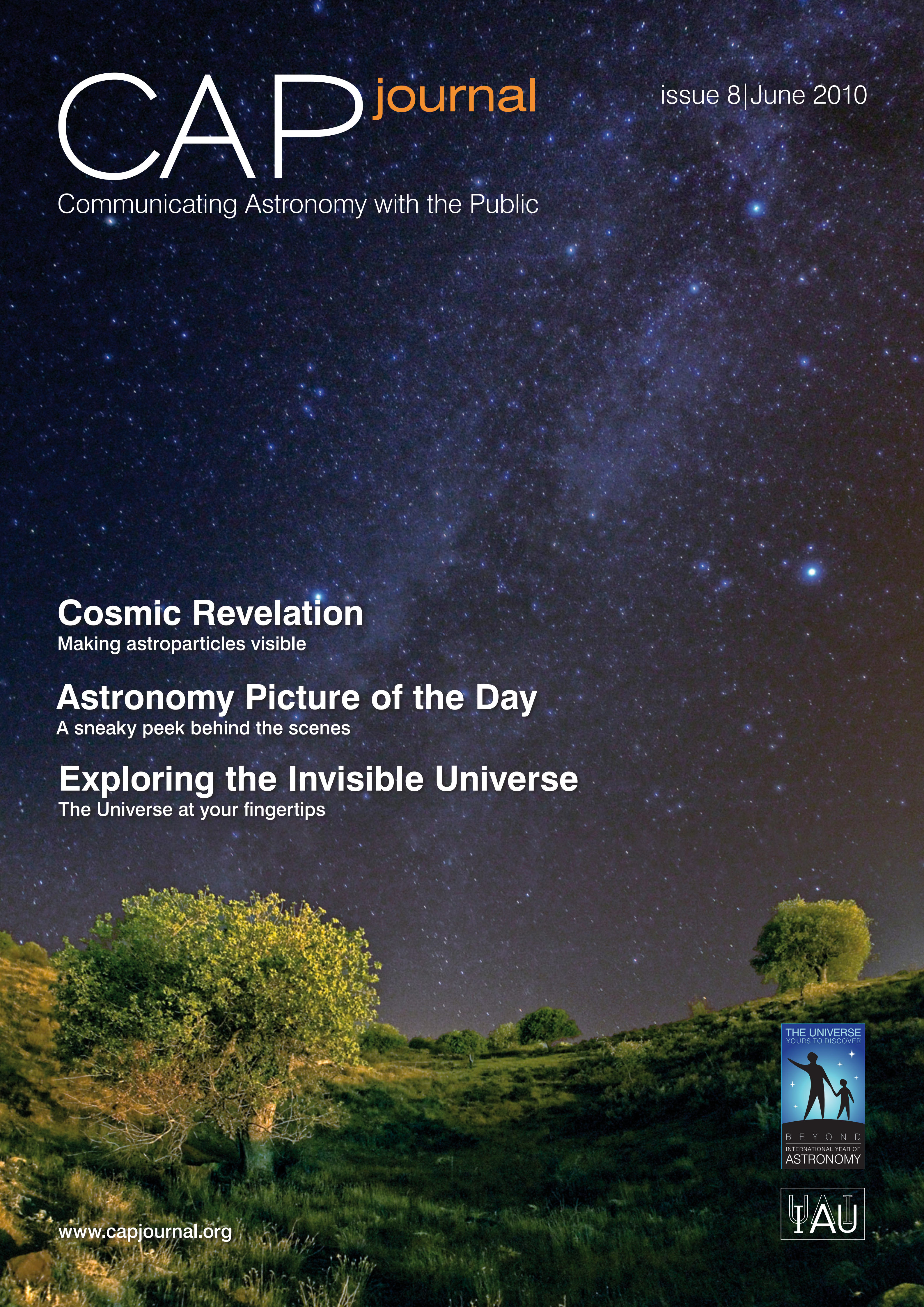

CAP journal

issue 8 | June 2010

Communicating Astronomy with the Public

Cosmic Revelation
Making astroparticles visible

Astronomy Picture of the Day
A sneaky peek behind the scenes

Exploring the Invisible Universe
The Universe at your fingertips

THE UNIVERSE YOURS TO DISCOVER
BEYOND INTERNATIONAL YEAR OF ASTRONOMY

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Cover: This serene view records a late summer night sky over the rolling, green hills of planet Earth. It was taken near the rural village of Saadat Shahr, Fars province, in southern Iran. This picture was featured as the Astronomy Picture of the Day on 12 September 2009. Credit: Babak Tafreshi/TWAN.

