

Communicating Astronomy with the Public

Inspiring the New Generation

Tips on how to craft astronomy news stories for young children

Modern Dialogic Approaches in Science Outreach

Investigating to what extent the public prefer newer dialogic approaches to those with educational content

Case Study: Public Science

What is the impact of bringing outreach events to public spaces?

In February, NASA's Curiosity rover successfully extracted the first sample of Martian rock from a hole drilled into the planet's surface. The diminutive size of the hole — only 1.6 centimetres in diameter and 6.4 centimetres deep — belies the significance of this historic moment in space exploration and the impact that it made in the media around the world.

Credit: NASA/JPL-Caltech/Malin Space Science Systems





Credit: Kevin Govender

Contents

Explained in 60 Seconds	4
A Radio Astronomical Star Party for those "On The Verge"	6
Casting a Light on Dark Sky Awareness in Madeira	9
Writing a Space Scoop in Seven Steps	12
Evaluating the Motivations and Expectations of those Attending a Public Astronomy Event	14
From Earth to the Solar System: A Case Study for Public Science Events	20
Visualising Astronomy: Using Impact to Inform	24
Colophon	27

This first issue of *CAPjournal* in 2013 ushers in a new era for the publication, as I take over the reins as Editor-in-Chief from Pedro Russo. While I hope to bring lots of fresh ideas to *CAPjournal*, there are no plans for any major changes to the format. As the saying goes, "if it ain't broke, don't fix it". Pedro will continue to contribute to *CAPjournal* in an advisory role in his capacity as Vice-President of the IAU's Commission 55 (C55), *Communicating Astronomy with the Public*.

In my role as International Outreach Coordinator for the newly established IAU Office for Astronomy Outreach (OAO), I intend to build on the momentum of the International Year of Astronomy 2009 (IYA2009). Therefore, *CAPjournal* will continue to promote outreach activities that are some of the fruits of IYA2009. In this issue, for example, there are articles concerning three IYA2009 Cornerstone projects: Dark Sky Awareness (page 9); From Earth to the Universe, under the guise of a follow-up project called From Earth to the Solar System (page 20); and Universe Awareness (page 12).

Many readers will be familiar with the IAU Office of Astronomy for Development (OAD). Last December, I had the pleasure of visiting the OAD team in South Africa to discuss synergies between our offices. The picture shown in the top left of this page was taken during that trip, at the South African Astronomical Observatory's observing site in Sutherland, which is roughly a four-hour drive from the OAD's office in Cape Town. After a run of cloudy nights, I was lucky with the weather during my one-night stay in Sutherland, and able to enjoy this wonderful dark-sky site in all its glory — my first ever observing session in the southern hemisphere.

The visit was also a valuable learning experience, as I gained a greater understanding of the societal impact of astronomy in Africa and various public outreach activities in Cape Town and Sutherland. I would encourage anyone working on outreach projects that have a developmental impact to contact me about writing an article for *CAPjournal*.

Looking forward, the next issue of *CAPjournal* will feature an article that will address the future of C55 in light of changes to the organisational structure of the IAU and the founding of the OAD and OAO. This will be the first in a series of articles that will take an in-depth look at the IAU's education, outreach and development activities.

I look forward to working with you all to promote and advance astronomy communication. Please send me an email at editor@capjournal.org if you would like to submit an article. Full submission guidelines are available on the website (www.capjournal.org).

Clear skies,

Sarah Reed

Editor-in-Chief of CAPjournal
International Outreach Coordinator for the IAU Office for Astronomy Outreach
 (www.iau.org/outreach)



Cover: This starry night at the shores of Dal River in Sweden was an opportunity for TWAN photographer P.-M. Hedén to give some lessons about the sky to his 8 year old son. The summer Milky Way from Scorpius (lower right) to Cygnus (upper left) is captured in this wide-field view. Credit: P.-M. Hedén/TWAN

Explained in 60 Seconds

Jay Heinz

Digital Production Manager for the Morehead Planetarium and Science Center

Fulldome

Fulldome videos are primarily science documentaries that are projected onto a domed surface, typically in a planetarium. Many full-dome videos deal with astronomy, but other subjects are also appropriate, especially those relating to topics or environments

that are difficult or impossible to experience, such as being deep underwater, inside the human body or in the future. We like to think of a flat-screen video as a window into another world, but with a full-dome video you can poke your head up inside that

world and become immersed within it; think of a 3D animated movie crossed with IMAX and put it in a planetarium.



Figure 1. Audiences are immersed in another world in a full-dome theatre.
Credit: Morehead Planetarium and Science Center

A Radio Astronomical Star Party for those “On The Verge”

Eva S. Wirström

Research Assistant,
Chalmers University of Technology,
Onsala Space Observatory
eva.wirstrom@chalmers.se

Robert J. Cumming

Communications Officer,
Onsala Space Observatory
robert.cumming@chalmers.se

Keywords

Public Outreach, Radio Astronomy,
Non-traditional Event, Informal Education

Summary

Here we describe the Onsala Stjärnträff (Onsala Star Party), an unconventional outreach event that was held during Sweden’s inaugural Day and Night of Astronomy in October 2012. The target group consisted of individuals who are “on the verge” of discovering astronomy; individuals who have a spark of enthusiasm for astronomy, but who have not yet taken this passive interest to the next level. For the event, we adapted the concept of a star party to provide insight, inspiration, hands-on experience and networking opportunities for the participants. Furthermore, the Onsala Space Observatory’s radio telescopes allowed us to compensate for poor weather and to fulfil our role in communicating radio astronomy to a wider public.

Introduction

Groups of visitors are welcomed several times a week to the Onsala Space Observatory, the Swedish national facility for radio astronomy. Typically, they consist of school classes, organisations for the retired and workplace outings. A couple of times a year we are open to the general public on a weekend day, mostly attracting families from the local area.

During a typical two-hour tour, visitors are given a presentation about astronomy and the facility and then guided to see the two large radio telescopes and the exhibition area. The purpose of the guided tours is threefold: to show that the work done at the observatory is not secretive, to encourage interest in science and research, and to provide a forum for the public to ask questions.

On 13 October 2012, the Swedish Day and Night of Astronomy (or Astronomins Dag och Natt (ADON) in Swedish), was celebrated for

the first time, with astronomy events taking place all over the country. The initiative for ADON came from the Swedish Astronomical Society (Svenska Astronomiska Sällskapet). It was intended to build on the enthusiasm for astronomy outreach and the wide range of events organised at many astronomical institutions and amateur organisations during the International Year of Astronomy 2009. If the first ADON was a success, then it would become an annual event. As one of the largest Swedish astronomical institutions, Onsala Space Observatory was keen to participate¹ in the event.

The idea

ADON gave us an opportunity to do something special for a small group of enthusiasts. We decided to try to attract a group of individuals who are enthusiastic about space and astronomy, but who have not yet found a way to develop their interest. Our vision was to create an event to feed

and nurture the enthusiasm of such individuals and inspire them to develop their passive interest and take it to the next level by joining, for example, an astronomy class or amateur astronomy society, or purchasing a telescope. Furthermore, it was a priority for the event to reach underrepresented sections of the astronomy community (women, young adults and minorities).

A star party was chosen as the format for the event. Star parties are traditionally focussed on optical night-time observations, but combined optical and radio star parties are not unheard of: the Green Bank Star Quest, for example, has been arranged in collaboration between amateur astronomer organisations and the National Radio Astronomy Observatory (NRAO) at the Robert C. Byrd Green Bank Telescope (GBT) in West Virginia every year since 2004². While these multiple-day events for hundreds of people mainly attract amateur astronomers, the vision for the Onsala Star Party was to reach a more diverse group of people.

The planned format of the Onsala Stjärnträff:

- Hands-on observations using the large radio telescopes, the smaller student radio antennas, SALSA (Such A Lovely Small Antenna), and optical telescopes would be offered.
- To promote the social aspect of a classic star party, participants would spend the night at the Observatory and observe throughout the night (weather permitting). The number of beds at the Observatory limits the number of participants to 15. A minimum age of 16 years was set for participants, and parental consent was required for participants younger than 18.
- To invite two external guest speakers from outside the research community who have expertise in astronomy, such as astrophotographers and science writers.
- To invite one of our local scientists to present astronomical research in an accessible way.
- The event would be free of charge and funded by the Observatory's budget for outreach. Participants would pay their own transport costs.
- Direct interaction between participants and professional astronomers would be a vital component of the Onsala Stjärnträff.

Finding participants

The slogan for marketing the event was chosen in an attempt to appeal to a wider audience than the usual star-party goers: "Are you fascinated by the Universe?" Furthermore, the language in the advertising was carefully chosen so that it was clear that no prior knowledge of astronomy was needed to participate; all that was required was an interest in, curiosity and enthusiasm for astronomy.

Reaching out to the public at large on a limited marketing budget was challenging. To keep costs down, the event was marketed online, on the Observatory's home page³, on social media accounts (Facebook and Twitter) and by direct email to contacts in the science media, academia, the amateur astronomy community, and high school teachers. The email actively encouraged recipients to spread the word about the event to friends, relatives, colleagues and students. These efforts led to

a few items in astronomy blogs, a blog entry at Chalmers University of Technology in Gothenburg, but there was no pick-up by the mainstream media.

Selecting participants

People who were interested in participating were asked to complete an online registration form, which asked about their age, gender and education, as well as some open-ended questions, such as "Introduce yourself in a couple of sentences!" and "Why do you want to participate in the Onsala Stjärnträff?".

By the application deadline more than 50 people had applied for the 15 available positions. However, six applications did not match the terms and conditions attached to the application and were disregarded. Of the 44 valid applications, 15 were submitted by women and 29 by men, with ages ranging from 16 to 73 years old. All applications were read by three astronomers at the Observatory and rated independently based on the perceived level of enthusiasm.

Figure 1 shows a comparison between the age profile and gender ratio of the applicants and the participants. This information was used in combination with the answers to the application questions to select participants in accordance with the goal of reaching underrepresented groups within the astronomy community: women and young adults.

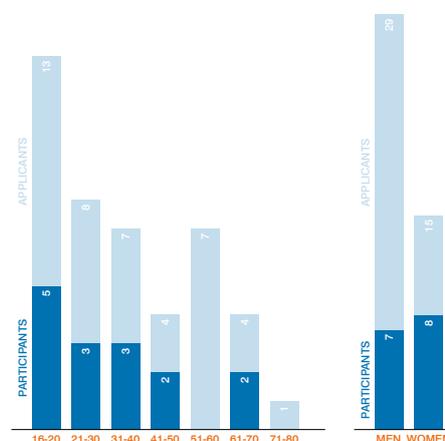


Figure 1. Age and gender distribution of the Onsala Stjärnträff's applicants and participants. Credit: Robert Cumming

The event

The Onsala Stjärnträff took place from 13:00 on Saturday, 13 October 2012, until 10:00 the following day. The schedule was built around three presentations and activities at four observational instruments. However, since the purpose of the event was to engage the participants, there was flexibility in the schedule to allow for discussions.

Astronomer and author Marie Rådbo⁴ kicked off the programme with a presentation about her work in communicating science and astronomy to the general public, followed by a question and answer session. Dr Carina Persson, the local radio astronomy expert, talked about scientific methods used in astronomy research in her presentation, "Spies in Space". Questions from the participants directed the focus of the talk towards what is known about the Universe in general, evolving into a group discussion that included the previous speaker.

