Issue 3 | August 4, 2022

Mirinae

미리내 The Milky Way

TABLE OF CONTENTS

#IAUGA2022 is an official hashtag of the IAUGA2022

Looking into the Sun and stars

Conny Aerts and Jørgen Christensen-Dalsgaard, Kavli Prize Winners

After completing his MSc at Aarhus University, Denmark, Jørgen started his PhD studies in Cambridge, UK, working on solar modelling and oscillations. During his studies, observations by Franz Deubner confirmed the modal identification of the five-minute oscillations made by Roger Ulrich. At the same time, data on the solar diameter by Henry Hill hinted at global solar oscillations (the data were later found to be spurious). This changed the direction of Jørgen's work towards testing the possibilities of using such data for probing the properties of the solar interior.

The first truly global solar oscillations were identified by George Isaac and his group in Birmingham in 1979, observing the Sun as a star. This restricted the modes detected to those of the largest scale on the solar surface, which are also the modes that penetrate to the solar core. Detailed observations of these modes were obtained shortly after from the South Pole by Gerard Grec and Eric Fossat from Nice, together with Martin Pomerantz, providing the first observational constraints on the solar core. Such data were used a few years later by Yvonne Elsworth and her Birmingham collaborators to confirm models of the solar core at a level that demonstrated that the observed low level of neutrinos from the Sun were unlikely to be caused by errors in the solar model. This has later been confirmed by the definite detection of changes in the nature of neutrinos en route from the sun to the detectors.

In parallel, the first observations were obtained of the resolved oscillations on the solar surface, providing a much richer set of data for modes sampling different parts of the Sun. On this basis Jørgen and his collaborators could make a first inference the sound speed in the solar interior in substantial detail, and with his student Jesper Schou he obtained an early determination of the variation of rotation inside the sun, from a dependence on latitude in the outer layers to nearly uniform rotation in the deeper interior.

Since these early investigations, space-based observations and ground-based networks have provided a huge amount of very detailed information on the solar interior. As an example, Fig. 1 shows inferred differences between the solar squared sound speed and that of a solar model. Superficially, the agreement is excellent, at a level below one per cent; however, compared with the very small statistical uncertainty in the results there are highly significant differences between the sun and the model, later aggravated by revisions in determinations of the solar composition. A determination of solar internal rotation is illustrated in Fig. 2, clearly showing the relatively sharp transition between rotation in the convection zone and the radiative interior. The origin of this behaviour is still not fully understood.

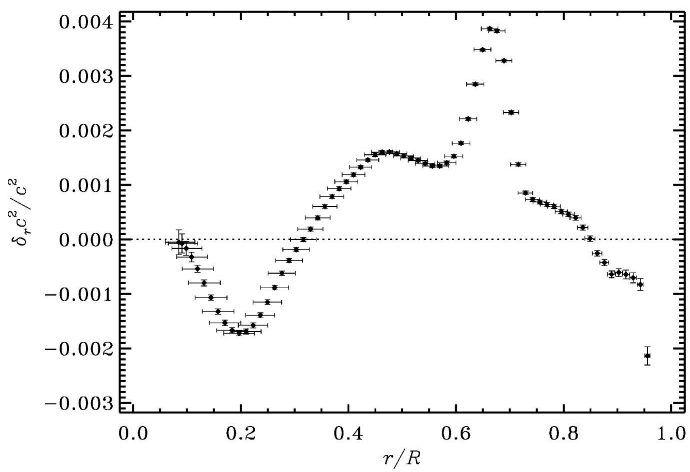


Figure 1: Relative difference between the squared sound speed in the Sun and the corresponding results for a solar model, as a function of the distance to the solar centre in units of the solar surface radius. The (barely visible) vertical bars show the statistical uncertainty in the results, while the horizontal bars indicate the resolution of the analysis. Courtesy Maria Pia Di Mauro.

From the realization that solar oscillations are excited by the turbulence in the outer convection zone followed that similar oscillations were expected in all cool stars with outer convection zones, including low-mass main-sequence stars. However, the very small oscillation amplitudes greatly complicated actual detection. The first definite success, in observations in 1995 made by Jørgen's group, concerned the subgiant η Bootis. This was followed by a few additional detections over the following years, notably for α Centaurus A, a solar twin, announced by Swiss astronomers at the Leuven pulsation conference in 2001. However, a major breakthrough came with the launch in 2009 of the NASA Kepler mission, with the primary goal of detecting extra-solar planetary systems using the transit technique. The exquisite photometric precision allowed the detection of solar-like oscillations in a large number of stars, including tens of thousands of red giants. Analyses of data on main-sequence stars hosting exoplanets have identified planetary systems twice as old as the solar system, while observations of red giants have distinguished between stars without and with helium fusion in their helium cores, and have determined the rotation rates of the cores, in tension with current models of stellar evolution.

