LSC LIGO Scientific Collaboration

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LIGO MAGAZINE

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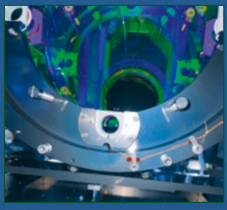
On-site Commissioning before O4b p.9



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Front cover

Aurora photo by Kar Meng Kwan. Taken with LIGO fellows at Hanford Reach.
For more aurora and eclipse photos see pp. 21 and 32-33.

Top inset: Virgo joins Observing Run 4 (O4). Article on p. 9.

Bottom inset: Earthquake recovery at KAGRA included re-gluing the test mass magnets. Article on pp. 10-11.

Bottom left (diagonal) inset: Encountering gravity as a LIGO Summer Undergraduate Research Fellow (LIGO SURF). Kushal Jain fine-tuning an optics experimental setup during his time as a LIGO SURF. Article on pp. 12-14.

Image credits

Photos and graphics appear courtesy of Caltech/MIT LIGO Laboratory and LIGO Scientific Collaboration unless otherwise noted.

Cover: Main image: Aurora photo by Kar Meng Kwan (note that the image has been reversed for artistic purposes).
Top inset: Virgo team photo by Giada Rossi/EGO. Bottom inset: KAGRA test mass photos by Takafumi Ushiba and Takayuki Toamru.
Bottom-left (diagonal): Photo of Kushal Jain by Alka Jain.

p. 3 Antimatter comic strip by Nutsinee Kijbunchoo.
pp. 7-8 GW230529 infographics by Shanika Galaudage/Observatoire de la Côte d'Azur (p. 7 & p. 8).
p. 9 Virgo team photo by Giada Rossi/EGO
pp. 10-11 Test mass photos by Takafumi Ushiba and Takayuki Toamru (p. 10). Cryostat photo by Masahide Tamaki (p. 11).
pp. 12-13 Photo of Kushal writing at the board by Alka Jain (p.12, left). Photo at long beach by Kushal Jain (p. 12, right).
Photo with the Caltech symbol by Anant Singh (p. 12, top). Photo of Kushal at the optics bench by Alka Jain (p. 12, bottom).
pp. 15-16 Author photo from Peter Kalmus. Daily sea surface temperature graphic from Copernicus Climate Change Service (C3S)/ECMWF.
See also the article at https://climate.copernicus.eu/copernicus-march-2024-tenth-month-row-be-hottest-record. Data source: ERA5.
p. 18 Family photo by Joey Shapiro Key.
p. 20 LAAC Survey results plot by Sylvia Biscoveanu (top). LAAC recognition webpage screenshot: https://laac.docs.ligo.org/recognition.
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pp. 28-30 Group photo by Isobel Romero-Shaw (p. 28). Iceberg photo by Isobel Romero-Shaw (p. 29).
Penguin photo by Debatri Chattopadhyay (p. 30).
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pp. 32-33 Eclipse and aurora photos (from left to right and top to bottom and also as credited in the image captions) are by Benjamin Knispel (bknispel.de), Oli Patane, Marco Cavaglia, Jasmin Mundi, Rahul Kumar, Shane Larson, Albert Kong, Rahul Kumar, Lynn Cominsky, Sareh Rajabi, Margaret Johnston, Kar Meng Kwan, Derek Davis. The background aurora photo is by Benjamin Knispel (bknispel.de).
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Back cover: LIGO/Virgo/NASA/Leo Singer (Milky Way image: Axel Melinger), annotated by Nutsinee Kijbunchoo.

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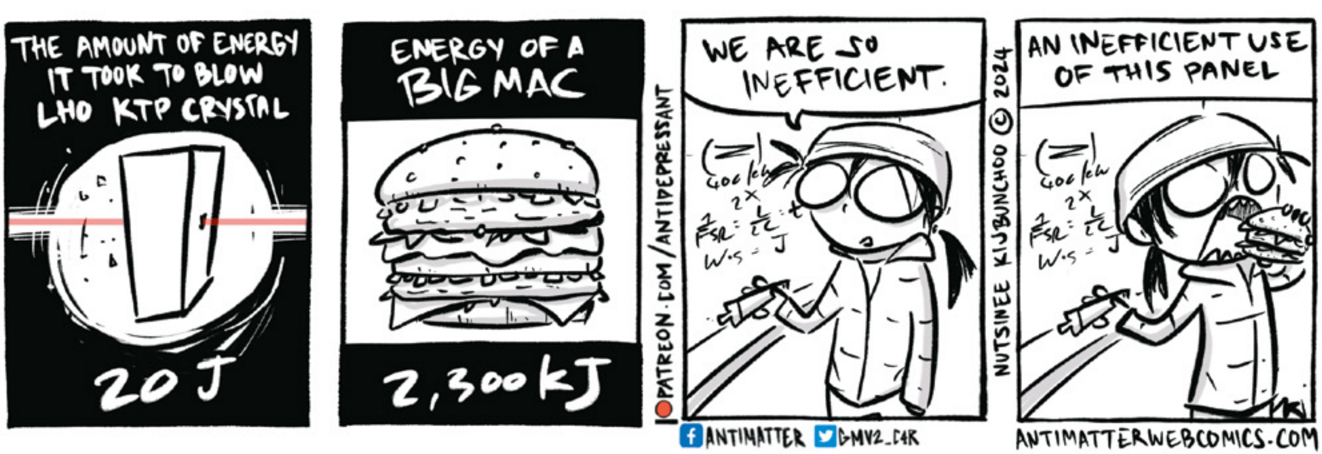
Antimatter by Nutsinee Kijbunchoo



Welcome to the 25th issue of the LIGO Magazine!

Hannah Middleton
Editor-in-Chief

Anna Green
Deputy Editor-in-Chief

Welcome to the twenty-fifth edition of the LIGO Magazine! We celebrate and send our congratulations as Virgo joins Observing Run 4 (O4) – a tale of perseverance and teamwork. After the largest earthquake in the region for a century, we catch up with the recovery progress at KAGRA. We look at the first exceptional results of O4 with a new flavour of binary system, GW230529, and on the back cover find out how having more detectors helps us to find which part of the sky gravitational-wave signals come from. Speaking of which, this edition's Meanwhile in Space focuses on wonderful aurora and eclipse photos from collaboration members around the world – a spectacular display!

Kushal Jain shares his experience as a LIGO Summer Undergraduate Research Fellow (SURF), while postdoc Artem Basalaev tells of his first trip to the USA, joining the LIGO Engineering Group. For those wondering 'what happens now?', after the news of Gingin's arm collapse in Issue 22, John Moore explains the ins and outs of installing the new vacuum tube and how you "can't compromise on perfection, or vacuum tubes for that matter!"

We also remember the life of Peter Bender. He was widely thought of as the father of the Laser interferometer Space Antenna (LISA) Project and the mission recently passed a major milestone of European Space Agency approval for implementation.

Our work brings its benefits and difficulties. Joey Shapiro Key offers a personal take on having children at an early career stage, and Sylvia Biscoveanu shares the LIGO Academic Advisory Committee (LAAC)'s recent endeavour in "Tackling the challenge of recognition in large collaborations". We also catch up with Alexei Ciobanu on transitioning from laser physics to data science with Australia Post in this edition's "Work After LIGO".

In the next in our series of "Climate Change Conversations", Peter Kalmus discusses his career change from gravitational waves to climate science as well as the fossil fuel crisis and climate activism. Undertaking a huge adventure, Isobel Romero-Shaw and Debatri Chattopadhyay learned leadership skills, worked on sustainability projects, and tested their limits through the Homeward Bound initiative in "A trip to the end of the world".

With this 25th edition, Storm Colloms takes a look back at the LIGO Magazine so far and looks forward to many more editions in "Behind the Authors of the LIGO Magazine".

As always, please send comments and suggestions for future issues to magazine@ligo.org.

Hannah Middleton and Anna Green, for the Editors

News from the spokespeople

The LIGO Scientific Collaboration (LSC) was founded 27 years ago and has grown to 1600 people including more than 750 students from all over the world. The first direct observation of gravitational waves from the collision of a pair of black holes in 2015 was the culmination of more than 40 years of work by many early contributors to our field. Since that watershed observation, the detection of gravitational waves from compact object mergers has become routine. With every improvement in detector sensitivity comes the opportunity to learn more about the Universe and possibly identify other sources of gravitational waves. The LSC continues to be successful by adapting our goals as we learn more about gravitational-wave detectors, the fundamental properties of gravity, and the astrophysics of gravitational-wave sources.

In 2005, we initiated a partnership with Virgo leading to the operation of the LIGO and Virgo detectors as a global network. We extended that collaboration to include KAGRA five years ago. Many of our collaborative activities are now fully integrated and the development of a new organization, the International Gravitational-Wave Observatory Network (IGWN), is underway. With this ambitious and challenging step, we aim to bring the LIGO, Virgo and KAGRA detectors together under one umbrella. The process involves agreeing on the goals and structure of the new organization and finding ways to work with funding agencies to co-ordinate support of the network. The potential benefits include reduced organizational overhead and the ability to more easily share expertise and financial resources. The IGWN would provide a testbed for global cooperation on construction and operations that will be beneficial to the next generation of gravitational-wave detectors. We encourage broad discussion of the IGWN concept and look forward to receiving your feedback on the new organization.

Reflecting on our collaborative journey and the road ahead, it's also important to acknowledge the socio-political changes occurring worldwide. Our collaboration is focused on pushing the forefront of gravitational-wave science, but we are not immune to concerns beyond our field. From the health and safety of our own families to the oppression of others, from climate change to famine, or from hate speech to free speech, the issues that we face are many and all deserve attention and action. As a collaboration, we strive to be inclusive by understanding and mitigating structural barriers within our organization. We strive for a safe collaborative environment that is welcoming to everyone. We strive to reduce our collaboration's negative impacts on the world, including carbon emission. We have a great deal of work to do on all of these issues. Let's find ways to educate ourselves, to identify the barriers in our collaboration, and make changes for the better.

Patrick Brady
LSC Spokesperson

Jess McIver
LSC Deputy Spokesperson

O4 → GW230529, a Compact Object in the Mass Gap

GW230529 was the first significant gravitational-wave event observed in the fourth observing run (O4) of the Advanced LIGO-Virgo-KAGRA network, and was an extremely interesting system to have kick off our run. It was detected on 29 May 2023 and only seen by the LIGO-Livingston detector, as all the other detectors in the network were either offline or did not have the required sensitivity to detect it. The source of GW230529 is a new flavor of compact binary mergers, and is most consistent with being a neutron star merging with a "mass gap" black hole between 3 and 5 times the mass of our Sun; a type of neutron star-black hole merger we haven't seen previously that may have had the neutron star ripped apart before being swallowed whole by the black hole. In this article we hear from a few people involved in various parts of the analysis of this event, themselves making up part of a big effort with many collaboration members involved.

Telling the Story of a Gravitational-wave Source in the Mass Gap

Mike Zevin is an astrophysicist at the Adler Planetarium in Chicago and a Visiting Scholar at Northwestern University. He has been a part of the LIGO Scientific Collaboration since 2015 and works on gravitational-wave populations, massive-star evolution, the formation of compact objects, and citizen science. When he's not looking up, he can be found traveling, hitting tennis balls, snowboarding, and playing music around the Windy City.

Being a part of the discovery of new gravitational-wave signals is always an exciting experience — it's one of the reasons we're in this field! Once we realize a signal is of particular interest, telling the scientific story of the signal and its astrophysical implications is simultaneously invigorating and demanding. Being a collaboration as large as we are, there are so many people involved in making each and every detection, and the editorial team of collaboration publications strives to make each and every voice heard while maintaining a compelling narrative and scientific rigor.

As someone that spends their time thinking about how massive stars lead to the compact object binary mergers that we see in gravitational waves, GW230529 particularly excites me because of the compelling evidence it gives for compact objects existing with masses between the heaviest neutron stars and lightest black holes observed in the Milky Way. This proposed gap in the mass spectrum of compact objects was hypothesized since the late 1990s. GW230529 and other recent discoveries indicate that this gap might not be as empty as we previously believed, teaching us about the supernovae that lead to the formation of compact objects.

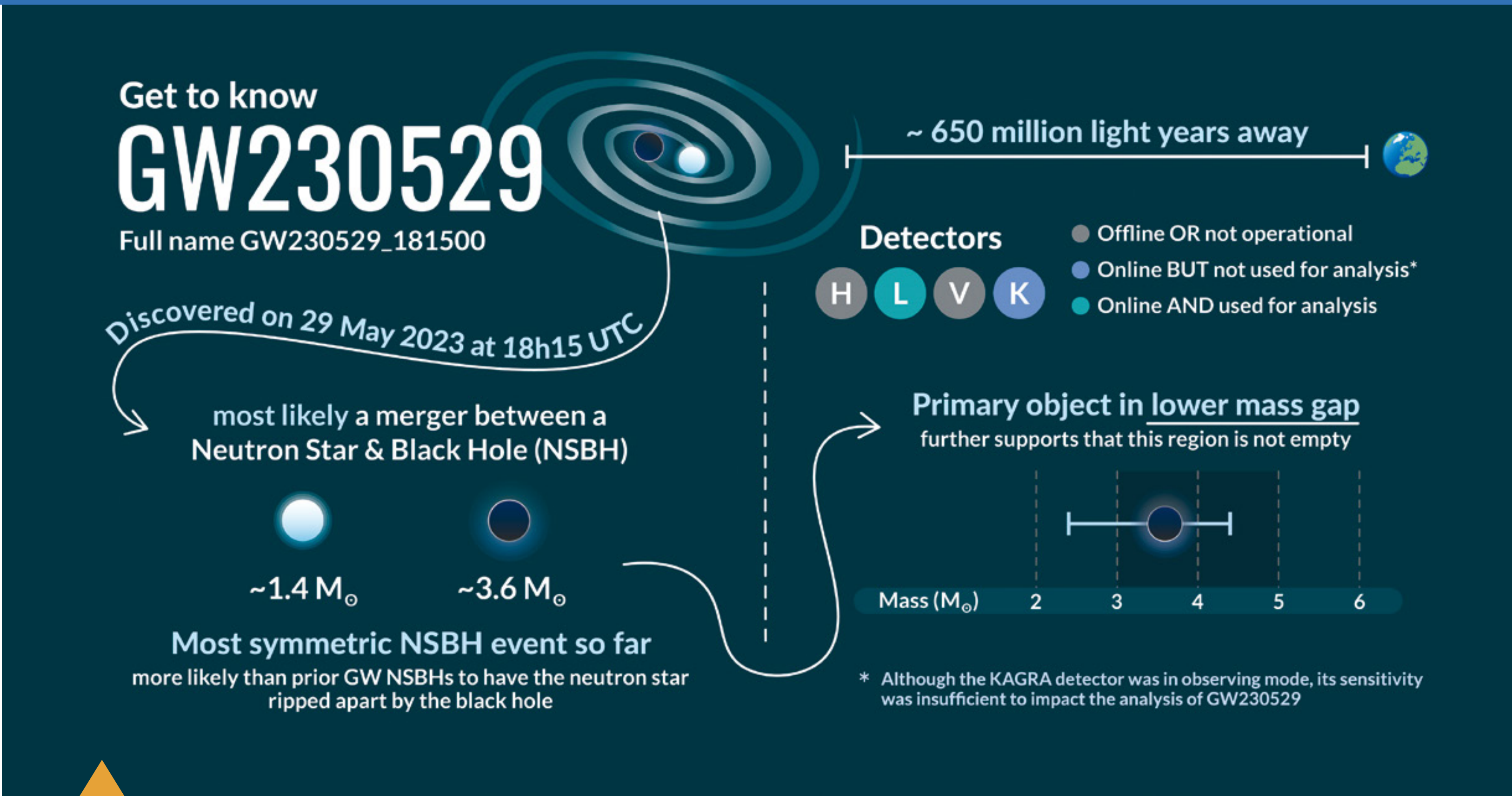
– Michael Zevin –

Vincent Juste is currently pursuing his research on compact binary coalescence detection as a postdoc at Université Libre de Bruxelles, Belgium. As a French southerner, he enjoys complaining about the weather and bathing in the sun. But you may also find him hiking, doing various sports or being bad at video games.