Participants were then given a taste for the beauty of the night sky with a presentation by astrophotographer P.-M. Hedén⁵. Tips about lenses, camera settings and software were offered, as well as examples of photos and a stunning time-lapse movie that he had put together of his favourite astrophotography sessions.

Hands-on observations

The Onsala 20-metre radio telescope was not being used that evening for research, so it was made available for use by the star-party participants. Participants were introduced to the concept of spectral line radio observations by Dr. Henrik Olofsson. For short demonstrations, each group observed water masers in Galactic massive star-forming regions. A longer observing project, which stretched over the entire star party, involved water megamasers near the centre of the galaxy NGC 4258.

Unfortunately the skies were covered by cloud throughout the star party, so the evening optical observing session was cancelled. In case of poor observing conditions, an alternative activity had been prepared. For this, Dr Peter Forkman introduced participants to the free open source planetarium software Stellarium⁶. In parallel to this activity, a few participants were introduced to SALSA⁷.

This pair of 2.3-metre radio telescopes was specifically built at Onsala Space Observatory to introduce students and teachers to radio astronomy by observing galactic HI 21-centimetre emission.



Figure 2. The 15 participants and coordinator Eva Wirström (third from left) in front of the 25-metre radio telescope at Onsala Space Observatory, enjoying one of the few rain-free moments during the star party. Credit: Klara Rättegård and James Dresch

Evaluation

Before concluding the star party in the morning, participants were asked to complete a questionnaire about their opinion of the event. The questionnaire included a number of statements regarding the expectations and outcomes for the star party, which participants were asked to mark as "I completely agree", "I partly agree" or "I don't agree". The three presentations were evaluated by choosing one or several descriptive words from a list. Furthermore, the time spent on each segment during the event was rated as "Too short", "About right" or "Too long". Finally, three open-ended questions were posed to participants: "The best things about Onsala Stjärnträff were:", "The worst things about Onsala Stjärnträff were:", and "The following changes would have improved Onsala Stjärnträff:".

Expectations and outcomes

All 15 participants completed the questionnaire. Fourteen participants "completely agreed" that they expected to get to know other space enthusiasts, learn more about astronomy research and discuss space with

experts. In addition, about two thirds of the participants "agreed completely" that they expected to learn more about the nature of the Universe, radio astronomy, observing the night sky and what it is like to be a professional astronomer.

The expectation that the participants would learn more about radio astronomy was the one that was best fulfilled: 13 participants "agreed completely" that this had been achieved, and none disagreed. Furthermore, all of the participants either "completely agreed" or "partly agreed" that they had connected with other space enthusiasts.

Other statements that at least two thirds of the participants agreed with: that they wanted to read more about space; that they planned to photograph the night sky (more often); that they planned to buy a telescope or make more frequent use of one that they already own; and that they intended to tell others about astronomy more often.

However, less than one third completely agreed that they knew more about the nature of the Universe following the star party, that they planned to join an astronomy club, or that they now planned to take astronomy classes.

Overall, the participants found the available time adequately divided between activities, but that more time should have been set aside for free discussion and questions to the experts. Three respondents wished for more time at the 20-metre telescope, to be able to get a better understanding of how it works and to learn how to operate it. Also, several concluding comments conveyed an interest in finding out more about current research at the Observatory. Naturally, the questionnaire reflected disappointment over the cancelled optical observations.

Conclusion

The unsophisticated marketing strategy could be improved in order to reach a representative group of astronomy enthusiasts. For example, the fact that all the advertisements and the application form were web-based may have excluded a significant group of potential applicants.

Feedback from the questionnaire shows that the goals of connecting a diverse group of space enthusiasts, to inspire them to

take their interest to the next level, and to promote radio astronomy, were all achieved. Furthermore, many of the participants expressed an intent to "tell others about astronomy more often" (11 people "completely agreed" with this statement), showing that the impact of the star party will reach beyond the 15 selected participants.

Weighing up the amount of work put into planning and arranging the event against the positive outcomes, we plan to organise the Onsala Stjärnträff again this year for the second ADON, which will be held on 28 September. For the next event, the questionnaire points out several things that could be improved. For example, dedicating more time to describing current research projects at the Observatory and trying to involve more local astronomers in the event in order to facilitate small group discussions.

Notes

- ¹ Also for ADON we organised another unusual outreach event, Astronomy Slam, in Gothenburg (see note 3).
- ² <http://www.greenbankstarquest.org>
- ³ <http://www.chalmers.se/rss/oso-sv/popularvetenskap/adon>
- ⁴ <http://marie.radbo.org/>
- ⁵ <http://klarhimmel.blogspot.se/>
- ⁶ <http://www.stellarium.org/>
- ⁷ <http://brage.oso.chalmers.se/salsa/>

Biographies

Eva Wirström is a Swedish astronomer interested in how interstellar chemistry influences the conditions of star and planet formation. She recently returned to Chalmers University of Technology, Onsala Space Observatory, after two years as a research associate at the NASA Goddard Center for Astrobiology. In her current position at Chalmers, she organises outreach activities at Onsala Space Observatory in parallel to her academic research.

Robert Cumming is the Communications Officer at the Onsala Space Observatory. He is also editor of the Swedish magazine *Populär Astronomi* and Sweden's representative in ESO's Science Outreach Network. He has written scientific papers on the kinematics of extreme star-forming galaxies and supernovae and their circumstellar environments.

Casting a Light on Dark Sky Awareness in Madeira

Pedro Augusto

Universidade da Madeira/
Centro de Astronomia e Astrofísica da
Universidade de Lisboa
augusto@uma.pt

Ilídio Andrade

Universidade da Madeira
ilidio.andrade@sapo.pt

Keywords

IYA2009, Dark Skies, Light Pollution

Summary

We have implemented Dark Sky Awareness — one of the Cornerstone projects of the International Year of Astronomy 2009 — in Madeira with an initiative called *O céu estrelado existe!* (*The Starry Sky Exists!*). Eight of the 11 municipalities in the region took part (260 000 inhabitants), with 356 people attending the events. Six talks were given and eight organised blackouts covered a total area of 112 km² (14% of Madeira's land area).



Figure 1. Bad lighting and good lighting in Machico: at night we can see that most of the light pollution is concentrated near the coastline. By day, we can see the type of modern lighting that is responsible for this problem. Credit: P. Augusto and I. Andrade

Dark Sky Awareness

*O Céu estrelado existe!*¹ is the title that we chose for our Dark Sky Awareness² project in Madeira. The programme involved a talk on light pollution followed by an observation session: 30 minutes with public lighting on, 30–60 minutes of blackout and then another 30 minutes with the lights on again. The aim of this was to show people the effect of light pollution on our ability to see the star-filled night sky.

Our original plan was to introduce this programme to all 11 of the municipalities

of Madeira, 19% of which is covered by UNESCO World Heritage Forest. However, we only managed to include eight: Ribeira Brava, Santana, Porto Santo, Câmara de Lobos, Porto Moniz, Calheta, São Vicente and Machico.

The talk

Since one picture is worth a thousand words, we decided to photograph each municipality to obtain evidence of the effects of light pollution. We also went out by day and photographed some examples of poorly

designed lights that are responsible for this pollution (Figure 1).

These photos were presented during a talk³ on efficient illumination given in the Mayor's House for six of the municipalities. (In Porto Santo and Câmara de Lobos the speakers were unable to present their talks as no members of the public showed up.)

In addition, data from the Madeira Electrical Company reports⁴ from 2005 and 2007 were presented, showing how much power each municipality uses for public lighting, its cost and the amount of carbon dioxide emitted.

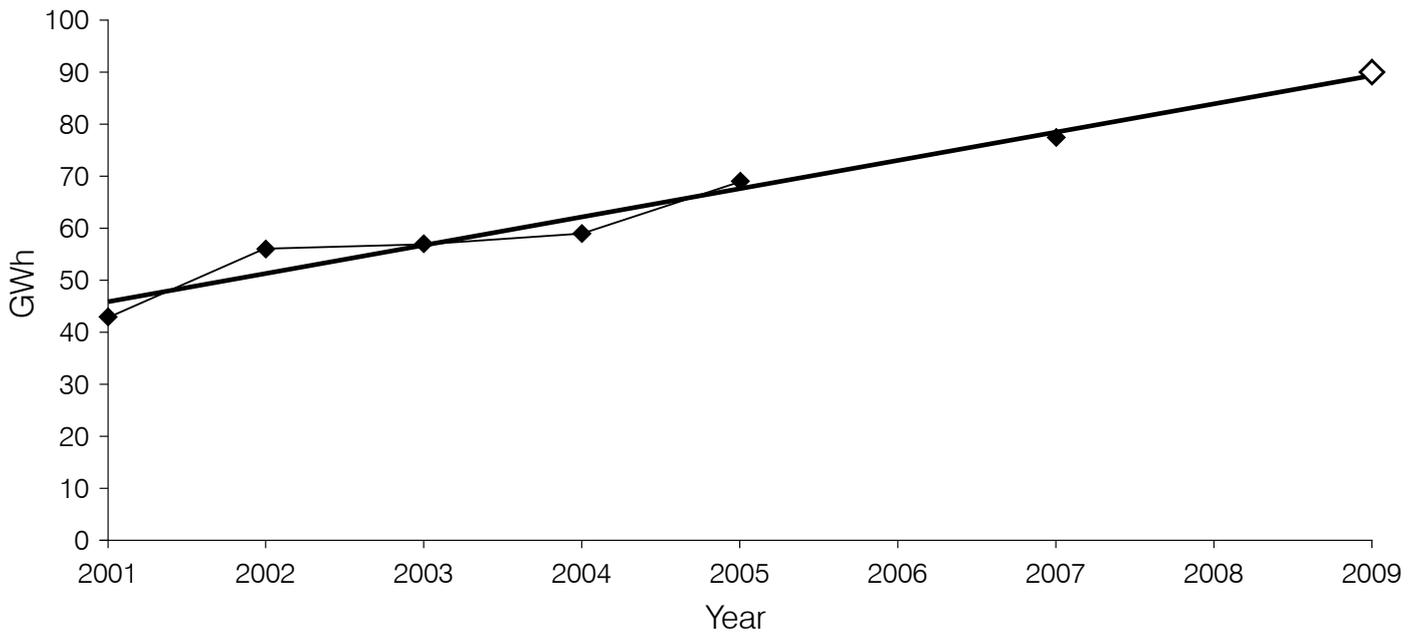


Figure 2. The growing energy consumption needed to feed public illumination on the island of Madeira. Data points from 2001 to 2007 show real values, while the 2009 point was extrapolated from the data up until 2005. The data for 2007 was accessed after the extrapolation was made, and was found to support the expected values for 2009. Credit: P. Augusto and I. Andrade



Figure 3. A very dark sky in the Santana municipality during a blackout. The sky brightness reached 20.2 mag/arcsec² at the zenith: almost eight magnitudes below the value achieved when all of the public lights were on. Credit: Sandro Correia

The information that 87% of the electrical power in Madeira comes from diesel burning was noted. We also presented our estimates for the amount of wasted energy that is directed up to the sky.