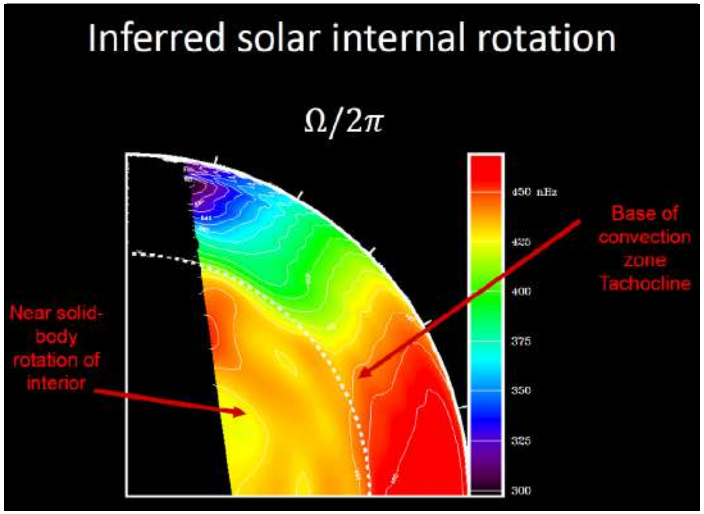


Figure 2: Rotation rate in the quarter of a cross-section of the Sun. The dashed line marks the bottom of the convection zone, which also marks the transition between the differential rotation in the convection zone and the nearly uniform rotation in the deeper interior. Courtesy Rachel Howe.

Kepler ended its mission in 2018, but similar observations are now carried out by the NASA TESS mission, and further extensive data of very high quality are expected from the ESA PLATO mission planned to provide its first data as of 2027. Both Jørgen and Conny are heavily involved in TESS and PLATO. While Jørgen is one of the founding fathers of helio- and asteroseismology, Conny is a representative of the second of meanwhile four generations of asteroseismologists. After completing her MSc studies in mathematics in 1988 at Antwerp University, she took up PhD studies in astrophysics in Leuven, both in Belgium. For her PhD, she developed methodology to identify nonradial oscillation modes from high-resolution time-series spectroscopy. This was at a time when such type of measurements constituted a technological novelty, only accessible with high signal-to-noise within short integration times of less than half an hour for bright stars. In her PhD thesis she presented mode identifications for several bright stars based on such high-precision spectroscopic data.

Meanwhile, Conny's asteroseismic studies cover stars with a broad range of masses, evolutionary stages, and rotation rates. She is mostly recognised for her work on massive pulsators, including those that will explode as supernova at the end of their evolution. In 2003 she offered the first asteroseismic measurement of the internal rotation rate at the convective core of such a "pre-supernova" pulsator from long-term multicolour photometric monitoring by many Leuven group members (during 21 years!). As a postdoctoral researcher, Conny undertook numerous asteroseismic studies of stars covering the broad mass range between 1.3 and 9 solar masses. Such stars reveal nonradial gravity modes with long periods of roughly half to three days. Such slow modes are among the toughest to study because their rotation and oscillation periods are similar, both on the order of the daily rhythm of our planet's rotation period. This not only offers a challenge observationally – essentially making ground-based asteroseismology of such stars impossible - it also implies a challenge for their modelling, as one cannot treat the rotation as a small perturbation as in the case of the fast oscillations of sun-like stars and red giants.

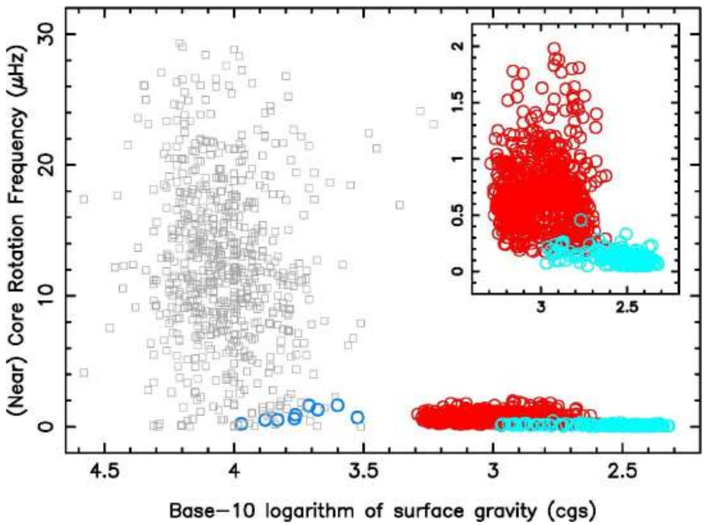


Figure 3: The core or near-core rotation frequency of more than 1000 stars in our Milky Way covering the mass range between 0.7 and 8 times the mass of the sun as deduced from asteroseismology is plotted against their surface gravity. The different symbols stand for core-hydrogen-burning dwarfs with a mass between 1.3 and 8 solar masses (grey squares), low-mass subgiants (blue circles), stars in the shell-hydrogen-burning stage climbing up the red giant branch (red circles), and core-helium-burning giants (cyan circles). Figure reproduced from Aerts, C., 2021, Reviews of Modern Physics, Vol.93, 015001.