Editorial

The close of the International Year of Astronomy 2009 (IYA2009) has revealed the truly vast scope of the venture. The organisers had always intended that the IYA2009 would be more than just a series of activities occurring over twelve months. It was designed and implemented as a springboard for the popularisation of astronomy in the long term. Grass-roots initiatives and global projects made this endeavour highly visible, with an impact that will last for years. IYA2009 created the largest astronomy network in history. 148 countries, from Afghanistan to Zimbabwe, all joined together to make astronomy accessible to everyone; the International Year of Astronomy 2009 truly has been international!

Imagine IYA2009 without the internet. Before the internet, coordinating global projects was difficult. Getting the word out, coordinating actions and events, and expanding a network quickly (IYA2009 has grown from the zero countries involved in 2006 to 148 in 2009) would have all been far more complex problems than they are today. Now, instant communication makes things easier and quicker. Webpages, blogs, Twitter, Facebook and countless other new media contribute to an entirely new dimension for global projects. The new technologies are all designed to connect and empower networks amplifying their efforts. We now have the tools, techniques and even the right people to continue our efforts to promote astronomy worldwide. It's our role and duty to keep up and continue the International Year of Astronomy way beyond 2009.

In this issue, the artist Tim Roth and his collaborators give us a behind the scenes look to their very successful science–art project *Cosmic Revelation* and our regular contributor, Matthew McCool looks back in time to the clash between science and the humanities.

Between issues you can stay in touch through our website, www.capjournal.org, where you will find the current issues in PDF format, an astronomy communication and education job bank, submission guidelines and back issues.

We also welcome astronomy and science communication events (conferences, meetings, etc.), training opportunities, job postings or courses offered. If you have astronomy and science communication-themed products such as books, DVDs, television programmes, magazines or websites that you would like to see reviewed by the CAPjournal editorial team, simply send the necessary information to: editor@capjournal.org. Any questions, comments or opinions can also be addressed there.