Using data for the energy consumption on Madeira from 2001 to 2005, values were extrapolated to 2009 — the year of the talks (Figure 2). At a later stage, data for 2007 was available and was found to be in agreement with the extrapolated results.

The blackouts

In addition to the talks, mini blackouts of up to an hour in the most illuminated part of each municipality (usually the centre) were held, and proved to have a big impact in attracting the attention of the local media. These took place either on the day of the talk or on the following day.

In Câmara de Lobos and São Vicente, the sky was cloud-covered, but there was still a noticeable difference in the amount of light reflected back from the clouds. At the other six sites, attendees were able to observe Jupiter and Saturn and their moons, star clusters, nebulae, and even galaxies. Measurements of the sky brightness were taken using a Unihedron device⁵

Date	Municipality	Exact place	Area (km ²)	Sky brightness (zenith) (mag/arcsec ²)		
				Lights on	Lights off	Difference
9 May	Ribeira Brava	Sea side	3.1	17.98	19.05	1.07
20 May	Santana	Mayor's House	18	12.58	20.20	7.62
22 May	Porto Santo	Mayor's House	42	17.45	18.26	0.81
9 Jun	Câmara de Lobos	Municipal garden	3.1	---	---	---
20 Jun	Porto Moniz	Sea side	3	17.22	19.72	2.50
18-19 Jul	Calheta	Sea side	1.5	15.87	19.95	4.08
13 Aug	São Vicente	Mayor's House	21	---	---	---
17 Oct	Machico	Sea side	20	18.62	20.14	1.52

Figure 4. Measurements of the sky brightness at the zenith taken during the blackout sessions. Measurements were not taken at the two cloud-covered sites: Câmara de Lobos and São Vicente. Credit: P. Augusto and I. Andrade

(see Figure 4), with the data announced to the public during the blackout sessions. In some cases, the light pollution was obviously worse than in others: ranging from ~ 13 mag/arcsec² for the brightest value in Santana to the fairly good measurement of ~ 19 mag/arcsec² in Machico. For comparison, a perfect dark sky, with no light pollution, would have a brightness of 21.6 mag/arcsec² (IAU Report, 1978).

All of the blackouts were extensive, covering several square kilometres on the ground, although restricted to public illumination. The largest area covered was at Porto Santo, where the public illumination was turned off across the entirety of this small island (42 km²). The total area covered by all of the municipalities reached nearly 112 km² (14% of the total area of Madeira).

Conclusion

In total, 356 people attended the talks and blackout events, including 14 politicians. The long-term impact of *O Céu estrelado existe!* is hard to predict. However, as part of its legacy, we are currently submitting a funding proposal for a new project with a consortium that includes two of the municipalities that took part in *O Céu estrelado existe!*, as well as the Madeira Electrical Company.

Following this project, we have since found it much easier to negotiate localised black-

outs with the Madeira Electrical Company, as they now understand what we are trying to do. For example, a blackout was organised at the university in Funchal during our Astronomy Week in 2010 (Augusto & Sobrinho, 2012).

Observing sessions that include blackouts are a great way to attract the general public to participate. This is becoming a popular way to observe in light-polluted areas, with the local amateur astronomy association now using this format⁶.

Acknowledgements

We had helpful discussions with Fabio Falchi that were vital for shaping this paper. We must also thank Laurindo Sobrinho for all the help with the organisation of IYA2009 in Madeira; most of the work presented in this paper would not have happened otherwise.

References

- Augusto, P. & Sobrinho, J. L. 2012, CAPJournal, 12, 24–27
- IAU Report 1978, Report and Recommendations of IAU Commission 50 (Identification and Protection of Existing and Potential Observatory Sites)

Notes

- <http://www3.uma.pt/Investigacao/Astro/AIA2009/ceuestreladoexiste.htm>
- <http://www.astronomy2009.org/global/projects/cornerstones/darkskiesawareness/>
- http://www3.uma.pt/Investigacao/Astro/AIA2009/Files/palestra_apagao_CLobos.pps
- <http://www.eem.pt/index.php?option=content&task=view&id=376&Itemid=303>
- <http://unihedron.com/projects/darksky/>
- <http://astronomiamadeira.net/?s=apag%C3%A3o>

Biographies

Pedro Augusto is Aggregate Assistant Professor of the University of Madeira (UMa) since 1998. As regional coordinator for IYA2009 in Madeira, he organised over 200 science outreach events, including hands-on lab activities, observing sessions, exhibitions, multimedia presentations, and talks. He has 15 years of experience in teacher training and communicating astronomy to the general public and students.

Ilídio Andrade graduated at UMa in Instrumental/Electronic Engineering Astronomy working on an Astronomical Seeing and Observatory Site Selection project at Madeira, including innovation (one patent). He has been an active collaborator in the Astronomy Group of UMa since 2006 and particularly in the IYA2009-Madeira, where he took part in 70 events.

Writing a *Space Scoop* in Seven Steps

Sarah Reed

IAU Office for Astronomy Outreach/NAOJ
Former Science Editor of
EU Universe Awareness
sarah.reed@nao.ac.jp

Keywords

Children, Writing, News, Education

Summary

Formal and informal primary education has traditionally shied away from the latest scientific breakthroughs. Yet sharing the excitement of the latest scientific discoveries is one of the best tools that we have to inspire the public — including young children. The question isn't whether astronomical news can inspire children, but how we can best communicate this information to youngsters.

The IAU-endorsed programme EU Universe Awareness has now produced more than 100 astronomy news stories for young children, called *Space Scoops*. It has successfully tackled a wide variety of subjects — everything from dark matter to cosmic reionisation. This article reveals the tips and tricks used to craft science news stories for children.

Prologue

In February 2011, EU Universe Awareness (EU-UNAWA) launched an astronomy news service for children aged 8+, called *Space Scoop*, in partnership with the European Southern Observatory (ESO). Since then, the following organisations have joined the *Space Scoop* family:

- Netherlands Institute for Radio Astronomy (ASTRON)
- NASA Chandra X-ray Observatory
- European Space Agency (ESA)
- Europlanet
- National Astronomical Observatory of Japan (NAOJ)
- Dutch Research School for Astronomy (NOVA)
- Royal Astronomical Society (RAS)
- South African Astronomical Observatory (SAAO)

This has made *Space Scoop* the biggest astronomy news service for children, with releases now available in up to 16 languages. (The number of translations varies, as the work is done by a team of volunteers.)

Writing for children: The basics

1) The general rule when writing for young children is to keep sentences short and

simple and don't assume any prior astronomy knowledge. This means talking in the first paragraph about a "cloud of gas and dust" and only using the term "nebula" after it has been explained. In general, try to keep the technical jargon to an absolute minimum, or back it up with things that children can relate to. For example: "You use infrared light at home to turn on the TV with a remote control." If that doesn't work, you can also take a light-hearted approach and mock the "catchy" name for that new exoplanet!

2) It is better to fully explain one or two concepts clearly in the story, rather than trying to cover every detail about a new discovery. The original press release can go into a lot of detail that isn't relevant for a 250-word *Space Scoop*. Furthermore, by isolating a key concept that you want to explain, it is easier to construct a story that has an intro, middle and an end.

Be creative

3) Before you start writing, try to look at the picture that is released with the story for a few minutes from the perspective of a child. Consider the following:

- What are your honest first impressions of the picture, based solely on appearance (disregarding for a moment how

scientifically interesting the image is)? If it looks boring or complicated to you, then it will to a child as well. Be honest and say what you see and then explain why this image is incredible^{1,2}.

- What does it look like? For example, does it resemble something from everyday life or science fiction^{3,4}?

4) Scientific breakthroughs are much easier to write, as the content of the *Space Scoop* is already there: the new discovery. For photo releases, it is often best to write something that is completely different from the original release in order to make sure that the story teaches children something new. This doesn't always have to be a lesson about the astronomical object in the picture. For example, *Space Scoop* has already covered the work of space artists⁵, general scientific principles⁶, how professional astronomers collaborate around the world⁷ and citizen science⁸.

5) References to popular culture and fairytales make for eye-catching headlines for children. Beyond this, they can also be useful for explaining difficult topics in a fun way⁹. It's important to keep in mind that the references must be familiar to the young audience. Furthermore, for *Space Scoop*, children from all around the world must understand the reference. Currently, *Space Scoop* has mentioned



Figure 1. Space Scoop releases are now available to download from the EU-UNAWE website (www.eu-unawe.org) as a PDF to make the resource easier to use in classrooms. The new templates have been designed to appeal to young girls and boys, while maintaining the feel of a professional news release. Credit: EU-UNAWE

*Indiana Jones*¹⁰, *Star Trek*¹¹, *Twilight*¹², *Lord of the Rings*⁹, and indirectly referred to *Little Red Riding Hood*¹³ and *Snow White*¹⁴. And why not refer to a big event in current affairs, such as the Olympic Games¹⁵?

Be open

6) Don't shy away from telling kids how much we still don't know about the Universe¹⁶. Instead, use it as an opportunity to highlight how there are many areas of research that they can contribute to when they are older. Furthermore, why should children be led to believe that scientists always have the right answer? Mistakes and failures help to show that scientists are real people.

7) The best way to know whether you have written a successful article is to listen to comments from parents and educators. In addition to inviting feedback from the organisation's network, every *Space Scoop* is evaluated before publication

by the National Project Manager for EU-UNAWE in Germany, Natalie Fischer, who has many years of experience in educating young children.

Acknowledgements

EU-UNAWE (www.eu-unawe.org) is funded by the European Community's Seventh Framework Programme (FP7/2007-2013) under grant agreement n° 263325.

Notes

Space Scoops quoted in the article:

- 1 www.eu-unawe.org/kids/unawe1217
- 2 www.eu-unawe.org/kids/unawe1149
- 3 www.eu-unawe.org/kids/unawe1138
- 4 www.eu-unawe.org/kids/unawe1125
- 5 www.eu-unawe.org/kids/unawe1149
- 6 www.eu-unawe.org/kids/unawe1209
- 7 www.eu-unawe.org/kids/unawe1230

- 8 www.eu-unawe.org/kids/unawe1150
- 9 www.eu-unawe.org/kids/unawe1138
- 10 www.eu-unawe.org/kids/unawe1119
- 11 www.eu-unawe.org/kids/unawe1232
- 12 www.eu-unawe.org/kids/unawe1147
- 13 www.eu-unawe.org/kids/unawe1214
- 14 www.eu-unawe.org/kids/unawe1225
- 15 www.eu-unawe.org/kids/unawe1235
- 16 www.eu-unawe.org/kids/unawe1222

Biography

Sarah Reed is Editor-in-Chief of CAPJournal and the International Outreach Coordinator for the IAU Office for Astronomy Outreach, which is hosted by the National Astronomical Observatory of Japan. From February 2011 until September 2012, she was Science Editor for EU Universe Awareness and responsible for writing its *Space Scoop* releases.

Evaluating the Motivations and Expectations of those Attending a Public Astronomy Event

Vickie Curtis

*The Open University, Milton Keynes, UK
vickie.curtis@open.ac.uk*

Keywords

Public engagement, Evaluation, Motivation

Summary

The focus on a one-way flow of information from scientists to members of the public has been criticised for presuming public ignorance and offering few opportunities for interaction and debate. In response to these criticisms, recent approaches have promoted dialogue, participation and engagement between scientists and members of the public.

