclusion, Diversity and Equity Meetings

By Francesca Rizzo

The Inclusion, Diversity and Equity (InDiE) Session is an initiative led by young researchers from the Cosmic Dawn Center and DARK that is open to researchers at any career stage who are interested in making positive changes in their workplace by using an intersectionality approach. Meeting twice a month, the InDiE meeting aims to share resources and promote conversations that help us become aware of the long history of inequity and discrimination against colleagues marginalized because of their sex, gender, race, ethnicity, sexual orientation, socioeconomic or disability status, and more. Participation in this meeting is a small way to inform ourselves about our biases and the shortcomings of the academic culture. At present, the InDiE sessions are hybrid. We also hold a monthly meeting where we present and discuss a peer-reviewed paper and a monthly seminar where external speakers describe potential solutions to make a more inclusive workplace. The seminar topics that have been discussed in the last semester are the following: impact of astronomy on climate change, mental health in academia, gender and unconscious bias.

This is the result of one of the activities during which after discussing the Woolston (2021), we answered the question: “Which are the negative impacts of precarity?”

References

Woolston, Chris (2021). “Researchers career insecurity needs attention and reform now, says international coalition”. In: *Nature* (cit. on p. 33).

Where the Earth Meets the Sky — DAWN Promoting the Transfer of Innovative Methods Across Scientific Boundaries.

By Iary Davidzon

This inter-disciplinary workshop took place in May 2021, counting more than 140 registered participants. The goal was to bring together researchers from Astrophysics and Medical/Public Health Sciences, to discuss the statistical and machine learning methods that are transforming both fields.

At a first glance, these two domains may seem disconnected from each other, as one focuses on problems affecting our planet while the other explores the deepest secrets of the universe. However, those issues are studied within an incredibly similar scientific framework: in particular, the analysis of big and complex data (digital telescope images, large galaxy surveys, etc. versus digital X-ray/MRI images, medical records surveys, etc.) by means of innovative statistical and machine learning methods. An interdisciplinary approach, as the one promoted by this workshop, is crucial to accelerate the pace of discoveries and extend the reach of scientific innovations.

A grant in the amount of 115,000 kr. was obtained from the NovoNordisk Foundation to fund the expenses of invited prestigious international speakers to Copenhagen. Unfortunately Covid regulations forced the workshop to go fully online, and the speakers gave their talks via Zoom. Despite the limitations of virtual interaction, Where the Earth meets the Sky was a successful occasion of “cross-pollination”, engaging both junior and senior researchers with very different backgrounds and from all over the world.

Courses & Summer Schools

Level	Title of Activity	ECTS
BSc	Extragalactic Astrophysics	7.5
BSc	Foundations of Astrophysics	7.5
BSc	Supervision of 7 first year projects	N/A
BSc	Introduction project	5
BSc	Experimental Physics	7.5
BSc	Ingeniørarbejde i Geofysik og Rumteknologi	10
BSc	Astrophysics	5
MSc	Galactic Dynamics and Galaxy Formation	5
MSc	Observational Astrophysics	7.5
MSc	Gravitational Dynamics and Galaxy Formation	7.5
MSc	Astrophysical Data Analysis	5
MSc	Scientific Computing	7.5
MSc	Astronomical Data Processing	7.5
MSc	Applied Statistics - From Data to Results	7.5

Courses

Title of Activity
Summer School in Observational Astrophysics
IRES-DAWN Summer Program
SURF Summer School

Summer Schools

MSc graduate Meghana Killi (middle-right) with her supervisors Gabriel Brammer (left), Darach Watson (middle-left) and her examinator Thomas Greve (right).

MSc graduate David Blanquez-Sese (middle) with his supervisors Georgios Magdis (left) and Iary Davidzon (right).

Information

MENU LOG IND

NATURVIDENSKAB Læsetid: 22 min.

Sådan her ender livet, Jorden og Solen og universet

Jorden er i dag cirka halvvejs i sit liv. Med tiden vil det gå ned ad bakke for den, og om hundreder af millioner af år vil planetens liv langsomt dø ud. Til allersidst vil også universet gå under i en klynken. Vi afrunder serien om naturvide… den eneste rigtige måde: med afslutning… hele

JESSE JACOB

Mikkel Vuorela
Johanne Pontoppidan Tuxen

MODERNE TIDER
18. december 2021

Naturvidenskaben forfra
Sådan her ender livet, Jo…
0:00

Himlen er prægtig, og dejlig er Jorden, nå… barn og glor op mod Månens blege skive g… lavet af to sammenlimede toiletruller. Og … mørke prikker en stjerne hul i den unge n… fotonfingre, og en lille smule lys afslutter … kan have varet i årtusinder eller det, der e…

Så er det let at blive sentimental og bare v…

Forskerzonen

Forside Kommentar Bøger Podcast Video Nyt om navne

Modeller afslører galaksers fascinerende udvikling

At studere galaksers udvikling kræver mere end bare at observere dem. En betragtelig del af en astronoms job går ud på at konstruere modeller, som forklarer galaksernes fødsel, liv og død.