Happy reading,

Pedro Russo
Editor-in-Chief

Explained in 60 Seconds: Astronomy Matters

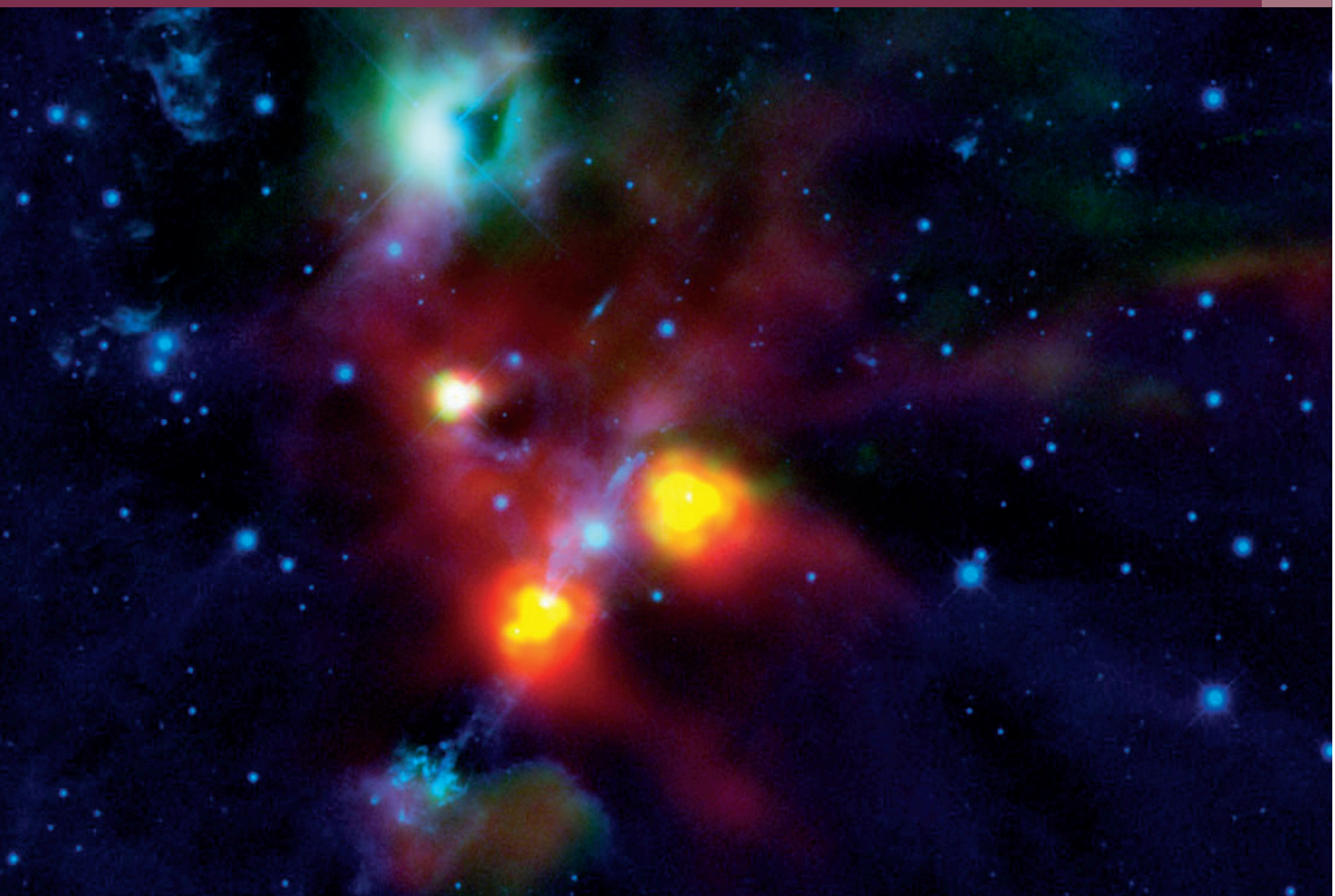
Key Words

Written Communication
Case Study

Astronomy is in some ways the very first science. Observational records date back thousands of years, from ancient monuments like Stonehenge in Great Britain to Persepolis in Iran. Supporting astronomy research encourages technological advances that benefit society. Investing in scientific research is a path to economic strength and helps countries maintain a competitive edge in international dealings. Although astronomy naturally focuses on space science, the need to measure, map and move with precision have benefitted many on Earth. Advances in astronomical and space science technology, brought about by applied research, can often have a greatly beneficial effect for humanity after decades, centuries or even more have passed. Today millions of people worldwide — often unknowingly — are affected by the short- and long-term advances made in astronomy and space science. Astronomy spin-offs include major technological innovations as well as more prosaic devices. There is no short answer to what makes astronomy so important, not for lack of reasons, but because there are so many to choose from. Perhaps the best reply is that astronomy raises our awareness of the Earth's place within the Universe, and improves life for everyone in many ways.

Lee Pullen
IAU/IYA2009

NGC 1999 is the green tinged cloud towards the top of the image. The dark spot to the right was thought to be a cloud of dense dust and gas until Herschel looked at it. It is in fact a hole that has been blown in the side of NGC 1999 by the jets and winds of gas from the young stellar objects in this region of space. This image combines Herschel PACS 70 and 160 μm data, and 1.6 and 2.2 μm data with the NEWFIRM camera on the Kitt Peak 4-metre telescope. Credit: ESA/HOPS Consortium.



Best Practices

Broadcasting Astronomy: *The Stars Meet on the Radio*

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Key Words

Astronomy Communication
Radio Broadcasting
New Media

Summary

In this paper we describe our project *Tutti Dentro — Le Stelle si incontrano in Radio* (*Come in everybody! — The Stars meet on the Radio*), an Italian radio show about astronomy and space. The format involved celebrities, young astronomers and a network of 95 FM and web radio stations during the period July 2007 – January 2009. We will explore its structure, the language and the strategies adopted, along with the technical equipment and the software for recording sessions and editing. Finally we will describe the response from celebrities, radio stations and listeners. Our results could be a useful reference for those wishing to create similar radio programmes to deliver astronomy to a wider audience.

