DIVISION C1
ASTRONOMY EDUCATION AND DEVELOPMENT
Education et Développement de l'Astronomie

Newsletter 86 – October 2017

Contributions to this newsletter are gratefully received at any time.

This newsletter is available at the following website
http://iaucc1.frm.utn.edu.ar/wp-content/uploads/2012/11/IAUNL86.pdf

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CONTENTS

A WELCOME FROM THE EDITORS WITH A NOTE ON EDITORIAL POLICY

Welcome to IAU Commission C1 Newsletter #86, the fourth to be published new divisional structure of the IAU established at the General Assembly XXIX in Honolulu, August, 2015. (We are continuing the numbering of the newsletter consecutive with the old C46 education newsletter.) This newsletter contains reports on several of our working groups, announcements of some upcoming meetings of interest, and we are pleased to continue the series of informative book reviews by Naomi Pasachoff.

As always, comments and contributions are both needed and welcome. Thanks to everyone who has made a contribution to this edition of the Newsletter. Please note the text in this Editorial highlighted in RED.

For the March issue the deadline for submitting material is **Friday 2 March 2018**. If you can include photos or illustrations with any material, please do so in the manuscript. Feel free to encourage others to submit material – anything with an astronomy education or development aspect will be considered.

IAU C1 NEWSLETTER – GUIDANCE FOR CONTRIBUTORS

The editor is happy to accept articles on any aspect of astronomy education or development, including obituaries and other articles on people. 500-2000 words are the approximate upper and lower limits. Shorter contributions, up to a few hundred words, such as meeting announcements, meeting reports, and other news items, are also welcome.

> Send contributions to me by email, at marschal@gettysburg.edu. or to the Kathy Eastwood, secretary of CC1 and co-editor of the newsletter: kathy.eastwood@nau.edu. Please send manuscripts as a Microsoft Word attachment (much preferred) or include the text in the body of the email. **Illustrations should be sent as separate, individual files**, preferably as JPEGs or TIFFs no larger than about 3 Mbytes each. **Please include contact information for the author, including email and postal address, DO NOT SEND ANYTHING AS A PDF.**
>
> Do not send a preliminary draft unless it is clearly marked as such, but feel free to contact me with preliminary ideas for contributions.

We try to edit as lightly as possible, and we certainly don't care whether US English or British spelling conventions are used, so you may notice an inconsistency in style insofar as such conventions can vary from author to author with no loss of comprehensibility. We also leave local turns of phrase untouched unless the meaning is obscure. Clarity, conciseness, and being interesting or informative are what is needed. Only in rare cases is heavier editing necessary.

Notes on Resources and Methods for Education

I welcome short notes pointing readers to resources useful for education. Such notes can just point to a website, or can include a paragraph describing the nature and application of the resources available. You will find several examples of these notes in this edition. I also welcome longer articles detailing methods and techniques and reports on educational activities and summer schools, and well as studies regarding the impact and effectiveness of such techniques for astronomical learning.

Book reviews

We welcome book reviews. Reviews should generally be of books centered on astronomy education or development or of historical interest for educators. If there's such a book that you think is worth reviewing, please send your review to me.

The C1 websites

The "official" IAU CC1 website is at http://iaucc1.frm.utn.edu.ar/ The IAU Office of Astronomy for Development (OAD) is at http://www.astro4dev.org/ and the IAU Office of Astronomy Outreach (OAO) is at https://www.iau.org/public/

Back issues of the C46 Newsletter, our previous incarnation

Back issues are available at http://iaucomm46.frm.utn.edu.ar/newsletters/. Newsletter 49, October 1998, has been scanned from hard copy, so the quality of reproduction is only modest. This is also the case for earlier ones, edited by John Percy. These extend back to February 1992, but there are gaps.

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EDUCATIONAL REPORTS

IMPROVING ACCESSIBILITY OF ASTRONOMICAL PUBLICATIONS : RECOMMENDATIONS FROM THE WORKING GROUP ON ACCESSIBILITY AND DISABILITY

by American Astronomical Society Working Group Accessibility and Disability (WGAD), Commission Education and Development-C1 International Astronomical Union (IAU)

Each individual copes, searches, thinks, performs, perceives, and interacts differently. Interaction implies a response to physical, cognitive, emotional, and other stimuli that have been processed by an individual. In the interest of disseminating knowledge to the community in a fully inclusive way, we would ideally accommodate the coping and cognitive needs of every single human being. Well-designed user-centered interfaces take into consideration characteristics of the target audience to create a Human- Computer Experience that will not prevent access, frustrate, or serve to disengage the user. For the field of astronomy, where thousands of publications are generated each year, the number of articles published by a scientist is highly weighted in performance and productivity metrics. To publish and stay up-to-date on the latest research is mandatory to find the next job. However, the pervasive dependence on language and expressions that fit only one perceptual style suggests that our field has limited itself to the participation of only this perceptual style. This dependence forces people with other learning styles to learn or memorize using this particular style. To unwittingly deny people with disabilities the same amount and quality of information that is available to a traditional visual learning astronomer has the exclusionary effect of severing our links with the field and society.

We recommend that journal staff consult User Centered, Universal Design specialists among other information access professionals rather than relying on a checklist for developers to follow to achieve “accessibility,” as the latter will lead to more complications than solutions. User Centered design considers all of the perceptual strategies of humans to design systems that will not disengage the user. This strategy lends itself to widen the participation of a large diversity of people by enabling their participation in tasks that have traditionally excluded non-visual learners. Astronomy and physics are very visual fields that often force people that do not fit that learning style out of the field.

Information Access (IA) technology (Assistive Technology, hereafter AT) is very expensive, which in itself excludes most people from efficient, effective and useful IA. Common assistive technologies used by people with disabilities are alternative keyboards, pointing devices, eye-tracking equipment, voice-recognition software and screen scanning options. Software in general is overcrowded and updates frequently change the way things are done whenever new features are added. Changes in software may frustrate users who are accustomed to a certain interface. This is a major challenge for people with disabilities. On top of that, we note that accessibility is not a priority for our culture: for example, journal display typically prioritizes use of PDF generators that save space over ones that make it easy for people with cognitive, attention, and

focus challenges. Technology used to improve accessibility should be compatible with freely available accessibility software; for example, the NVDA (NonVisual Desktop Access) screen reader is compatible with the Mathematical Mark-up Language (MathML). A culture where the use of words does not disempower people is mandatory if science is to become truly representative. Moreover, accessibility should be performed automatically and not as an exception.

Deaf and hard of hearing people are often assumed to not face difficulties when reading or navigating webpages. That assumption is far from reality, and excludes many individuals. Words commonly used in astrophysics often lack direct equivalents in sign language and so must be painstakingly spelled out letter by letter. Ideally every word used in a journal article should have a translation to sign language. The Office of Astronomy for Development (OAD) and the Office of Astronomy for Outreach (OAO) are coordinating efforts to address the lack of sign language for astrophysical words at the professional level, and as needed to develop international signs. We advise the journal staff to seek their advice.

In this document, the reader will find recommendations for improving the accessibility of astronomical journals. It is important to highlight that no user-centered testing or focus group has been performed to gather the suggestions below. These suggestions should serve as a guide and motivation for the reader to perform a user-centered study and deepen the research on how best to use technology to bring different learning styles on board. We mentioned previously that a list of steps for developers to follow is not the solution, even though our suggestions below may look like a list. Lists limit creativity, limit possible new solutions, and may be unintentionally taken as absolute, thereby leaving out the very important phase of continuous focus groups and usability testing. Good back-end and front-end design is guided by continuous usability evaluations. We hope that readers will gather help from experts on user-centered design, human computer interaction, and disability in astronomy to enrich the field at all levels.

On the same token, there are many learning styles and disabilities, and we are not specialists in all these learning styles. It is not our intention to leave any disability out, but if we did then please reach out to us with your suggestions. These suggestions were gathered from astronomers whose experiences are informed by our own disabilities.

The full document can be recovered from:
http://sion.frm.utn.edu.ar/iau-inclusion/wp-content/uploads/2017/10/JournalAccess.V2.pdf

For more information the reader may write to access-astronomy@googlegroups.com or to the chairs of the American Astronomical Society Working Group on Accessibility and Disability,

Nicholas Murphy, namurphy@cfa.harvard.edu and
Wanda Diaz-Merced, wanda.diaz.merced@gmail.com

INTERNATIONAL SYMPOSIUM ON ASTRONOMY AND ASTROBIOLOGY EDUCATION: THEORY, METHODS, IMPACTS AND FUTURE DIRECTIONS. (UTRECHT, NETHERLANDS, JULY 3-8TH 2017)

Co-Chairs:

- **Beatriz García,**
  President of IAU-C.C1, Instituto en Tecnologías de Detección y Astropartículas, Universidad Tecnológica Nacional-FRM, Mendoza, Argentina.
- **Muriel Gargaud,**
  Chair of the IAU-Inter Commission C1-F2-F3-H2 WG on Education and Training in Astrobiology; President of the Société Française d'Exobiologie, Laboratoire d'Astrophysique de Bordeaux,CNRS-Université de Bordeaux, France

SOC-Members:

- Susana Deustua (United States), STScI
- Kathleen Eastwood (United States), Northern Arizona University, Flagstaff
- Wolf Dietrich Geppert (Sweden), Stockholm University
- Kalle Kirsimae (Estonia), Tartu University
- Nicoletta Lanciano (Italy), Universita di Roma "La Sapienza"
- Anthony Lelliott (South Africa), University of the Witwatersrand, Johannesburg
- Rosa M. Ros (Spain), Technical University of Catalonia, Barcelona
- Magda Stavinschi (Romania), Astron. Institute of the Romanian Academy, Bucarest
- Inge Loes ten Kate (Netherlands), University of Utrecht
- Akihiko Tomita (Japan), Wakayama University

LOC

- Inge Loes ten Kate (Netherlands, University of Utrecht), Kirsi Letho and Jaakko Lamminpää (Finland, University of Turku).

Coordinating organizations:

- IAU Division C Education, Communication with the Public, History and Heritage,
- IAU Division F Planetary Systems and Astrobiology.
- European Astrobiology Campus

Website: ISE2A.uu.nl

This international symposium co-sponsored by the International Astronomical Union (IAU) and the European Astrobiology Campus (EAC, http://astrobiology-campus.eu/), was designed to bring education research in astronomy in general, and in astrobiology in particular, to the professional scientific community.

Education has always played a large role in the field of astrobiology and in part this workshop was a follow-up of the successful International Workshop on Education in Astrobiology (IWEA) held in Höör, Sweden, in 2013 (http://www.nordicastrobiology.net/IWEA/). On the other hand, education research has seldom been the main subject in IAU events, yet the scientific results from this field have a great potential to improve the teaching and learning of astronomy for students of all ages. New results and research methodologies from the cognitive and learning sciences domains can, however, be of large influence on the work of educators but generally, professional astronomers are not fully

aware of the results from astronomy education research.