Som de fleste andre elliptiske galakser er ESO 325-G004 her stort set ophørt med at forme nye stjerner og er derfor blevet orange. Hvorfor kan du læse nedenfor. (Foto: NASA/ESA/HST)

Peter Laursen - Ph.d., astrofysiker og videnskabsformidler, Cosmic Dawn Center, Niels Bohr Institutet, Københavns Universitet og DTU Space & **Mikkel Stockmann** - Ph.d., tidligere postdoc ved Cosmic Down Center, Niels Bohr Institutet, Københavns Universitet

Hvordan arbejder astronomer egentlig? Ja, de studerer universet og alle dets bestanddele og fænomener, men hvordan?

Enhver kan jo sætte sig og kigge i et teleskop, men vil vi forstå, hvad det er, vi ser, må vi gå et skridt videre.

Grundlæggende tror vi, at universet kan beskrives ved nogle fysiske sammenhænge, og vores job går så ud på at afsløre de bagvedliggende lovmæssigheder.

Men hvorfor er det vigtigt at forstå? Hvorfor kan vi ikke bare nyde universets skønhed uden at skulle sætte det på formler?

ALMA

En Es

Press Releases

ALMA Discovers Rotating Infant Galaxy with Help of Natural Cosmic Telescope

22 April, 2021 / Read time: **8 minutes**

Scientific Paper

Using the Atacama Large Millimeter/submillimeter Array (ALMA), astronomers found a rotating baby galaxy 1/100th the size of the Milky Way at a time when the Universe was only seven percent of its present age. Assisted by the gravitational lens effect, the team was able to explore for the first time the nature of small and dark "normal galaxies" in the early Universe, representative of the main population of the first galaxies, which greatly advances our understanding of the initial phase of galaxy evolution.

"The fact that RXCJ0600-z6 has a very high magnification factor also raises expectations for future research," explains Seiji Fujimoto, a DAWN fellow at the Niels Bohr Institute. "This galaxy has been selected, among hundreds, to be observed by the James Webb Space Telescope (JWST), the next generation space telescope to be launched this autumn. Through joint observations using ALMA and…

Public Outreach

Activity	Subject	Contributor
Lecture, Kompedal Star Party	Gravitational lenses	Lise Christensen
Open University Lecture	Distant galaxies	Lise Christensen
TV documentary interview BBC/PBS (UK.USA)	Early universe galaxy formation	Charlotte Mason
Radio interview NPR (USA)	JWST, early universe galaxy formation	Charlotte Mason
Book chapter	100 year celebration of the NBI	Johan Fynbo
Public talks	Talk on Research for reseasrch talents	Johan Fynbo
Public talks in Folkeuniversitetet	Gamma Ray Bursts	Johan Fynbo
Public event	End of the world	Johan Fynbo
Press release including web article	ALMA Discovers Rotating Infant Galaxy with Help of Natural Cosmic Telescope	Seiji Fujimoto
Presentation on Galaxy Evolution	Event organised by the Faculty of Physics of the University of Barcelona for the International Women's Day (March 8, 2021)	Clara Arteaga
Article	Was a passing satellite mistaken for a distant gamma-ray burst?	Charles Steinhardt
Presentation for Astronomy on Tap London	An unprecedented ultra HD view of a distant galaxy	Francesca Rizzo
Webinar for a general public (in Italian)	Observations of galaxies at high redshift	Francesca Rizzo
Podcast - interview (in Italian)	Observing galaxies with JWST	Francesca Rizzo
Presentation	Distant galaxies, origin of the Universe, JWST	Iary Davidzon
Interview/Radio4	What can go wrong for James Webb?	Peter Laursen
Interview/DR TV Avis	James Webb launch	Peter Laursen
Interview/TV2 Nyheder	James Webb launch	Peter Laursen
Interview/TV2 NEWS	Commenting on the full James Webb launch	Peter Laursen