However, it is not known to what extent members of the public prefer newer dialogic approaches to those with educational content. What do they value in a science outreach event? To explore this issue further, I investigated nine weekly public open evenings at the Institute of Astronomy at the University of Cambridge, UK. In this article I will describe the main features of these public events, outline my approach in exploring the participants' motivation to engage with astronomy, and detail my research findings.

Introduction

Until recently, what is now referred to as the “deficit model” has dominated thinking in relation to the way that scientists communicate with the wider population (Einseidel, 2007; Irwin & Wynne, 1996). The deficit model has been described as the assumption of “public ignorance” in matters of science and technology, and efforts by the scientific community have tended to focus on educating members of the public. Such an approach has also been described as “first-order” thinking. However, over the past 15–20 years, there have been calls to shift the emphasis towards “second-order” thinking, which supports a dialogic approach (Irwin, 2008). This approach promotes engagement with members of the public and other stakeholders as active participants alongside scientists.

It is therefore important to explore how science communication events are changing, and to what extent those who attend these events really want this change. In other words, what do members of the public who attend public events really value? To what extent do they desire educational or dialogic approaches to science engagement?

In order to explore this issue further, quantitative and qualitative data were collected

about a series of nine open evenings, held on a weekly basis, at the Institute of Astronomy (IoA) at the University of Cambridge.

General observations

The open evenings were held during the autumn and winter months. About 150–200 people attended each of these evenings, regardless of the weather¹. Each event typically consisted of a lecture given by a member of the research staff or a postgraduate student, followed by a Q&A session.

The lectures were on a variety of topics and intended to appeal to non-astronomers, although some lectures contained quite a lot of technical information. Some were marketed as child-friendly events and were labelled as such on the programme of lectures on the IoA website.

On clear evenings, the audience were led outside for an observing session led by members of the local astronomy group, Cambridge Astronomical Association (CAA), in which images from the group's telescopes were projected onto a large screen. The historical telescopes at the IoA were also opened up, and particular items of interest could be observed. Sometimes,

members of the IoA were on hand with binoculars and laser pointers to show objects of interest.

On cloudy evenings, the IoA staff invited the audience to stay for informal discussions with IoA staff over tea and biscuits. Not everyone stayed for this, but it offered an opportunity for those with a particular question to talk to an astronomer on a one-on-one basis.

Quantitative data: Who attends and why?

In order to get an idea of the demographic of the open evening audience, a one-page quantitative questionnaire was handed out to attendees upon arrival at the IoA. This contained questions relating to age, sex, level of general education, level of science education, distance travelled to the event and key motivational factors for their attendance. In total, there were 254 responses over the nine evenings. Those who had already filled in a questionnaire were asked not to complete any more on later visits.

The data showed a diverse range of ages for the attendees, with a higher ratio of males to females (a ratio of approximately 2:1).



Figure 1. On clear nights, members of the Cambridge Astronomical Association (CAA) deliver a short outdoor presentation of objects that are currently visible in the night sky. Credit: Alex Calverley

The latter feature is not surprising, since astronomy has been traditionally male-dominated both in academia and within amateur astronomy societies.

The majority of those who attended were local (from within the city of Cambridge) yet a large proportion (nearly 18%) had travelled over 30 kilometres. The overwhelming majority of those attending did so with others: only 15% attended alone. This may demonstrate that, like many science communication events, the open evenings are social activities. Interestingly, 48% of those questioned had attended the open evenings before (a group of “regulars” were easily spotted after observing a few of the open evenings).

It is worth noting that the attendees were well educated, with approximately 68% of all respondents having a university qualification. This is perhaps not surprising, as the city of Cambridge has a higher than average percentage of the population with an undergraduate degree or equivalent (41% versus 20% nationally). However, it does illustrate some of the challenges in engaging with citizens who have not studied academic subjects at degree level, or who decide not to study science subjects beyond the age of 16.

Furthermore, only about half of those with a degree were qualified in a scientific subject, suggesting that this event was as appealing to those with a background in subjects other than the sciences.

When asked why they attended the event, approximately a third of respondents stated that it was due to a general curiosity about astronomy. Nearly 20% stated that they wanted to look through the telescopes, and 16% stated that the subject of that evening’s lecture was one of the main draws. This could be interpreted as a desire on the part of the audiences to learn more about the scientific subject and to receive information from specialists in this field. To explore this issue in more detail, the opinions of members of the audience were explored.

Opinion research

In addition to gaining an understanding of the audience demographics, the audience reaction to this event was explored. A second questionnaire containing six open-ended questions was distributed using the SurveyMonkey online research tool. The attendees were asked:

1. What aspects of the evening were most/least rewarding for you and why?
2. What was it about this event that attracted you to come, and in what ways has it stimulated your interest in astronomy?
3. Some scientific events are educational with the scientists teaching and you learning. Other events focus on a two-way dialogue between scientists and “the public”. After attending this event, do you think it would be valuable to have a dialogue about astronomy — and if so, how would you like that to happen?

4. What do you consider to be a “science communication” event or place, and what makes you want to (or not want to) be a part of them?
5. Do you think that factors such as age, sex, or level of education influence how an audience responds to a science communication event, and in what way?
6. Please use the space below to add any more comments or thoughts.

The organisers of the open evenings agreed to place a link to this questionnaire on the IoA website, and it was advertised before the beginning of several lectures. In total, 33 attendees completed this questionnaire.

One criticism of this approach is that the respondents will not be random, as they represent a self-selected sample. However, self-selection in qualitative questionnaires is less problematic than with quantitative research, as the goal is to gather authentic views and experiences from the participants’ perspectives (Cresswell, 2009). Indeed, some researchers have argued that self selection in qualitative surveys can be desirable in some cases (Jensen & Holliman, 2009).

The survey revealed that the majority of these respondents attended in order to learn something new, or to put new knowledge into practice while observing the night sky on their own. This was true of both the lectures and the observation portion of the event. The following examples from the questionnaire data illustrate these points.

“Having someone explain and point out constellations etc. on a screen has encouraged me to look at the night sky and feel more confident in identifying what I see.”

“The talks have encouraged me to investigate the scientific aspect of astronomy. Before that, I was mainly interested in learning the names of the constellations.”

“I have always found astronomy fascinating, but without some teaching it is a hard discipline to undertake alone.”

These comments emphasise the importance of educational framing in this event; receiving new scientific information was essential to the respondents’ enjoyment of the event, and it was one of the main reasons why they attended. This was also highlighted to be an important factor for those who attended with their children.



Figure 2. Informal discussions between the organisers and attendees on a cloudy evening outside the auditorium at the Institute of Astronomy. Credit: Vickie Curtis

"I love the lectures. I come with my daughter who is interested in astronomy and the lectures have given me some basic understanding of astronomy."

"We were doing a home-schooling project on space with our children and thought it would add to their knowledge of the subject."

The importance of learning was more closely examined in the responses given to question 4. Interestingly, many respondents felt that an event involving some sort of lecture — an "open day", or some other situation that primarily involved the one-way transfer of information — would be the hallmark of a desirable event. Several respondents also went on to state that they were attracted to events where they could learn something new (ideally from working scientists) or be enlightened in some way.

"I like to receive information via a person using various methods: lecture, presentation, video. I'm not at all keen on 'hands-on' stuff. Very passive, I know — but that's just me!"

"I want to be enlightened. I like being taught, I like to find out interesting facts (although remembering them is another matter). For me, it widens my horizons and that can't be bad."

"I want to learn. If an event or place makes me think I can learn something, I would like to be a part of it."

The involvement of a respected academic institute and the participation of working scientists were also of importance to a number of respondents.

"A place where there are specialists who can share their knowledge, enthusiasm and answer questions. Enthusiastic experts who bring the subject to life."

"A science communication event usually involves an academic institution opening its doors to members of the public and presenting science in such a way which can be understood by people with a wide variety of academic experience or ability including people who have had very little education."

Thus, the concept of the general public looking to an expert for information is important to some of the people who attended this event.

Question 5 looked at factors that could affect how an audience member perceives and responds to a science communication event. Through this question, I was hoping to gain insights into the respondents' ideas with regards to certain factors (such as age, sex, and level of education) that might affect their perception of an event. One of the most important factors outlined in the responses was the level of education of those attending. Not only did respondents argue that the level of education affects a person's understanding of the scientific content of an event, but it could also influence an individual's decision to attend in the first place.

"It can influence understanding, but also more educated people are more open and confident to go to such events and feel they can learn something."

"An audience's level of education can determine how much they gain from an event as it is very easy for the speaker to use a scientific term or assume knowledge of a concept which some members of the audience do not understand."

"Some people may not even attend events believing that they will be far too intellectual for them."

The fact that these respondents argued that education levels could affect one's confidence in deciding to go to a science communication event may influence how individuals decide whether to attend themselves, and also if they would invite friends and family members to join them. However, it is also worth noting that several respondents argued that a lack of formal qualifications could be overcome by being interested and enthusiastic.

"What's really important is the level of interest in the audience and of inspiration on the part of the scientific communicator."

This finding indicates that the pool of self-selecting audience members could be extended with careful promotion of events, enthusiastic science communication practitioners and a willingness on the part of the audience members to try something new.

What about dialogue?

One of the key points of interest in the opinion research was to explore views on dialogic approaches for public astronomy events, and what form such engagement should take.

The phrasing of question 3 attempted to differentiate between a more "educational" framing of events, as opposed to those that required some sort of active participation from members of the audience. With this in mind, it is worth noting that the terminology associated with science communication and public engagement is broad and relatively new in some instances, and there does not appear to be a fixed definition of the terms involved within the literature (Holliman & Jensen, 2009; Davies et al., 2009). Given that this is the case within the research community, it would be unreasonable to expect that attendees at these astronomy events would immediately grasp what was meant by "dialogic approaches".

Nor should they necessarily be aware of the fact that different approaches to science communication exist and are currently being debated.

This was a difficult question for some of the respondents to answer and there were a number of people who responded with “not sure” or “don’t know”. Most of the respondents, however, (24 out of 33) attempted to answer this question, and some suggested ways in which more dialogic approaches could be introduced. Eleven respondents felt that more dialogue would be a good idea, in theory.

“I suppose a dialogue session is always beneficial, especially because there are so many doubts and questions about the astronomical world out there.”

“In principle it’s a great idea. Lots of the public have knowledge and experience, which would be good to share.”

“I think two-way dialogue could be interesting, but I don’t have any bright ideas about how it might work best.”

Interestingly, several respondents considered the regular Q&A session as an adequate opportunity for dialogue. For these respondents, the current format of the IoA open evenings was sufficient as there is always the opportunity to ask questions or to speak informally to the astronomers after the lecture.

“Dialogue and Q&A sessions are good because there are some hard concepts and a lot of jargon, so it is easy to confuse people and leave them with misconceptions if the communication is one-way.”

“There is always an opportunity for dialogue during question time or informally afterwards, so I think you’ve got that one covered.”

Seven respondents provided a possible way of introducing dialogic approaches within the overall scope of this event. A number of these involved small group seminars, in which a group would discuss a specialist topic, or some astronomy-related problem with an expert from the IoA. A panel discussion approach similar to the TV programme BBC *Question Time* was mentioned, as were informal one-to-one sessions between an astronomer and a member of the audi-

ence. One respondent suggested a social event at a local bar where interested members of the public could have an informal chat and a drink with experts and students. Such a suggestion has similarities with the successful Café Scientifique movement (Grand, 2009).