By this first meeting in astronomy education and by combining it with its growing subdiscipline astrobiology, we aimed to strengthen both fields through cross teaching collaborations. The symposium was designed specifically to expand awareness of the results of the cognitive and learning sciences, as well as to provide a forum for active scholars in astronomy and astrobiology education

Nine invited talks were given by international leaders in discipline-based astronomy education research and in astrobiology. Forty five contributed talks were solicited from astronomers and educators who have conducted studies in this field, and from all scientists working in astrobiology and with experience in teaching interdisciplinary subjects to various audiences. Nine sessions were organised on the following subjects :

- State-of-the-art of astronomy education research
- Research on leveraging new media and information systems for teaching and learning
- Astronomy Education Research in Schools
- Innovations in research methodologies and instrumentation
- Research into the value and influence of astronomy education in other disciplines AND Interplay of students' worldviews with the worldview of science in a globalizing world
- Teaching astrobiology to a university multidisciplinary audience: opportunities and pitfalls
- Organization of astrobiology teaching and training in different institutions and countries / Future international cooperation in astrobiology teaching
- How to present astrobiology lectures to the general public and young pupils (10-16 years old)
- Innovative teaching and new assessment methods.
- Research results on impact of 2015 International Year of Light

Due to the great success of this symposium, a new ISE2A will be organised the next in 2020, in Malaga, Spain

THE ROAD TO THE STARS: INSAP X, OXFORD XI AND SEAC 25TH CONFERENCE

by A. César González-García
Instituto de Ciencias del Patrimonio,
LOC chair and SOC co-Chair

A hundred and twenty researchers from as many as 32 countries on five continents presented the results of their latest studies on the vision of the sky in different cultures and societies from prehistory to the present in Santiago de Compostela (Spain) from September 18th until 22nd. They also lectured on a wide variety of topics: from megalithic astronomy to the influence of the heaven in contemporary art, passing through Egypt, Mesopotamia, the Incas, Easter Island or the sky around the Cathedral of Santiago.

Promoted by the Spanish National Research Council through the Institute of Heritage Sciences, the University of Santiago de Compostela and the IAC, this was the first time that the meetings of the European Society for Astronomy in Culture (SEAC), the International Society of Arqueoastronomy and Astronomy in Culture (ISAAC) and the meetings 'Inspiration of Astronomical Phaenomena' (INSAP) gathered together at the same venue.

The oral presentations were arranged in a number of sessions dealing with the Land and Skyscapes, Ancient Astronomies, Anthropology of the Sky, From Rome to Santiago, Education and Heritage, Inspiring Skies and Methods. In this sense, a number of talks were directly devoted to how to promote Cultural Astronomy courses and Heritage among students, young scholars and heritage professionals, including curricula were the astronomical relevance of heritage is underpinned.

The congress also developed a program open to the general public with an art exhibit at the cloister of Fonseca, an artistic performance by the artist John David Mooney, a classical music concert with themes related to astronomy and a NerdNite (three short popular science talks at a local bar). This last event was one of the main successes of the Conference as nearly 450 people cramped in the bar to listen to the three speakers with great expectation.
The experienced was a great success judging by the overall high quality of the nearly 100 oral presentations exposed during the five days of the conference and the lively discussions during the sessions.

The final result of the art performance by artist John David Mooney at the Neo-classic cloister of the University of Santiago. It merged the local architecture with the sky lore and images of the pilgrimage route to Santiago using the sunlight and special lanterns used for this event. Picture by Alejandro Gangui.

The participants included researchers from 32 nations from throughout the world

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GAMING TO LEARN ASTRONOMY, AN INNOVATIVE APPROACH, TWO STUDY CASES

by Margarita Metaxa, Philekpaideutiki Etaireia, Greece' National Observatory of Athens

By developing and promoting the teaching of Astronomy in the broadest possible way to students we can introduce students to science in a very pleasant way and easily prepare them for a "life– long learning" journey. Furthermore, the cultural and philosophical role of Astronomy is undisputed. Studying the Universe is a way of searching for our own origin, learning to situate ourselves within cosmic infinity and developing a sense for the beauty and fragility of our planet the Earth. It also allows us to keep a critical approach towards irrational pseudo-sciences.
Thus it's a unique opportunity to involve Astronomy to the new case for Educational Learning through Play, which allow people to go beyond immediate imagination and direct physical activity, help students to develop non-cognitive skills that are as fundamental as cognitive skills in explaining how we learn and if we succeed.

1. Study Case I: the board game "StarStorm, The Galaxy Domination"

The game "StarStorm " was created for entering to the National Hellenic Contest of Astronomy to celebrate the 2009 IYA, run by the Hellenic Physical Society, where it won the second place. The team that created the board game was a school team of mine consisted by 8 students.

The general objective of the created board game is to promote students/public understanding of science and astronomy, that is by playing. The "StarStorm" board game engages the game-players I. from 10-18 years old, to activate their personality on the intellectual, the emotional, the desire, the intuitive and the imaginative level II.Older than 19 years, to discover the wonders of the Universe, the myths and basic characteristics of the constellations. Additionally "StarStorm" passes to the players the message that it's not only luck (dices) but it is also scientific knowledge (question and cosmic events cards) which makes a civilization to survive. The evaluation showed excellent results !

Figure 1. The board game "StarStorm"

2. Study case II: Learning about the Galaxy by constructing a Galactic Garden at school

All about our Galaxy and more can easily be explained and taught to students by creating a galactic garden at school, with them !! The aim, is to engage students in the learning process by gamification. The procedure we followed was to learn about a) galactic coordinates, b) the structure of the galaxy, then set up the scale of the model to "plant" and decide about the content to be demonstrated and carefully choose the plants/flowers that will correspond to the content and make up the budget! Then ..work for the creation.. ..and.. walk around this Galactic Garden asking and answering questions.

All the data used were taken by the 2008c-10b map of NASA/JPL- Caltech /R.Hurt . Students always enjoy walking, asking and learning through the galactic-garden about the Galaxy.

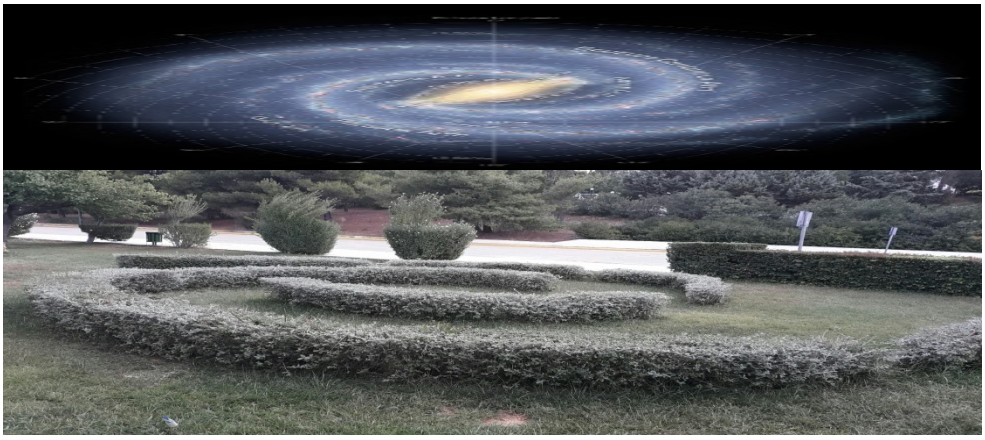

Figure 2. The Galactic Garden.

3. Conclusion

Students played the 'StarStorm" game and entered the gamification procedure of creating a Galactic Garden, got thrilled by the experience! Astronomy is a unique opportunity for implementing "New Literacies", which expands the conception of literacy beyond books and reading and through it to introduce science to students.

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IAU INTER-COMMISSION B2-C1-C2 WG DATA DRIVEN ASTRONOMY EDUCATION AND PUBLIC OUTREACH (DAEPO)

With a new item appearing on the IAU Working Groups webpage, the new approved IAU Inter-Commission B2-C1-C2 WG Data Driven Astronomy Education and Public Outreach (DAEPO) was launched officially in May, 2017.

This inter-commission working group is hosted at the IAU Division B (Facilities, Technologies and Data Science) Commission B2 (Data and Documentation), and organized jointly with Commission C1 (Astronomy Education and Development), Commission C2 (Communicating Astronomy with the Public), Office of Astronomy for Development (OAD), Office for Astronomy Outreach (OAO) and several other non IAU communities, for example International Virtual Observatory Alliance (IVOA) Education Interest Group, American Astronomical Society (AAS) Worldwide Telescope Advisory Board, International Planetarium Society, Zooniverse project, International Planetarium Society. The WG consists of 16 founding members, including 9 members and 7 associate members.

With the development of many mega-science astronomical projects, for example CTA, DESI, EUCLID, FAST, GAIA, JWST, LAMOST, LSST, SDSS, SKA, and large scale simulations, astronomy has become a Big Data science. Astronomical data is not only necessary resource for scientific research, but also very valuable resource for education and public outreach (EPO), especially in the era of Internet and Cloud Computing. Maximizing the values of astronomical data in education and public outreach is the mission of the WG. The working group has the major objectives to: 1) Act as a forum to discuss the value of astronomy data in EPO, the advantages and benefits of data driven EPO, and the challenges facing to data driven EPO; 2) Provide guidelines, curriculums, data resources, tools, and e-infrastructure for data driven EPO; 3) Provide best practices of data driven EPO.

Presentations about the new created working group will be given at various events, including the International Symposium on Astronomy and Astrobiology Education (IS2A), IVOA Interoperability Meeting and ADASS conference. The concept of “Data-driven Education and Public Outreach” will be propagandized though newsletters, news reports, website portals, and various public media in different countries and in different languages. In April 2017, the creation of the WG and the concept of DAEPO had become hot topics in China.

To provide guidelines for DAEPO, a call for best practices will be send to the global community in the coming months. More information about the Working Group is available at:

http://daepo.china-vo.org

Check this website for the latest information on the Working Group.

THE AMERICAN ECLIPSE OF 2017

by Jay Pasachoff, Williams College

Over ten million people are thought to have seen the solar corona from totality during the solar eclipse of 21 August, with a view of partial phases for over a hundred million more from the top of Canada southward through the US, Mexico, and Central America to northern South America.

Totality, only about 100 km wide, passed through parts of 14 U.S. states. Original cloudiness statistics (Jay Anderson, http://eclipseophile.com) favored the northwest states, especially Oregon, Idaho, and Wyoming, though totality was a few tens of seconds shy of the 2 m 40 s predicted for iffier weather at the peak totality of 2 min 40 s for southern Illinois and part of adjacent Kentucky.

Tourists from all over the country flocked into totality. A Task Force on the eclipse of the American Astronomical Society worked to get out clear information to the general public on how to observe the eclipse safely and why it was desirable to view totality. Tens of millions of eclipse glasses were distributed, including two million distributed free via public libraries. Astronomers without Borders is collecting used partial-eclipse glasses to send to South America for use during the 2019 and 2020 total eclipses that will be visible there.

My own eclipse site at Salem, Oregon—chosen as a spot in the most statistically favorable cloud-free region with facilities of a local university and local hotels—proved to have perfect weather on eclipse day, with not a cloud in the sky at eclipse time of 10:17 am local. We were protected by the Cascade mountain range from the forest fires that had put smoke in the air for weeks in advance and which led to worries for the many people who were to observe from eastern Oregon. The especially hot dry summer—even with temperatures greater than 40°C in Salem two weeks before the eclipse—has led to widespread major forest fires in the American northwest.

My own scientific expedition carried dozens of cameras and telescopes, and was sponsored by the Committee for Research and Exploration of the National Geographic Society. We took spectra of the corona, with an aim of continuing to follow the ratio of the coronal emission lines of Fe X and Fe XIV as a marker of coronal temperature over the sunspot cycle. We took high

frequency observations at 3 Hz through narrow (0.3 nm) filters in the same emission lines to look for periodic variations as a test of models of coronal heating. Our imaging is being used to match predictions based on MHD models of the corona from previous measurements of the photospheric magnetic field from the ground and from an instrument on NASA's Solar Dynamics Observatory. We also measured the effect on Earth's atmosphere from the umbra, which resulted in a drop in temperature and wind changes. We have posted some of our observations at:

http://totalsolareclipse.org.