Introduction

"We live in an era of unprecedented scientific progress. The growing impact of technology has brought science ever more into our daily lives." Lars Lindberg Christensen[1]

Our project *Tutti Dentro — le Stelle si incontrano in Radio*[2] (*Come in Everybody — The Stars meet on the Radio*) started in April 2007, following previous successful experiences as astronomy communicators using the web and Italian local radio stations. Our aim was to plan and then produce a new weekly radio programme involving celebrities, young researchers and everyone interested in space. In contrast to previous broadcasts, we decided to avoid the "old formula" based on the scientist talking to and teaching people in a a top-down, vertical communication path, with the scientist set above and apart from the audience, and so we aimed for a horizontal connection between the speakers and listeners, typical of commercial and private radio broadcasting, with all parties on an equal footing. Once these guidelines were established, we selected the topics, wrote the scripts and e-mailed celebrities to fix dates for the recordings of the telephone interviews. In each programme, a "star" of music, sport or television talked about their feelings for the Universe, gave their opinion on the current topic and on other space subjects. In the same programme a young astronomer would also talk about their own work, the technological side of space exploration, and their professional and private life. From July 2007 to January 2009, we produced 52 programmes that were broadcast by a network of 75 local FM radio stations, covering more than half of Italy, and by 20 web radio stations.

The format: language, music and structure

Our format had three basic aims:

- to target a wide audience, specifically listeners aged 20–60;
- to establish a horizontal communication connection with the audience and keep as close as possible to the "stationality" (i.e. the "personality") of each radio station; and
- to maintain and be part of the distinctive "flow" of the daily radio programming.

To meet these aims, given the many radio stations involved, each with its own identity, we adopted a general approach that allowed us to integrate dialogue and music. We used simple and informal language, neither too popular nor too intellectual or scientific. Jingles and songs create breaks and keep the momentum of the show going. The playlist included a selection of songs from the 1980s to avoid musical identification with a specific generation. The structure of each programme, whose length was 30–35 minutes on average, was divided into a sequence of five subsections called "modules", each five to eight minutes long. The five modules were:

a) a small introduction and a song to present the weekly topic;

Figure 1. On December 2008 Tutti Dentro *won the eContent Award Italy, in the eScience Category, as the best content in digital format.*

b) the first part of the interview with the celebrity to promote his/her work and interests;
c) a song or a jingle as a break to introduce the second part of the interview with the celebrity dedicated to the topic of the programme, and other space subjects;
d) a musical break and an interview with the researcher or scientific journalist; and
e) the final part where we sometimes read out funny questions and answers collected from our listeners on our website and from Yahoo Answers Italy.

The a), d) and e) modules were, for the most part, scripted: we wrote them using astronomy books, scientific articles and from our own personal knowledge. Almost none of the celebrity interviews were the results of written questions, so as to give a spontaneous feel.

Format strategies

a) Spicing up the topic: a question introduced the topic, sometimes in a provocative fashion. For example: “The sacrifice of animals in the 1960s for the conquest of space: an unavoidable choice or a violation of rights?”
b) Talking to everybody: following the “infotainment” philosophy, we did not explain or teach, but we gave information in an entertaining context. In a sense we returned to the traditional triad “to educate, inform and entertain”, coined by John Reith (BBC) in the 1920s.
c) Changing the popular image of the astronomer: young researchers played the leading role in representing a new, dynamic and current view of space science, in contrast with the traditional image of the old astronomer tied to his telescope, watching the stars and totally uninterested in ordinary life and people.
d) Updating the popular image of astronomy: when possible, we underlined the application of space technology to every–day life — mobile phones, satellites for telecommunications, X-ray scanners etc.
e) Involving celebrities: for over a year we involved Italian celebrities in our programme, such as the singers Riccardo Fogli and Mario Biondi, the actor Carmine Scalzi, who was with us from the first programme; the international chef Gualtiero Marchesi, and many other famous people. Their popularity attracted the attention and curiosity of radio listeners, and of course of the radio station managers themselves.