Activity	Subject	Contributor
Event/Planetarium	Live-streaming of James Webb launch, talks, and press conference	Peter Laursen
Interview/videnskab.dk	James Webb	Peter Laursen
Interview/UCPH press release	James Webb	Peter Laursen
Interview/Dagbladet Information	The end of the Universe	Peter Laursen
Interview/Weekendavisen	James Webb	Peter Laursen
Interview/Dagbladenes Bureau	James Webb	Peter Laursen
News story/cosmicdawn.dk	Star-forming gas in the early Universe	Peter Laursen
Popular science article/"Astronomi"	How do galaxies get their spiral arms	Peter Laursen
Public talk/Planetarium	Inauguration of the new dome	Peter Laursen
Public talks/Videnskaben På Besøg	Astronomy/cosmology/galaxies	Peter Laursen
Press release/UCPH	Early galaxies running out of gas	Peter Laursen
Interview/Radio4	A new spiral arm in the Milky Way?	Peter Laursen
Interview/videnskab.dk	A new spiral arm in the Milky Way?	Peter Laursen
Interview/P1 Morgen	Supernova prediction in 2037	Peter Laursen
Press release/UCPH	Supernova prediction in 2037	Peter Laursen
Popular science article/videnskab.dk	Black holes reflect the Universe	Peter Laursen
News story/cosmicdawn.dk	Fast radio bursts	Peter Laursen
Press release/UCPH	Black holes reflect the Universe	Peter Laursen
Seminar/Planetarium	Space seminar for teachers Peter	Laursen
Popular science article/UCPH	Galaxies	Peter Laursen
Popular science article/videnskab.dk	Galaxy evolution	Peter Laursen
Talk/Astronomy on Tap	The early Universe	Peter Laursen
Quiz show/Videnskabsklubben	Galaxy formation	Peter Laursen

Activity	Subject	Contributor
Talks/Forskningens Døgn	Astronomy/cosmology/galaxies	Peter Laursen
Science dissemination/UCPH	@KU_forskeren's weekly guest	Peter Laursen
Interview/videnskab.dk	Gravity	Peter Laursen
Educational video/Ministry Of Education	Everything is made of particles	Peter Laursen
Press release/UCPH	Danish participation in James Webb	Peter Laursen
Presentation (Forskningens Døgn 2021)	A View to the Universe from Hawaii	Thomas Greve
Radio Interview (DR, Vildt Naturligt)	JWST Launch, Galaxies	Thomas Greve
TV Interview (DR1, TV-avisen)	JWST Launch, Galaxies	Thomas Greve
TV Interview (DR2, Deadline)	JWST Launch, Galaxies	Thomas Greve
TV Interview (TV2, Go' Morgen Danmark)	JWST Launch, Galaxies	Thomas Greve
Interview with journalist Gunver Lystbæk Vestergård	JWST	Peter Jakobsen

Albert Sneppen (MSc Student at DAWN) in an article by Berlingske talking about his paper on the optical properties of black holes.


Image credit: Gabriel Brammer

Conferences, Events & Talks

Conferences

Title of Event
Scientific Organising Committee, European Astronomical Society meeting 2021, special session "Gamma-Rays as Cosmic Probes"
European Astronomical Society Symposium 2022: The Universe at the reionization epoch
European Astronomical Society Annual Meeting; Dusty Star-Formation at high-z (Special Session)
DAWN Summit 2021, 20–23 September
JWST Observation Application Writing Course
Virtual Workshop "Where the Earth Meets the Sky" (27–28 May 2021)
SOC member of conference, SAZERAC2.0 — Summer All Zoom Epoch of Reionization Astronomy Conference, Held online
Co-Chair of EAS Special Symposium, Towards a Complete Census of Star-Formation in the Early Universe, Held online
CIDER: The Cold ISM During the Epoch of Reionisation, Sazerac Conference
DTU Astrophysics Seminar
DAWN Winter School