Our scientific team of about 10 scientists from around the world (U.S., Slovakia, Greece, Venezuela) was joined by my 8 Williams College undergraduates, three of our alumni who are now graduate students, two alumni with Ph.D.s in astronomy, and additional collaborators. On site, we were also joined by a dozen Williams College alumni often there with families and a dozen or so professional astronomers from around the country who were taking welcome advantage of our logistics. We were also joined by a tourist group of a couple of hundred people on campus for the eclipse. We had coordinated and advised a team of almost 50 Japanese astronomers who were also on campus and a team of 28 Chinese astronomers who were a few dozen kilometers away. We had additional support from the N.S.F. for three black alumni and additional student support from the Massachusetts NASA Space Grant Consortium, the Clare Booth Luce Foundation, and Sigma Xi (the honorary scientific society), as well as from Williams College funds.

We are now preparing not only for the three partial solar eclipses in 2018 but also for the next total solar eclipses, both of which will cross Chile and Argentina. The wintertime July 2, 2019, total solar eclipse after it crosses the Pacific will end over first Chile north of La Serena and then near the Argentinian coast. The summertime—and therefore presumably with better cloudiness statistic—December 14, 2020, total solar eclipse will peak in the Atlantic, leaving prime observing near Las Grutas, Argentina.

In 2018, the February 15 partial eclipse will be maximum over Antarctica but will be visible from southern Chile and Argentina. The July 13 partial eclipse will be maximum over Antarctica but will be visible from Tasmania and the Melbourne area in Australia. The August 11 partial eclipse will be visible from a wide swath of the northern part of the world, including the Scandinavian peninsula and northern Russia and China.

Links to maps and other information about eclipses is available at the site http://eclipses.info for the Working Group on Solar Eclipses of the International Astronomical Union, and will be discussed at the General Assembly of the IAU in Vienna in late August 2018.

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WHERE IS NASA'S NEW HORIZONS GOING NEXT?

by Jay Pasachoff, Williams College

In an astounding feat of navigation and long-distance operation, NASA's *New Horizons* spacecraft culminated a 9-year passage from Earth by flying close to dwarf-planet Pluto on July 14, 2015.

About two Earth weeks (= 2 Pluto days) before the flyby, I participated from Canterbury University's Mt. John Observatory in New Zealand with using their 2-m telescope to observe Pluto occult a star. We were able to inventory Pluto's atmosphere on that date, with not enough time for the atmosphere to change before the flyby, so we have a direct comparison with our years of monitoring Pluto's atmosphere via stellar-occultation studies. It was my pleasure to be at Johns Hopkins University Applied Physics Laboratory in Maryland for the Pluto flyby, and a good time was had by all.

Anyway, during the 9 years of flight, it was assumed that some Kuiper belt object more-or-less straight ahead could be located; *New Horizons* was billed for NASA as a flight to Pluto and the Kuiper belt, a KBO (though Pluto itself is actually a Kuiper belt object). After several years of searching among the most star-dense parts of the Milky Way, and discovering approximately 50 objects near to, but still out of reach of the spacecraft, scientists involved asked for 200 orbits of *Hubble Space Telescope* time. They were offered 20 orbits with the rest contingent on finding two KBOs in the first 20 orbits, which happened. So in 200 orbits of Hubble time, the scientists found 5 objects, and finally selected one: 2014 MU69. Many of the KBOs that were not accessible by the spacecraft for flyby will be observed at better-than-Hubble distances and resolution by New Horizons.

From the mere name, 2014 MU69, you can tell that the object was found only in 2014, so its orbit isn't very well known. Figuring out where it is precisely enough to send the spacecraft to it would be difficult. With careful astrometry, it was figured out that there would be three stellar occultations on June 3, July 10, and July 17, respectively. New Gaia star catalogue of stellar positions from the European Space Agency allowed the team to figure out exactly where on Earth telescopes should be deployed. The object, 2014 MU69, is about 27th magnitude while the stars were about 12th through 15th magnitude. So basically, the star in view would blink out entirely, with nearly no light received from the occulting star.

But much would be gained from such an occultation, if successful. For one thing, KBOs can have albedos anywhere from 4% or so to 99%, meaning that the SwRI group would like to know the size of the KBO so they could compute the albedo. Pinpointing the position of the KBO so precisely, improves spacecraft targeting. With that in mind, Stern got a grant from NASA to buy 23 0.4-m Dobsonian telescopes with inexpensive CCDs and to send about 60 of us to set up in more-or-less a north-south line, a "picket fence," to capture where the object was and how big it was.

On June 3, I was part of the Argentinian half of the expedition, with the other half going to South

Africa. My partner as an observation pair was Muzhou Lu, a Williams College alumnus who is now a graduate student in engineering at the University of Colorado at Boulder. We set up on a north-south line mostly south of the Argentinian city of Mendoza, spaced about 8.2 km apart. We practiced one night in a local park and three nights in the countryside before our actual night of observation. On each of those occasions, we drove our telescope and equipment out from the city to a roadside position, set it up, and took some observations. An equal-size group was spread out in South Africa, though with the eventual cloudiness near the Atlantic coast, half of them the preceding night decamped and moved hundreds of kilometers east, in search of clear weather. In Argentina, Marc Buie headed our team and calculated where we should go, based on the latest predictions.

Finally, about midnight on June 3, we succeeded in getting all 12 of our telescopes on target, providing light curves in clear sky. But no occultation was seen. All the light curves were flat.

Buie continued to get Hubble data, with 140 new observations of MU69. The data were reduced in time for the flight of NASA's 2.5-m telescope aboard its Stratospheric Observatory for Infrared Astronomy (SOFIA) on July 10. Scientists with SOFIA took data at 20 Hz, largely in a search for debris or rings near MU69 that could endanger the eventual spacecraft passage. The light curve seemed horizontal—though with one (!) low point. The pilots had taken the 747 airplane within 4.5 wingspans of the expected location within a second of time, but still didn't have a full occultation. Perhaps the path just clipped the end of the KBO.

On July 17, all the two dozen telescopes, plus a couple more, were in Argentina, but farther south—colder and windier for both the latitude effect and the seasonal change. I was unable to participate this time because of my pre-solar-eclipse responsibilities. This time, five of the telescopes picked up occultations—dropouts of less than a second in the brightness of the target star (https://www.theverge.com/2017/7/21/16000942/nasa-new-horizons-pluto-2014-mu69-occultation).

The occultations lasted only a second or two, and, strangely, they didn't give a sensible shape for the object from the lengths of the dropouts. It seems that MU69 may even be a double object, with one object more-or-less behind the other during the July 17 event. Amanda Sickafoose's light curve with a big telescope at the South African Astronomical Observatory for the June 3 event may have missed the occultation by only a half-dozen kilometers, beyond our picket fence of hundreds of kilometers.

At the October meeting in Provo, Utah, of the Division for Planetary Astronomy of the American Astronomical Society, a fantastic session of a half-dozen 10-min papers were given about various aspects of the MU69 results; a final paper covered the Hubble light curves, which were flat.

Marc W. Buie; Simon B. Porter; Dirk Terrell; Peter Tamblyn; Anne J. Verbiscer; Alejandro Soto; Lawrence H. Wasserman; Amanda M. Zangari; Michael F. Skrutskie; Alex Parker; Eliot F. Young; Susan Benecchi; S. Alan Stern, 2014 MU69 Occultation Team
504.01. Overview of the strategies and results of the 2017 occultation campaigns involving

(486958) 2014 MU69

Simon B. Porter; Marc W. Buie; John R. Spencer; William Folkner; Alex Parker; Amanda M. Zangari; Anne J. Verbiscer; Susan Benecchi; S. Alan Stern; Dirk Terrell; Alejandro Soto; Peter Tamblyn; Lawrence H. Wasserman; Eliot F. Young, 2014 MU69 Occultation Team
504.02. Ultra-High Resolution Orbit Determination of (486958) 2014 MU69: Predicting an Occultation with 1% of an Orbit

Amanda M. Zangari; Marc W. Buie; S. A. Stern; Dirk Terrell; Simon B. Porter; Anne J. Verbiscer; Alejandro Soto; Peter Tamblyn; Susan Benecchi; Alex Parker; Lawrence H. Wasserman; Eliot F. Young; Michael F. Skrutskie, 2014 MU69 Occultation Team
504.03. A stellar occultation by (486958) 2014 MU69: results from the 2017 July 17 portable telescope campaign

Alex H. Parker; Marc W. Buie; Amanda M. Zangari; S. Alan Stern; John R. Spencer; Anne J. Verbiscer; Simon B. Porter; Susan Benecchi, 2014 MU69 Occultation Team
504.04. Multiplicity of the New Horizons Extended Mission Target (486958) 2014 MU69

Anne J. Verbiscer; Marc W. Buie; Simon B. Porter; Peter Tamblyn; Dirk Terrell; Susan Benecchi; Alex Parker; Alejandro Soto; Lawrence H. Wasserman; Eliot F. Young; Amanda M. Zangari, 2014 MU69 Occultation Team
04.05. Portable Telescopic Observations of the 3 June 2017 Stellar Occultation by New Horizons Kuiper Extended Mission Target (486958) 2014 MU69

Eliot F. Young; Marc W. Buie; Simon B. Porter; Amanda M. Zangari; S. Alan Stern; Kimberly Ennico; William T. Reach; Enrico Pfueller; Manuel Wiedemann; Wesley C. Fraser; Julio Camargo; Leslie Young; Lawrence H. Wasserman, 2014 MU69 Occultation Team
504.06. Debris search around (486958) 2014 MU69: Results from SOFIA and ground-based occultation campaigns

Susan D. Benecchi; Marc W. Buie; Simon B. Porter; John R. Spencer; Anne J. Verbiscer; S. Alan Stern; Amanda M. Zangari; Alex Parker; Keith S. Noll
504.07 The HST Lightcurve of (486958) 2014 MU69

I am one of about six-dozen members of the “2014 MU69 Occultation Team”; we will be collaborating on the paper soon to be submitted to a scientific journal. The calculations, with a lot of Bayesian statistics, were very difficult and abstruse, and do not give a clear result. Still, the albedo turns out to be about 10%, and the spacecraft can be sent to within about 3500 km, about 3 times closer than it went to Pluto.

The results of the January 1, 2019, flyby of 2014 MU69 by *New Horizons* should be spectacular. I intend to join the group of SwRI and other scientists at the Johns Hopkins University Applied Physics Lab to await the results, as we did for the Pluto flyby in 2015.

Jay Pasachoff, Chair, IAU Working Group on Eclipses
Field Memorial Professor of Astronomy, Williams College, Williamstown, MA 01267, USA

NOTICES AND ANNOUNCEMENTS

STUDENT RESEARCH PROJECTS IN VARIABLE-STAR ASTRONOMY

Since 1911, the non-profit American Association of Variable Star Observers (AAVSO) has been enabling "citizen astronomers" to contribute to astronomical research by making systematic, sustained measurements of the changing brightness of variable stars. Over 33,000,000 measurements are freely available in the AAVSO International Database (AID), accessible through the AAVSO website http://www.aavso.org, for professional and amateur astronomers and students. These data have already contributed to literally thousands of research papers. The AAVSO website also provides a gold mine of information and resources on variable stars, including software which amateur (or professional) astronomers and students can use to further analyze the data.