Interestingly, a number of respondents stated that some sort of learning would have to take place before any meaningful dialogue could occur. One of the respondents who suggested smaller seminar groups added the following caveat:

“It might work best if all concerned (especially the public) are asked to do homework and prepare questions prior to the workshop. It would involve much more commitment from the public than just showing up.”

The need for some background knowledge as a prerequisite for dialogue was expressed by other respondents.

“I know so little about astronomy that there’s not really any point in a two-way dialogue for me.”

“I think a lecture at the beginning makes sense, particularly because there are those of us in the audience who don’t really know enough to know which questions to ask, let alone to carry on a dialogue.”

This need for preparation before dialogue has been encountered by other researchers when investigating public engagement events. For example, Davies et al. (2009) found that those attending interactive events at the Dana Centre at the London Science Museum want and expect information to be presented, and when this is not given to them “they are frequently disappointed”. The concept and need for preparation before dialogue has been a feature of more formal dialogue activities in the UK, such as the GM Nation? consultation (Heller, 2003) and for nanotechnology engagement events (Chilvers, 2006). Of course, this requires a greater commitment of time on the part of members of the public, which may deter some.

The view that members of the public require some level of scientific literacy before dialogic approaches can be successful leads to questions about the nature of dialogue itself, and perceptions of expertise. What can dialogic approaches deliver, and can they

be framed to allow scientists and members of the public to genuinely learn from each other? This has important implications for all dialogic events, including those that form the basis of a consultation to inform science policy, and where there are societal or ethical implications.

Davies et al. (2009) examined dialogue events that had no bearing on public policy and found that these could exist in many different formats, from small discussion groups to more traditional question and answer sessions. Within such a context, there is a shift from the institution to the individual, and the focus is on much smaller outcomes. They go on to argue that dialogue events become opportunities for individual learning through social processes. In effect, these informal dialogue events provide opportunities to empower individuals, potentially increasing participation and ultimately becoming part of a gradual step-by-step change in “science and society” as a whole.

The interaction of specialists and individuals can bring an added social and cultural dimension to a public event, particularly if the chosen forum does not imply the superiority of one form of knowledge over another. While a member of the general public may not necessarily be able to contribute technical expertise, they can provide insight with regard to the societal impact of astronomy, how information may best be presented to other members of the public, and provide researchers with an alternative view of their work. One postgraduate student that I spoke to at the IoA said that sometimes a member of the audience can ask a question that frames their research in an alternative way that makes them revisit some of their own underlying assumptions. This echoes experiences from other areas in the sciences (Wilsdon et al., 2005). This was a sentiment also expressed by one of the respondents:

“I do believe that the public have an important role in helping scientists to present their thoughts and analyses clearly. There’s nothing quite like a dumb question from an audience to re-inspire a re-appraisal of a long-held and possibly fallacious point of view.”

In this way, scientists themselves can learn from participation in public engagement activities, but only if they show a willingness to engage and learn as part of this process (Holliman et al., 2009).

Conclusion

The quantitative survey showed that the IoA open evenings attracted people of all ages, most of whom are well-educated, and that many attended with friends or family. Almost half attend more than one event throughout the observing season. Many people were drawn to the event to learn something new, and to explore astronomy with practising astronomers. Nearly 18% of respondents had travelled large distances to attend the event, which may, perhaps, be due to the prestige associated with the University of Cambridge.

Meanwhile, the opinion data delved deeper and revealed a number of insights about respondents' perception of public engagement and dialogic approaches within the context of an astronomy event. It could be argued that a desire for dialogue is not a pressing concern among those who responded to the questionnaires and there was little evidence that participants felt excluded from discussions with the scientists at the IoA. In fact, many of the regular attendees were clearly on friendly terms with the organisers and with members of CAA (who have recruited new members through the open evenings).

The main appeal of this event, according to respondents, was the opportunity to learn something new from the lectures and to be inspired by observing the night sky. The enthusiasm and the accessibility of the scientists involved in running the event were valued by those attending. Several of the respondents to the second questionnaire argued that they were already having an informal dialogue with the IoA scientists through the Q&A sessions. This informal dialogue also took place on cloudy evenings over tea and biscuits.

This doesn't necessarily mean that there isn't a need to develop the idea of dialogue in astronomy outreach. There is clearly an interest among some of those who responded to the questionnaires, despite the fact that this may not be fully informed by an adequate appreciation of what dialogue means in this context, and what kind of events may be available. However, given that a number of astronomy outreach programmes are making use of new communication technologies, there may be the potential for some innovative approaches that increase the opportunity for dialogue and

active participation between astronomers and members of the public.

I am now embarking on a research project to explore online citizen science projects. Some of the most successful of these projects are found in the field of astronomy, for example: SETI@home, Stardust@home and the suite of GalaxyZoo projects. Digital technologies are providing opportunities for citizens to interact with scientists and to contribute to data analysis on a scale not previously seen. My research will aim to explore what motivates citizens, as well as scientists, to become involved in these types of activities, and to what extent online tools are shaping and adapting public engagement activities, and ultimately, the relationship between science and society.

Acknowledgements

I would like to thank Professor Carolin Crawford of the Institute of Astronomy, University of Cambridge, for allowing access to the open evening events, and for providing one of the images used in this article. I would also like to thank Dr Richard Holliman, Senior Lecturer in Science Communication at The Open University, Milton Keynes, UK, for feedback and advice while writing this article.

References

- Chilvers, J. 2006, *Engaging research councils? An evaluation of a Nanodialogues experiment in upstream public engagement*, BBSRC, retrieved from http://www.bbsrc.ac.uk/society/dialogue/activities/nanodialogues_evaluation.pdf, accessed 02-06-09
- Cresswell, J. W. 2009, *Research Design: Qualitative, Quantitative and Mixed Methods Approaches*, (London: Sage)
- Davies, S. et al. 2009, *Discussing dialogue: perspectives on the value of science dialogue events that do not inform policy*, *Public Understanding of Science*, 18, 338
- Einseidel, E. 2007, *Editorial: Of publics and science*, *Public Understanding of Science*, 16, 5
- Grand, A. 2009, *Engaging through dialogue: international experiences of Café Scientifique*, in *Practising Science Communication in the Information Age: Theorizing Professional Practices*, edited by R. Holliman et al., (Oxford: Oxford University Press)

Heller, R. 2003, *GM Nation? The findings of the public debate, the Report of the Steering Board of the public debate on GM and GM crops*, retrieved from http://www.aebc.gov.uk/reports/gm_nation_report_final.pdf, accessed 02/06/09

Holliman, R. & Jensen, E. 2009, *(In)authentic science and (im)partial publics: (re)constructing the science outreach and public engagement agenda*, *Investigating science communication in the information age: Implications for public engagement and popular media*, edited by R. Holliman et al., (Oxford: Oxford University Press)

Jensen, E. & Holliman, R. 2009, *Investigating science communication to inform science outreach and public engagement*, *Investigating Science Communication in the Information Age* edited by R. Holliman et al., (Oxford: Oxford University Press)

Irwin, A. & Wynne, B. 1996, *Introduction, Misunderstanding Science? The public reconstruction of science and technology* edited by A. Irwin & B. Wynne, (Cambridge: Cambridge University Press)

Irwin, A. 2008, *Risk, science and public communication. Third-order thinking about scientific culture*, *Handbook of public communication of science and technology* edited by M. Bucchi & B. Trench, (London: Routledge)

Turney, J. 2006, (ed.) *Engaging science: Thought, deeds, analysis and action*, (London: Wellcome Trust)

Wilsdon, J., Wynne, B. & Stilgoe, J. 2005, *The public value of science: Or how to ensure that science really matters*, (London: Demos)

Notes

- ¹ http://www.ast.cam.ac.uk/public/public_observing/talks2012-13

Biography

Vickie Curtis is a PhD student at the Open University, UK. She is investigating how developments in communication technologies are influencing public engagement activities in the sciences.



ESOcast now with subtitles!

Choose between different languages
or contribute a translation yourself.



Has your local club joined the IAU Astro Clubs Portal yet?

Creating a global network to bring established and newly formed amateur astronomy clubs together
Providing a communication channel for disseminating news to the amateur astronomy community
Promoting the sharing of best practices and resources among associations around the world



www.iau.org/outreach/clubsportal

From Earth to the Solar System: A Case Study for Public Science Events

Kimberly Kowal Arcand

Chandra X-ray Center/SAO
kkowal@cfa.harvard.edu

Megan Watzke

Chandra X-ray Center/SAO
mwatzke@cfa.harvard.edu

Keywords

Astronomy, Outreach, Public science, Accessibility

Summary

The term “public science” is proposed to describe science outreach events and activities that are conducted in public spaces. In this article, the photography exhibition “From Earth to the Solar System” (FETTSS) is outlined as a case study to evaluate the impact and the types of audiences reached by public science programmes.

Public science

Public art is defined on Wikipedia as “works of art in any media that have been planned and executed with the specific intention of being sited or staged in the physical public domain, usually outside and accessible to all”. It is a well-established means through which people can become engaged in art during their everyday activities. Typically, public art pieces have some connection to their location, as well as the potential for community involvement and collaboration.

The same types of easy-access events are already taking place in science outreach. Astronomy, in particular, has had success in engaging the public in everyday situations through city centre star parties, sidewalk astronomy, and outdoor exhibitions. It is therefore suggested that the term “public science” should be adopted for outreach projects that attempt to reach new audiences by being held outdoors or in another type of public or accessible space (Arcand & Watzke, 2011). Public science could help frame such outreach events that attempt to attract incidental or casual visitors (Crettaz von Roten, 2011).

From Earth to the Solar System

From Earth to the Solar System (FETTSS) was conceived as a response to NASA’s Year of the Solar System (which ran for one Martian year, from October 2010 through August 2012), and arguably provides a solid case study for the newly defined category of public science.



Figure 1. *The Big Yellow Rabbit is a large (13 metres tall) and evocative piece of temporary public art created by Dutch artist by Florentijn Hofman and displayed in Orebro, Sweden in 2011. Credit: Peterappelros, Wikimedia Commons (CC)*

As with its predecessor project, From Earth to the Universe (FETTU), the FETTSS organisational structure follows a grassroots approach (Russo & Christensen, 2010) in which local organisers print their own version of the exhibition for their selected venues. The FETTSS project supplies high-resolution electronic files that have been approved for non-commercial outreach use to be displayed in any way that makes sense for a given venue. However, the printing, installation, and other logistics are the responsibility of the local hosts.

One major implementation of the FETTSS programme, organised by the Chandra X-ray Center/Smithsonian Astrophysical Observatory and NASA Astrobiology Institute, is a traveling FETTSS exhibit and a tactile Braille all-weather poster series for the visually impaired. The NASA-funded exhibit, which consists of 15 all-weather, double-sided image stands (bilingual in English and Spanish), is being loaned free of charge to over a dozen venues that

commit to hosting the project. Each host must also organise an additional event to supplement the exhibit, such as a star



Figure 2. *A selection of the 95 images that were curated for the FETTSS collection. FETTSS content weaves together themes in multi-wavelength astrophysics, astrobiology and planetary science and includes images from amateur astronomers, field scientists and ground- and space-based missions. Credit: FETTSS*

party, scavenger hunt or a question and answer session.