Talks Given by DAWN Employees

Title of Event	Venue	Participant(s)
Tenure Lecture	NBI Auditorium A	Charlotte Mason
THESEUS 2021 Virtual Conference	(Online)	Lise Christensen
Seminar Series	Turku, Finland (Online)	Lise Christensen
European Astronomical Society Annual Meeting	Leiden (Online)	Johan Fynbo
Epoch of Reionization Astronomy Conference	Online	Seiji Fujimoto
Seminar talk at UCLA	Online	Seiji Fujimoto
Seminar talk at UT Austin	Online	Seiji Fujimoto
Seminar talk at Cambridge	Cambridge	Seiji Fujimoto
Seminar talk at Universtiy of Tohoku	Online	Seiji Fujimoto
Sino-French Workshop: Confronting Simulations with Observations of High-redshift Galaxies and (proto)Clusters	Online	Francesco Valentino
Colloquium, Kavli Institute, University of Cambridge	Online	Georgios Magdis
Colloquium, Hellenic Astronomical Society	Online	Georgios Magdis
Seminar at LAM	Online	Georgios Magdis
Plenary Colloquium	Kapteyn Instutute, University of Groningen, The Netherlands	Iary Davidzon
CON-Quest Conference	Zoom / Gothenburg	Thomas Greve
DAWN Summit	DTU Space	Thomas Greve
Double Profile Galaxies Conference	Zoom / Paris	Thomas Greve

Image credit: Vadim Rusakov

Guests & Visitors

Guest Speakers

Speaker	Location	Date	Title
Ian Hothi (Imperial College London)	Virtual	16-12-2021	Finding the Needle in the Haystack
Pavel Mancera Piña (Kapteyn Astronomical Institute & ASTRON)	NBB	09-12-2021	The startling dynamics of gas-rich ultra-diffuse galaxies
Maria Bergemann (MPI for Astronomy in Heidelberg & NBIA)	NBB	25-11-2021	Probing the physics of supernovae Type Ia with Galactic stars
Kasper Elm Heintz (University of Iceland)	NBB	21-10-2021	Measuring the HI gas mass of galaxies in the early Universe with gamma-bursts
Martin Sparre (Potsdam University and AIP Leibniz)	DTU	12-10-2021	Multiphase gas flows in the circum-galatic medium of galaxies
Arianna Long (University of California, Irvine)	NBB	16-09-2021	Missing Giants: The Impact of Dust-Obscuration on Stellar Mass Assembly Through Cosmic Time
Andrei Diaconu (SURF)	NBB	02-09-2021	Beyond the Star Forming Main Sequence
Tommy Clark (SURF)	NBB	02-09-2021	Why Do Galaxies Die?
Emile Timothy (SURF)	NBB	02-09-2021	Solving a Water Crisis: Identifying Chemicals Through Dimensionality Reduction
Amelia Whitworth (SURF)	NBB	02-09-2021	Simulating the Absorption Spectra for DLA Galaxy Counterparts
Tom Gilbert (SURF)	NBB	18-08-2021	Life through the hologenomic window
Patrick Rim (SURF)	DTU	01-09-2021	Summer School Talk

Speaker	Location	Date	Title
Ishaan Kannan (SURF)	DTU	01-09-2021	Summer School Talk
Alice Cheng (SURF)	DTU	01-09-2021	Summer School Talk
Dr. Alkistis Pourtsidou (Queen Mary University of London)	NBB	09-09-2021	HI constraints from cross-correlations of intensity maps with optical galaxies
Hollis Akins (IRES)	NBB	19-08-2021	ALMA reveals extended gas and dust emission around the $z = 7.13$ galaxy A1689-zD1
Zoe Kearney (IRES)	NBB	19-08-2021	Exploring high O[III]-C[II] line ratios in the early universe
Casey Carlisle (IRES)	NBB	19-08-2021	Star Formation Histories of Galaxies in COSMOS2020
Michael Messere (IRES)	NBB	17-08-2021	Searching for Starburst-Driven Ionized Gas Outflows at $z \sim 1.5$ Main-Sequence Galaxies with KMOS
Julia Homa (IRES)	NBB	17-08-2021	Groundtruthing Rotation Curve Models of Galaxies at $z = 2$
Troels Petersen(NBI)	NBB	13-08-2021	Variated talks on physics and teaching
Aasa Feragen (DTU)	NBB	11-08-2021	AI for medicine: bias and fairness
Morten Ravn (Viking Ship Museum in Roskilde)	NBB	04-08-2021	Underwater archaeology in Denmark: History and recently conducted investigations
Thomas Blunier (SURF)	NBB	28-07-2021	Climate research from ice cores
Morten Holm Christensen (NBI-CMT)	NBB	21-07-2021	More is Different
Anders Gorm Pedersen (DTU)	DTU	14-07-2021	From pandemic to the common cold
Namiko Mitarai (NBI)	NBB	07-07-2021	Bacterial persistence: Life is a gamble
Bryan Scott (IRES)	Virtual	22-07-2021	Astrophysics and Cosmology with Intensity Mapping