Technical equipment and software

Recording sessions were made in our private home studio, consisting of two Behringer cardioyd microphones (B1 and C1 models); a Behringer Xenyx 1622FX mixer; a Behringer Composer Pro MD 2600 multiprocessor (acting as a compressor, limiter, de-esser and peak limiter). A Behringer UCA USB external sound card connected the mixer to a desktop pc for recording.

To obtain better results during the recording sessions, we adopted the following techniques:

a) a back-to-back arrangement for the two microphones to avoid leakages;
b) keeping a minimum distance between microphones and walls to reduce echoes;
c) using the enhancer function (a light noise gate) available on the Composer to suppress background noises and microphone self noises.

We recorded in wave format, 44 kHz, 32-bit float. The files were edited using the audio editor Audacity to cut, paste, mix and normalise the volume. The free encoder SCMPX was used for mp3 conversion at 192 Kbps, stereo, 16 bit. We divided each programme into two mp3 files, so that every radio station could insert their jingles and spots in between. Files were published on the web, free for download by the network of radio stations. A striking example of convergence between new and traditional media.

Response and results

A few days after the press release announcing the development of the project, 30 radio stations contacted us for further information. After a few months, 75 FM radio stations had joined us. They were fascinated by the format involving celebrities, stars and planets, with an informal but, at the same time, professional style. In January 2009 we counted 95 local and web radio stations, with an FM coverage of more than half of Italy and about 30 000 listeners a week. The majority of local FM radio stations (36%, see Figure 4) broadcast *Tutti Dentro* in the middle of the morning (from 9:00 to 12:00), the typical time slot dedicated to information, news and talk. A small fraction (14%) broadcast us in the early afternoon (from 15:00 to 17:00), and only one local radio station in the mid-afternoon, the time slot dedicated to younger listeners, especially teenagers. It was evident they considered our programme as an information product addressed to adults (30–55) and middle-aged people (55–65). Our target was the age range 20–60: we missed the 20–30 range, but hit the 30–60 range right in the middle.

Many of the radio stations included our photos and biographies on their own websites as if we were members of staff and listeners wrote e-mails or phoned the local radio stations instead of writing directly to us. This confirmed our insertion into the flow of each radio station, as was our aim.

Our sole regret was the lack of synchronisation with the many radio communities, something that is impossible to establish without a live broadcast. However, the pre-recorded format was the only way to

Figure 2. Tutti Dentro *homepage. Credit: Authors.*

Figure 3. Tutti Dentro *blog. Credit: Authors.*

be broadcast by dozens of radio stations and reach a wide audience. Each week we published the current programme on our public website (Figure 2), reporting about 100 downloads a week.

In 2008, we opened the *Tutti Dentro* blog (see Figure 3): with 1800 hits a week, it became a place for discussing topics we could not talk about during the programme, due to time constraints and format requirements.

Some months ago, we also created a group on Facebook, with over 100 fans in five days and 20–30 hits a week. Soon it was clear that radio listeners, bloggers and the Facebook group formed three different communities: listeners preferred to listen and write to their radio stations, bloggers preferred to download the programmes from our website and then surf the blog looking for other interesting topics, while Facebook followers just wanted to be informed about space research news. In other words: different media, different communities and different needs.

Last but not least, the celebrities: we discovered that many of them were very interested in space travel, science fiction and astronomy in general. In their childhood, some of them had dreamt of becoming astronauts, some had imagined themselves on other planets. Our interviews often revealed unknown and introspective sides of their life, giving an unusual and original feeling in comparison with standard television and radio interviews. In many cases their words, together with their enthusiasm for space, became spots to promote scientific research in general. A strong result in itself.

Conclusions

Communicating astronomy using new technologies and radio broadcasting was the main goal of our project, avoiding the old formula of a radio science programme based on long interviews with a scientist, and breaking with the traditional image of the expert who teaches science to the people. We adopted an original formula and came close to modern radio language, extremely youthful and spontaneous, and managed to insert our product into the radio flow. Our experience confirmed that radio is a great medium to spread astronomy to a wider audience in new and non-traditional venues. We hope that the format, strategies and results described in this paper could be useful to anyone interested in science radio broadcasting and involved in future astronomy radio programmes.