Two decades ago, the AAVSO recognized the educational potential of variable star observation and analysis, and created *Hands-On Astrophysics (HOA)*, with National Science Foundation support. *HOA* evolved into an online resource, *Variable Star Astronomy:* http://www.aavso.org/education/vsa It enables students to develop and integrate their science and math skills by doing real research, with real data. For links to our other educational resources, see http://www.aavso.org/education The AAVSO has also built up a list of suggestions for student projects: http://www.aavso.org/student-observation-projects

Now, the AAVSO is reaching out to instructors, and their students, who want to carry out and publish astronomical research, using AAVSO data and software. The *Journal of the AAVSO (JAAVSO),* founded in 1972, and professionally edited and produced, is a refereed journal which publishes high-quality student research, as well as other research on variable stars and related topics. If you are a senior high school or college or university astronomy instructor, with an interest in astronomy, and with students who are looking for research projects, we would like to help you. We would also like to hear from you. We value your interest, feedback and suggestions, as we again commit to supporting student research on variable stars. We will continue to keep you informed of the resources which are available for student research projects, and the opportunities to publish them.

You can read about my own experience in using variable-star observations for student research projects at http://arXiv.org/abs/1710.04492

Professor John R. Percy
Editor-in-Chief: JAAVSO
American Association of Variable Star Observers
49 Bay State Road, Cambridge MA 02138
www.aavso.org; aavso@aavso.org

IAU- ONE DAY WORKSHOP ON EDUCATION IN ASTRONOMY AND ASTROBIOLOGY -GA 2018

Sunday 2018-08-19, Kuffner-Observatory, Johann-Staud-Straße 10, 1160 Wien, Austria

SOC: Rosa Ros, Margarita Metaxa, Constance Walker, Rosie Cane, Jonas Souza, Muriel Gargau, Inge Loes ten Kate, Beatriz García

After the ISE2A (https://ise2a.uu.nl/) symposium organized on July 3rd-6th 2017, in Utrecht, we realized that a permanent action on Education in Astronomy and Astrobiology could be useful to

- install this subject in both communities,
- start a discussion about good practices by teaching professors how to teach astronomy and astrobiology in the classroom
- inviting professional astronomers to join us in this activity

In this opportunity, as part of the satellite activities proposed because the XXX IAU-GA 2018, the Inter-Division B-C Commission Protection of Existing and Potential Observatory Sites, the C1- Education and development of Astronomy and the Inter-Commission C1-F2-F3-H2 WG Education and Training in Astrobiology, propose a meeting to develop different topics and resources ready to be used for educators and invite Secondary and High School professors as well as IAU Colleagues to a OneDay Workshop on Education.

For more details or for inscriptions, please contact:

Margarita Metaxa (marmetaxa@gmail.com), Rosie Cane (rosiecane93@gmail.com), Beatriz Garcia (beatriz.garcia@iteda.cnea.gov.ar)

Agenda

8:00-08:30

Inscription and Opening

8:30-11:00 - **First session**

Light Pollution and Quality Lighting Teaching Kit.

- Introduction to the motivation for the project and how it benefits students (15 min)
- Light pollution issues relevant to students' lives and how the issues connect with the activities (15 min)
- Hands-on experiences with the six activities (20 min each for 5 activities; 30 min for one activity)

- Question and answer discussion period (20 min) (This may be interwoven with the above topics.)
- Globe at Night project.

11:00- 11:30 Coffee

11:30 – 14:00 - **Second Session**

Network for Astronomy School Education (NASE)

- Introduction: NASE and ISO Quality Management (20 min)
- NASE activities about 10 minutes for each one (1.5 hour)

- Local Horizon
- Sun-Earth-Moon System
- Instruments: quadrant, goniometer, celestial charts, sundial.
- Electromagnetic Spectrum: te spectrometer and astronomy beyond the visible and
- Cosmology

- Evaluation (15 minutes Beatriz)
- WEB contributions rom Local Working Group (15 minutes)
- Summary (10 minutes) Beatriz and Rosa

14:00- 15:00 Lunch

15:00 -17:30 - **Third session**

Astrobiology Workshop :

- **Introduction to astrobiology** (20 minute presentation)

ㅎ ㄹ Overview of astrobiology, some of the most likely places we might be able to find life beyond Earth and how it can be used to introduce various other subjects to the science curriculum.

- **Astrobiology-in-a-box activities** (1 hour) composed of:
- Detection of Life Experiment (20 minutes)

Experiment about the characteristics of life, how we can identify life and what the implications might be for the search for life elsewhere.

- Extremophiles and the Limits of Life (15 minutes)

Experiment looking at the limits of life, how the growth of life is influenced by its environment and what sorts of physical conditions might limit life.

- UV Radiation and Damage to Life Experiment (10 minutes)

Experiment specifically focused on radiation as a damaging agent for life - links to radiation on Mars. Ultraviolet radiation in sunlight in particular can limit the ability of life to grow.

- Pressure and Limits of Life Experiment (15 minutes)

Experiment demonstrating that pressure can influence the boiling point of water and the availability of liquid water for life.

- **Introduction to astrobiology lesson plan booklet and exoplanet Top Trump cards** (1

hour)

Run through of the ‘detecting life on exoplanets’ activity from astrobiology lesson plan booklet and introducing educational Top Trumps card game.
(lesson plan booklet will be available soon).

- **Summary** (10 minutes)

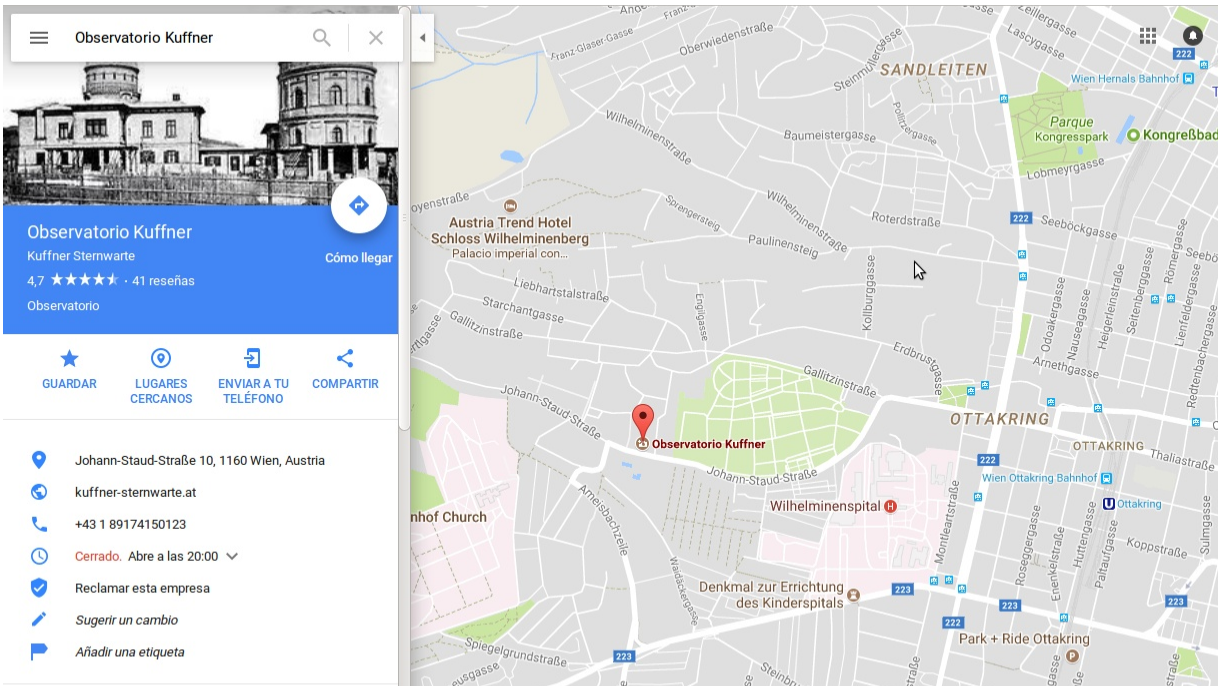
17:30- 18:00 Coffee

18:00 - 18:30

Conclusions
Closing session

The Observatory

Kuffner-Sternwarte is a historical Observatory dating from the end of the 19th century. Moriz von Kuffner, former owner of the brewery in Ottakring, founded the Observatory as a private scientific institute in the year 1886. Today, Kuffner Observatory can be visited during guided tours, exhibitions and seminars.
ttp://kuffner-sternwarte.at/index.php



HANDS IN THE STARS: AN ENCYCLOPAEDIC DICTIONARY OF ASTRONOMY FOR SIGN LANGUAGE IN FRENCH, ENGLISH AND SPANISH

by Dominique Proust, Amelia Ortiz-Gil and Beatriz García

…From an Astronomy for Sign Language French dictionary by Dominique Proust, Daniel Abbou, Nasro Chab, Yves Delaporte, Carole Marion and Blandine Proust (Burillier ed. 2009).

In the world of science in general and astronomy in particular, Sign Language has enabled a remarkable advance in communication, both in the knowledge of deaf culture and by the use of sign language (SL), thus removing any barriers between the deaf and the hearing.

Science signs

SL is a perfectly structured language with its own vocabulary and grammar. It is expressed within precise rules which are linked to basic physical movements. Like every language, it continually evolves and its scientific and technical vocabulary is getting permanently established with new signs such as Numeric, Internet, DVD, Microprocessor, etc.
In mathematics, numbers are signed in a sequence of signs: 1,515 is signed as ONE THOUSAND + FIVE HUNDRED + FIFTEEN. Large numbers (millions, billions) have their own signs and operators. For example, the square root sign √ is signed using both hands in an identical way. All quantities are signed whether weight, surface, volume or distance. Pythagoras' Theorem is signed in a similar way to the oral version such that the hypotenuse is signed as "the side facing the right angle". Geometry follows the same rules with the hands firstly describing a perpendicular, a plane or an area. The derivation of a system of co-ordinates is precisely indicated.

Physics uses a number of explicit signs for each area. Constants are named using the same letter e.g. "c" is the velocity of light (SPEED + LIGHT) where c = 300,000 km/s. "Electricity" is signed with the fists facing each other in front of you with the index fingers curving inwards and upwards just like electrodes. "Nuclear energy" uses two signs, the first being a generic sign for all forms of energy and the second symbolizing nuclear power. In Chemistry, the elements are signed either specifically or by the chemical symbol.

Astronomy is one of the areas where signing in SL is both rigorous and at the same time poetic. Signs attributed to the different planets of the Solar System have recourse to their own characteristics. For example, Mercury is very close to the Sun, Mars is red, Jupiter is represented by its famous red spot which has been seen by telescope for centuries, Saturn is known by its rings. The representation of the heavens is helped by the majority of constellations evoking animals or objects which already have a sign e.g. bears (great and little), swans, fish, whale etc. Mythological names follow legend so for example Orion is a hunter while Centaurus is a being with the body of a man mounted on a horse.

Scientific technology is signed as well with for example computers identified by their model (PC, laptop etc). Certain terms are very often found with an equivalent particular sign such as “digital” which becomes 1-0-1-0-1-0. Medicine and biology have their own very complete and technical vocabularies.