The gravity modes of intermediate- and high-mass stars are strongly affected by their rotation. Kepler data revealed that stars born with a convective core have a diversity of internal rotation periods, with some stars revolving only once during several hundred days while others do it in less than a day. The Coriolis force implies a serious mathematical complication in the description of the internal structure and nonradial oscillations of rapid rotators, but at the same time it offers a wonderful diagnostic tool to unravel the rotation rate near their convective core. Fig. 3 is a reproduction of Conny's summary plot of internal rotation rates for more than 1000 stars, assembled by three generations of asteroseismologists. Two decades ago, this diagram was empty! The first measurements occurred between 2003 and 2011 for less than a handful of massive stars. Evolved low-mass stars started populating this figure as of 2012. Since rotation has a major impact on the way chemical species get mixed inside stars, asteroseismology brings a powerful tool to evaluate how gradients of the internal rotation contribute to the chemical evolution of stars, which will ultimately offer a new understanding of the yields expelled throughout stellar life via stellar winds and supernova explosions.

In conclusion, asteroseismology of thousands of low-mass stars offers precise age-dating for galactic archaeology and of exoplanet hosts, while its applications to hundreds of massive stars allows us to calibrate the chemical evolution models of our Milky Way. In the next era, TESS and PLATO will offer the use of this wonderful tool to more than a million metal-poor and metal-rich stars in the Milky Way. Along with Gaia measurements, the duet of space asteroseismology and astrometry will make it possible to look back upon our galaxy's history and to guide the way to compute its future chemical enrichment and fate.

Autobiographies are available at
https://www.kavliprize.org/conny-aerts-autobiography
https://www.kavliprize.org/jorgen-christensen-dalsgaard-autobiography

Helioseismology - My role in the beginnings

Roger Ulrich, Kavli Prize Winner

Helioseismology began with the 1962 report by Leighton, Noyes and Simon announcing the discovery of the 5-minute oscillations. As a side note, the Babcock magnetograph included a cam with an attached meter stick on the Doppler compensator which tracks the displacement of the spectral line being used to measure Zeeman splitting. Bob Howard later commented to the Mt. Wilson staff that he had seen oscillations in the cam position but never reported the motions to the astronomical community. The attached photograph shows the meter stick and Howard. Leighton and students adapted a technique invented by Fritz Zwicky to image the velocity by subtracting spectrally resolved photographic images from the red and blue wings of the line. The Leighton, Noyes and Simon paper references Howard for a private communication about the oscillations in 1961.

The discovery above all happened before I was a professional astronomer. As a graduate student at UC Berkeley I worked in Louis Henyey's group studying stellar structure and evolution. My thesis was on convection where I tried to improve the mixing length theory. As I was nearing completion of the thesis, John Bahcall visited and suggested we should compute a solar model. I computed a solar model, sent it to John and was greeted by return mail with a list of things that had to be fixed. These got done and a paper published with help from fellow graduate students. I got an invitation from John to come to Cal Tech and work on computing solar models. I accepted John's invitation and started a collaboration studying solar neutrino fluxes that lasted years.

My interest in the solar 5-minute oscillations began with observations by fellow graduate student Ed Frazier which showed that the oscillatory motion was disrupted by convection cells rather than being generated. Based on that clue, I carried out a modal analysis of a numerical representation of a convective envelope. My calculations showed that the oscillatory power should be restricted to frequencies that depend on the horizontal wavelength.

Confirmation of my prediction required using measurements from new instruments developed at Sacramento Peak Observatory and at Kitt Peak Observatory. These instruments obtained 2-dimensional grids of the velocity at regular time intervals for a duration of hours. Eventually

lines involved, no real discrepancy is indicated. The oscillatory motions have also been detected by Howard (1961), with the Babcock magnetograph in its Doppler mode, guided carefully on a fixed point on the sun with a small aperture. His time correlation data are in close agreement with our results.

REFERENCES

Allen, C. W 1955, *Astrophysical Quantities* (London: Athlone Press), p.133
Blackman, R. B., and Tukey, J. W 1959, *The Measurement of Power Spectra* (New York: Dover Publications, Inc)
Edmonds, F. N 1960, *Ap J*, **131**, 57.
Evans, J. W., and Michard, R 1961, *IAU XI Gen. Assem., Berkeley, Calif* (August).
Frenkiel, F. W , and Schwarzschild, M 1952, *Ap J* **116**, 422.
Hart, A B 1956, *M.N*, **116**, 38
Howard, R. 1961, private communication.
Jager, C. de. 1959, *Hdb. d. Phys.* (Berlin: Springer-Verlag), Vol **52.**
Kahn, F. D. 1961, *Ap. J*, **134**, 343
Lamb, H. 1945, *Hydrodynamics* (New York: Dover Publications Inc) p. 541
Leighton, R. B 1959, *Ap. J*, **130**, 366.
———. 1960, *4th Symposium on Cosmical Gas Dynamics, Varenna, Italy* (August)
——— 1961, *IAU XI Gen Assem, Berkeley, Calif* (August).
McMath, R R , Mohler, O C , Pierce, A K , and Goldberg, L. 1956 *Ap J*, **124**, 1
Plaskett, H H 1954, *M N*, **114**, 251
Richardson, R S., and Schwarzschild, M. 1950, *Ap.J.*, **111**, 351
Stuart, F. E , and Rush, J. H. 1954, *Ap J*, **120**, 245
Whitney, C. 1958, *Smithsonian Contr Ap*, **2**, 365.