Internationally, the FETTU network was leveraged to advertise the opportunity beyond NASA and US-specific audiences. As of November 2012, about 100 FETTSS venues in 25 countries have either signed up to participate or have already hosted FETTSS events. The following section details a few locations that have hosted the FETTSS exhibition in the United States.

FETTSS on location

1) La Palmera, Corpus Christi, Texas, US

In the US, the first port of call for FETTSS was at a high-traffic shopping mall called La Palmera, located in Corpus Christi, Texas, from 9–31 May 2011. This coincided with a programme of events for NASA's Space Week, coordinated with the Corpus Christi Museum of Science and History and the National Center for Earth and Space Science Education. FETTSS was covered in television news broadcasts, online articles and promoted through the museum.

2) National Air & Space Museum (NASM), Washington DC, US

The exhibit was hosted outside NASM from 1 June to 11 July, 2011. FETTSS funds were used to allocate two summer interns to act as docents at the outdoor exhibition. Each weekday, two 15-minute tours were offered in the mornings on the moons in the Solar System and cosmic weather. The materials used to supplement the exhibit included the FETTSS exhibit guide and FETTSS postcards. The FETTSS exhibition also played a part in the National Mall Astronomy Night, which was held on 8 July in Washington DC. At this event, more than 300 visitors visited the astronomy exhibits, theatrical events and star-gazing parties that took place.

3) Science City, Kansas City, US

FETTSS travelled to host organisers at the Science City science centre at the historic train station, Union Station, in Kansas City, Missouri, from 6 March–8 May, 2012. The landmark is a tourist destination not only for its historic architecture, but also its indoor mall that hosts unique shops and restaurants. The FETTSS exhibit opening was part of the train station's Science City 2.0 kick-off



Figure 3. FETTSS visited Washington, DC from 1 June to 11 July 2011, with hundreds of visitors attending the National Mall Astronomy Night held on 8 July in Washington DC. Credit: NASA/CXC/SAO/J. DePasquale

event to celebrate a new nature centre, planetarium show and the reopening of the public mall space in front of the "Engineerium", where students perform experiments in a simulated engineering environment. The organisers scheduled numerous school field trips and also inserted FETTSS into their Astronomy Week festivities (1–8 May 2012).

4) University of Central Florida (CFU), Orlando, US

FETTSS travelled to the John C. Hitt Library at the University of Central Florida in Orlando, Florida, for display from 11–29 May, 2012. The university's Planetary Sciences Group within the College of Sciences organised the exhibit's stop in Orlando to help "give community members a chance to see what inspires scientists every day to continue research into the formation of the Solar System and the possibility of life beyond Earth".

Evaluating the impact and audience reached by FETTSS

The FETTSS research questions follow on from previous public science project results (Arcand & Watzke, 2010), as well as results from the ongoing Aesthetics & Astronomy research project (Smith et al., 2010). These questions include: Who are we attracting with science displays in these everyday situations? Are there more

incidental visitors than intentional visitors with public science events? Do any participants follow up with their local science centre or library or other resources? FETTSS data may help shed light on whether public science events can be effective ways of reaching new audiences.

Tables 1–5 show preliminary self-reported results from 5 out of 11 questions from surveys distributed to population samples of one in three adults at the FETTSS sites described above. The graphs were prepared by external evaluator Jan Crocker LLC associates and edited by the first author. In the tables, La Palmera, Corpus Christi = CC; National Air and Space Museum = NASM; Central Florida University = CFU, and Union Station, Kansas City = KC.

A noted difference between the data is that the population surveyed at NASM came from across the US, as well as from other countries, whereas those surveyed at the other sites came from relatively nearby locations. This is not a surprising find, since NASM is a significant tourist destination. Another noticeable difference is the average age of the audience, with a younger crowd at CFU (average age 28 years) compared to those attending NASM (average age 42.1 years). This is likely because more multi-generational family units visit NASM, and many college students live near to CFU.

Average Age

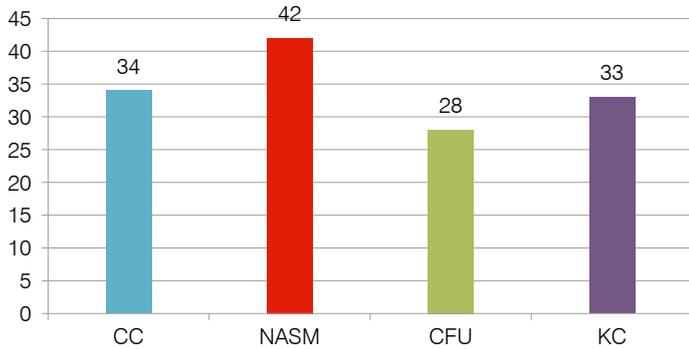


Table 1. Question 4 on participant age: The somewhat older age for NASM reflects the family audience that typically visits the museum.

Average Rating of Knowledge of Astronomy On a scale of 1–5

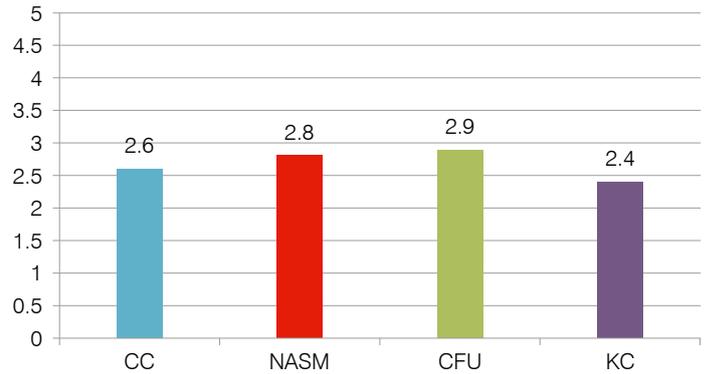


Table 2. Participants were questioned about their existing knowledge of astronomy on a scale of least (1) to greatest (5). The similarity in self-reported knowledge across the venues is, perhaps, surprising and requires further analysis with the remaining data from the survey.

How Do You Feel About FETTSS? Average responses on a 1–5 scale

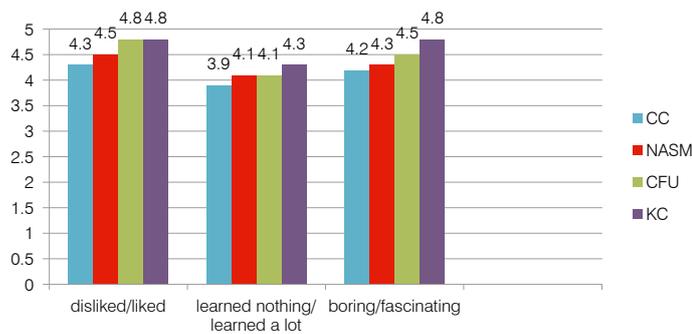


Table 3. Respondents were asked to indicate a score between 1 and 5, where 1 represents disliked/learned nothing/boring and 5 represents liked/learned a lot/fascinating. The results indicate that the biggest impact may be that of an aesthetic experience, based on the higher ratings in the “like/dislike” and the “boring/fascinating” categories.

How Do FETTSS Increase/Decrease Interest in the Following Average responses on a 1–5 scale

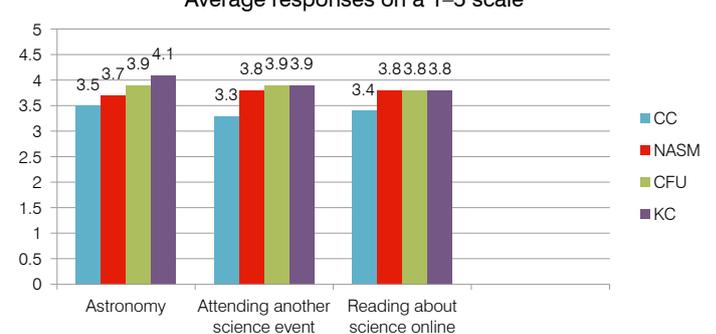


Table 4. Question about the participants’ interest in astronomy as a result of seeing the FETTSS exhibition, and the likelihood that they will attend other science events or read about science online. The range of responses across sites was similar, with slightly lower numbers from the mall site in Corpus Christi.

Was Drawn to the Exhibit because:

Numbers in percents based on number of responses

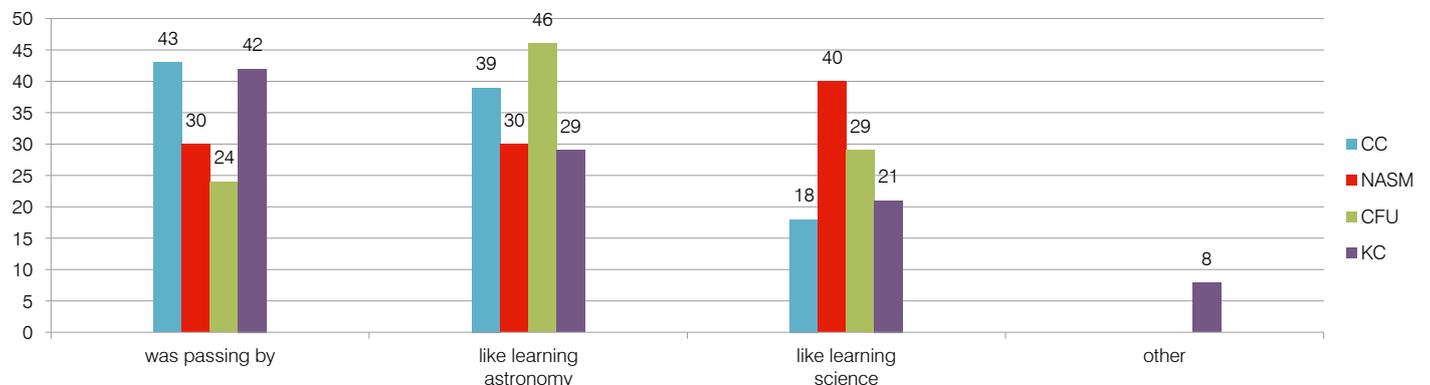


Table 5. Participants were asked why they had been drawn to the exhibit with numbers in percentages, based on the number of responses. CFU had the highest percentage of people who visited the exhibit because they were interested in astronomy, which is perhaps not surprising as the hosts mentioned in an email that they would encourage staff and students to attend the exhibit. CFU and NASM had the two lowest ratings in the “was passing by” category. In the case of NASM, where the exhibit was set up outside, near the entrance, it is suggested that most participants were intentionally visiting the museum and may have viewed FETTSS as part of its collection, hence the low number of reported passers-by.

It is also of interest to note some similarities between the responses from participants at different venues. For example, one might think that viewers at a shopping mall setting would have a lower level of astronomy knowledge than those at a science museum. Yet, the responses to the survey were relatively consistent. Further analysis with data from other sites should help to clarify this finding. It is worth noting, however, that this mall is near to a large academic community (Texas A&M University Corpus Christi), but the results could also indicate that public science events attract participants with an existing interest in the field, even when held in non-traditional venues.