This overview can obviously only give a rough idea of scientific communication in SL. Facial expression is extremely important whether it’s to express that a mathematical sequence tends to infinity, and is thus “very small” or that the star Vega in the Lyre constellation has a surface temperature of 35,000 degrees and is thus “very hot”. Besides the rigors imposed in scientific language, the signer accompanies (in the musical sense of the term) his words with gestures by which the linking of the signs together relies on their interpretation. This duality interpretership – interpretation transforms the precision of the words to one where there is not only understanding but also feeling. In this way, the association of physical expression with the narrow observance of academic scientific discussion brings a touch of humanity and sharing to an otherwise rough world.

An SL astronomical dictionary

The idea of an astronomical dictionary first saw the light of day following a program broadcast in SL in the French television series “The Eye and the Hand”. Furthermore, since 2000 there have been monthly classes in astronomy organized by the Paris Observatory at Meudon in the program of “Astronomy for All” (AfA) with a goal of sharing knowledge linked to astronomy, astrophysics and related sciences (planetology, climatology, exobiology…) with the general public who have difficulty in accessing the culture of science.

This dictionary is the first one to create a detailed link between astronomy and the deaf community. If astronomy is probably the most ancient of the sciences, the difficulties of man’s perception of an immense universe where space and time come into play join up with certain of the concerns of the deaf in a world of sound. As a consequence, the signing of some of the terms essential to astronomy has resulted in the creation of neologisms, in particular for terms borrowed from tradition. As an example, it’s easy to find an equivalent sign for the name of a constellation where it’s a question of animals or objects but where the name of a constellation refers back to the time of Ptolemy and Ancient Greece, this calls for a bit of imagination. Cepheus is represented by the compound sign “Bearded King”, Cassopeia by the sign “Queen” and their daughter, the princess Andromeda by the compound sign “Chained Woman” which is a reference to the myth which shows her chained to a rock having attracted Poseidon’s wrath.

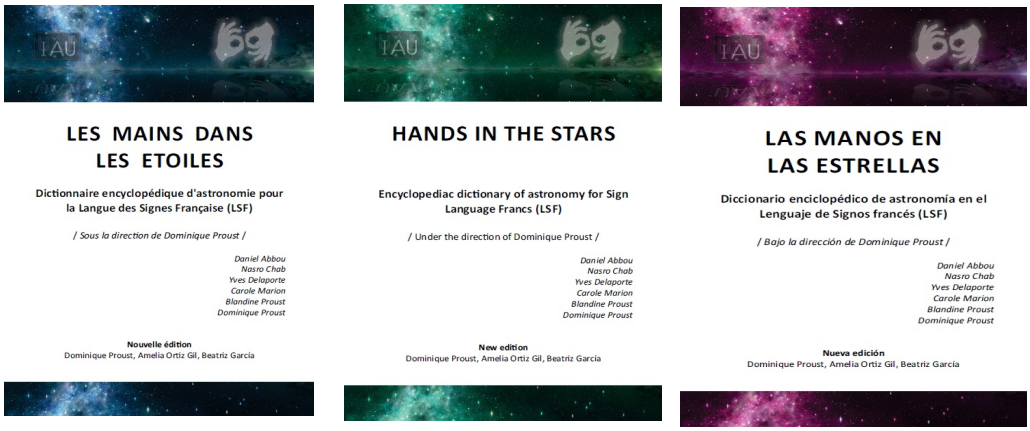
We have been careful to avoid homonyms or paronyms. For example it’s essential to be able to distinguish between Saturn with its ring and a galaxy with its disc. This research into signed equivalents has given rise to long reflection when the astronomical tem is itself of recent appearance and refers to a very complex object. One particular example of this concerns the quasar which is contraction of the English “quasi-stellar radiosource”. We had to wait until the 1960s to understand that a quasar was not a star, even if it appeared to have the same dimensions, but a much further object whose energy burst, identical to that of an entire galaxy, comes from a tiny core. A sign for this that has been put forward by the deaf collaborators on this dictionary

goes as follows: “I see a small brilliant source of light in the sky; I open it to see the interior; I am amazed to see the central area of a galaxy enclosed in this space with considerable energy.” Finally, we came up with the compound sign “Same + Galaxy + Energy + Power”.

This dictionary has as its aim to bring together the essential components of astronomy and to turn them into an SL encyclopaedia. For the reader who doesn’t practice SL, we recommend doing a basic course in parallel. This can be found within different organizations and associations run by deaf teachers. We have wanted to create a work tool aimed at teachers as well as those interested in deaf culture and astronomy.

Each entry is accompanies by a picture of the corresponding sign as well as a commentary explaining the different parameters of each sign. Where the sign refers to antiquity, this commentary also has an etymological slant. The drawings are the work of Carole Marion; movements are represented by arrows in line with the publisher SL long-established conventions.

Website: http://sion.frm.utn.edu.ar/iau-inclusion/



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NOBEL PRIZE AWARDED FOR DISCOVERY OF MOLECULAR MECHANISMS CONTROLLING THE CIRCADIAN RHYTHM

Article by the International Dark-Sky Association (IDA) (www.darksky.org)

On October 2, the Nobel Assembly at Karolinska Institute announced the 2017 Nobel Prize in Physiology or Medicine is awarded jointly to Jeffrey C. Hall, Michael Rosbash and Michael W. Young "for their discoveries of molecular mechanisms controlling the circadian rhythm." This monumental and important work can now be added to the growing body of evidence that affirms the importance of natural light and darkness.

*Using fruit flies as a model organism, this year's Nobel laureates isolated a gene that controls the normal daily biological rhythm. We now recognize that biological clocks function by the same principles in cells of other multicellular organisms, including humans. With exquisite precision, our inner clock adapts our physiology to the dramatically different phases of the day. The clock regulates critical functions such as behavior, hormone levels, sleep, body temperature and metabolism. Our wellbeing is affected when there is a temporary mismatch between our external environment and this internal biological clock, [and there] are also indications that chronic misalignment between our lifestyle and the rhythm dictated by our inner timekeeper is associated with increased risk for various diseases. (*1)

Since the 18th century, we've understood that the circadian rhythm exists and that disturbances to the biological clock can harm plants, animals, and humans, but we lacked an understanding of the mechanisms that controlled these inner rhythms. The Nobel Assembly's recognition of Hall, Rosbash and Young's work aligns with IDA's position on artificial light at night and further builds on the recommendations of the American Medical Association, which affirmed human health impacts from LED lighting in 2016.

Dr. Richard G. Stevens, Professor of Community Medicine and Health Care at UConn Health, told IDA, "Until quite recently, circadian biology was considered a quaint little sub-topic of biology in general. However, the 2017 Nobel Prize for discovery of the mechanisms controlling circadian rhythmicity highlights the fact that circadian biology is fundamental to all biology in almost all organisms on the planet."

Referring to the Nobel Prize citation, Stevens further noted that “Electric light that is too bright, and too blue at the wrong time of day disrupts our circadian rhythmicity. Using it unwisely is the most potent source of ‘misalignment’ in the modern world.”

Today’s announcement is indicative of the importance of understanding the underpinnings of the circadian rhythm: how organisms, including humans, respond biochemically to changes in the intensity of light in their environments. With more detailed information about the molecular machinery that translates the environmental cues in the day/night cycles of our world to biological action, we can better appreciate the disruption caused by exposure to artificial light at night.

Elevation of circadian biology to Nobel-worthy science affirms many of the concerns IDA has raised since 2010 regarding known and suspected hazards to human health and wellbeing. (2,3) To the extent that today’s Nobel Prize highlights the mechanism of the circadian rhythm, it clearly implies the main source of its disruption: the careless application of artificial light at night.
The potential for circadian rhythm disruption to cause or contribute to human disease should be evaluated cautiously and skeptically. IDA urges further research into artificial light exposure and its effects on biology.

NOTES:
1) The 2017 Nobel Prize in Physiology or Medicine – Press Release. (n.d.). Retrieved October 02, 2017, from https://www.nobelprize.org/nobel_prizes/medicine/laureates/2017/press.html

2) IDA, “Visibility, Environmental, and Astronomical Issues Associated with Blue-Rich White Outdoor Lighting” (2010). White paper. Retrieved October 02, 2017 from http://darksky.org/wp-content/uploads/bsk-pdf-manager/8_IDA-BLUE-RICH-LIGHT- WHITE-PAPER.PDF

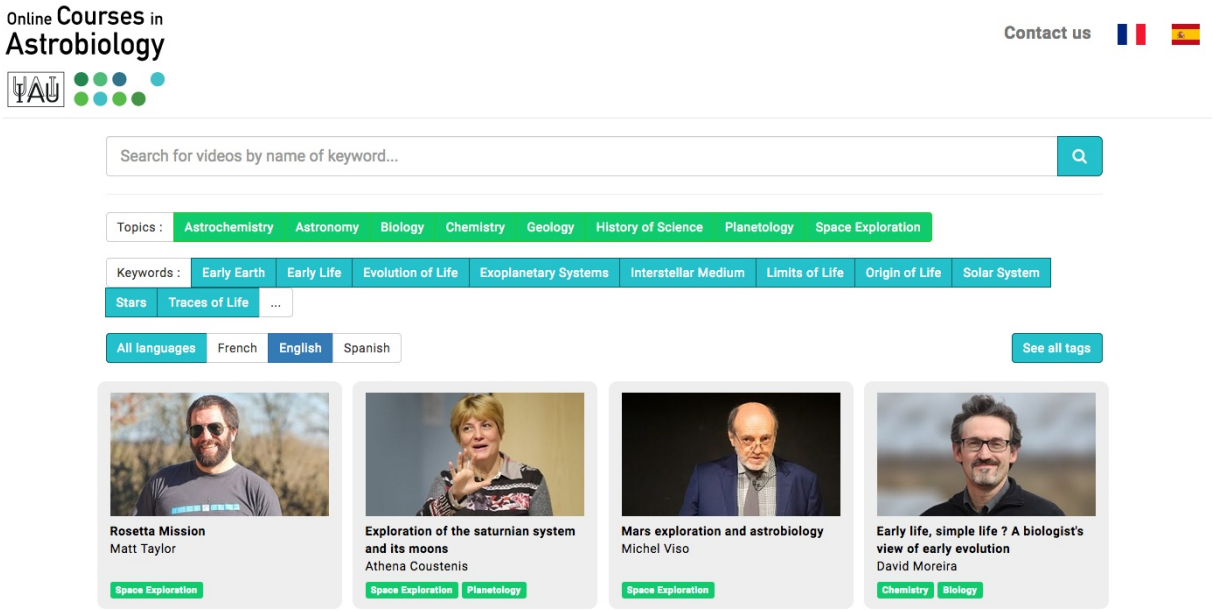
3) IDA, “IDA Issues New Standards on Blue Light at Night”. Blog post. Retrieved October 02, 2017 from http://www.darksky.org/ida-issues-new-standards-on-blue-light-at-night/

ONLINE COURSES IN ASTROBIOLOGY

In the framework of the IAU Inter-commissions C1-F2-F3-H2 WG on "Education and Training in Astrobiology", we are pleased to announce the launch of the platform "Online Courses in Astrobiology »: http://astrobiovideo.com/fr/

This platform accessible for free to everybody aims to collect high quality lectures in astrobiology for Master/PhD students in french, english and spanish (more languages may be added later on).

General public conferences can also be considered.



Please don't hesitate to suggest us any high quality recorded lecture you may have given or you are aware of, one international expert panel will check the eligibility of each proposal.