Preparing the ground for GW230529's detection

As a member of a search pipeline team, most of the work involving GW230529 actually took place before the event occurred. The search pipeline I work on is called MBTA[1]. Search pipelines are software that execute chains of processes to pick up astrophysical signals from the detectors' data.

[1] *Multi-Band Template Analysis*



Summary infographic about GW230529.

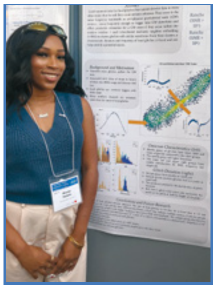
During the previous observing run (O3), MBTA was only looking for detections that are coincident in at least two detectors, meaning that we missed events that were seen by only one detector. During the break between O3 and O4 I joined the MBTA team as a PhD student and I was tasked with developing an analysis that can claim confident detections of astrophysical signals with only one detector. This work mostly involved selecting events based on data quality checks to avoid picking up noise and setting up a method to compute the significance for such events. The hardest part for me during this work was the unavailability of new data: I was preparing an analysis for O4 but could only test on O3 data.

All of this development led to the detection of GW230529, which was only seen in LIGO Livingston, by MBTA just a few days after the start of O4! The following days/weeks we worked to verify the data quality around the detection and re-analyzed the event offline to make sure it was real.

> GW230529 excites me because of the compelling evidence it gives for compact objects existing with masses between the heaviest neutron stars and lightest black holes.

Being part of the paper writing team was a great opportunity to follow closely the work of other people with different expertise beyond detection, and I really enjoyed it.

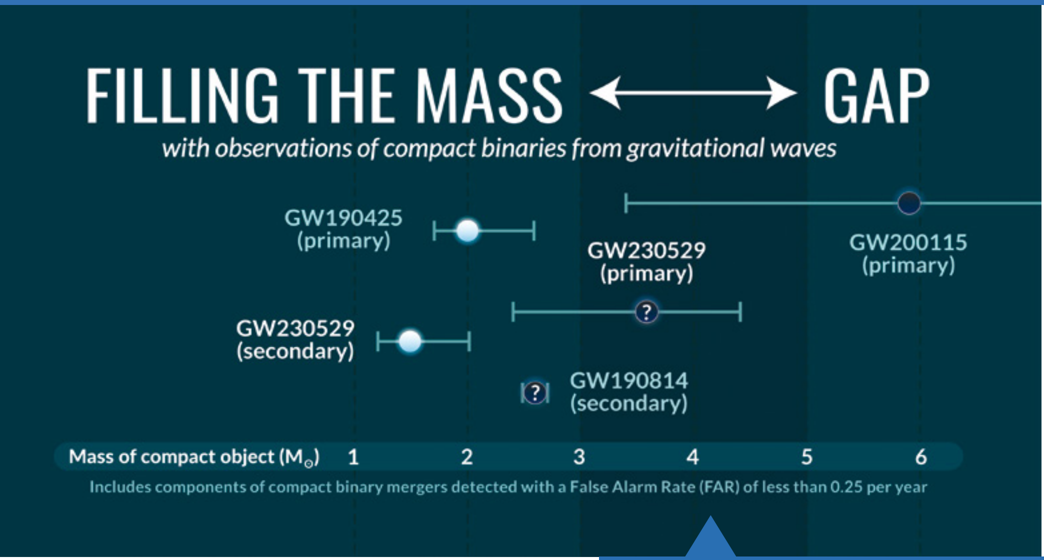
– Vincent Juste –



Shania Nichols, a graduate student at Louisiana State University, focuses on investigating and characterizing loud transient noise in Advanced LIGO instruments. Outside of her research, she enjoys practicing yoga, watching anime, playing fetch with her Yorkie, and spending time with her family in Trinidad and Tobago.

Quieting the Noise for the Discovery of GW230529

The Detector Characterization (DetChar) Group works tirelessly to understand the noise present in LIGO data to improve data quality, allowing for more gravitational-wave signals to be detected. Members of the DetChar group often interact with commissioners at



The source of GW230529 is most consistent with being a neutron star merging with a mass gap black hole. This infographic compares the component masses of GW230529 with other gravitational-wave events that lie near to the mass gap.

the LIGO sites to investigate and mitigate noise, improving the instrument performance. We also work with data analyst groups to avoid and remove noise artifacts that may affect gravitational-wave signals.

Leading up to O4, the LIGO instruments underwent a series of upgrades to improve the broadband detector sensitivity. Some of these improvements included the implementation of frequency-dependent squeezing, the reduction of scattered light noise, increased laser power and commissioning of feedback control loops. The dedication and efforts of the instrument scientists and the DetChar group in preparing for O4 are exemplified by the discovery of GW230529. At the time of the gravitational-wave signal, LIGO Livingston had a binary neutron star range near 150 Mpc and was locked for approximately 66 hours prior to the merger time. There also was no evidence of noise present that could affect the recovery of the gravitational wave signal!

As a member of the GW230529 Editorial Team, I enjoyed working with members from the various LIGO-Virgo-KAGRA working groups and learning how the research done in each group plays a role in the detection of gravitational-wave signals.

– Shania Nichols –

Understanding GW230529's place in the population

Exceptional events like GW230529 are exciting, that's why we have a paper dedicated to it! However, I think it's cool to look at these events in the context of the overall population, and that was my primary role for this paper. We found the event is not unexpected compared to the overall population, so I'm hoping we see more events like this! I also contributed to aspects of the review of analyses, the preparation of the data release and making the paper plots have a consistent style.

This is my third time working on a collaboration paper writing team, but the first time on a discovery paper. It felt much more fast-paced this time around, with the time from the assembly of the paper team to the paper going live being about 6 months, but it was cool to dive into the nitty-gritty details of this event. It was also great to work with people from different research areas that I normally wouldn't have the opportunity to work with.

I also contributed to the science communication of this event by making a couple of infographics to share with the community. It was fun to design these infographics to share my excitement about this event and also to have it translated into several languages to help communicate the highlights of this event to a wider audience.

– Shanika Galaudage –

Shanika Galaudage is a postdoctoral researcher at the Observatoire de la Côte d'Azur in Nice, France. Outside of studying populations of colliding black holes and neutron stars, she enjoys designing greeting cards, playing chess and making desserts.

by Monica Seglar-Arroyo

Virgo Joins Observing Run 04

Monica Seglar-Arroyo is a Juan de la Cierva postdoctoral researcher in IFAE, Barcelona. Her interests span from interferometer calibration and precise signal construction to multi-messenger astrophysics, where she focuses on transient gamma-ray sources. In her free time, she enjoys embarking on sporty adventures.

Some years ago I got asked: "but guys, are you sure you are detecting gravitational waves? It seems so complicated, I am astonished." A genuine question coming from a senior scientist from another high-energy area. And this is probably because of how incredible it is to do what we are doing: detecting perturbations of spacetime—something well-deserving of a Nobel prize.

Technology allows us to reach that level of precision – a relative change in the length of the arms of ground-based interferometers of about 10^{-18}, or eighteen zeros between the comma[1] and the one. Or, in other terms, a length equivalent to changing the distance between Earth and the center of the Milky Way by a cheeseburger. A very difficult task, indeed!

I had the luck of staying at Virgo for the last months before the start of Observing Run 4b, witnessing the on-site commissioning firsthand. "Everybody who knows how to use dataDisplay, go look at the data now!" shouts Julia Casanueva (current head of Interferometer Sensing and Control, ISC). A new puzzle to solve. Three hours later, the interferometer is locked again. Commissioning is quite a rollercoaster—a delicate working state, which requires the synchronization of many teams over Europe.

For those that are not close to the detector, commissioning is another step of the chain – predictable, foreseeable. Yet it is a hectic period when in the control room people come and go, and many languages are spoken at the cafeteria. The first part is dominated by hardware updates and reaching the 'locked' state again. Then the second part is controlling the interferometer and reaching the expected sensitivity.

The path to Observing Run 4 has been a tough one for Virgo. There have been many challenges on the way: the reduction of the input laser power, the installation of actuators to modify the radius of curvature of the power recycling mirror, the west input test mass that fell as a wire broke, the replacement of the north end test mass, lots of thermal tuning, and many many others. The two main ongoing challenges? A large, elusive broadband noise in the bucket[2] which scales with frequency as $1/f^{2/3}$, and the limitations of the current optical design of the interferometer. All of the commissioning team, both on-site and remote, persevered.

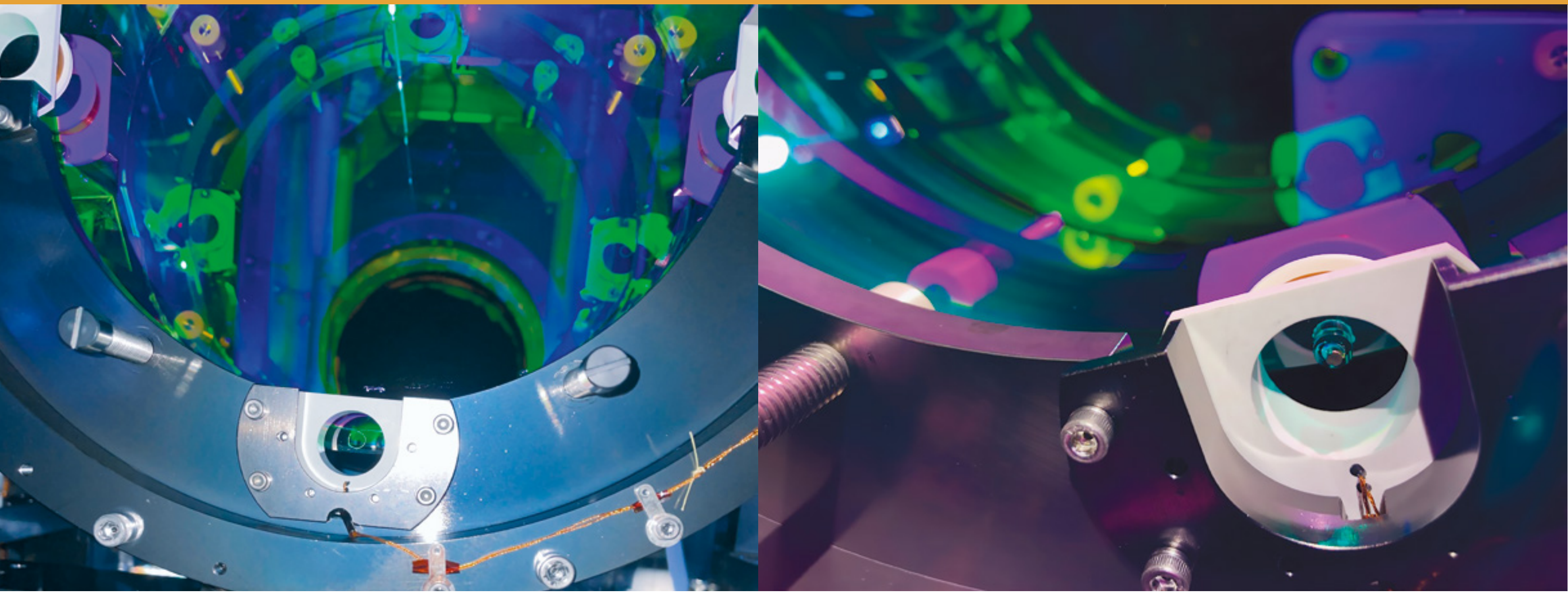
The start of an observing run has very different meanings for the different parts of the gravitational wave community. For some, it is the culmination of a long, hard, enduring problem-solving journey when technology has to work at its finest. For others, it is a new beginning—the exploration of the sky through gravitational waves resumes.

Nowadays Virgo has a high-duty cycle and, thanks to its presence in the network, we could reach exceptional source localizations—shout out to S240615dg, localized at 5 square-degrees at 90% probability!

Cheers to those that don't surrender and cheers to the teamwork!

[1] *or period/decimal, for those based outside Europe*

[2] *The middle of our most-sensitive frequency range.*



Test mass (TM) with the magnet removed (left) and glued (right).

Recovery from the Earthquake and Beyond

Masahide Tamaki

is a Ph.D. student at the University of Tokyo. He joined KAGRA in 2021 as a master student and has been working mainly on characterization and control of cryogenic suspensions. When he's not tapping away at the keyboard, you can find him brewing fresh coffee or absorbed in a detective novel.