In general, there was much consistency of responses for the questions about the attendees' overall impressions of FETTSS (Table 3) and how it had altered their interest in astronomy and their likelihood of attending another science event (Table 4). It is suggested that the slightly lower rated responses to "learned nothing/learned a lot" in Table 3 reflect the responses of people who commented that they were already knowledgeable about astronomy. Additionally, it may be that the biggest impact may be that of an aesthetic experience, based on the higher ratings in the "like/disliked" and the "boring/fascinating" categories.

Perhaps the most encouraging result of all of these questions from an astronomy communication perspective is that the responses were decidedly positive, no matter what the venue.

Conclusion

As with the FETTU project (Arcand & Watzke, 2010), the preliminary FETTSS evaluation data suggest that public science projects can have a positive impact on viewers' perception and their relationship with science events (see tables 3 and 4). Deeper and longitudinal studies of public science events will help to shed more light on these early observations. Furthermore, projects similar to FETTSS from other scientific fields would help to further demonstrate any impact that public science may have on society.

In future studies we will consider increasing the scale used in the survey from 5

to 10 points, as used in the Aesthetics & Astronomy studies (Smith et al., 2010). Additionally, future studies might attempt to align survey language and indicators in order compare data with potential benchmarks from current research, such as the Longitudinal Study of American Youth (LSAY) (Miller, 2012) and other existing US-wide data samples.

Meanwhile, in the current study, we are continuing to analyse the data that has been returned as the NASA-funded FETTSS exhibit travels to other locations in the US. We are gathering additional information on the perspective and experiences of FETTSS hosts from the US and worldwide organisers, as well as gathering information about the online interest in FETTSS through website and social media statistics.

Acknowledgements

This material is based on work supported by the National Aeronautics and Space Administration under grant NNX11AH31G issued through the Science Mission Directorate. Portions of this paper have been presented at the Astronomical Society of the Pacific (ASP) conference (2011), Communicating Astronomy with the Public conference (2011), European Planetary Science Congress (2012), in a paper published by Science Communication (Arcand & Watzke, 2011) and the ASP conference proceedings (Arcand et al., 2011).

References

- Arcand, K. K. et al. 2011, "From Earth to the Solar System": Public Science Exhibitions for NASA's Year of the Solar System, Astronomical Society of the Pacific "Connecting People to Science"
- Arcand, K. K. & Watzke, M. 2011, *Creating Public Science With the From Earth to the Universe Project*, Science Communication, 33, 3
- Arcand, K. K. & Watzke, M. 2010, *Bringing the Universe to the Street: A Preliminary Look at Informal Learning Implications for a Large-Scale Non-traditional Science Outreach Project*, JCOM Journal of Science Communication, 9, 2
- Bell, P. et al. (Eds.) 2009, *Learning science in informal environments: People, places and pursuits*, (Washington, D.C.: The National Academies Press)

Cole, P. R. & Cutting, J. M. 1996, *The Inside Story of Science City- An Outdoor Public Science Exhibition*, Curator: The Museum Journal 39, 4, 245–261

Crettaz von Roten, F. 2011, *In search of a new public for scientific exhibitions or festivals: the track of casual visitors*, JCOM Journal of Science Communication, 10, 1, 1–8

Miller, J. 2012, *How many young adults know their cosmic address?*, The Generation X Report, A quarterly Research Report from the Longitudinal Study of American Youth, University of Michigan Institute for Social Research, 2, 1, 1–8

Norsted, B. A. 2010, *Take Me Out to the Ball Game: Science Outreach to Non-traditional Audiences*, Barnes, J. et al. (Eds.), Science Education and Outreach: Forging a Path to the Future, ASP Conference Series, 431, 170–173

Riise, J. 2008, *Bringing Science to the Public*, in D. Cheng et al. (Eds.), *Communicating Science in Social Contexts*, (Brussels: Springer), 301–309

Russo, P. & Christensen, L. L. (Eds.) 2010, *International Year of Astronomy 2009 Final Report* International Astronomical Union, ISBN: 978-3-923524-65-5

Smith, L. S. et al. 2010, *Aesthetics and Astronomy: Studying the public's perception and understanding of imagery from space*, Science Communication, in press

Notes

<http://fettss.arc.nasa.gov>

<http://chandra.si.edu/fettss>

Biographies

Kimberly Kowal Arcand is the Visualisation & Media Production Coordinator for NASA's Chandra X-ray Observatory. She is principal investigator of the From Earth to the Solar System (FETTSS) project and co-author of the FETTU- and FETTSS-based book *Your Ticket to the Universe* with Megan Watzke.

Megan Watzke has worked in astronomy communication for the past 12 years. As the Press Officer for NASA's Chandra X-ray Observatory since 2000, she has worked toward infusing science in the public's consciousness, trying to remove the stigma that science holds for so many, especially girls, women, minorities and other under-represented groups.

Visualising Astronomy: Using Impact to Inform

Ryan Wyatt

California Academy of Sciences, USA
 rwyatt@calacademy.org

Keywords:

Asteroid, Visualisation



Figure 1. A Hayabusa image of asteroid 25143 Itokawa.
 Credit: Courtesy of JAXA

Pop culture has visualised asteroids in a way that has made a far greater impact in the public domain than the outreach community can ever hope to achieve. Films such as *Meteor* (1979), *Armageddon* (1997) and *Deep Impact* (1997) may score poorly on scientific accuracy, but they have influenced our collective consciousness. (Perhaps in a fit of pre-millennial anxiety, the late 1990s saw a host of films featuring an asteroid or comet on a collision course with Earth¹.) In addition to the destruction of Earth's cities, the *Millennium Falcon* dodging giant tumbling boulders in *The Empire Strikes Back* has probably influenced more people's mental image of an asteroid belt than any other single visual.

Insofar as "asteroid" simply means "rock from space" in the popular imagination, cinema has cemented images in many people's minds. This may have created some misconceptions, but it also has introduced people to a mental model that can provide a basis for further discussion and engagement. I think we have an opportunity right now in terms of visualising asteroids — both in terms of their appearance and of their dynamics — and their relevance to humanity as sources of raw materials and as potential threats to the survival of our species.

In the past decade, spacecraft have returned remarkable high quality images of asteroids. Most recently, the *Dawn* mission has given us a spectacular view of the asteroid Vesta, with similar results expected for the dwarf planet Ceres. Hayabusa's

images of the more modestly sized Itokawa (Figure 1), coupled with its impressive story of landing on the asteroid and returning to Earth, make for a compelling story. Indeed, a Japanese production consortium created a lovely planetary show about Hayabusa: a main character in the show is the asteroid itself, reconstructed from observed data².

A detailed model of Itokawa exists online in a variety of resolutions and file formats³, and you can download freeware to view and interact with the models. A free Android application also exists that allows users to manipulate the model in three dimensions; unfortunately, the bare-bones implementation offers no interpretation in terms of science or even scale information, making it of limited interest⁴. The outreach community should work on a way of making three-dimensional data more accessible, since it's the non-spherical nature of asteroids that makes them more visually interesting than most planets.

The freeware programme Celestia⁵ has a few asteroids in its database, including Itokawa, but the fairly low-resolution models (with low polygon counts that make

them resemble computer-generated potatoes) don't inspire a positive aesthetic response. More models are available in the Celestia Motherlode⁶ — an online repository for add-ons for objects in Celestia — but the data representing the asteroids' trajectories make for a more compelling message. For example, options exist in the Celestia Motherlode to add several thousand near-Earth asteroids, and there's even a collection of "potentially hazardous" objects. Unfortunately, illustrating the asteroid orbits creates a pixelated mess of digital spaghetti, and the software lacks a straightforward means of showing individual objects in a time-evolved depiction of the Solar System.

A less cluttered (but also less intuitive) interface appears when you elect to "show orbit diagram" in the JPL Small Body Database⁷. The Java applet allows you to view the orbits of individual asteroids and adjust time using sliders. You can't easily get a perspective on the sheer number of objects, but a little fiddling gives you a sense of how things evolve over time. The visualisation software WorldWide Telescope⁸ probably gives the greatest flexibility in terms of depicting the sheer number of asteroids as

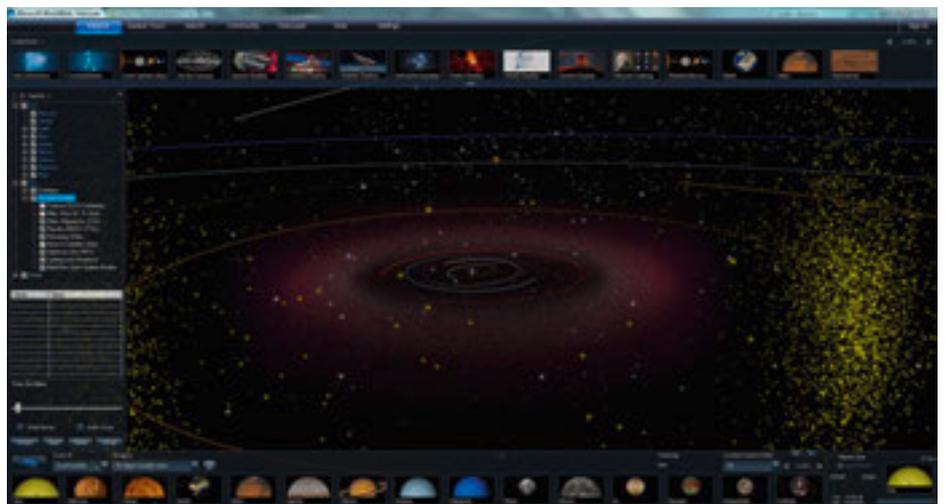


Figure 2. A screenshot showing the user interface for the visualisation software WorldWide Telescope.
 Credit: Microsoft Corporation

objects orbiting the Sun, but alas, you can't view the asteroids as anything other than points.

A critical component of mapping the Solar System is to understand its inherently dynamical nature. And as all those Hollywood productions suggest, the real story lies in the potential for catastrophe. In June 2012, the California Academy of Sciences had the pleasure of hosting a press conference for the B612 Foundation, announcing the proposal to launch Sentinel, the world's first privately funded space telescope, which will orbit the Sun at approximately the distance of Venus, scanning Earth's orbit to detect asteroids. Tuned to infrared wavelengths that reveal objects at Earth's approximate distance, the Sentinel mission should detect upwards of 900 000 asteroids 40 metres in diameter or larger. The foundation (named for the asteroid in *The Little Prince*⁹) has already supported research into the best ways to deflect or destroy potentially hazardous objects, so this mapping mission rounds off a programme whereby potential threats can be identified early, enabling humanity to take action.

I supervise a team at the Academy that has created two short videos in support of the press conference: one tells the story in a standard short form, with talking heads and other traditional video techniques¹⁰, while the other captures an unbroken flight through a virtual space used to accompany a live presentation by former astronaut and B612 CEO Ed Lu¹¹. (The latter video is available online as an HD crop of a full-dome video, originally designed to play in a modern digital planetarium). In both cases we used visuals created by the planetarium software *Uniview*¹² to depict asteroid orbits — and to convey the relative crowdedness of the inner Solar System.