Edward Rhodes, Jr., myself and Franz Deubner made the required observations and confirmed the predicted pattern.

Ed and I subsequently spent years persuading NASA to put an instrument on a spacecraft where the solar oscillations could be observed continually. In parallel a network of instruments was built by the Global Oscillation Network Group (GONG) to make the necessary observations from multiple ground instruments. These projects led to the development of helioseismology as a major technique for the study of solar interior structure and dynamics.

I enjoyed an important opportunity supported by the American Astronomical Society who decided to hold their 2017 Fall meeting in Portland Oregon so that an excursion to the August 17 eclipse could be arranged. I invited family members to take advantage of this and twelve relatives came and enjoyed the totality.

An extended version of my story is at:
https://www.kavliprize.org/roger-k-ulrich-autobiography

The oral history project at Cal Tech includes a description of the 5-minute oscillation discovery which can be found at:
https://resolver.caltech.edu/CaltechOH:OH_Leighton_R SESSION 4: January 13, 1987

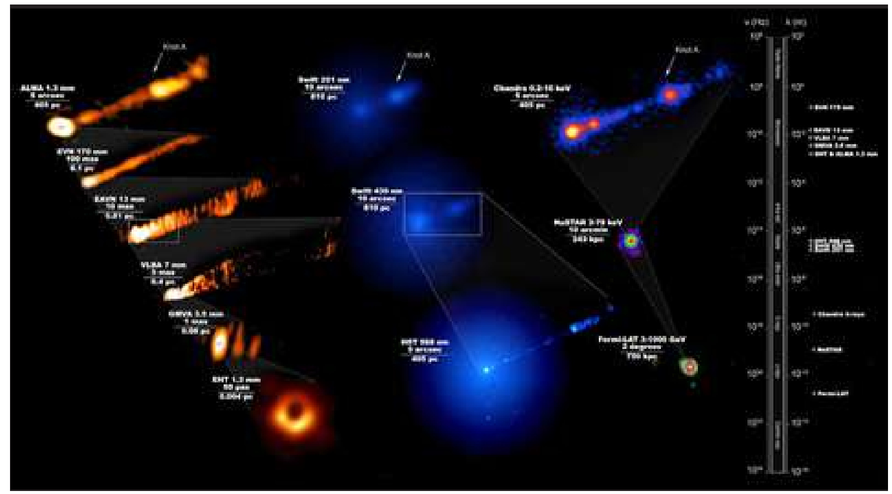
Focus Meeting 1

Physics of relativistic jets on all scales

Relativistic jets are among the most powerful manifestations of the energy released by compact objects on galactic and extragalactic scales. Non-thermal processes operating in jets are responsible for multi-messenger emissions, such as broadband electromagnetic radiation, from radio band to gamma rays, and high-energy neutrinos. Active Galactic Nuclei with powerful relativistic jets represent the dominant fraction of the extragalactic population observed at the highest energies. Their gamma-ray emission is often characterized by huge flares that may also be detected at longer wavelengths. The location (close to or at pc-scale from the central engine) and the physical mechanisms responsible for the gamma-ray emission is still largely debated, with shocks, turbulence, and magnetic reconnection, among others, being plausible particle acceleration mechanisms. Direct comparison between theoretical models and multiband observations provided by current and forthcoming facilities will be crucial for understanding the dissipation processes. Moving to larger scales, numerical simulations have been playing a key role in our understanding of jet structure and evolution as jets propagate in the environment. The presence of outflows of gas in active galaxies pinpoints the impact of relativistic jets on the host galaxy and the ambient medium, providing crucial information on the AGN-galaxy feedback. The importance of jet interaction with the surrounding medium, either within or beyond the host galaxy, needs to be considered in light of improved high-resolution multiband observations in continuum and spectroscopy. AGN are not the only engine able to produce a relativistic jet. Moving to galactic scales, jets are involved in many transient phenomena like long and short gamma-ray bursts, the latter being associated with the coalescence of binary neutron stars, giving gravitational waves.