On the first day of 2024, an earthquake struck the Noto Peninsula, causing significant damage to the residents celebrating the New Year. This earthquake, the largest in the Hida-Takayama area in the past 100 years, also had a substantial impact on our research facility located approximately 120 km away. The 'shindo' (the Japanese seismic intensity scale of 0 to 7) was 5 lower, a level that induces fear and makes people feel the need to hold onto something for stability. Indeed, staff who were in the analysis building (on the ground) during the New Year's shift reported that the shaking was so severe that it was difficult to stand.

However, as some of you may have seen during the tour at last year's LIGO-Virgo-KAGRA meeting, the KAGRA site is located underground. Consequently, the shaking there was less intense than at the surface, with the 'shindo' of 3 at the site. This demonstrates the advantage of having the facility underground. Had it been constructed above ground, there could have been catastrophic consequences, such as the test masses falling.

That said, there was still damage. I usually work around the Type-A suspension (ITMX, ITMY, ETMX, ETMY[1]) that holds the sapphire mirrors, so I will comment on that. For example, the displacement sensor (LVDT[2]) signal cables for ITMX and ETMY had been severed. Additionally, we discovered that most of the magnets used to actuate the test masses fell off and needed to be re-glued. Especially in the lower part of the suspensions, where cooling had progressed, we needed to warm up and vent the system again for repair work. We also found that the viewports for the optical levers were dirty or foggy - perhaps due to the warning and venting - necessitating additional cleaning work. Since we cannot use organic solvents inside the cryostat, we had to painstakingly remove and clean each of the many viewports one by one. I remember thinking, "When will this ever end?" (At the same time,

[1] *These denote the Input and End Test Masses in the X- and Y-arms of the detector*

[2] *Linear Variable Differential Transformer*

though, it was a good opportunity to talk about various things with the staff I work with...)

Many other suspension systems also suffered significant damage. Although I was unable to participate in many of the repair activities due to my frequent absences from Kamioka, there were staff members working day and night, and I have great respect for them. Moving forward, I would like to put in more effort to participate in the observations with significantly improved sensitivity.

We will also be introducing upgrades for Observing Run 4b. It is safe to say, however, that the recovery work from the earthquake has largely been completed and the commissioning by the site members at Kamioka resumed in earnest in July.

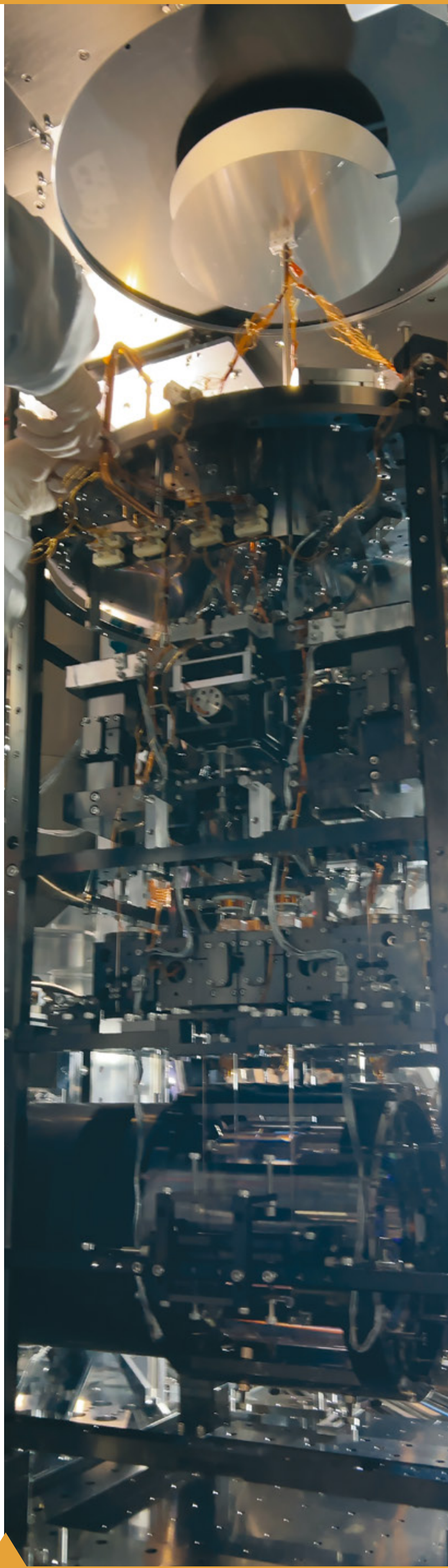
Many suspension systems suffered significant damage in the earthquake. There were staff members working day and night.

As of the end of July, when I am writing this manuscript, the commissioning of the vibration isolation system seems to have been the most active. Routine health checks, such as measuring transfer functions to verify the state of the suspensions, were conducted. Additionally, fine-tuning of the controllers for each suspension and degree of freedom was carried out to reduce the suspension local control noise, which had been a low-frequency wall for KAGRA. Moving into August, work around length sensing and control will intensify as we aim to lock the power-recycled interferometer. Moreover, adjustments to alignment sensing and control, including phasing of the wavefront sensing quadrant photodiodes and the tuning of differential arm alignment control loops, are planned.

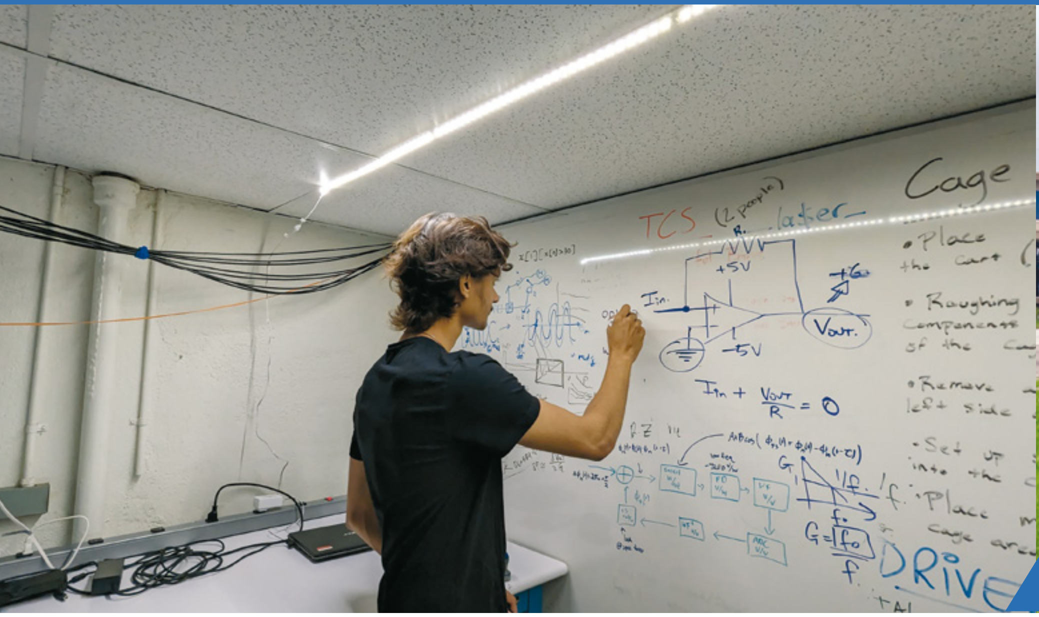
While such upgrades undoubtedly contribute to improved sensitivity, I believe there are even more significant changes happening at KAGRA. This is entirely my personal impression, but one that seems to reflect reality: there appears to be a substantial increase in the number of people participating in commissioning activities in the control room compared to before Observing Run 4a. The rise in the absolute number of hands-on personnel is certainly notable, but what's truly exciting is the renewed energy and enthusiasm it brings. Given that KAGRA has been lamenting a decrease in staff over the past few years, this influx of motivated individuals is a welcome change.

As for myself, despite my earlier claims about contributing to sensitivity improvements, upon reflecting on this month's activities while writing this article, I realize that I haven't been able to participate on-site as much as I would have liked due to my own experiments or trip for conference.

As one of the youngest members, I am eager to actively engage in this enjoyable (and challenging) work, which is arguably one of the most crucial aspects of the KAGRA project.



Work in the cryostat to check the cryogenic payload.



Left: *Exploring the functioning of deceptively simple, yet notoriously complex optics.*
Right: *Enjoying a sunny Calif morning in Long Beach with friends and Caltech SURFers.*

Encountering Gravity at Caltech

Kushal Jain

is an incoming PhD student at Cardiff University. He graduated recently from Ashoka University in Sonipat, India, with a postgraduate diploma and a B.Sc. (Hons) in Physics. He enjoys experimentation and is interested in astronomy. In addition to physics, he often invests his time in writing sci-fi and fantasy stories and playing outdoor sports.

My time as LIGO Summer Undergraduate Research Fellow (LIGO SURF) at Caltech in the summer of 2023 was the most eye-opening experience of my life. This article carries my story and experience as a LIGO fellow. I hope it motivates future fellows to bring out their best through this program.

It was 9:00 AM on May 22, 2023. I gazed at the doorplate that read “LIGO 40m Lab". This forty-year-old prototype interferometer at Caltech, a 100x scaled-down version of the actual observatories, holds the prestige of being a foundational building block in gravitational wave research. Its purpose was to demonstrate the cutting-edge tech needed to realize the detection of ripples in spacetime that are 1/1000th of the size of a proton. A brief tour of the prototype left me in awe, and to be honest, it also contributed a bit to my nervousness. Though I feared underperformance, I felt grateful for getting this opportunity that eventually boosted my confidence, provided me with enough clarity about my strengths and weaknesses, and gave me some everlasting friends and memories.

But how did it all begin? What did it take to become a part of this prestigious program? Was it worth it?

Applying for the program

I have always enjoyed experimentation, and during my undergraduate years, I have had multiple opportunities to work on experiment-based projects. However, I still needed exposure to the life of a researcher and the experience of working on a project that tested me to my limits. I kept an eye for such an internship program for a long time and finally found LIGO SURF. The LIGO SURF program hosts about 25 fellows annually and offers multiple computational and experimental projects. The program is generally separate from the Caltech SURF program. You do not need to directly email a mentor for the LIGO SURF program whether you are applying from India or not. General application details are found on LIGO’s website[1], and they accept US and in-

[1] *https://labcit.ligo.caltech.edu/LIGO_web/students/SURF/*

ternational undergraduate students! Additionally, Indians can apply through a form floated by the Gravitational Wave Research Group at the Inter-University Centre for Astronomy and Astrophysics (IUCAA) on their website[2], advertised on LIGO-India social media. This application package requires the applicant to write some essays on topics such as their laboratory and programming experience and a Statement of Purpose (SOP). The candidates must also submit their academic mark sheets and two Letters of Recommendation (LOR). IUCAA then filters out some applications and forwards the selected ones to the experimental LIGO-Caltech group for further scrutiny. I advise applicants to invest at least two to three months in preparing a solid application. After submitting the form at the beginning of January, I received an email the following month informing me of my selection for the next round, the questionnaire. Consisting of three physics problems, the questionnaire demanded two sleepless nights and a pressure equivalent of a semester's amount of work. Within two weeks of submitting the questionnaire, I received an invitation for a 20-minute interview (though it went on for about 40 minutes).

The friendly interview entailed my introduction, motivation to be a LIGO SURF intern, and technical questions regarding my previous projects. The interview marked the application's end and brought an uncomfortable restlessness for another couple of weeks. I was eating tender coconut flavored ice cream on an early March evening with my parents when the anxious silence broke into celebrations when I received an acceptance email from LIGO-Caltech. The overcrowded shop witnessed my strange dance that involved jumping and hugging my parents. With about two months until the start of SURF, I began the next quest to acquire a U.S. Student Visa. This process is usually exhausting and requires one to fill out a gazillion forms. However, if I can do it, anyone can. I advise applicants to start collecting the required documents and applying for the Visa as soon as they receive the acceptance email.

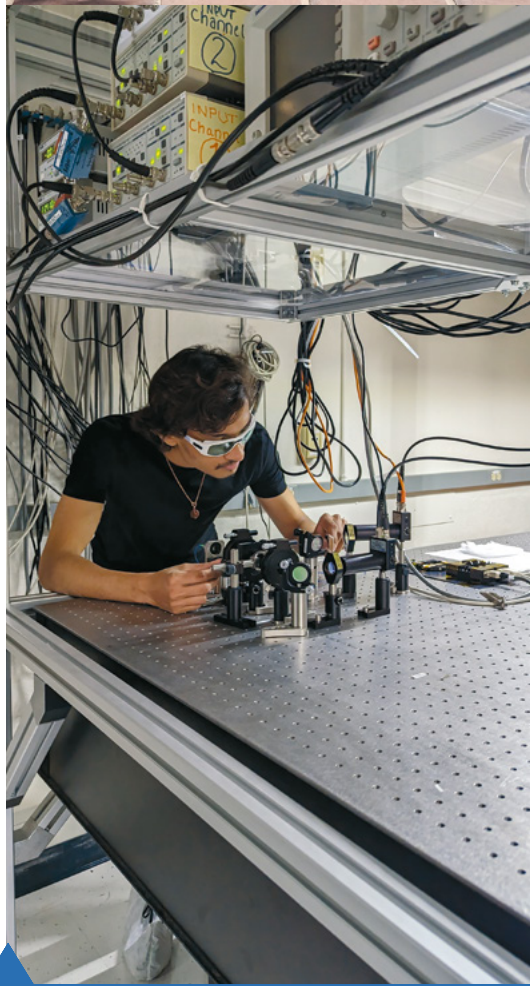
How did it all begin? What did it take to become a part of this prestigious program? Was it worth it?

Analyzing silicon test masses for LIGO-Voyager

Now, sharing about my work. The proposed upgrades for the LIGO-Voyager (future generation) detector involve the use of crystalline silicon test masses. Silicon comes with many benefits but a few problems, one being birefringence. Birefringence is the property of a material to split a light beam that passes through it into two. The detector's arms are supposed to have only one beam. However, due to birefringence, we may have more than one beam in the arms with different polarizations, which may interfere and result in the degradation of the signal-to-noise ratio. Moreover, thermal fluctuations in the arm cavity may cause fluctuations in birefringence. This poses a significant threat to the detector's performance.