Visualising the effects of an asteroid impact can help convey the reality of these events beyond Hollywood's fanciful depictions. Don Davis has painted several inspirational images for NASA¹³ that capture an asteroid suspended in a surreal moment between impact and annihilation. Data-driven visualisations, however, are few and far between. I had a chance to work on a visualisation of the KT impact (responsible for the Cretaceous-Tertiary extinction) based on simulations by Galen Gisler and his collaborators at Los Alamos National Laboratories¹⁴ for the American Museum of

Natural History planetarium show *Cosmic Collisions* (2006). Gisler has posted at least one video of the simulation on his current research website¹⁵, but the final animations, which integrate the impact into a global view of its effects, remain generally unavailable unless your local planetarium leases the show¹⁶. Alternatively, you may have lucked out and grabbed one of the many DVDs that NASA gave away a few years ago.



Figure 3. An artist's impression of an asteroid impact, created by Don Davis, that has left a persistent mental image in the minds of many. Credit: NASA

In the near future, asteroids will become a hot topic for public outreach, not only because of our interest in self-preservation, but also because they provide stepping stones to more distant destinations. Indeed, President Obama's administration has proposed a human trip to an asteroid by 2025¹⁷. On a commercial front, the newly formed company called Planetary Resources made headlines in April 2012 with its proposal to sample and eventually mine asteroids¹⁸. This was followed by a similar announcement by Deep Space Industries in January 2013¹⁹, offering a positive spin on asteroid discoveries by Sentinel and other programmes.

In the last decade, many members of the public grappled with Pluto's loss of planetary status, but perhaps this has opened people's minds to our changing understanding of the Solar System. I think we have a real opportunity to describe the

richness and diversity of our neighbourhood, with a focus on asteroids. Beautiful images of these tiny worlds make for a compelling aesthetic connection (in spite of their rather dreary greyness). More importantly, the visuals communicate the physicality of these places that could play a role in humanity's survival.

Notes

- ¹ <http://pan-starrs.ifa.hawaii.edu/public/asteroid-threat/movies.html>
- ² www.goto.co.jp/english/show_content/worldwide_distribution/wd_show_content_hayabusa.html
- ³ <http://darts.isas.jaxa.jp/planet/project/hayabusa/shape.pl>
- ⁴ <https://sites.google.com/site/avelcoinfo/itokawa>
- ⁵ www.shatters.net/celestia/
- ⁶ www.celestiamotherlode.net/
- ⁷ <http://ssd.jpl.nasa.gov/sbdb.cgi>
- ⁸ www.worldwidetelescope.org/
- ⁹ De Saint-Exupéry, A. 1943, *Le Petit Prince*, Gallimard
- ¹⁰ <http://vimeo.com/44837633>
- ¹¹ <http://vimeo.com/45276477>
- ¹² <http://scalingtheuniverse.com/>
- ¹³ http://impact.arc.nasa.gov/gallery_main.cfm
- ¹⁴ www.lanl.gov/quarterly/q_spring03/asteroid_text.shtml
- ¹⁵ <http://folk.uio.no/galeng/research.html>
- ¹⁶ www.amnh.org/traveling/planetarium/cosmic.php
- ¹⁷ www.nasa.gov/news/media/trans/obama_ksc_trans.html
- ¹⁸ www.planetaryresources.com/2012/04/asteroid-mining-plans-revealed-by-planetary-resources-inc/
- ¹⁹ <http://deepspaceindustries.com/media/announcements/>

Biography

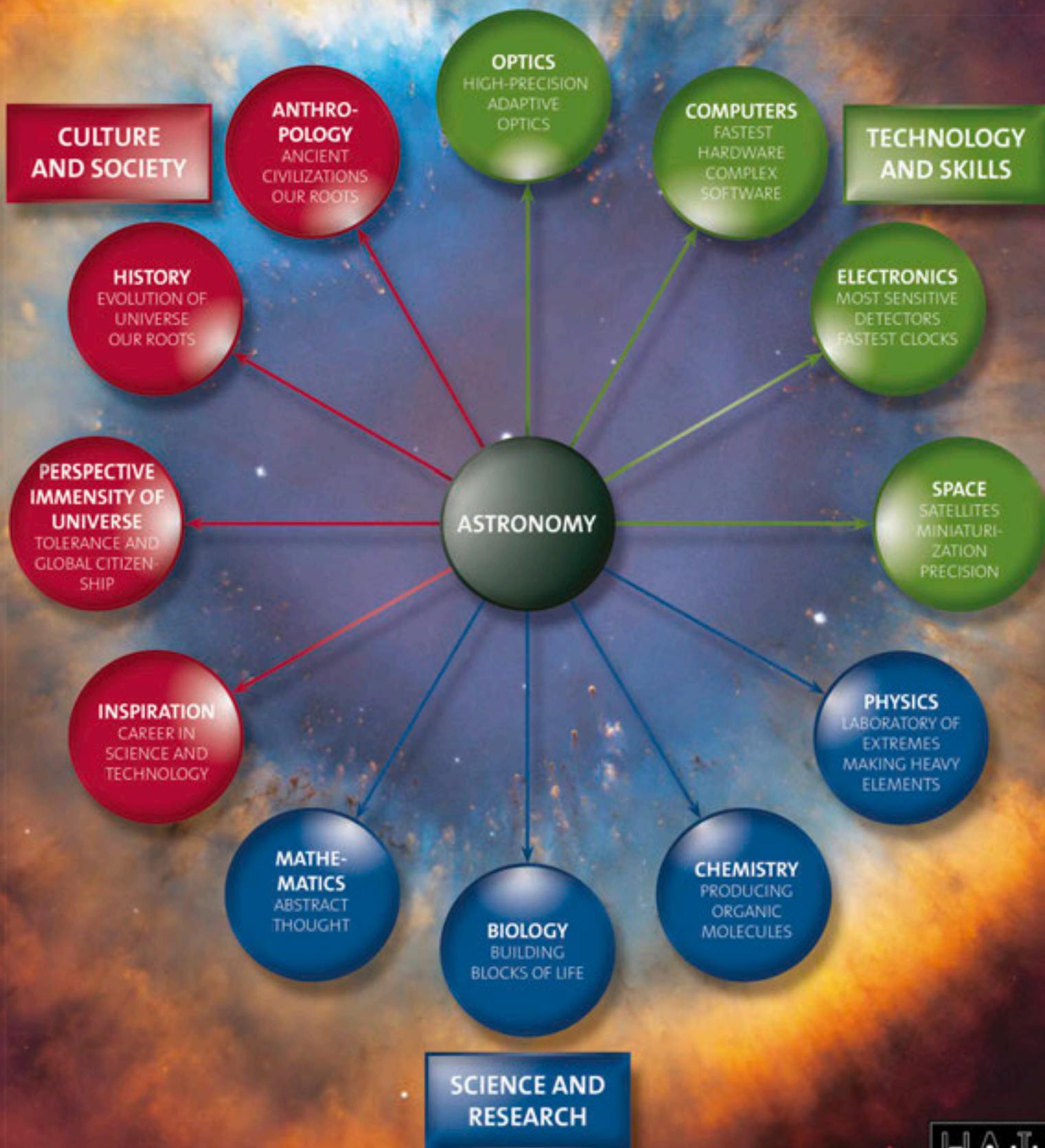
Ryan Wyatt is the Director of Morrison Planetarium and Science Visualization at the California Academy of Sciences in San Francisco, California, USA. He writes a blog, "Visualizing Science," available online at <http://visualizingscience.ryanwyatt.net/>.

Astronomy for Development

Building from the IYA2009

Strategic Plan 2010–2020

with 2012 update on implementation



Colophon

Editor-in-Chief
Sarah Reed

Executive Editor
Lars Lindberg Christensen

Proofreader
Anne Rhodes

Layout
Mafalda Martins
André Rebelo

Production
Mafalda Martins

Contributors
Ilídio Andrade
Kimberly Kowal Arcand
Pedro Augusto
Robert J. Cumming
Vickie Curtis
P.-M. Hedén
Jay Heinz
Sarah Reed
Megan Watzke
Eva S. Wirström
Ryan Wyatt

Web Design and Development
Mathias Andre
Raquel Shida

Distribution
Mark Beat von Arb
Oana Sandu

**IAU DIVISION XII,
Commission 55:
Communicating Astronomy with
the Public Journal Working Group**
Farid Char
Lars Lindberg Christensen
Detlef Koschny
Bruno Merín Martín
Sarah Reed
Pedro Russo

Sponsored by:
IAU and ESO

Address
CAP journal,
ESO ePOD
Karl-Schwarzschild-Strasse 2
85748 Garching bei München
Germany

E-mail:
editor@capjournal.org

Website:
www.capjournal.org

Phone: +49 89 320 06-7 61
Fax: +49 89 320 23 62

ISSNs
1996-5621 (Print)
1996-563X (Web)

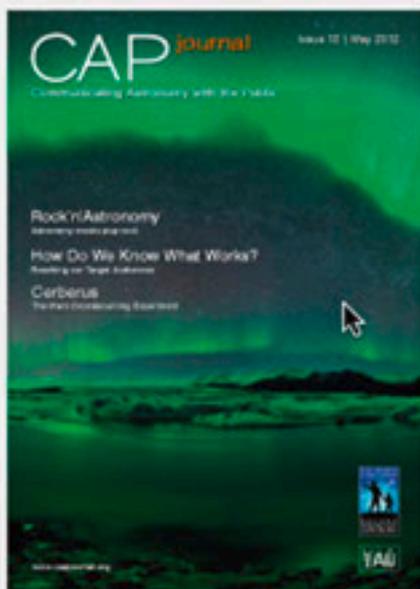
It's never been easier to learn more about the fantastic images of the Universe
ESO images now with Astronomy Visualization Metadata



Compatible with WorldWide Telescope, Google Sky and Stellarium
Enjoy it at www.eso.org/public/images

Issues

Issue 12 - May 2012



Issue 11 - July 2011



Issue 10 - December 2010



CAPjournal submission guidelines

We are keen to encourage readers to submit their own articles, reviews, etc. Some key points are addressed below.

Technical and esoteric language should be either avoided or used with a footnoted explanation if absolutely required. All contributions will be made to conform to British spelling and punctuation practice. Figures and tables should be referred to 'Figure n' and 'Table n' respectively. Acronyms should be spelt in full once and then parenthesised; henceforth they can then be used as lettered acronyms. Numerals should be used for numbers greater than two words and always for numbers greater than ten.

Manuscripts should be delivered in MS Word or text (.txt) format, with no formatting apart

from bold, italics, super and subscripts. Hard carriage returns after each line should be avoided, as should double spacing between sentences. If the contribution contains figures, these may — just for the sake of overview — be pasted inline in the Word manuscript along with the caption (Word files below 4 MB are encouraged). However, images must also be delivered individually as Tiff, PDFs, vector-files (e.g. .ai, .eps) in as high a resolution as possible (minimum 1000 pixels along the longest edge).

Copyright

Authors are solely responsible for ensuring copyright clearance to reproduce illustrations, text, etc., for which they themselves do not own the copyright. CAPjournal accepts only original submissions and will only reproduce previously published work by special arrangement.

Contact

Submissions should be sent to the Editor: editor@capjournal.com

Submit articles for one of the following journal sections:

Announcements

Reviews

News

Resources

Innovations

Research & Applications

Letters to the Editor

Opinion

Best Practices

Interviews

Column

www.capjournal.org

Online issues
Free subscriptions
Article submission

Sponsors