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Notes

[1] Lindberg Christensen, L. 2006, *A Hands–on Guide for Science Communicators,* (Springer: New York)
[2] http://www.tuttidentro.info
[3] http://tuttidentro.wordpress.com

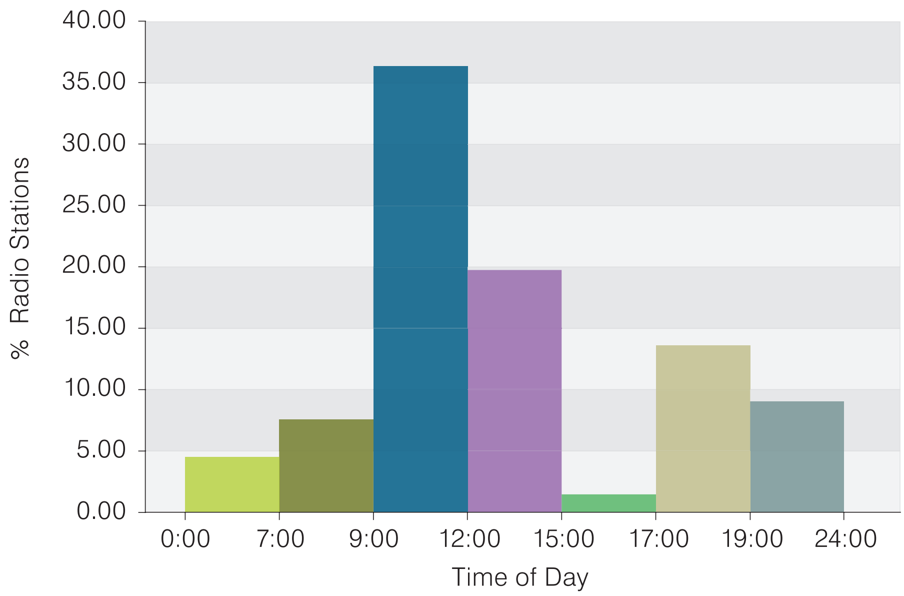

Figure 4. Most of the local radio stations broadcast Tutti Dentro *in the morning and in the early afternoon. Credit: Sabrina Masiero.*

Biographies

Luca Nobili is an astronomer and scientific communicator for the Italian Institute of Astrophysics (INAF), radio speaker and teacher of “Theory and Techniques of Radio Languages”. Since the year 2000 he has been involved in the production of the weekly astronomy Web and radio bulletin *Urania*, broadcasted by over 100 Italian local radio stations. He also talks about astrophysics in the national italian radio station Radio Deejay.

Sabrina Masiero is a PhD student in the Dept. of Astronomy at the University of Padua, Italy. The project *Tutti Dentro* is the topic of her PhD Thesis in communicating astrophysics. She is the Italian translator of the official IYA2009 cosmic comic book *The Lives of Galileo* by Fiami.

Cosmic Revelation: Making Astroparticles Visible

Innovations

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Key Words

Light Art
Astroparticle Physics
Cosmic Rays
Sculpture
Art and Science
Meta-communication
Atmosphere
Air Shower
Land Art

Summary

Cosmic Revelation is a prime example of a successful art and science project connecting art and astroparticle physics. One of the main reasons for its success might be that the collaboration between the KArlsruhe Shower Core and Array DEtector (KASCADE) experiment and Tim Otto Roth is both a minimalist light art project and a scientific experiment. In a field of 16 flashing mirror sculptures connected to the KASCADE detector field at KIT (Karlsruhe Institute of Technology, Germany) the impact of high energy cosmic rays on Earth can be experienced directly. In just one year the project has developed from the initial concept to its first presentation in a public space in autumn 2008. We explain how the project developed, and also highlight the practical and conceptual conditions for its realisation.