I worked with Dr. Yuta Michimura and Prof. Rana Adhikari on analyzing the compliance of silicon test masses

[2] *https://www.gw.iucaa.in/ligo-surf-program/*



Top: *Finding a moment of reflection and gratefulness atop the iconic Caltech symbol.* ***Bottom:*** *Kushal fine-tuning the optics experimental setup.*

with the requirements of LIGO-Voyager by measuring the birefringence and its fluctuations in silicon. Our research marked the first-ever measurement of fluctuations in birefringence. This experience taught me to develop and execute an independent research agenda. And yes, when the SURF website says "Independent project," they mean it. After suffering a bit initially, I learned to solve problems independently, navigate through setbacks, and

Yes, when the SURF website says "Independent project," they mean it.

efficiently use the available literature. Several times, I brainstormed computational methods with my peers, which taught me the importance of collaborative efforts. I soon started enjoying the freedom, and my decision to pursue graduate studies in the field was cemented. By the end of the summer, I had gained exposure to the life of a researcher. I found my experimental skills were much more refined, and I improved my ability to think of new methods.

My lab was situated in the second basement of the West Bridge Building, which also hosted offices and labs of some of the world's most remarkable scientists. The work culture was very supportive and relaxed. I could come to the lab anytime as long as I got the work done. Although the building officially shuts at 5 PM, I remember working till 2 AM on several occasions. I would often work out the math and do mock presentations late at night in the Richard Feynman Lecture Hall (yes, this is literally the place where Prof. Feynmann delivered his lectures that we all are crazy fans of!)

My experience working at Caltech is incomparable to any other. As the campus was bustling with the smartest people working on interesting problems, ranging from genetic engineering to Mars rover enhancement, I met people and made friends worldwide. LIGO arranges several lectures and workshops for the holistic growth of their interns. Being a LIGO fellow has many privileges, including a fully-funded visit to the LIGO-Hanford site. The SURF organizers' Student-Faculty Programs (SFP) conduct seminars to prepare SURF students for graduate school applications, and host student-faculty dinners every week. They also organized several day trips to the most beautiful and happening places around Pasadena.

Calif mornings

Being an avid traveler and fond of outdoor activities, I spent my weekends exploring California's cinematic sceneries. Numerous beach towns and hiking trails surround the laid-back city of Pasadena. The LIGO SURF program allows its interns to develop a work-life balance, and my memorable and adventurous journeys ensured I made the most of my working hours. With my friends, I made an exhilarating 'things-to-do' list. I remember mimicking Harry Potter scenes with my friends at the Universal Studios' Wizarding World. And trying out the most random cuisines from the strangest places was a daily top-priority mission.

However, nothing could beat the happiness and adrenaline rush that came with the evening foosball tournament amongst my friends. I advise all interns to travel around and explore as much as possible. Working on such projects for hours without deriving results can be frustrating, especially when we are habitual to our university lab courses, where we are provided with well-established handouts. Enjoying and relaxing can significantly help declutter our minds, allowing us to approach the problem with a fresher perspective.

I advise all interns to travel around and explore as much as possible.

New beginnings

At 1:00 AM, July 29, 2023, I locked my lab door one last time. I remember how difficult it was to walk out of that basement corridor. Experimentation may accompany frustration, and I started enjoying that frustration by the end of my fellowship. My time as a LIGO SURF has been the highlight of my academic journey. I am grateful for receiving such an opportunity that gave me insights into a researcher's life and cemented my commitment to pursue a Ph.D. in the field. I strongly recommend science undergraduates seek such internships before setting out for long-term commitments like a doctorate.

I cherish the strong bond I built with my mentors and look forward to meeting them and my friends as we move into the next phase of our journeys. I believe there is no better conclusion for this article than my mentor's words: "The results you conclude matter not half as much as the experience you gain." I could not have asked for a better experience.

Interview with Peter Kalmus

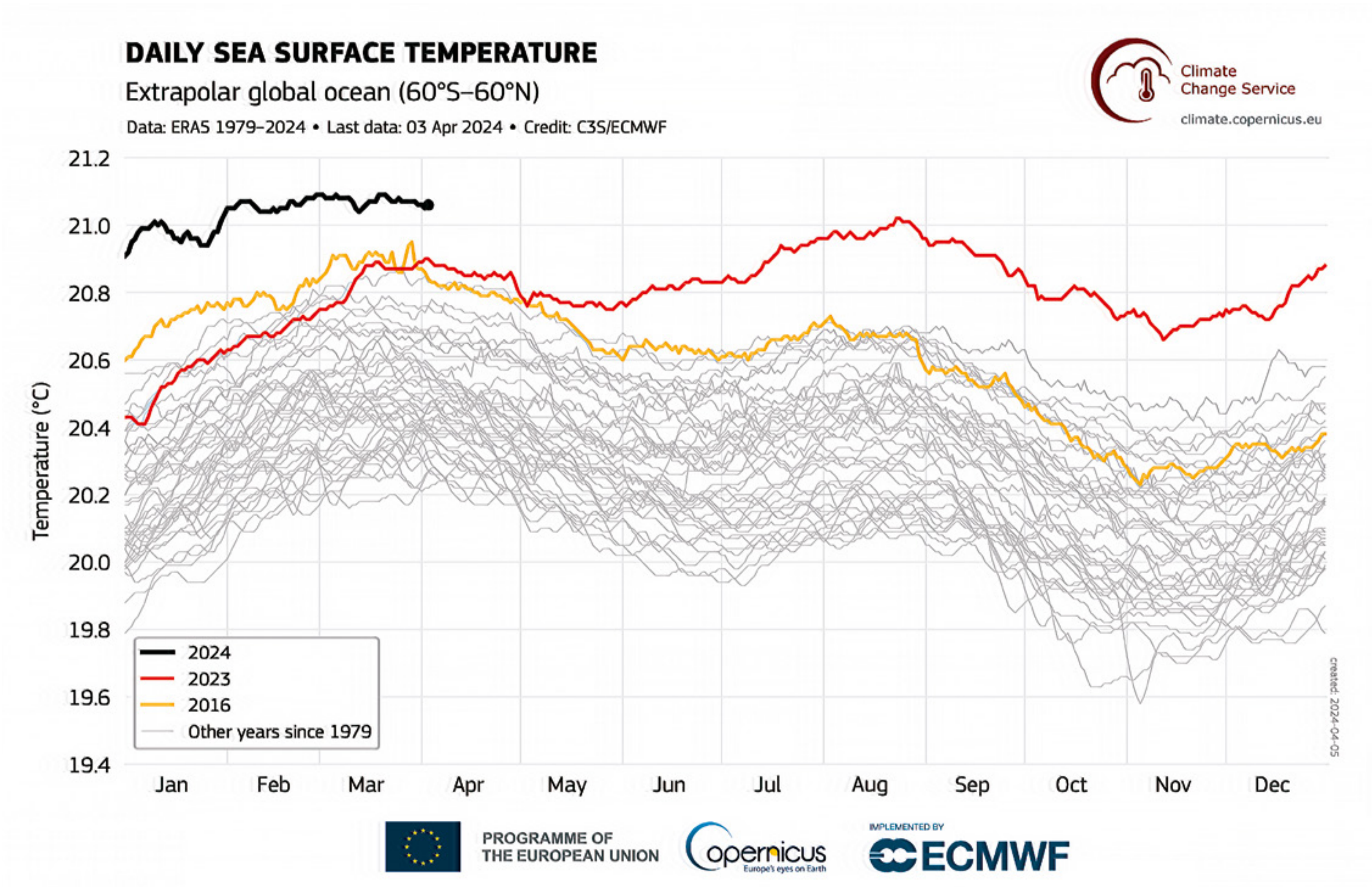
Peter Kalmus is a climate scientist at NASA's Jet Propulsion Laboratory and a climate activist who writes and leads on nonviolent climate disobedience. He spent eight years with the LIGO-Virgo Collaboration working on detector calibration and control; designing and leading burst searches from sources such as magnetars and supernovae, and relativistic modeling. In this interview, he is speaking on his own behalf.

Welcome to Climate Change Conversations. In this installment, we interview climate scientist Peter Kalmus on the fossil fuel crisis, on his career change from gravitational-waves to climate science, and his participation in climate activism. Asking the questions is Sharan Banagiri, a member of the LIGO-Virgo-KAGRA Committee on Climate Change and postdoctoral associate at Northwestern University.

Sharan: Thanks for talking with us Peter. Let's start with the big question. We've all started feeling the impacts of anthropogenic climate change over the last decade. As a professional climate scientist, can you give us a rundown of the current state of the planet? How bad is the situation?

Peter: My overwhelming sense is that it's very, very bad. As you say, we've all started feeling the impacts. The cause is fossil fuels. Heat waves, floods, hurricanes, wildfires are all getting worse. Ecosystems are dying, ice sheets are melting. Tipping points are getting closer - some experts feel that the loss of the Amazon rainforest is now inevitable. I did some work on the future of coral reefs, and I feel that the loss of most corals around the world, including the Great Barrier Reef, is now inevitable by mid-century at the latest. Sustained mean heating of 1.5°C over pre-industrial is now inevitable, and heating appears to be accelerating and no one really understands why yet. Meanwhile, financiers and world leaders – including Democratic presidents in the United States – continue to support the fossil fuel industry in expanding production. No one really knows precisely how all this will affect the global food supply, or global geopolitical stability. I personally believe we are on a pathway to losing essentially everything. I am beyond angry and dis-

> We can still save a lot if we wanted to and worked together, but the people in power continue to take us in the wrong direction.



The daily sea surface temperature average over the extra-polar global ocean (60°S–60°N). This year is shown by the black line with data up to April 2024. The years 2016 and 2023 are shown in yellow and red, respectively. All other years between 1979 and 2022 are shown with grey lines. Data source: ERA5.

appointed at so-called leaders around the world. We can still save a lot if we wanted to and worked together, but the people in power continue to take us in the wrong direction.

Sharan: You did gravitational-wave science at Columbia and Caltech before moving into climate science in 2013. What motivated you to undertake this change?

Peter: Starting in 2006, halfway into my PhD, my first son was born and I started to think about climate change and his future. The more I learned, the more concerned I became, until I had trouble focussing on gravitational-wave science.

I remember going to LIGO-Virgo Collaboration meetings and convening groups of gravitational-wave scientists to talk about climate change during my postdoc at Caltech. There were three or four other scientists who were also concerned, and we'd have lunch and talk about climate stuff.

Sharan: You're a senior scientist at NASA-JPL now. What do you work on and what is your day-to-day like?

Peter: I am the principal investigator on three projects. One is on understanding changes in severe storms in the US midwest. One is projecting the future of severe coral reef bleaching. The third is projecting the future impact of extreme humid heat on humans around the world. Each project has its own team. We use satellite datasets, global climate models, statistical models and ecological models to address science questions concerning future impacts of extreme heat.

Sharan: What was your career path like once you transitioned into climate science?

Peter: It was tough. I had a postdoc offer after my PhD to work on cloud modeling at NASA GISS, which is a few blocks from Columbia on the Upper West Side, but I wasn't ready to take it yet. I was still extremely committed to the search for gravitational waves! It felt too scary to switch fields. However, a few years after that, during my postdoc at Caltech, I was ready. I spoke with several climate scientists at Caltech to see if anyone wanted to hire me as a postdoc. A scientist at JPL was willing to try, and I worked on an initial project for him on a provisional basis, and he decided to hire me. That was in cloud physics. It was an intense learning curve. After a few years I wrote my first proposal on coral reef bleaching projection. It didn't succeed. So I tried again in a year with another opportunity and was selected. I became increasingly interested in biodiversity impacts and extreme heat.

Sharan: What pathways currently exist for current climate-conscious gravitational-wave scientists also interested in transitioning to climate science? In the US and outside the US?

Peter: Hmm. I suppose it's similar in most countries, and my own process was probably pretty typical. You would need to start reading about climate science and learning it - it's quite different, but a lot of the physics and data science skills from gravitational-wave" work should be highly transferable – and then start knocking on lots of doors until you find someone willing to take you on. Be curious and be passionate, and lean on what you've learned as a gravitational-wave" scientist. One weird trick I used both to help me get into graduate school and to transition into climate science was offering some free work part-time on some preliminary project to demonstrate interest and capability, for two or three months, but obviously not everyone would be in a position to do this. Another option could be to go back to grad school for climate science! I think there are advantages and disadvantages to both approaches.

The Earth is a complex and interconnected system. There's still so much we don't understand. But we understand enough to know that the only real solution to global heating is to stop burning fossil fuels!

Sharan: How do you find working in climate science? Are there any major challenges you experienced early on? Or now?

Peter: Climate science is very challenging! There is so much data, and it's extremely complicated. The Earth is a complex and interconnected system. There's still so much we don't understand. But we understand enough to know that the only real solution to global heating is to stop burning fossil fuels!

Sharan: In addition to being a scientist, you are also an activist (In fact, that is how I learned about you first). Tell us a bit about your activism and how you go between those two.

Peter: Well, as I said above, there's a lot we don't understand but we understand way more than enough to know we need to ramp down fossil fuels as quickly as we possibly can. But despite how obvious this is, it's still not happening. This is because of power. Power doesn't care about knowledge, it doesn't care about science, it doesn't care about honesty. It cares about money and more power. There is a mountain of evidence showing that the fossil fuel industry has been lying and spreading disinformation in a coordinated way for decades, and bribing policymakers to continue paving the way for fossil fuel expansion and to not act to stop climate change. In other words, more scientific papers probably won't help matters much. Instead, we need to find ways to shift these power dynamics, and that's where the activism comes in. The most effective activism I've found so far is civil disobedience. I've been arrested three times for climate civil disobedience. It's basically a communications technology. If we had a large enough fraction of the population urgently wanting to stop global overheating, we'd do so quickly, because the power would shift.

Sharan: Do you have any more words of advice for those in the LIGO-Virgo-KAGRA who are interested in working on climate change?

Peter: Go for it!

Children at an early career stage

Having children presents many challenges on various fronts. For scientists, especially those in early stages of their career, these challenges are further complicated by intense working periods, lack of job stability and the necessity for mobility. Additionally, financial support systems do not always apply to students or postdocs, varying significantly by country or region. Jessica Steinlechner and Mikhail Korobko spoke to Joey Shapiro Key, who raised two children while moving across various places in the US.