Focus Meeting 1: Physics of Relativistic Jets on All Scales	
START DATE	Thursday, 4 August
END DATE	Tuesday, 9 August
ORAL SESSIONS	Room 109, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website



Event Horizon Telescope Multi-wavelength results of M87

The goal of this Focus Meeting is to bring together experts in observational, theoretical and computational astrophysics with the aim of promoting our understanding of the physics of relativistic jets. Relativistic jets are unique laboratories for studying the physics of matter and magnetic field in extreme conditions. This new era of multi-messenger astronomy will offer us the unprecedented opportunity to combine more than one messengers to solve some long-standing puzzles of jet physics. Critical to future understanding of jet physics will be joint observations and multi-wavelength electromagnetic coverage combined with the information from the different messengers. The Event Horizon telescope has already proved new imaging capabilities of horizon scales, something that was never achieved before. New and forthcoming facilities and new surveys that are collecting information on a large part of the sky at different wavelengths, are bringing new capabilities and coverage. At high energies, the Cherenkov Telescope Array with its greatly improved sensitivity in the TeV energy range and the almost full sky cover, will open a new window to the high-energy sky, allowing for the first time statistical studies of jets at the highest energies.

The sessions planned in this Focus Meeting reflect these topics, which are key for understanding the physics and role of jets. Contributions will cover a broad range of communities working on jets providing the latest research findings and fostering interdisciplinary research and new ideas. Please join us!

Monica Orienti, Co-Chair of Focus Meeting 1, is a Researcher of National Institute for Astrophysics, Italy.

Bong Won Sohn, Co-Chair of Focus Meeting 1, is a Principal Researcher of Korea Astronomy and Space Science Institute, South Korea.

The Dawn of Cosmology and Multi-messenger Studies with Fast Radio Bursts

Fast radio bursts (FRBs) are brilliant bursts of radio emission that typically only last for milliseconds from sources located in distant galaxies. Their short durations and large distances necessitate extremely energetic and compact sources like neutron stars. Despite the discovery of thousands of FRBs since 2007, their true nature and energy production mechanism remains unclear. What makes them most intriguing is that they are cosmic messengers from halfway across the Universe. The radio signal is influenced by the material along their journey to the telescope on Earth and consequently are a gold mine of information as they bear the imprint of the intervening ionised gas. This provides us with a novel way to investigate the structure, matter and magnetic fields between stars and galaxies outside our Milky Way. With the ongoing development of new instrumentation and software, we have now reached a point where radical changes in the field occur on timescales of a few months. As a result, the quest to answer the fundamental questions of their enigmatic nature, progenitors, environments, spatial distribution, and their potential for use as cosmological probes is gaining enormous momentum. The aim of this symposium is to facilitate the essential convergence of data and theory at a time when many of the latest experiments will have been running for sufficient time to make significant progress in answering these questions.

IAU Symposium 369: The Dawn of Cosmology & Multi-Messenger Studies with Fast Radio Bursts	
START DATE	Tuesday, 2 August
END DATE	Thursday, 4 August
ORAL SESSIONS	Room 101, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

The last few years have revolutionized FRB astronomy, and as a community we are on the brink of answering some of the open questions regarding the nature and uses of FRBs. The entire electromagnetic spectrum along with gravitational waves and neutrinos are now open for FRB detections. With the potential of multi-wavelength detections and their uses as effective cosmological probes, it appears that FRBs have formed a bridge across all astronomy. The field has now reached a stage where progress in the field requires, and will benefit from, collaborations and exchange of knowledge and ideas with researchers from across the photonic and non-photonic windows as well. The Scientific Programme of the IAU Symposium 369 is built to aid and facilitate in the confluence of astronomers with expertise in other areas like cosmology, galaxy properties and dynamics, high-energy phenomena and stellar physics, which will be very useful for strategizing and planning the next decade of FRB astronomy. This look forward to the future is essential as the continuous improvement of current facilities and building of superb new facilities promise decades of exciting (astro)physics to follow.

Manisha Caleb, Co-Chair of IAU Symposium 369, is a Discovery Early Career Researcher Fellow and Lecturer at the University of Sydney. She is actively involved in the MeerTRAP project at the MeerKAT telescope to discover and study fast radio bursts.

Benjamin Stappers, Co-Chair of IAU Symposium 369, is a Professor at the University of Manchester. He is the PI of the MeerTRAP project at MeerKAT and his primary research interests are radio pulsars, neutron stars and rapid radio transients.

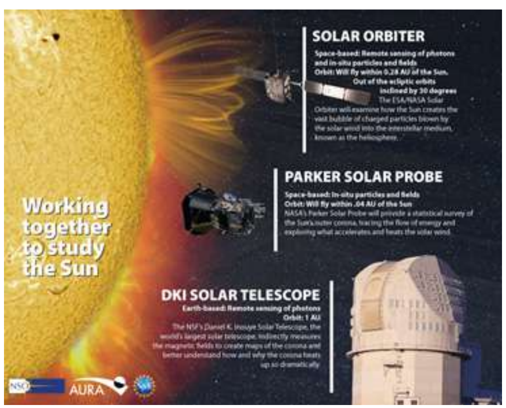
The Era of Multi Messenger Solar Physics

IAU Symposium 372: The Era of Multi Messenger Solar Physics	
START DATE	Tuesday, 2 August
END DATE	Friday, 5 August
ORAL SESSIONS	Room 104, Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