Contact:
Muriel Gargaud(muriel.gargaud@u-bordeaux.fr) and
Herve Cottin (herve.cottin@lisa.u-pec.fr)

ESASKY: TEACH ASTRONOMY WITH REAL ASTRONOMY DATA

by Belén López Martí and Bruno Merín
(On behalf of the ESASky team[1])

One of the most important goals of science education is that students understand how science works. To achieve this, students' work should resemble as much as possible that of real scientists –allowing them to put the scientific method in practice and to discover and test scientific facts on their own. Yet this is not always easy, in particular in fields like Astronomy, where the requirements (in terms of equipment and working conditions) make it complicated to translate real-science activities into classroom activities.

Fortunately, in the last decades, technological developments have contributed a lot to simplify this task: Computers (or tablets) are now a common sight in many classroom landscapes, and software tools have been developed that enable students to work with astronomical data in a similar (but simplified) way to professional astronomers. They can even perform real-time observations from their classrooms using robotic telescopes that may be located on the other side of the world. All this effort has contributed to make Astronomy education easier and funnier, and to reach students of younger and younger ages.

Yet the use of real professional data, and especially data from space missions, in Astronomy education is still very limited, and very often restricted to the most advanced (college-level) students, for three main reasons: i) the difficulty in finding and retrieving those data, usually kept in archives and databases with not very intuitive access interfaces; ii) the variety of data products available, that makes it difficult for a non-expert user to identify the most suitable product for their specific needs; and iii) the need, in many cases, to process the data prior to their scientific use, a step that requires good knowledge of the data and their acquisition process, and that most students and their teachers are not prepared to carry out.

By a happy chance, these problems are the same that professional astronomers must face when they want to use data from a telescope, instrument or wavelength range they are not familiar with. This is a serious caveat in a time when astronomical research has become increasingly more and more multi-wavelength. In addition, while the utility life of the data products from a given mission may extend long beyond the operational life of that mission, after a few years, memory of the mission's characteristics and peculiarities is almost forgotten by the community. Therefore, in the last decade, all major astronomical data providers have devoted efforts to develop tools that ease the task of searching and retrieving data from their data archives to users of all levels of expertise. It is now standard practice that observing facilities and space missions provide pipelines for quick and efficient data processing, and/or science-ready products that match the requirements from most users. It has also become customary that these data are served online through customisable archive interfaces.

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[1] Team members: Fabrizio Giordano, Henrik Norman, Bruno Merín, Deborah Baines, Elena Racero, Sara Alberola, Belén López Martí. We acknowledge Beatriz González, from the CESAR team, for her support in the preparation of the educational activities.

Within this context, at the ESAC Science Data Centre (ESDC) we have developed *ESASky* (http://sky.esa.int), a science-driven discovery portal providing simplified access to astronomical data from space missions. This web-based tool allows users to quickly visualise data from all ESA space missions, as well as missions from other agencies, and to easily retrieve science-ready data from the corresponding mission archives, without assuming any prior knowledge of the mission and/or data characteristics.

While originally designed with the professional user in mind, the tool's advanced visualisation capabilities and its ease-of-use make it very appropriate as well for Astronomy students of all levels. The application includes a large number of *skies*, all-sky panoramas (technically called Hierarchical Progressive Surveys, or HiPS) displaying all the observations carried out by ESA's major astronomy missions across the spectrum, as well as observations by missions and ground-based telescopes from other data providers (CDS, NASA, JAXA…). Thus, it is now possible, with just a quick glance, to know if a given astronomical object has been observed by a given mission and what it looks like in that particular wavelength range. The application allows users to create a stack of these panoramas and seamlessly switch between them, either by hand or using the video-style buttons, to see how an object's appearance changes across the whole electromagnetic spectrum *(Figure 2)*. This way, students can inspect and compare astronomical images in all wavelength ranges and extract conclusions from the appearance and colours of the objects, all without having to download or process anything. They can also take snapshots of the sky regions being visualised to include the images in school reports, web pages, or blogs.

More advanced students can download the images themselves to carry out measurements and data analysis locally in their computers. This is done by clicking in the appropriate button to bring up the imaging data menu, which provides information on all the images available in the area of the sky being visualised, grouped by mission and wavelength range, in a graphic colourful chart where each box size provides a graphical idea of the amount of data available for that given mission/range combination. By clicking on the box, a table is open summarising the information on those data (central coordinates, filter, duration, etc.), and, at the same time, the contours or *footprints* of the images are displayed on top of the visualised sky *(Figure 3)*. It is possible to sort the table columns and to filter the data to display only the information on those images fulfilling certain conditions, and to select and download only those images we really want.

And not only images: *ESASky* also provides catalogue data and spectra. All data are science-ready (fully processed and calibrated), and they are retrieved directly from the scientific archives. For the most advanced students, the tool is VO-compliant, so they can send the data directly to their favourite VO application.

Another functionality with high potential in education is the possibility to search for Solar System objects (comets, asteroids and dwarf planets). When the name of a Solar System object is entered into the search box, the application provides information on all the imaging observations available that intersect (in space and time) the orbit of that object in the sky. The procedure is the same as with other data: By clicking on a box in the graphical chart, a table opens summarising all the information on the available data from that mission and wavelength range, and the image

footprints are displayed in the sky. But in this case, all images over the whole sky are displayed (and not only in the region visualised), together with the path followed by the object in the sky over the whole mission lifetime *(Figure 4)*. This is a fast and visual way of identifying observations of that particular object in the mission archive, but also to see how it has moved in the sky –providing, for example, a nice visual example of prograde and retrograde motion. Students may even find images that have serendipitously observed their target because it happened to be in the field of view, which may yield to exciting discoveries.

At the ESDC we are so convinced of the possibilities that *ESASky* opens for Astronomy education, that we have started a collaboration with the *Cooperation through Education in Science and Astronomy Research* (CESAR) project at ESAC (http://cesar.esa.int) to develop educational activities that make use of the application. The first activities are already available in the CESAR pages or through the URL: https://www.cosmos.esa.int/web/esdc/esasky-for-education. They use the skies visualisation feature of *ESASky* in a guided investigation for students to discover the properties of galaxies and of the interstellar medium. We plan to keep offering more activities in the near future, adapted to different student levels, and some of them making use of other tool functionalities.

To conclude this contribution, we want to invite educators to test the application and to develop their own activities with it. If you do so, we kindly ask you to provide us feedback on the issues you may find and the features you would like us to improve/add to make it a better tool for education. You can contact us in: http://esasky.userecho.com/

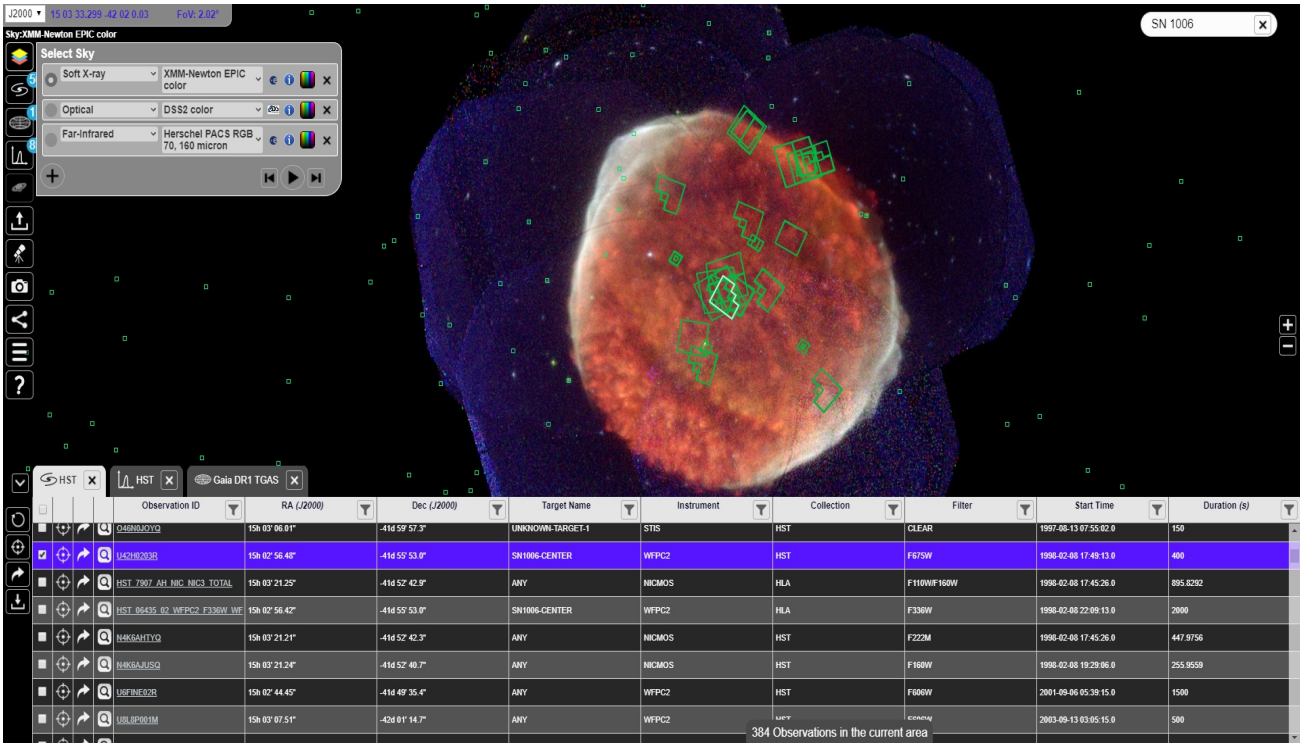

Figure 1: The ESASky interface with some of its functionalities.

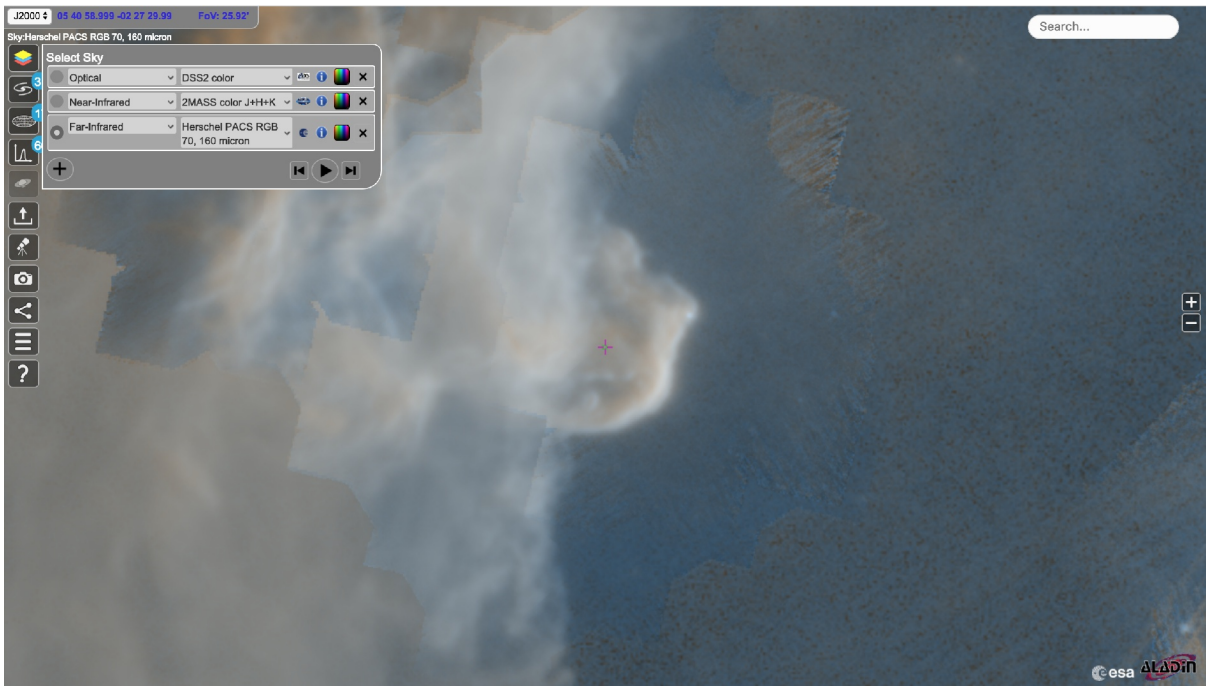

Figure 2: The ESASky skies menu, with a stack of several maps. The image displays the Horsehead Nebula as observed by the PACS instrument onboard the Herschel Infrared Observatory.