Please tell us about your family situation!

I am married, with two kids and one dog. Our daughter is 17 and a senior in high school, our son is 14 and a freshman in high school. Rocco is our 2 year old mini Australian shepherd.

At which career stage did you have your children?

Our daughter was born when we were both graduate students[1] at Montana State University, at the start of my fourth year. I was pregnant with our son when I graduated and interviewed for a job at the university, starting my first job out of grad school after the baby was born.

Which was the main challenge of having children at this career stage?

Childcare arrangements were very important so we could continue with our graduate work. Our grad school friends also had a baby, so we helped each other with childcare.

Did you have any family support close by?

Two sets of grandparents were each about one day's drive away – too far for much help in everyday life, but we could visit for holidays. The kids are very good at road trips!

When did your children start daycare?

Daycare started in the first year and preschool started around age 3. The campus preschool was conveniently located near the physics building. I valued the expertise of the early childhood educators and social experiences for the kids.

Do you see jobs in academia as particularly family friendly/unfriendly?

Both – there is good flexibility in academia, but there are challenges associated with moving institutions with a family.

Do you think having children at an early career stage has put you at a disadvantage?

It took away time from research, but also established firm outside responsibilities that led to efficient use of research and work time and effort.

Would you decide again to have children at the same time in your career?

Yes, graduate school has good schedule flexibility and the kids were already in school by the time I started a faculty position.

Do you have any advice for other early-career scientists who are thinking about having children?

This is a family decision that is impacted by many factors, including work responsibilities and career goals. Seek out and ask for the resources that you need to support your family responsibilities and professional success. There will be challenges, but it is also very rewarding to be a parent.

– Jessica Steinlechner & Mikhail Korobko –

Here you can find information and ways to connect for parents within the LVK:

- *wiki.ligo.org/LSC/ParentingLVK*
- *chat.ligo.org/ligo/channels/parenting*
- *subscriptions.ligo.org/mailinglists/parenting*

[1] *'Studying a combined Masters and PhD program - this form of 'grad school' is common in the US, taking 5+ years, usually starting after a 4-year Bachelor program.*

Tackling the challenge of recognition in large collaborations

Over the course of the last century, the revolution in physics has been accompanied by a revolution in how we do physics. The model of the lone genius devising a new fundamental theory has been replaced by one of large scientific collaborations—groups of hundreds or thousands of scientists working together on experiments with costs approaching or exceeding billions of dollars. This model provides early career researchers with resources, expertise, and opportunities far beyond what is accessible to those working in a small research group or lab. However, young scientists working in large collaborations face the challenge of distinguishing themselves and getting appropriate credit for their work.

The LIGO-Virgo-KAGRA (LVK) Collaboration is not immune to this problem. For early career researchers seeking permanent jobs, whether in academia or industry, identifying ourselves as the expert on a particular topic is critical to developing our personal brand and how we market ourselves to potential employers. Simply being a member of the LVK is not enough; we need to be able to highlight our unique contributions. While Working Group telecons and biannual LVK meetings provide opportunities to advertise our work within the collaboration, these efforts are not externally visible. Collaboration papers always use alphabetical authors lists, in an effort to ensure that those who consistently make hidden contributions (like the instrument builders) are given equal credit to those performing analyses. However, this approach obscures the contributions of individual analysts and paper writing team members. Getting public-facing credit for contributions to detector upgrades and commissioning or key software used by the collaboration is even more difficult.

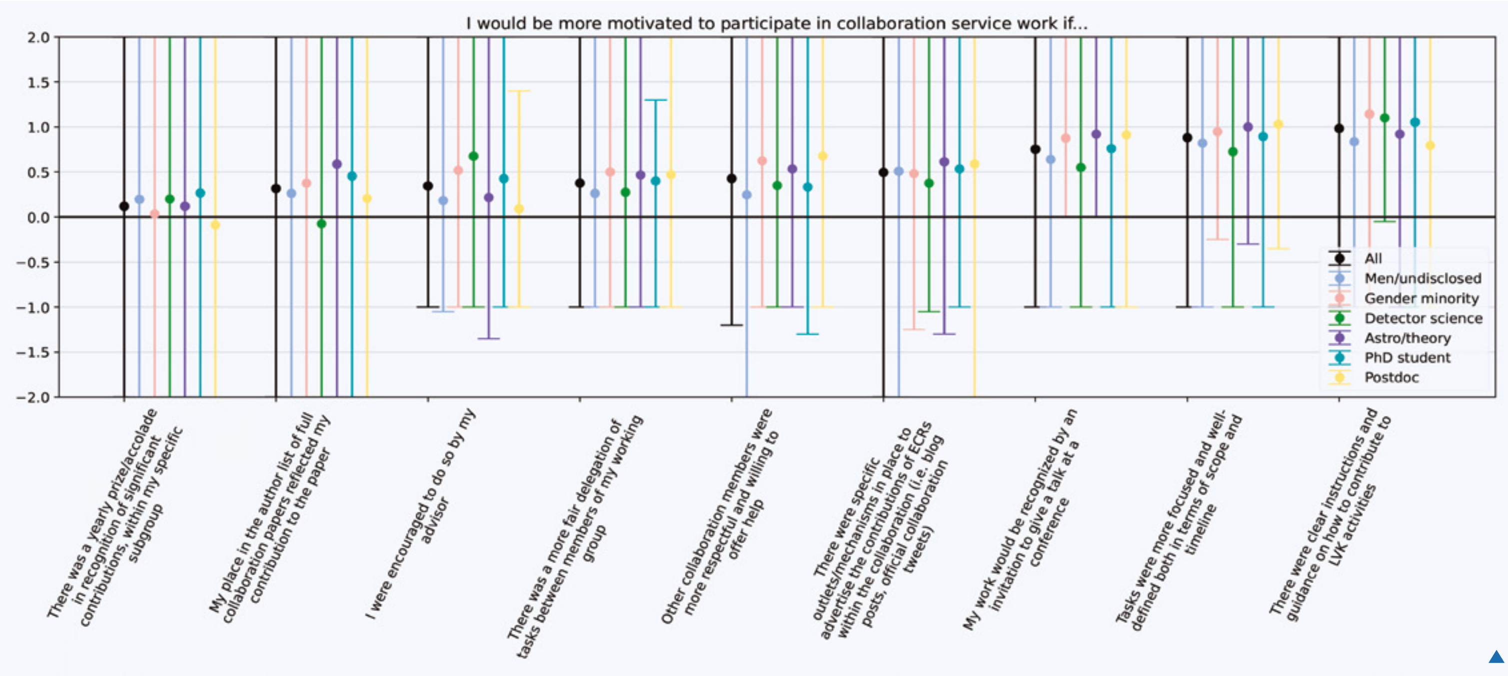
Sylvia Biscoveanu

is a postdoctoral fellow at Northwestern University - CIERA working on using gravitational-wave data to understand the properties of compact-object mergers, their electromagnetic counterparts, and the stochastic gravitational-wave background. She served as one of the LAAC student representatives from 2021-2023. She is also an avid musician (violin and viola) and cat lover.

For those of us looking for academic jobs, there is often a mismatch between the activities most valued by hiring committees and by the LVK. Commissioning the detector, keeping the data clean and calibrated, and maintaining key software like search and parameter estimation pipelines are mission-critical activities for the collaboration. However, this kind of work alone normally doesn't lead to a faculty job or prize postdoc position unless we also apply these pipelines to observational results published in high-impact papers or develop novel methods and detector improvements where we can demonstrate we took the lead.

Young scientists working in large collaborations face the challenge of distinguishing themselves and getting appropriate credit for their work. The LIGO-Virgo-KAGRA (LVK) Collaboration is not immune to this problem.

While we were personally familiar with these challenges, our attention as LAAC members was really brought to this topic after seeing the outcome of several recent surveys. These included targeted questionnaires within working groups (CBC) and broader surveys of mental health in the collaboration. In a survey of early career researchers that we performed in Fall 2022, respondents indicated that they would be more motivated to participate in collaboration service work if there were specific mechanisms in place to



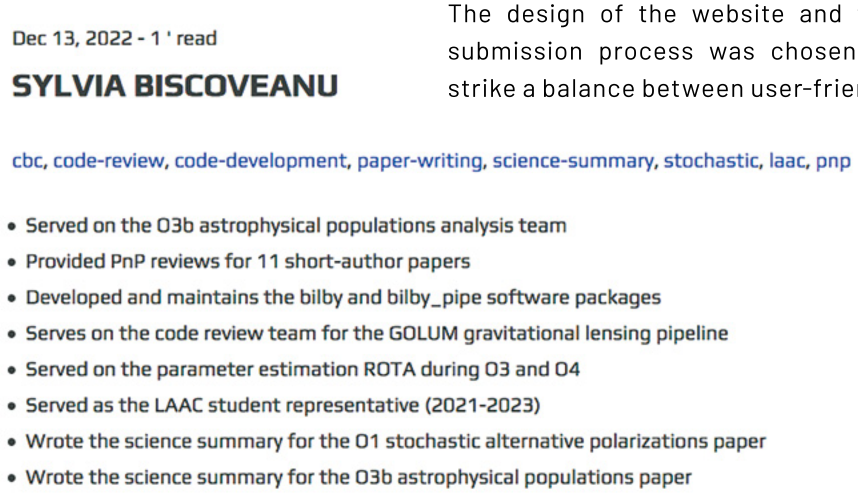
Results of a survey conducted by the LAAC in Fall 2022. 119 respondents were asked what would motivate them to participate in LVK collaboration service work. Respondents ranked the different options on a five-point scale and answered several identification questions, including gender, career stage, and research theme. The men/undisclosed category includes respondents who identified only as men or who omitted this identification question.

advertise their contributions. To our surprise, this option was more popular than establishing a yearly prize in recognition of significant contributions and changing the author lists of full-collaboration papers to reflect individual contributions.

In October 2023 we therefore introduced a new recognition initiative displaying the contributions of individual LVK members on a public website: laac.docs.ligo.org/recognition. This is an opt-in initiative; anyone wishing to add their contributions to the website can fill out a Google form (available at https://forms.gle/2UnmBJPHgEBw4EDA6 or via the QR code below), which includes a standard but personalizable set of recognized contributions such as serving on a paper writing team, participating in the LSC fellows program, contributing to code review, and developing an outreach resource.

Each submission is accompanied by documentation backing up the requested contribution, which can be as simple as a link to a git or wiki page. Submissions are reviewed and approved by LAAC members on a rolling basis, so your list of contributions can become public within a couple of days.

The design of the website and the submission process was chosen to strike a balance between user-friend-



Screenshot of Sylvia Biscoveanu's page on the new public website.
[Visit the Google form to add your contributions to the website now.](https://forms.gle/2UnmBJPHgEBw4EDA6)

liness and usefulness for job, conference, and award applications. If your CV mentions LVK working group leadership or significant contributions to a collaboration paper, you can include a link to your list of contributions on this website. Because the contributions are externally verified (and this is highlighted on the website), you are no longer dependent on those writing your letters of recommendation to corroborate your internal LVK work. However, the website is also useful for sharing with reference-letter writers so that they have a centralized list of all your collaboration service activities.

We hope that the recognition program is a step towards giving early career

In a recent survey, LVK early career researchers indicated that they would be more motivated to participate in collaboration service work if there were specific mechanisms in place to advertise their contributions.

researchers adequate credit for our LVK contributions and look forward to seeing your contributions up on the website soon! Feedback on the program is welcome and can be submitted via git issue:

https://git.ligo.org/LAAC/recognition/-/issues

Aurora, Eclipses and the LVK

It was cloudy and raining here in our area of Chicagoland, U.S, when reports of the aurora storm started rolling in. We definitely could not see anything, even through a few meager gaps in the clouds. By chance, I went out around 2am just to check before I went to bed, and it was clear and the event was still going on! I got my family up – it was the first time my daughter had ever seen the aurorae! We stayed out until 4am, then went to bed, the aurora still going strong.

The modern cameras in phones picked up AMAZING colors! From where we were watching in suburban Chicago, you could see tinges of color, but nothing as brilliant as the cameras could pull out. The aurorae were definitely there, but ghostly and changing, which made it different to the usual light pollution glow. By desaturating the colors in photoshop, I also made pictures that look more like it really looked to the naked eye.

There's been a bit of grousing on the internet about how the aurora photos from phones are really giving people a false sense of the experience. But that just isn't true! People were SO EXCITED they could see the aurorae, and even MORE EXCITED they could see them on their phones and capture the experience and REMEMBER it. That is the important thing we should focus on – the fact that we live in a future where the technology is so good, it helps people experience and appreciate the grandeur of the world around them. We need more of that, so let's let people bask in this awesome spectacle Nature provided.

– Shane Larson –

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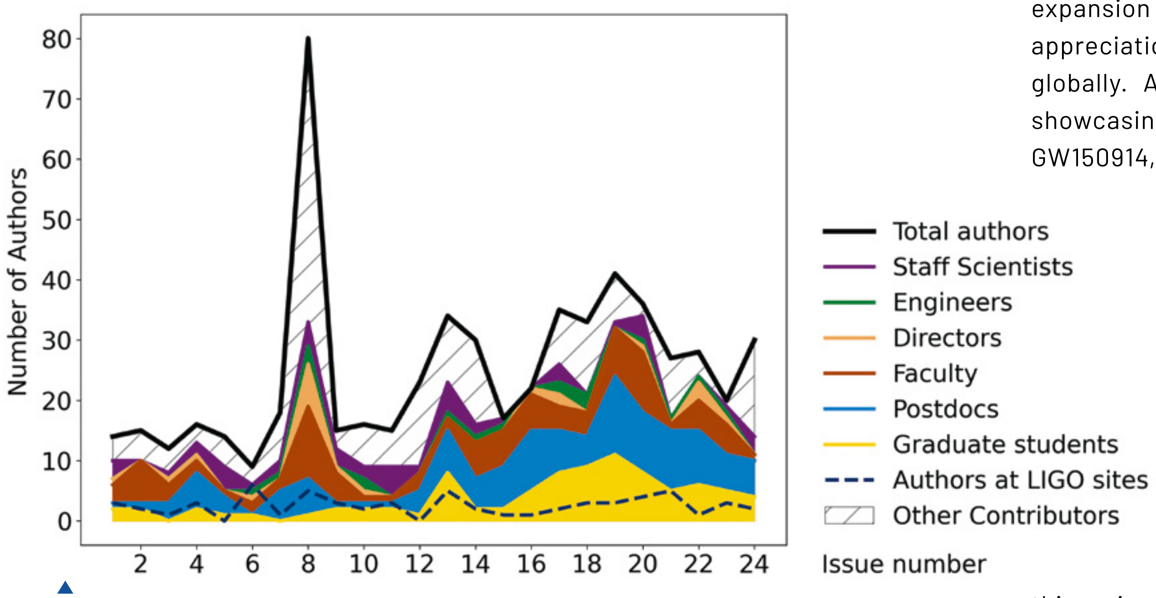
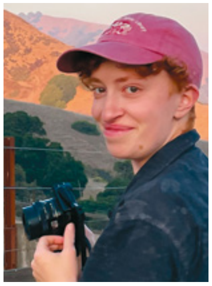
Behind the Authors of the LIGO Magazine



The number of authors contributing to each issue of the LIGO Magazine, as well as various career stage contributions from authors at time of publishing. 'Other contributors' includes those who wrote for the LIGO Magazine but did not provide their career stage, as well as other categories including, for example, outreach and education specialists, artists, and filmmakers.