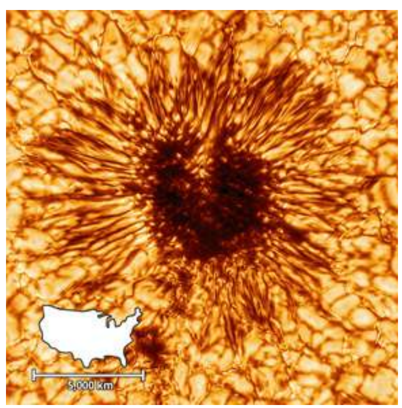
For details on presenters, topics, and times see the online program on the GA website

Multi-messenger science has a long history in solar astronomy. For decades, direct measures of particles emanating from the Sun, like the solar wind, have been used together with electromagnetic field diagnostics as the couriers of information. This approach has shaped our understanding of how solar activity forms and relentlessly influences its environment, and the planetary system existing within it.

A number of new facilities are now heralding an exciting era of scientific opportunities within multi-messenger solar physics. The NSF's 4-m Daniel K. Inouye Solar Telescope (DKIST), the largest high-resolution solar optical/IR ground-based telescope ever built, commenced its Operations Commissioning Phase in early 2022. Early science observations are already revealing details of the solar photosphere and chromosphere at scales of 20 km at the solar surface. The daring encounter missions Parker Solar Probe (PSP, NASA) and Solar Orbiter (SO, ESA/NASA), launched in 2018 and 2020 respectively, are both getting closer to the Sun during each orbit, providing unprecedented measurements of the outer solar atmosphere and solar wind. At the end of its nominal mission in 2025, Parker Solar Probe will approach our star at closer than 10 solar radii, well below the interface between the solar atmosphere and the freely flowing solar wind. Over the next several years, Solar Orbiter will instead gradually leave the ecliptic and reach an inclined orbit of up to 33 degrees, allowing the first clear view of the solar poles with remote sensing instrumentation. The upcoming multi-instrument Aditya mission from India, slated to operate at the first Lagrangian point, will add to this powerful suite of space facilities. Recent access to astronomical radio observatories like ALMA and LOFAR has added novel wavelength ranges to the already accessible spectrum, allowing us to better study the outer atmospheric layers of the Sun, as well as the creation and evolution of transients in the heliosphere, such as Coronal Mass Ejections and related disturbances. Dedicated solar imaging spectroscopy and polarimetry at microwave frequencies from EOVSA and MUSER are rapidly changing our understanding of the active solar corona and flares.



How to work together



DKIST first sunspot with scale

Each facility will provide fantastic new results. Still, the most profound advances in our physical understanding of the Sun and its environment are expected from combined, coordinated observations using many of them at once. Being able to observe the same target, at the same time, using many different diagnostics, allows us to clearly identify physical processes from their solar source to their effects at Earth, a unique capability that should be thoroughly exploited. Scientific synergies, as well as coordinated efforts among the different observatories (space or ground-based) are thus needed. Given the many different stakeholders, priorities, operational models and scheduling constraints, all embedded in a quickly changing scientific landscape, this is a quite challenging task that we are just starting to address.

During IAUS372 we will discuss these new facilities, their coordination, and the exciting science they are enabling. The main scientific sessions will be held on August 2-4, 2022, and the plenary talk in the morning of August 5th.

Gianna Cauzzi is a scientist at the National Solar Observatory (USA). Her main scientific interests are related to the dynamics of small scale structures in the solar lower atmosphere. She is currently in charge of community activities related to DKIST science.

Alexandra Tritschler is a senior scientist at the National Solar Observatory and the DKIST Program Scientist for Operations. Her main scientific interests focus on the study of solar active regions.

Astronomy for Education 101

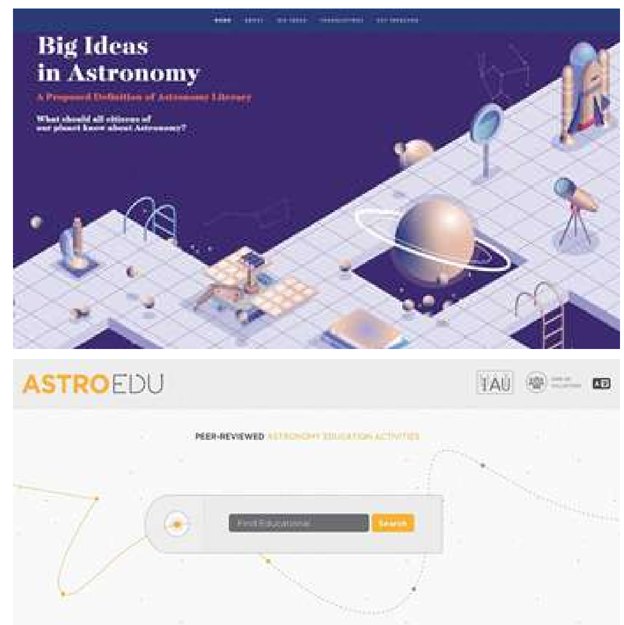
Office Meeting: IAU Office of Astronomy for Education	
START DATE	Thursday, 4 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 108 (8/4), 103 (8/8), Convention Hall, 1st Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Education is both one of the UN Sustainable Goals for Development and also one the five Goals of the IAU Strategic Plan 2020 - 2030. In the context of the IAU, the focus on education is being led by the IAU Office of Astronomy for Education (OAE), which was officially launched in December 2019 at the IAU Headquarters in Paris. The OAE is based at Haus der Astronomie (literally “House of Astronomy”) in Heidelberg, Germany, but has quickly built up a large network of collaborators, including several branch offices (which are called OAE Centers or OAE Nodes).