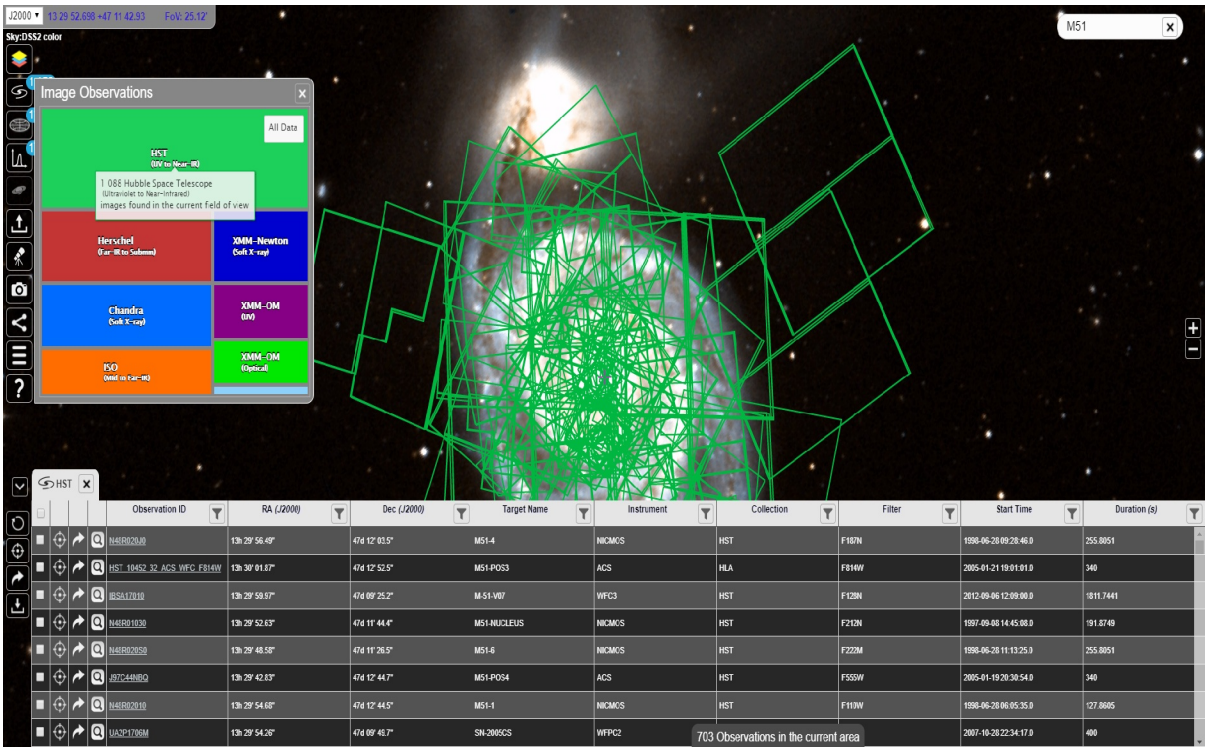

Figure 3: The ESASky imaging data panel displaying the available data in the region of M51, the Whirlpool Galaxy (in the image). The open table summarises the available Hubble Space Telescope data, whose footprints are displayed on top of the sky image.

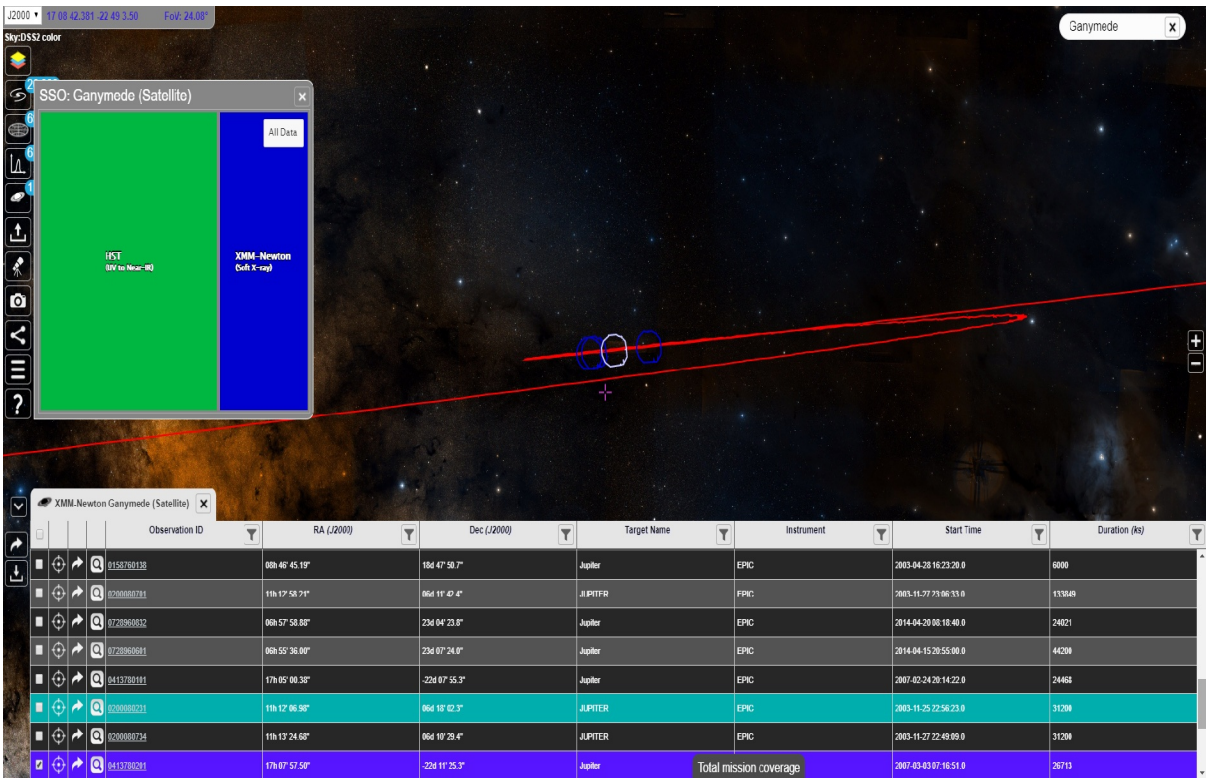

Figure 4: The ESASky Solar System object functionality. The data panel shows the data available for asteroid Vesta. The table summarises the data available from the Herschel mission, whose footprints are displayed on the sky together with the orbit of the asteroid in the sky.

ANNOUNCEMENT OF BULGARIAN ASTRONOMICAL JOURNAL

by Daniela Kirilova, Dr.Sc. Editor in Chief of BAJ

Dear colleagues,

You are cordially invited to submit or recommend articles to the 28th volume of the Bulgarian Astronomical Journal. Review articles are highly appreciated as well.

Advantages of the journal: peer review; no page charges; on line and printed versions available; free online access; indexed/abstracted by ADS, SCOPUS, Elsevier, Clarivate Analytics and other databases, increasing impact rang.

The deadline for submission of manuscripts is 15 November 2017.

Manuscripts should be submitted to the journal at journal@astro.bas.bg. Bigger than 2 Mb you may send to kirilovadp@gmail.com.

More information about the journal is available at: www.astro.bas.bg/AIJ/.

Best regards,

Editor in Chief,
Dr. Sc. Daniela Kirilova, Assoc. Prof.
Institute of Astronomy and NAO
Bulgarian Academy of Sciences

OAD ANNOUNCEMENT : ANNUAL CALL FOR PROPOSALS

Period: 1 April to 26th October 2017

by Kevin Govender, IAU Office for Astronomy Development

1. **OAD Annual Call for Proposals:**
   a. Based on lessons learned from the first 5 calls, the structure of the 6th call (in 2017) was significantly changed to a now two-stage call process, after consultation with Task Forces (TFs), Regional Offices of Astronomy for Development (ROADs) and Language Centres of the OAD (LOADs).
   b. Stage 1 was opened on 28th April 2017 and closed on 31st May 2017. We received a total of 114 proposals for Stage 1 (31 for TF1, 58 for TF2, 25 for TF3).
   c. During June 2017 TFs scored and selected the proposals to proceed to Stage 2. ROADs/LOADs provided comments on proposals relating to their regions, and chose one project per region to send through to Stage 2. By the end of June 2017, 40 proposals were selected to move on to Stage 2, and proposers of all 114 projects were notified of the results, with feedback from regions and TFs.
   d. The 40 selected Stage 2 proposers interacted with the OAD, ROADs/LOADs and other collaborators as relevant (e.g. a development economist and an anthropologist who came to the OAD weekly to help discuss these proposals). Final proposals were received in mid-September after which they were submitted to the TFs for review. Results will be finalized during November 2017.
   e. This new call process is already proving very useful to enhance the quality of proposals. Several lessons are being documented for discussion at the next face-to-face meeting of the OAD Steering Committee in January 2018.

2. **Regions:**
   a. The second face to face meeting of all regions took place in Ethiopia on 26th May 2017, as a side event of the Middle East and Africa Regional IAU Meeting (MEARIM). There was also a special plenary session for OAD regional offices at MEARIM itself.
   b. A new coordinator has been appointed for East African ROAD (Ethiopia), and a side event to the MEARIM meeting was used to sign an addendum to the East African ROAD agreement. The addendum was signed by Piero Benvenuti and Minister of Science and Technology, and reflects structural changes in the Ethiopian astronomy and space landscape.
   c. Govender visited the Arab World/Arabic Language ROAD/LOAD in Jordan. There are structural changes underway with a move to a new physical location in September 2017. A regional workshop will be held in November. Jordan also hosts the World Science Forum that month.
   d. The host of the South East Asian ROAD, NARIT, inaugurated the UNESCO International Centre for Training in Astronomy in August. Govender attended a workshop on Astronomy Education and delivered a talk on the work of the OAD and its regions.

e. Various engagements are ongoing regarding the potential establishment of a ROAD in Europe, with the lead organization being the European Astronomical Society.
f. The Portuguese Language Office held a workshop in Brazil on 7th September 2018, in order to consolidate the network and plan activities. The meeting was in Portuguese so the OAD only joined by video for a (translated) presentation and discussion.
g. The three African ROADs and the Arab ROAD met in person in Ethiopia on 6th October 2017 as part of a Space Awareness event. This was a useful opportunity to work together on regional plans. Among the items agreed to, is that these regions will meet regularly and separately from the others in order to better coordinate the African region.
h. The most recent quarterly meeting of regional coordinators took place on 29th September 2017. Individual conversations are ongoing regarding reviews of offices.