With this 25th issue we celebrate the start of the 13th year of the LIGO Magazine, the first issue having been published in September 2012. More than 470 authors have contributed to this initiative over the years, from frequent contributors to one-off authors, those working in the gravitational-wave (GW) community and beyond, all passing through the Magazine offering their stories and experiences. Not forgetting the 49 Magazine editors, and three editors-in-chief of the Magazine who work to piece together these works which document the history of this science and the people who contribute to it.

Storm Colloms



is a PhD student at the University of Glasgow researching the origins and evolution of binary black holes. Outwith astrophysics they spend their time taking digital and film photos, and making fun doodles of their research.

Who puts together the LIGO Magazine?

The LIGO Magazine's authors (up to issue 24) have represented 237 workplaces in 23 countries, from undergraduate students to faculty, scientific directors, emeritus professors, engineers, data scientists, artists, and filmmakers. The number of authors and the geographic diversity of the contributors has grown with the expansion of the field as the work and appreciation of GW science has spread globally. An extended issue in 2016 showcasing the first GW detection, GW150914, had contributions from more than 80 authors.

What has the Magazine achieved?

The LIGO Magazine presents news on GW science, personal stories, opinion pieces, and advice, and the archive of issues available online create a record documenting how this science has evolved and those who have moved through the field. By inviting a wide array of authors and having a diversity of voices and stories, together we showcase the reality, struggles, and highlights of the scientific experience! The Magazine is read by collaboration members and interested public including teachers, government officials, and current and prospective students.

What's the future of the Magazine?

Highlighting the members of scientific collaborations helps change people's perceptions of who can be a scientist and what real science looks like. We hope that the LIGO Magazine can make GW science inclusive, and inspire interest in those who have been made to feel like science is not for them. Thanks to all the contributors who have made this possible over the years. We are looking forward to many more editions to come!

Remembering Pete Bender

Dr. Peter L. Bender passed away April 20th at age 93. He was a founder of JILA at the University of Colorado Boulder – now an internationally renowned research institute – and had been a researcher there since 1962. Initially he was a NIST staff scientist and later an adjunct professor in the Department of Physics.

Pete was a central figure in gravitational-wave research, in addition to making seminal contributions to atomic physics, time and frequency standards, terrestrial magnetism, geodesy, gravimetry, fundamental constants, fundamental laws, lunar science, and solid earth science.

For ground-based gravitational-wave detection, Pete led the JILA LSC group that demonstrated active seismic isolation concepts for LIGO between 1986 until 2001. With an eye toward advanced detectors, Pete set the early goal of 6 orders of magnitude isolation at 1 Hz. Pete, Jim Faller, and Tuck Stebbins constituted the sustaining members of the group throughout its existence. Visiting Fellows, Peter Saulson and Norna Robertson each spent over a year at JILA. Postdocs Pete Nelson, Joe Giaime, and Giles Hammond participated in the construction and operation of a demonstration apparatus and prototype development, respectively. Doctoral students, Dave Newell and Sam Richman earned their theses on the construction and performance of a proof-of-principle demonstration. Pete's group delivered the demonstration system to MIT in 2001.

Seismic isolation platforms based on the JILA design now support almost all LIGO vacuum payloads and will likely serve (with improvements) in all future upgrades. Pete's leadership of the Colorado group set the foundation for LIGO's low-frequency response today.

For space-based detectors, Pete is widely regarded as the "father" of LISA, laying the conceptual foundations for both the instrumentation and the science. Stimulated by the work of a NASA committee (and a dinner with Rainer Weiss, a fellow committee member) in 1974, Pete began to assemble a concept for a space-based gravitational-wave detector. With Jim Faller, Jan Hall, and others at JILA, he worked out a concept for an interferometer between spacecraft separated by millions of kilometers. He incorporated the technology of "drag-free" spacecraft to realize free-falling test masses. Working with postdoc Mark Vincent, Pete discovered unique orbits that enabled a very stable constellation of satellites without active station-keeping.

Pete also spearheaded the development of the LISA science case, identifying source types, estimating their numbers and signal strengths, and outlining the science that could be done by their detection. Pete and Dieter Hils identified massive black hole mergers and extreme-mass-ratio inspirals as important source classes. With Ron Webbink, Pete and Dieter also evaluated the signal contributions and confusion threshold from galactic systems of compact binary objects.

Peter Bender at work in his office. "Retirement at JILA, 80 yr old JILA Fellow, Peter Bender. Physics ... not just a job" – Cindy Torres

Pete tirelessly refined and promoted the LISA concept for 5 decades, participating in all aspects of the mission: concept development, analysis, engineering, and science. He also vigorously investigated alternate and follow-on concepts. The European Space Agency recently approved the LISA Project for implementation, with NASA as a junior partner. The estimated launch date is 2035.

The many collaborators and colleagues who worked with, or just met, Dr. Bender will remember him for his approachability, his enthusiasm, and his selflessness. And, as his colleague of 7 decades, Rainer Weiss, said: "He got his facts right."

– David Shoemaker, Joe Giaime, Tuck Stebbins –

Artem is happy to be in the LHO control room

My days as a LIGO Visitor

Artem Basalaev

is a postdoc at University of Hamburg, mainly working on reduction of control and seismic noise. In his free time, he enjoys open-water swimming when there's a chance, or in a pool when not.

After a lunch break outside under bright southern California sun – which is especially nice and mild in December – I'm taking a short stroll around Caltech campus. It is quite beautiful, with fragrant fruit trees and views of San Gabriel Mountains here and there between the buildings. Soon I'm going to come back to a bunker-like heavy concrete building with tiny windows, where the LIGO Engineering Group has offices (why do physicists always get buildings like this?) It will be pitch black outside when I come out again. Winter days are short.

This was my first time in California, and in the USA for that matter. I've been a LIGO member at University of Hamburg in Germany since 2021 (as I started my postdoc there), but until recently, I did not have a chance to actually see the LIGO Lab and LIGO detectors. In 2023, I considered applying for the LIGO Visitor program, which is a somewhat lesser-known alternative to the LIGO Fellowship program. While the LIGO Fellowship program is geared towards longer stays, the LIGO Visitor Program[1] can support shorter visits.

The LIGO Visitor program is "mainly focused on applicants at the graduate level or above" (per its description) and requires first establishing a contact ("sponsor") in the LIGO group where you are planning to go. It is probably better to have established such a connection before applying, but they can also help you find someone.

In Hamburg, our involvement in LIGO activities is mostly geared towards technology development for future detectors. A prominent example is interferometric displacement sensors. These sensors will help to substantially improve seismic isolation and control of relative positions of various detector elements, increasing sensitivity and duty cycle. But this technology still has to mature.

While it is fascinating to, in a way, help define the future by working on new technologies, I was always curious to get a glimpse of what is happening at LIGO today. Besides, I was still trying to find my niche in this new (to me) field, having done my PhD on Higgs boson analysis for the ATLAS experiment at CERN. I decided to focus on things related to the very things our sensors will come to address – reduction of control and seismic noise.

Once, as I was browsing through noise detection and subtraction techniques, I stumbled upon a paper with an intriguing title: "Machine-learning nonstationary noise out of gravitational-wave detectors" by G. Vajente et al. I immediately became fascinated by the idea that perhaps machine learning can be a magic black box that

[1] https://www.ligo.caltech.edu/page/visitor-program

cleans the data all by itself: by learning dependencies between noise recorded with thousands of witness sensors and the recording of differential arms measurement (DARM), where signal is detected. Only later did I come to appreciate the scale of the problem here: the parameter space is just too vast. It takes someone like Dr. Gabriele Vajente who understands "where to look" to make even modest progress in that direction. I certainly had no idea where to look, even channel names consisting of acronyms said nothing to me. That is why I contacted Gabriele.

> There were frequent Zoom meetings with detector teams, and naturally, discussions followed into the corridors. Sometimes, interventions would be done right from here, since the meeting room has terminals with direct access to the control rooms.

In the following months, I learned some things but quickly realized that email-based interaction with 8 hours of time difference is not very efficient. This is when I applied to the LIGO Visitor program to stay at Caltech for 1.5 months. After a short wait, I was surprised and thrilled to learn that my application was successful. And so, I was going to Los Angeles! It turned out to be very different from European cities, and at the same time somehow familiar – of course, we have all seen Hollywood movies. Being at world-famous Caltech added to the feeling that I'm, myself, in some kind of a movie.

And so, I would go to the office every day and try to dig into ideas that Gabriele bombarded me with from the beginning. I had to do quite a bit of learning to catch up. The "InsideLIGO" wiki page with acronyms was quite handy[2]. But here I was also surrounded by experts: basically, if I felt that I needed any help, I could get it quickly.

It was a very motivated, focused group of people. Here I was much more immersed in actual day-to-day activity of LIGO, even though we were quite far from actual detectors. There were frequent Zoom meetings with detector teams, and naturally, discussions followed into the corridors. Sometimes, interventions would be done right from here, since the meeting room has terminals with direct access to the control rooms. Even the small details like a tally of detected events on the wall were reminding me of great work being done by LIGO teams right now.

I spent most of my time researching another way to address detector noise. There has been some preliminary evidence that a slightly worse low-frequency sensitivity of the LIGO Hanford Observatory (LHO) compared to that of the Livingston Observatory (LLO) might be in part due to difference in the actuation on the mirror, performed with electrostatic drive (ESD). To simplify, it seemed that LHO actuates more on the mirror with ESD, which results in more of its noise coupling into DARM. Following up on previous work, I made a simple projection of ESD noise. While my studies did not reach a definitive conclusion, and likely overestimated the amount of noise, there were more hints that supported the idea of higher ESD noise at LHO. I left Caltech in December, and less than a week later, Gabriele shared breaking news: people at LHO tried a new control scheme with the goal to somewhat reduce actuation with ESD and it was a success: low-frequency noise went down!

I would go on to get accepted for a Visitor Program for another two-week visit to LHO to work with Dr. Sheila Dwyer there, digging deeper into the workings of ESD. These were very busy two weeks and I learned a tremendous amount more about LIGO. I'd like to thank program organizers for making it possible; Dr. Gabriele Vajente and Dr. Sheila Dwyer for supporting my visits and a very fruitful scientific collaboration. Also, I'd like to thank Nately Sych at Caltech and Eadie Balint at LHO, who helped me navigate all the formalities related to the visits and welcomed me on site.

The NSF LIGO Visitors Program has been hosting scientists and engineers since 1996. This program is mainly focused on applicants at the graduate level or above who wish to visit the NSF LIGO Laboratories to become involved in the science and techniques associated with the field of interferometric gravitational-wave detection, while at the same time contributing their accumulated skills and abilities to enhance the performance of the LIGO team.

www.ligo.caltech.edu/page/visitor-program

Applications from women and under-represented minorities are particularly welcome.

[2] *https://wiki.ligo.org/Main/InsideLIGO (for LVK members)*

The Gingin arm collapse of 2021

John Moore

is the Operations Manager for the Gingin Gravity Precinct and has had a long association with the quest for Gravitational Wave Detection with the UWA's Physics Department over four decades. When time permits, John likes nothing more than heading out into Australia's beautiful and rugged wilderness to immerse himself in nature at its finest!

▲

Installation of 8.0 meter 304 stainless steel vacuum tube with CF flanges onto modified adjustable stands with SUSTAMID6G Cast Nylon supports.

In the previous episode... "Over the weekend the South arm tube collapsed. A loud noise was heard by a Gravity Discovery Centre employee between 1:00 and 1:30pm Saturday the 11th 2021 who was working on the bush walk. There is no clear indication of a single cause of collapse...."

Issue 22, March 2023

One year later.

After recovering from the initial shock of losing one of the High Optical Power Facilities (HOPF) 400mm diameter vacuum arms, work commenced on several fronts. Decisions would need to be made as to how to continue using the remainder of the unaffected 7-meter section of experimental space so scientific work could continue; how best to remove the damaged section of vacuum tube without compromising the clean-room status of both the main laboratory and the adjoining South End Station; what design parameters were required for the new 8-meter sections of vacuum tube, specifically around vacuum tube wall thickness and flange seal design; who was going to perform this work; and most importantly who was going to pay for it!

Work commenced on removing the damaged section of vacuum tube in

October 2021, which required slicing up the HOPF's once magnificent cylindrical vacuum tube into 2.4-meter sections. (I almost cried as this process got underway as I had been intimately involved in its initial construction – but onward and upward!) Once both flanged end sections were removed from each building, a temporary sealing plate was installed to maintain clean room integrity.

During this process, I was wrangling with several layers of bureaucracy as to who was going to pay for the repair, but eventually managed to present it as an insurable claim.

Having got the finances sorted, I was able to focus entirely on the replacement vacuum tube and flange seal design. Eventually, after consultation with the HOPF researchers, we settled on a thicker vacuum tube wall thickness of 5 mm and the use of CF (ConFlat) seals on the joining flanges to future-proof the system for a higher-vacuum status.

The next stage was to identify a local vacuum supplier who could arrange for the manufacture of this non-standard and difficult-to-acquire vacuum equipment. Having had many years dealing with AVT Services, work began on designing and quoting for the various vacuum components, which were manufactured to a high standard by HTC in China.