The IAU OAE has established five overarching objectives: professionalizing astronomy education; providing access to effective resources for teaching astronomy; promoting astronomy in curricula; creating, maintaining and growing a network of associates in support of the OAE mission; and spreading the news.

The IAU OAE focuses on education in primary, middle and secondary school, and has developed its objectives in such a way as to enable and support teachers, and educators from around the world to take advantage of the potential offered by astronomy in engaging students. Given the nature of astronomy, it is vital that any effort towards fostering and supporting astronomy for education include the global astronomy and education communities. As such the OAE continues to establish a worldwide network of National Astronomy Education Coordinators (NAECs). The aim for the NAEC network (https://www.astro4edu.org/naec-network) is to support the promotion of astronomy in national curricula, supporting teachers with evidence-based education research and helping the community with its professional development. The OAE is also intended to facilitate discussion and knowledge sharing within the community, particularly between astronomers, astronomy education researchers and practitioners.



Drawing on the IAU OAE objectives, the OAE sessions at the IAU GA 2022 bring together individuals active in astronomy education, and members of the OAE network to focus on four overarching themes:

- The role of national bodies in astronomy education
- Astronomy education projects placed in extracurricular activities
- Astronomy education: Tools and resources
- The OAE's network of Centers and Nodes

These sessions will be an opportunity for the IAU community to learn about the field of astronomy education, how to engage with the astronomy education community, the role of OAE in the education ecosystem, and more importantly the theme of ‘Astronomy for all’. To view the program please visit: https://www.astro4edu.org/GA2022/

At the IAU OAE there are always various opportunities for scientists to volunteer their time, this could include, but not limited to: reviewing definitions for the astronomy glossary (https://astro4edu.org/resources/glossary/search/); providing input into scientific aspects of teaching resources; helping with events hosted by the OAE and much more. Please feel free to contact us: oae@astro4edu.org. In addition, Scientists could also engage with their local NAEC team and to find out how they can best support them in their efforts of developing and enhancing astronomy education in their respective regions.

To learn more about the IAU OAE and collaboration opportunities, please visit: https://astro4edu.org

The IAU OAE which was officially launched in December 2019 at the IAU Headquarters in Paris. The OAE is based at Haus der Astronomie (literally “House of Astronomy”) in Heidelberg, Germany.

A Time to Reflect on How to Impact Young Astronomers Education

The Office for Young Astronomers (OYA) has as its main program the International Schools for Young Astronomers (ISYA), started in 1967 by the IAU, and nowadays also co-sponsored by the Norwegian Academy of Science and Letters. It organizes three-week intensive graduate schools in parts of the world where students have less opportunity to be directly exposed to the full extent of up-to-date astrophysics. The program targets mainly, but not exclusively, students from astronomically developing countries. ISYA offers students coherent lectures that cover the basic concepts of selected fields of astronomy and astrophysics, the opportunity to carry out and analyze multi-wavelength data, engage in group projects, workshops on career development and a network of fellow students to grow with into the next generation of leaders in their countries.

Office Meeting: IAU Office for Young Astronomers	
START DATE	Thursday, 4 August
END DATE	Monday, 8 August
ORAL SESSIONS	Room 202 (8/4), 104 (8/8), Convention Hall, 1st and 2nd Floor
POSTERS	e-Poster Zone, Convention Hall, 3rd Floor

For details on presenters, topics, and times see the online program on the GA website

Over its 55 years of existence, there have been 42 ISYA organized in 27 countries. Schools usually have 30-50 students from the host country and from countries in the same IAU region. They are aided by a team of 10-15 lecturers which are world-wide experts on their topics. Over time, ISYAs have hosted over 1400 students and 400 lecturers. Many prominent IAU members were students of the program, and time has come when alumni are enthusiastic promoters and lecturers of new ISYAs.

OYA is hosting an open Office Meeting during the General Assembly (4th and 8th of August). We invite participation from all IAU members to brainstorm on the most effective ways to impact young astronomers' careers in the developing world. We will have an in-depth analysis of the successes and challenges experienced by ISYA alumni in the past and in recent years. Testimonials from four historical alumni and five recent alumni coming from different IAU regions will be a highlight of the program. We will also have an expert on career perspectives and challenges from Nature. The leaders of several specialized graduate schools will participate in a round table to discuss how to enhance the chances of students from the developing world to participate in those, and how ISYA and specialized graduate schools can interact. Finally, we will review the prospects for the new generation of astronomers in parts of the world where Astronomy is starting to get developed.