Speaker	Location	Date	Title
Rebecca Larsonă (IRES)	Virtual	15-07-2021	Islands of Reionization - A Potential Ionized Bubble Powered by an Over-density at $z = 8.7$
Sidney Lower (IRES)	Virtual	01-07-2021	Improving Galaxy SED Modeling Techniques with Cosmological Simulations
Kevin Harrington (European Southern Observatory and the Joint ALMA Observatory)	Virtual	27-05-2021	PASSAGES: A Multi-J CO and [CI] line study of single dish observations of the lensed Planck selected starbursts at cosmic noon
Maria Maistro (DIKU)	Virtual	20-05-2021	Is most published research wrong?
Sirio Belli (Harvard CfA)	Virtual	15-04-2021	Molecular gas in high-redshift quiescent galaxies
Fabio Vito (Scuola Normale Superiore di Pisa)	Virtual	08-04-2021	The furthest QSOs in the X-rays
Tony Mroczkowski	Virtual	18-03-2021	Towards an Atacama Large Aperture Submillimeter Array (AtLAST)
Jorryt Matthee	Virtual	11-03-2021	The X-SHOOTER Lyman-α survey at $z = 2$
Hannah Staceyă	Virtual	04-03-2021	100-pc resolution of $z \sim 2$ quasar host galaxies with ALMA: witnessing the formation of compact spheroids
Sam Cutler		11-02-2021	Diagnosing DASH: A Morphological Catalog for the COSMOS-DASH Survey
Takahiro Morisita		04-02-2021	(G)old mining in high-redshift galaxies: Application of SED fitting in the era of JWST
Lukas Furtak		14-01-2021	How robustly can we constrain the $z \sim 6 - 7$ stellar mass function?

Guest Researchers

Visitor	Arrival	Departure	Affiliation
Luca Di Mascolo	13-12-2021	18-12-2021	University of Trieste
Daniele Bjørn Malesani	01-10-2021	01-10-23	Radboud University
Xin Lin	18-10-2021	11-09-2021	Université de Versailles Saint-Quentin-en-Yvelines
Martin Sparre	11-10-2021	12-10-2021	Potsdam University
Will Roper	06-09-2021	22-09-2021	University of Sussex
Julia Homa	09-08-2021	20-08-2021	University of Massachusetts
Sidney Lower	09-08-2021	20-08-2021	University of Massachusetts
Bryan Scott	09-08-2021	20-08-2021	University of Massachusetts
Rebecca Larson	09-08-2021	20-08-2021	University of Massachusetts
Alkistis Pourtsidou	05-08-2021	05-09-2021	Queen Mary University of London
Emile Timothy Anand	21-06-2021	04-09-2021	Summer Student Caltech
Alice Cheng	19-06-2021	04-09-2021	Caltech
Tommy Clark	19-06-2021	04-09-2021	Caltech
Andrei Diaconu	19-06-2021	04-09-2021	Caltech
Amelia Whitworth	28-06-2021	04-09-2021	Caltech
Patrick Rim	Virtual		Caltech
Adam Bertelli	Virtual		Carnegie Mellon University
William Mann	Virtual		Caltech

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Meet the Cosmic DAWN Team

Meet the Team

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Minju Lee

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Lijie Liu

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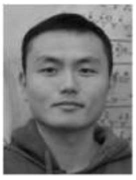
DAWN Fellow

Nina Bonaventura

Postdoc



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Guozhen Ma

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Han Lei

MSc Student

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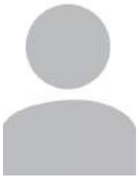
Jiaming Yao

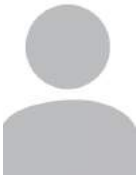
MSc Student

Guests



Daniele Malesani

Guest



Alkistis Pourtsidou

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International Associate

Karina Caputi

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Kristian Finlator

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International Associate

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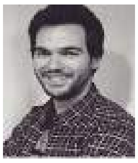
PhD Student

Isabella Cortzen

PhD Student



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Cecilie Nørholm

MSc Student

Christina Konstantopoulou

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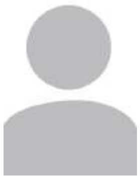

Mette Vindbæk-Madsen

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Charlie Meinertz

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DAWN Publications 2021

DAWN Publications 2021

Rodney, Steven A., Gabriel B. Brammer, Justin D. R. Pierel, et al. (Sept. 2021). "A gravitationally lensed supernova with an observable two-decade time delay". In: *Nature Astronomy* 5, pp. 1118–1125. arXiv: 2106.08935 [astro-ph.CO] (cit. on pp. 12, 17).

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