In parallel to this, I had arranged for two 400mm diameter x 500mm long single unrestrained bellows that provide a flexible interface between the vacuum tube and the experimental vacuum chamber's located at each end of the vacuum tube to be manufactured by Radcoflex Australia. These were designed with rotatable O-ring flanges welded onto one end for final vacuum tube alignment with the experimental vacuum chambers and CF flanges on the other end.

After recovering from the initial shock of losing one of the High Optical Power Facilities (HOPF) 400mm diameter vacuum arms, work commenced on several fronts. Decisions needed to be made as to how to continue using the remainder of the unaffected 7-meter section of experimental space so scientific work could continue.

AVT began the installation on Monday 8th July 2024, initially inserting the first 8-meter section through the wall of the main laboratory so the penetration could be sealed up to maintain clean-room integrity. At this stage, this section was not connected to the bellows. Work commenced on Tuesday 9th July to evacuate and then helium-leak-detect the bellows, which was taken to 7x10^{-3} mbar, achieving a leak detection reading of 8x10^{-9} mbar·Litre/second. Upon applying helium gas to the bellows' joints and welds, the leak detection reading of 8x10^{-9} mbar·L/s remained constant. This is an acceptable level for our vacuum system. The first 8-meter section was then installed onto the bellows and the leak detection procedure repeated by placing a blanking flange at the end of each section as they were installed.

With installation of the new HOPF southern vacuum tube completed at the end of July, work will now commence on pumping the whole vacuum system down to its ultimate vacuum over a period of several weeks before final helium detection is performed. It's been a long road to get to this point, but as we all know you can't compromise on perfection or vacuum for that matter!

"Will our team of vacuum specialists manage to install the tube with no delays and no hitches? What will the result look like?

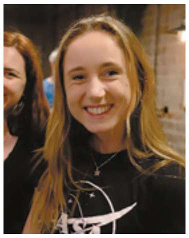
This and more in Episode III of the Gingin arm collapse saga, stay tuned!"

Read Episode I of the Gingin arm collapse saga in LIGO Magazine Issue 22.

The group before departure from Puerto Madryn on the ship MS Island Sky.

A trip to the end of the world

Isobel Romero-Shaw



is a Herchel Smith Research Fellow at the University of Cambridge. She enjoys rock climbing, drawing, and looking after her new baby giant African land snail Boudica.

Debatri Chattopadhyay

is a postdoctoral researcher at Cardiff University (soon joining CIERA, Northwestern University). She enjoys Indian classical dance, reading and travelling in her spare time.

At the start of December 2023, we returned from a challenging three-week voyage to the end of the world: Antarctica. Our lungs were full of cold, fresh air that had seemed to radiate out of the miles of glaciers we'd seen, and our minds were full of icebergs, penguins, whales, and motivation to drive changes for a sustainable future. But how did we get here?

In 2019, we were both selected from a pool of over 400 applicants to join 98 other scientists in the eighth cohort of a prestigious sustainable global leadership initiative for women and non-binary people in STEM, Homeward Bound. After several years of delays due to COVID-19, and a rigorous online leadership development program tailored to each cohort member as individuals, we had finally completed our voyage. We were initially inspired to apply for the program by LIGO member Professor Susan Scott, who had taken part in Homeward Bound in 2017. Another LIGO and OzGrav member and Homeward Bound alumnus, Dr Lilli Sun, further encouraged us. We were excited about the opportunity to develop leadership skills that put a focus on sustainability — both for organisational structures, and for the planet. And of course, we were entranced by the idea of visiting Antarctica.

The impact of climate change is confronting in and around Antarctica. As well as storms and unusual wind patterns, the temperature was higher than it should have been, leading to high quantities of icebergs that had broken off of long-lived glaciers drifting into the ship's planned route. Although seeing so many unique and beautiful icebergs was breathtaking, there was a sense of bittersweetness, and a genuine sense of the concern felt by the ship's captain and expedition crew: none of them had seen weather patterns like the ones we were experiencing, and many of them had been working in the polar regions for decades. Our captain described the process of navigating a safe passage through the densely-packed icebergs as analogous to "playing chess with the ice".

Although the sound of the ice bumping into the hull was unnerving, we were not too worried for our safety: our ship, the MS Island Sky, is ice-strengthened and specifically designed for polar regions. The most frightening sailing occurred as we headed from the Falkland Islands to Antarctica via the Drake Passage, combatting 8-metre high waves — even the crew were feeling quite sick! Not one waiter, though, who helpfully played the music from the Titanic film on the piano as we pitched and rolled in the waves. For us, Antarctica was characterised by an intense duality of overwhelming awe—which inspired lightheartedness—contrasted with sudden fear for its future, and the sad likelihood that human-driven climate change will irreversibly alter this fragile and beautiful place.

Our days were generally structured around expeditions. Unpredictable weather meant that on some days we had two excursions, and on some we had none. Whenever we were restricted to the ship, we would have workshops: some, which targeted our leadership development and strategic thinking, led by the Homeward Bound leadership team; others, led by us participants. As a group, we decided to split into smaller teams to initiate several projects centred around sustainability, green investment, and visibility of women and non-binary people in STEMM that have endured beyond our three-week voyage. Some of these projects are still in the works, while others have already been brought to completion: one of the smaller groups has already had a paper published about sustainability questions and uses for AI[1]. Each day finished with a recap by the crew and expedition team, who would talk about notable Antarctic novelties we'd seen that day. One talk by an excursion team member gave us a fascinating insight into whale poo and its vitality to the ocean ecosystem after several of us spotted a large cloud of the substance floating next to the ship!

> *The impact of climate change is confronting in and around Antarctica. As well as storms and unusual wind patterns, the temperature was higher than it should have been, leading to high quantities of icebergs that had broken off of long-lived glaciers drifting into the ship's planned route.*

Our main cause for concern on each excursion was keeping the wildlife of Antarctica safe from us. Before we left the ship, we disinfected all of the clothing we would wear outside. On every outing, we walked through disinfectant and bristle brushes to make sure our boots didn't track any alien germs into this precious and precarious wilderness. We could not take anything with us that might fall out of a pocket, so we hoovered out any crumbs and reattached loose buttons. Additionally, we were given strict instructions to remain 5 metres away or more from any wildlife that we encountered, and to always give them the right of way. This was particularly important for penguins, whose regular and routine

One of the beautiful icebergs we saw from the ship. This one was several times larger than the ship itself.

[1] *www.atlanticcouncil.org/blogs/geotech-cues/the-sustainability-questions-policymakers-should-be-asking-about-ai/*

paths through the snow were clear pink indentations in the white landscapes.

Staying 5 metres from the wildlife was not always easy — on Goudier island, the penguins have made their nests underneath the aptly-named penguin post office! — and although the expedition leads marked out safe paths for us at each landing, curious one-month-old baby elephant seals knocked over the markers and snuggled up to them and inquisitively followed us around. But we never touched the wildlife, and at all times we stayed well-removed from the adult male elephant seals — huge beasts that can be as large and as heavy as a car — who would not even notice us in their paths if they decided to charge at another male.

Each expedition was an opportunity to become completely immersed in the frozen environment, but none more so than Deception Island. This island is a collapsed-but-still-active volcano: it looks like an unbroken land mass from the outside, but as the ship travels through a small break in the caldera wall, the central lake expands to fill the view. From this lake, a near-complete ring of snow and ice, with soft black and grey sand showing through in places, surrounds you.

Staying 5 metres from the wildlife was not always easy – on Goudier island, the penguins have made their nests underneath the aptly-named penguin post office.

The ship was moored at Telefon Bay on the edge of the Deception Island lake, and small semi-inflatable boats called "zodiacs" took all of us to the shore. After a hike up to the top of a snow-covered ridge and back again — passing a few lounging seals on the way — it was time to embrace the cold: by running into the Antarctic water to complete a Polar Plunge. The water at Telefon Bay was heated to a balmy -0.6 degrees Celsius by the latent volcanic activity!

Every person on this trip was from a different corner of the globe and had an incredible background — we were sharing our ship with an Australian marine biologist, a New Zealand medical doctor, a Puerto Rican innovation engineer, a British polar oceanologist, a Mexican glaciologist, a Zimbabwean zoologist, an American analogue astronaut… and so many more amazing people! Getting to live and work closely with these inspiring people for three weeks was one of the most important parts of the journey, and having been thrown into an extremely isolated environment together, the connections we made will be long-lasting (especially with our bunk-mates, with whom we experienced the surprisingly rough waves of the first night, and subsequent seasickness).

After our second — thankfully calmer — sail through the Drake Passage on the way back from Antarctica to Ushuaia at the southernmost tip of Argentina, we stayed for a few days in the local area to hike in the mountains and forests. As we began to sail up the Beagle Channel, the scent of seasalt began to fill the air, and we realised how strange it was that the Antarctic Ocean had not had this smell. Seeing trees lining our watery path, after three weeks of our only greenery being Antarctic moss, was a surprisingly emotional experience; we felt a little like astronauts returning to Earth after a stint on the Moon. With fresh eyes, each representation of nature in the world looked more precious and vital. Since coming back, we have both made significant changes in our lives such that they align better with our values—becoming more independent and more eco-friendly in as many areas as possible, choosing recycled or sustainably-sourced products whenever possible, and voting for politicians who promise to commit to net-zero targets and global ocean treaties. These may seem like small changes, but having watched penguins huddling together against the cold, we take their lesson: although one individual might be overwhelmed by the adversity facing them, as a group, we can work together towards the right solution.

Data science ... all part and parcel!

***Alexei Ciobanu** is a data scientist at AusPost. He completed his PhD in 2021 at the University of Adelaide, with a thesis covering topics on optical modeling & mode matching for LIGO.*

At the end of my PhD, I decided to accept a full-time data science position at Australia's national postal service, AusPost. I imagine this came as a surprise to most people who knew me because up until that point I was primarily a laser physicist. I did some numerical modeling for sure, but also my fair share of lab work, like aligning mirrors and hacking electronics together. I didn't hate the work that I did, in fact quite the opposite, so the question remains as to why I decided to make the transition to industry data science.

The postal service was the first industry position to respond to me, out of all the ones I had looked at up to that point. Of course, I had put some thought into the industry positions I was considering. The postal service was appealing to me because it was large, essential, and not morally reprehensible in my opinion. People need to receive their packages, and it seemed like it would be fun to see if I could improve the service.

As for why I didn't look for a postdoc position, it just seemed like it was not the right fit for me. The last few years of my PhD were difficult for me and I wasn't sure if this was something that would continue into a future postdoc career. During that time, I had been struggling with depression and my main coping strategy was to endure through it. I would recommend against this strategy if you are going through something similar. I find it difficult now for me to put myself back in that headspace and to do any kind of introspection. I am not sure what exactly was the cause of it in the end. I felt like the way out was to make as many changes as possible in my life, and luckily it seems to have worked.

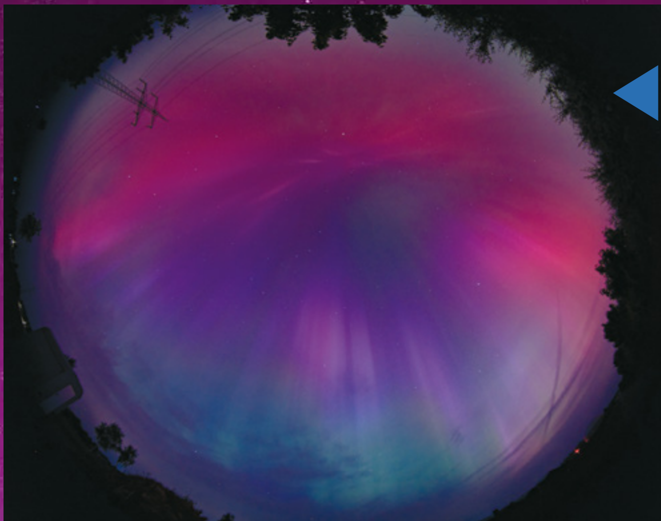
The work I do at the moment at AusPost is primarily constructing models of various parts of the logistics network. Performing experiments and A/B tests on the network in the real world takes a lot of time and effort. If some of that can be offloaded to a model, then that should help direct the resources to more useful experiments and network upgrades. It is not dissimilar to how the instrument scientists at LIGO perform detector upgrades informed by models of the interferometer, though unfortunately, there doesn't appear to be an equivalent to Finesse for modeling logistics networks.

I thought that I might be able to continue my physics research as a hobby when I started working at AusPost. I believe that this thought was based on the assumption that the work at AusPost would not be intellectually demanding enough, and that I would be able to use the remaining mental energy for my hobby research. This has not been the case. Maintaining a healthy work-life balance and trying to avoid overworking myself has left me with little time for my side passion. While a bit disappointing, I still actively respond to questions about my research and occasionally do the odd peer-review.

At heart, I am still a researcher, a tinkerer, and a hacker. My experience at AusPost has shown me that I will always do the same kind of thing no matter where I am. It is the only thing I know how to do. Whether or not I will ever return to professional physics, it has been a fun and meaningful journey that I will cherish for the rest of my life.