INVITED AND KEYNOTE SPEAKERS

Itziar Aretxaga (INAOE, Mexico; ISYA Director) & David Mota (Univ. Oslo, Norway; ISYA Deputy Director) “The 5-decade long ISYA program under observation”

Michele Gerbaldi (IAP, France) & Jose Miguel Rodríguez Espinosa (IAC, Spain; IAU General Secretary): “Challenges perceived from within the IAU”

Chris Woolston (Careers Nature, USA, 30 min) The Challenges and Possibilities of a Science Career: “Lessons from Nature”

Historical alumni testimonials: Mónica Rubio (Univ. Chile), Xiaohui Fan (Univ. Arizona, USA), Kingsley Opkala (Univ. Nigeria), Somaya Saad (NIARG, Egypt)

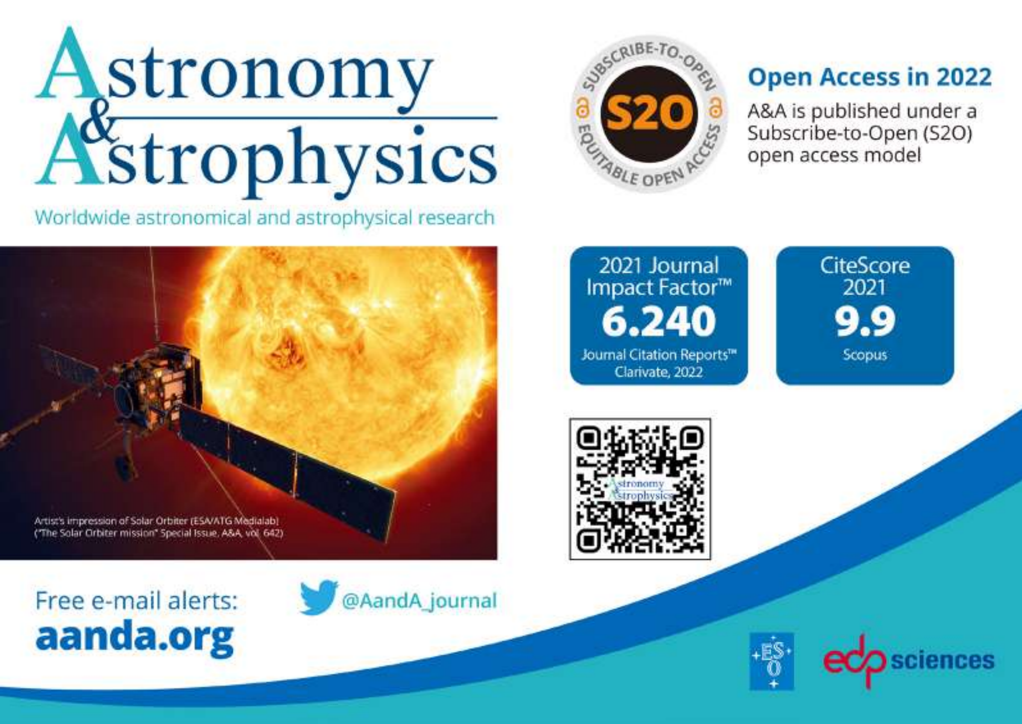
Recent alumni testimonials: Hira Fatima (Univ. Karachi, Pakistan), Etseganet Getachew (ESSTI, Ethiopia), Daudi Mazengo & Privatus Prius (Univ. Dodoma, Tanzania), Luis Salazar-Manzano (Univ. Texas at Rio Grande Valley, USA).

Interaction with other graduate school programs: Mariano Méndez (Univ. Groningen, The Netherlands; I-HOW/COSPAR), Basilio Ruiz (IAC, Spain; IAC Winter Schools).

Itziar Aretxaga is research professor at INAOE, Mexico, specialized on galaxy formation and evolution.

David F. Mota is a professor at University of Oslo, Norway, specialized in Gravity and Cosmology. They are the current directors of the ISYA Program.


SLLAB
SL LAB, INC.
SPACE LIGHT LABORATORY
ASTERA series
· 0.5 / 0.6 / 0.8 / 1.0 / 1.2 / 1.5m Line-up
· Diffraction Limited 100mm image plane
· 32bit Absolute Encoder with Direct Drive motor
· Tracking Accuracy : under 1arcsec for 10min
· Pointing Accuracy : RMS 10arcsec or less
REALIZATION OF THE FUTURE ASTRONOMY
· Telescope on Earth
· Telescope in Space
· Astronomical Research
· Astronomical Education
www.sllab.co.kr
Astera 1.2m telescope
Gwangju science museum




2022 Gruber Cosmology Prize Winner

Invited Discourse 1_Klaus Pontoppidan