3. **Staffing:**
   a. Eli Grant officially left the OAD on 31st August. We continue to enjoy her advice and support as a volunteer.
   b. We bid farewell to Karabo Makola, who had spent a year at the OAD as a DST/NRF intern dealing with OAD communications.
   c. Wanda Diaz-Merced was away in the US (hosted at Harvard CfA) for a few months working with various collaborators and attending conferences. She returned in August.
   d. Paul Anthony Wilson, OAD fellow working on the bridge between astronomy and data science, left the OAD in early June but returned in July 2017 (at own cost). He completed his fellowship at the end August 2017.
   e. Euan Broderick, a self-funded intern from the UK, spent a few weeks at the OAD expanding on the work done by a previous intern on the consolidation of OAD projects information, and assisting with OAD communications.
   f. Annika Müller, a self-funded design intern from Germany spent 6 weeks at the OAD during August/September, during which time she contributed significantly to the OAD brochures and yearbook. She continues to volunteer for the OAD from Germany.

4. **Strategic Highlights:**
   a. McBride submitted a successful proposal for a session at Science Forum South Africa entitled “Astronomy for Development: a discussion on inclusion.” There will also be an event during the Forum recognizing the South African individuals who contributed significantly to the establishment of the OAD.
   b. The OAD, following wide consultation among its various structures, prepared and submitted a comprehensive response to the IAU call for input into its next Strategic Plan (available upon request). This submission also represents the OAD’s vision for the next decade.
   c. McBride and Govender delivered a talk at the NRF on the work of the OAD (12 June 2017). During that trip several other meetings were held at NRF, DST, SAIP, ICSU Africa and HartRAO. These meetings are important to maintain relations with those

organisations that support and fund the OAD in South Africa.

d. McBride won a scholarship to attend the AAAS-TWAS course on Science Diplomacy, which she completed in Trieste (Italy) in August. We felt it would be important to have this skill/knowledge/experience within the OAD as the subject of Science Diplomacy becomes increasingly popular. McBride's experience, combined with engagements with senior officials at the DST, positions the OAD well to understand this field better.
e. Conversations across disciplines continue to gather momentum under the leadership of McBride. These culminated in two talks, one by the OAD at RESEP (Research in Socio-Economic Policy) at Stellenbosch and a corresponding one by RESEP at the SAAO – both in September. Following these talks a mini-workshop was held at the OAD on 9th October bringing together various disciplines – this will now be a monthly activity as we build meaningful collaborations across sciences.

More information:
http://www.astro4dev.org/

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BOOK REVIEWS

BLACK HOLE BLUES AND OTHER SONGS FROM OUTER SPACE

(Editor's Note: This review was written before the award of the 2017 Nobel Prize in Physics to the LIGO team, before the third gravitational wave detector, VIRGO, went into operation and the detection of gravitational waves and electromagnetic radiation from the coalescence of two neutron stars, GW170814. These remarkable events add to the timeliness of Dr. Levin's book and to Naomi Pasachoff's review.)

Janna Levin, *Black Hole Blues and Other Songs from Outer Space* (New York: Knopf, 2016). 243 pages, HB $26.95. ISBN 978-0-307-95819-8.

If you were a member of the Caltech community in February 2016—even if only, as in my case, by virtue of a spouse's visitor appointment—it was hard not to get swept up in the euphoria of the long-awaited announcement of the first detection by the Laser Interferometer Gravitational-wave Observatory (LIGO) of ripples in spacetime. Gravitational waves—today often described as ripples in spacetime—were first introduced into the scientific vocabulary by Albert Einstein in his General Theory of Relativity, published in 1915. While I did not attend the live broadcast in Cahill Auditorium on February 11th of the official National Science Foundation announcement of LIGO's discovery, twelve days later I was in the audience in the packed Beckman Auditorium for a celebratory Caltech public event, featuring a series of fascinating short talks by a panel of scientists who described their connections to the project. When a month later I chanced upon an interview on NPR's *Science Friday* with Janna Levin, a Barnard professor and theoretical cosmologist, and learned about *Black Hole Blues,* her new book on the history of the search for gravitational waves, I knew I wanted to read it. The book lay still unopened on my desk when, on June 15th, I was excited anew at the American Astronomical Society's summer meeting in San Diego by the keynote address by LIGO spokesman Gabriela González, in which she announced the second detection of a gravitational wave signal from a collision of black holes, the two events having inaugurated a new era of gravitational wave astronomy. I am very pleased to have learned about and now to have read the book, which proved a strangely comforting undertaking in this summer of our discontent, with overabundant bad, non-scientifically-related, news, both in the US and abroad.

As the Source Notes at the end of the relatively short and eminently readable 16-chapter book indicate, Levin has succeeded in writing a very personalized history by virtue of the interviews she herself has conducted over a three-year period beginning in 2013 with the main protagonists in the story, bolstered by the always-expert interviews of some of the same individuals, administered from about 1997 through 2000, by Shirley Cohen on behalf of the Caltech Oral History Project. The book is as compelling as many a novel, thanks in large part to the vivid portraits Levin paints, with the voices of the individuals coming across very distinctively. She

recounts memorable anecdotes about the so-called Troika—Rainer Weiss of MIT, and Kip Thorne and Ronald Drever of Caltech—the three scientists who were present at the creation, so to speak, of the project. In the months since the first detection, the Troika have already been awarded the Kavli Prize in Astrophysics, the Special Breakthrough Prize in Fundamental Physics (which they are sharing with 1,012 contributors to the discovery, all of whose names are included in a 6-1/2-page section at the end of the book), the Shaw Prize in Astronomy, and the Gruber Cosmology Prize—all since the publication of the book in the early spring. In the book itself, Levin tells us, "For the record, the consensus on the street is that the Troika as a group will be under consideration for the Nobel"—and, at this point, "under consideration" seems unduly modest.

I am unlikely to forget, for example, that Berlin-born Rainer Weiss had the childhood ambition of making music easier to hear, and to that end salvaged twenty movie-studio quality loudspeakers following a fire at the Brooklyn Paramount theater; that Kip Thorne was raised by two Mormon professors, and when his mother took him at age eight to an astronomy lecture, his professional lifetime goal shifted from driving a snowplow to becoming an astrophysicist; or that Ron Drever, born and educated in Scotland, attributed his difficulties in accommodating to a Big Science project to the lingering aura over British science of Ernest Rutherford, father of the atomic nucleus and former head of the Cavendish Laboratory in Cambridge, England, who was perhaps the greatest practitioner of "string and sealing wax" physics.

Outside of the Troika, the scientist to whom Levin probably pays the most attention is Joseph Weber, whose history ends less happily, but whose scientific prowess even his severest critics don't seem to doubt. As far back at 1969, Weber claimed to have detected evidence of gravitational waves using what we now call a Weber bar. When other scientists over the years failed to replicate his results, Weber's personal reputation was tarnished, given his continued insistence on what he claimed to be finding. In addition, when it came to funding the Big Science project that LIGO was poised to become about two decades later, many in the scientific community were also leery of channeling so much taxpayer money into a field with a blot on its escutcheon. I will long remember Levin's moving recounting of Weber's marriage to the much-younger and at least equally brilliant astrophysicist Virginia Trimble, of the wintry accident near his Maryland lab in 2000 that culminated some months later in his death, and of Virginia's conversion to Judaism and prowess in singing the Kaddish, often called the prayer for the dead.

Even the less focal figures in Levin's narrative get the same personalizing treatment, so, for example, I will remember the second director of LIGO, Barry Barish, for having defused a potential crisis after hunters shot bullets in the still-under-construction LLO (LIGO Livingston Observatory), by ignoring FBI advice to put in place security barriers, choosing instead to have lunch at the hunters' lodge. Also at LLO, Rana Adhikari, the go-to-guy for all things LIGO, carries the memory of the tears his sixth-grade teacher crying when the Space Shuttle Challenger came to its tragic end in January 1986.

Levin is also good at taking us with her into the LIGO-related places she visits in the

course of her research, including the so-called Plywood Palace at MIT, where Rai Weiss did much of his early modeling of interferometers; LHO (LIGO Hanford Observatory); LLO; and even the Los Angeles pub where the postdocs working on LIGO at Caltech and their visiting colleagues go to drink on Taco Tuesdays.

Much as I enjoyed reading the book, however, and much as I admire it, I have some reservations. My main objection is directed not necessarily at the author but possibly only at the publisher. The book was scheduled to be released in August 2016, but following the announcement of the first detection in mid-February, an editorial decision was made pushing up the publication date to April. I do not know whether Levin could have insisted that she be given enough time not only to write the brief Epilogue that is included, recounting the September 2015 detection and its confirmation and announcement, but also to update the sixteen already-written chapters that precede it. I do know, however, that the book would be much stronger—and would likely have sturdier "legs," as publishers are wont to say about books that become classics—if she had done so. Throughout the book, having heard the "chirp" that resulted from the collision of two black holes, I was annoyed by statements like "If the gravitational observatories succeed and we just marginally make out the reverberations against the noise" (Chapter 8) and "There remains no guarantee that a pair of compact objects will collide within a detectible range in our lifetimes" (156).

I have several other reservations, listed below in no particular order of significance:

(1) Levin is great at personalizing the history of this remarkable project, less good at grounding the reader in firm dates. I often found myself looking up dates as I finished a chapter, not realizing that several chapters further on I might (or might not) find the information I wanted. The book would be a more useful reference if the publisher had included a Chronology at the end, listing dates of milestone events in the story of the search for gravitational waves.

(2) Like many students of the history of science, I am happy to read details of the unpredictable messy personal conflicts that often pave the way to scientific breakthroughs. I was disturbed, however, to read at the end of Chapter 13, which gives a detailed account of the upsetting episode pitting the first director of LIGO, Robbie Vogt, against Troika-member Ron Drever, Rainer Weiss's remark to Levin: "That whole episode is the bad part of LIGO. Ron Drever is a tragedy. Neither Robbie nor Ron ever really recovered. Nobody wants to resurrect this stuff. It's unfortunately in the public record now. But it doesn't have to be in your book." Yet it is in her book

(3) I don't find the title descriptive enough. Had I not chanced upon the NPR interview, I might not have guessed that Levin's book was about LIGO. I suggest *The Chirp from Space: A Brief History of LIGO* as a more effective alternative.

(4) The book is clearly intended for a general audience, one for whom Levin feels it necessary to spell out that "postdocs" is "shorthand for postdoctoral research scientists" (Chapter 15). So why does the first mention of J. Robert Oppenheimer early in the book give only his last name?

(5) As a former affiliate of the Institute for Advanced Study community (once again, by virtue

of a spouse's year-long appointment as a Member), I am puzzled that a New York City-based theoretical cosmologist like Levin does not known that while the IAS is in nearby Princeton, it is not part of Princeton University, and I am surprised that no one who read Levin's manuscript as it neared publication pointed out that not once but twice she incorrectly associates the late John Bahcall (about whose strong objection to NSF funding of LIGO I had been unaware) with the university rather than the institute.

Concluding on a more positive (maybe) note, I read *Black Hole Blues* while the US was shaking from too many episodes of cops killing minorities and of revenge killings on cops, not to mention the fear-mongering preached at the Republican National Convention. At the same time, the world at large was reeling from an attempted coup in Turkey, terrorist attacks in France, and the uncertainty in world markets because of the unexpected outcome of the Brexit vote. I find it comforting to reflect on the LIGO Scientific Consortium, founded in 1997, involving 15 countries worldwide, and over a thousand scientists from different institutions working individually and collectively to open a new window into the cosmos. There is something to be proud of after all and to make us hopeful for the future.

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