– Alexei Ciobanu –

Meanwhile in Space ... Aurora, Eclipses and the LVK

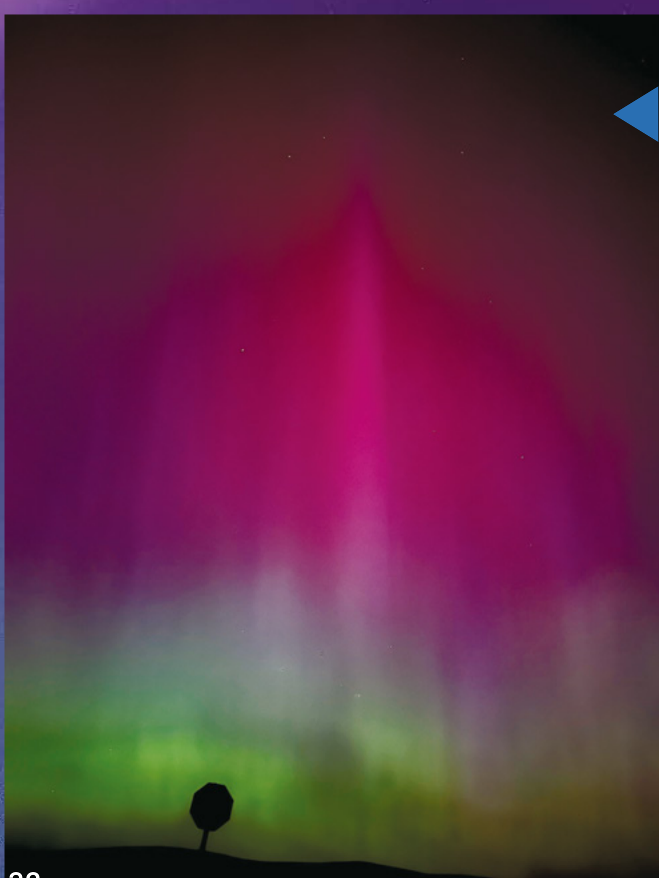


The aurora on May 10, showing the full sky. Taken from Wedemark, north of Hanover, Germany.
- Benjamin Knispel -

I'm an operator at LIGO Hanford and I was on shift the night of the aurora so I went up to the roof and watched it for a while. It was absolutely the coolest thing I've ever seen!
- Oli Patane -

The aurora as seen from Missouri, U.S. on May 10, at about 11 p.m. CDT (Central Daylight Time). Still pretty amazing and unusual at this low latitude (38° North).
- Marco Cavaglia -

A view of the solar eclipse through a telescope, with solar activity around the edge of the sun. We didn't get rained out in Washington, D.C. this time!
- Jasmin Mundi -



We were lucky to witness the aurora borealis from Washington State (U.S.). We drove to Prosser city (a 30 minute drive from LIGO Hanford Observatory) to find a dark sky and the view was spectacular.
- Rahul Kumar -

The aurora viewed from Chicagoland showing the amazing colors that modern phone cameras could pick up alongside a desaturated version showing the ghostly aurora closer to how it looked to the naked eye.
- Shane Larson -

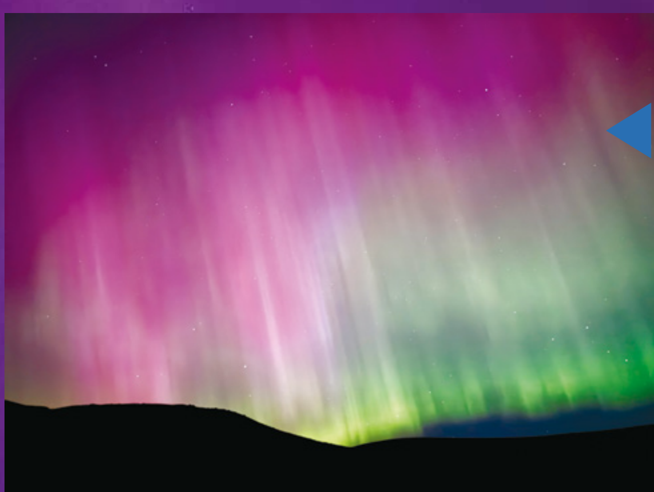
I drove 5 hours to look for good weather and finally settled down in Clarksville. Luckily, the sun appeared shortly after the first diamond ring - my 8th successful total solar eclipse.
- Albert Kong -

Watching the aurora from Washington State.
- Rahul Kumar -

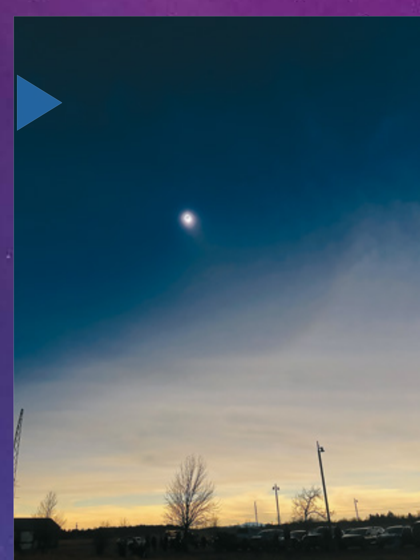
I traveled to Buffalo, U.S., to try to watch the eclipse with my 95-year old mother, who was the person who introduced me to Astronomy as a young Brownie Scout. Alas, since it was Buffalo, the cloud cover prevented us from seeing the solar disk, but it did get really dark for 4 minutes.
- Lynn Cominsky -

On 12 August 2024 near Canberra, Australia. The Aurora was visible to the naked eye at its peak, which is a rare occurrence at latitude 35° South.
- Sareh Rajabi -

Visiting an old friend in Toronto, I had the pleasure of introducing her to her first total eclipse. I projected the partial phase through handheld binoculars onto my hand so others in the area could see the crescent sun without needing eclipse glasses.
- Margaret Johnston -



Aurora photo at Hanford Reach as the solar wind intensified. Photo captured on phone, with 30 seconds exposure placed on the ground with some self made props.
- Kar Meng Kwan -



The final moments of the eclipse from the Missisquoi National Wildlife Refuge, Vermont, U.S.
- Derek Davis -

The Simple Joys of Stargazing

This year has been an exciting time for watching astronomical phenomena with a total solar eclipse in April 2024 and some stunning aurora. Several members of the LVK community experienced the eclipse or aurora and captured some amazing images!

Career Updates

Chiara Di Fronzo has recently joined the University of Western Australia as a research associate and Ozgrav member, working on suspensions and optical cavities at the Gingin facility for GW test bench experiments

Andre Guimaraes received his Ph.D. in August 2023. Currently, he is working as a senior data scientist in Michelin.

Shania Nichols successfully defended her Ph.D. thesis in July 2024.

Lalit Pathak defended his Ph.D. thesis on June 18, 2024, at IIT Gandhinagar, India. His work mainly focused on developing rapid parameter estimation methods for compact binary sources generating Gravitational waves detectable by Ground-based Gravitational waves detectors. He has joined Prof. Suvodip Mukherjee's group at the Department of Astronomy and Astrophysics, Tata Institute of Fundamental Research, Mumbai, India as a postdoctoral fellow and currently working on Rates & Population and Cosmological aspects of Gravitational waves.

Artem Basalaev will be moving to Albert Einstein Institute, Hannover in October 2024. Currently he is a postdoc at University of Hamburg. At AEI, he will work on the 10 m prototype.

Margaret Johnston from the University of Nevada, Las Vegas defended their PhD thesis "An analysis of the propagation of gravitational radiation under a graviton of nonzero mass and its implications for cosmological measurements". Margaret is looking forward to getting out of their office and back to sailing competitively.

Liu Tao from the University of Florida has defended his Ph.D. thesis, and now he is a postdoc at University of California at Riverside.

Lynn Cominsky from Sonoma State University was named a fellow of Sigma Xi, the scientific honor society. She has been serving as a Distinguished Lecturer for Sigma Xi since 2023.

Alvin Ka Yue Li defended his Ph.D. thesis at Caltech and joined the University of Tokyo LIGO group in July 2024.

Jane Glanzer defended her Ph.D. thesis at LSU and joined the Caltech LIGO Lab group in July 2024.

Sophie Bini defended her Ph.D. thesis at Pisa and will join the Caltech LIGO Lab group in September 2024.

Virginia d'Emilio has left the Caltech LIGO Lab group and moved on to a data science position in Milan, Italy in July 2024.

Koustav Chandra successfully defended his thesis from IIT Bombay in September 2023 and joined as a postdoctoral fellow at Pennsylvania State University.

Aditya Vijaykumar has defended his Ph.D. thesis from ICTS Bangalore and joined CITA as a postdoctoral fellow.

Srashti Goyal has defended her Ph.D. thesis from ICTS Bangalore and joined the Albert Einstein Institute (Potsdam) as a postdoctoral fellow.

Divyajyoti successfully defended her Ph.D. thesis from IIT Madras in July 2024 and will be joining as a postdoctoral fellow at Cardiff University.

Sylvia Biscoveanu will join the physics department at Princeton University as an assistant professor in the Fall of 2025.

Awards

Cort Posnansky from Penn State University has won the OSG David Swanson Award for "achieving significant Distributed High-Throughput Computing-enabled research outcomes. https://osg-htc.org/community/school/david-swanson.html

David Reitze was awarded an Honorary Doctorate of Science degree from Northwestern University in June 2024.

Mohammed Khalil, a former PhD student at the Max Planck Institute for Gravitational Physics (Albert Einstein Institute) in the Potsdam Science Park, has been awarded the Otto Hahn Medal for his outstanding doctoral thesis. https://www.aei.mpg.de/1163445/otto-hahn-medal-for-mohammed-khalil.

Divyajyoti was awarded the Institute Research Award in January 2024 from Indian Institute of Technology Madras, India for "recognition of her excellent Ph.D. work".

Ajith Parameswaran (International Centre for Theoretical Sciences) has been elected a Fellow of the Indian Academy of Sciences.

Ajith Parameswaran (International Centre for Theoretical Sciences) has been awarded the Laxminarayana & Nagalaxmi Modali Award of the Astronomical Society of India.

Ajith Parameswaran (International Centre for Theoretical Sciences) elected to the associate fellowship of the Indian National Science Academy, for his contributions to the gravitational lensing of gravitational waves .

Archana Pai, IIT Bombay has been selected for the Prof. Peraiah Foundation Lecture for 2023. The award is given every two years as a token of appreciation for the scientist's contribution to the field of Theoretical Astrophysics.

New LSC positions

Mairi Sakellariadou has been elected as Stochastic co-chair.

Laura Cadonati has been elected as LSC Management Team Member.

Other News

The **Equity, Diversity, and Inclusion committee of the LSC** undertook a demographic survey of the LSC in June-July 2024. Roughly 40% of the LSC responded, and analysis launched to be able to present initial conclusions at the 2024 Barcelona LVK meeting.

The newly appointed international LISA Science Team includes LVK members: **Anna Heffernan, Nikolaos Karnesis, Astrid Lamberts, Alberto Vecchio, Neil Cornish, Joey Shapiro Key, Deirdre Shoemaker, Gijs Nelemans.**

Other News cont.

Corey Gray had a Blackfoot headdress transferred to him in a ceremony that took place in June 2024. The Blackfoot headdress is the highest honor one can receive in Blackfoot culture. He received this honor for his work in LIGO since 1998, his science communication work, and for recruiting his mother (Sharon Yellowfly) to translate LVK documents into the Blackfoot language. The headdress was made by Charlene Plume Prairie Chicken of the Kainai-Blood tribe. The ceremony occurred with family and friends at the Piiksapi (Gordon Yellowfly) Memorial Arbor in the Siksika Nation.

www.instagram.com/p/C-Bek17yT_q/?img_index=1

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Gathering of Minds at the Gravitational Wave Advanced Detector Workshop (GWADW), Hamilton Island, Australia 2024

How do we estimate where in the Universe gravitational-wave signals from binary neutron stars and binary black holes come from? The process is known as "sky localization". There are two primary factors that determine our estimate of where the signal came from: the time of arrival and the amplitude of the signal in each interferometer.

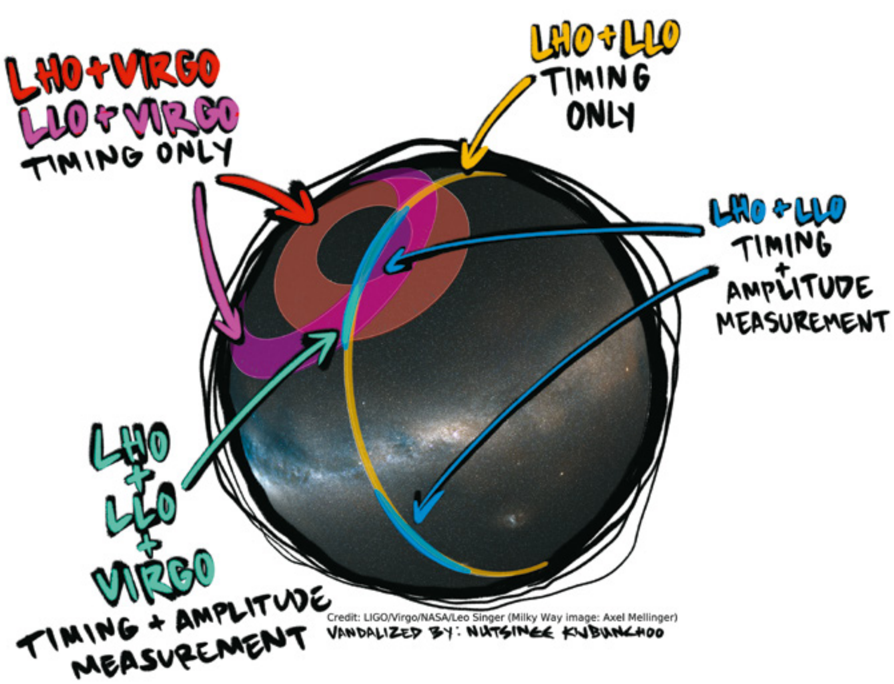
We measure the arrival time of the gravitational-wave signal in each interferometer. Measuring the arrival time at two interferometers limits the possible sky locations to a ring on the sky map. A third interferometer enables a more precise estimate of the sky localisation. The amplitude of the observed signal, along with other properties of the source, also enables us to estimate the distance to the binary.

Interferometers are not equally sensitive to signals in all directions. They are most sensitive to signals directly above and below the detector plane. There is a blind spot to signals that travel directly between the interferometer arms (the null direction). This sensitivity map for an interferometer is described by the sky-dependent antenna response. Analysing the relative amplitude of the signal in different interferometers can help reduce the ring on the sky map to a few patches even for a two-detector observation.

The 2017 binary neutron star observation, GW170817, is a particularly interesting example for sky localization. Timing and amplitude measurements in the two LIGO interferometers (Hanford and Livingston) provided an initial localization covering a pair of large ellipses (blue). However, since Virgo did not pick up a signal, giving a "null measurement", a more precise localization could be made (green ellipse).

In Observing Run 4 (O4), two complementary localization algorithms are automatically used when a signal is observed. Within seconds of the observation an initial estimate is produced by the Bayestar algorithm. A more precise localization is then produced by the Bilby software, within minutes for binary neutron star mergers or hours for binary black hole mergers.

Localization for binary neutron star GW170817. LHO is LIGO Hanford and LLO is LIGO Livingston.



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