Forty thousand square metres were lit at KIT in March 2009, bringing science to life. *Cosmic Revelation* changed KASCADE into a light installation unique in its size for Germany, making the cosmic rays that originate in the depths of space visible as they interact with our planet. A couple of times a second the “cosmic energy” flared as bright, momentary flashes over sixteen “cosmic mirrors” — light sculptures created especially for the project.

Cosmic Revelation[1] showed that, though invisible, we are always in the middle of a giant astrophysical experiment. Particles are not only created artificially, as in the Large Hadron Collider (LHC) at CERN in Geneva[2], but are also abundant in the Earth’s atmosphere. Large-scale international astroparticle experiments such as KASCADE show that on Earth we experience a continuous flux of high energy radiation “raining” down from space, hitting the atoms in the atmosphere as well as our own bodies with their secondary products. These atomic nuclei (mainly hydrogen, but also helium and heavier elements up to the mass of iron are present in the cosmic rays), can reach very high energies — a million times more energetic than particles in manmade accelerators. When such high energy particles hit the terrestrial atmosphere, the cosmic particles interact with the atomic nuclei of the atmospheric gases. The energy released by these collisions is transformed into a variety of elementary particles initiating a particle cascade — extended air showers. KASCADE consists of an array of several hundred stations equipped with particle detectors registering the resulting muons and electrons arriving at the Earth’s surface[3]. By reconstructing the energy spectrum and elemental composition of cosmic rays, the experiment aimed to explain the origin, acceleration

Figure 1. One of the 16 light sculptures from Cosmic Revelation in the KASCADE field. Credit: M. Breig/ Karlsruhe Institute of Technology.

and propagation mechanisms of cosmic rays, still not fully understood even 100 years after their discovery[4].

Cosmic Revelation changed the KASCADE detector array, with its 252 gauging stations housed in little cabins, into a flashing field of light. If a highly energetic shower hit a detector cluster of 16 gauging stations it triggered the high power strobe in the "cosmic mirror" connected with that cluster. So the incoming air showers flooded a field as big as four football pitches (200 x 200 metres) with light and a massive 24 000 Watts of power. Associations with Walter de Maria's *The Lightning Field* in New Mexico (1977) are elicited[5]. The flashing "cosmic mirrors" could be understood not only as formal response to de Maria's approach, but also as a kind of scientific explanation: recent theories suggest that cosmic particles deliver the initial energy that triggers lightning in the atmosphere[6].

Sixteen tiny red flashing lights triggered the idea for a light orchestration of much larger proportions. The artist Tim Otto Roth and the scientist Andreas Haungs met for the first time in autumn 2007 during an interview series with scientists and astronauts, reporting on the impact of high energy cosmic rays in Earth and space. At the interview in the large open–air detector field of the KASCADE experiment they passed by an old minimalist event display from KASCADE consisting of 16 blinking light emitting diodes to document the impact of cosmic particles from space on Earth in real time. This display of four by four red light diodes was used to indicate that an air shower had hit that part of the detector field. Most interesting were the situations when more than one light flashed simultaneously, hinting that an air shower had hit. If all the lights flashed simultaneously, signifying an event of the magnitude of a collision in a particle collider, Haungs couldn't hide his excitement even after so many years working on the experiment. It was that excitement for the minimalist play of light that seeded the idea to use powerful lights to show the energy of air showers directly in the detector field.

For the scientists the motivation was to create a spectacular visualisation of the measurements after a decade of running KASCADE and receiving thousands of scientific and public visitors at the experiment. As KASCADE will end soon, the idea was to combine outreach with something new, going beyond a pure event, as a finale. *Cosmic Revelation* allows not only the public, but also the scientist to have a new visual experience of the physical phenomena. Above all, *Cosmic Revelation* can be considered as an approach of meta-communication, bringing something to the public that would normally only appear in the scientific literature, but is essential for the scientist's motivation to explore new boundaries.

The steps towards the realisation of this display were more down-to-Earth: developing a technical solution to bring a lot of light to an outdoor location and finding an event as a "host" for the project. From an organisational point of view there was the problem that the KASCADE field is located on the northern campus of the KIT, a restricted area not open to the public. So a double strategy was conceived: present the project during an event when the campus is open to the public and make the installation flexible and transportable, so that it could also be shown in other places.

The technical solution resulted from linking the artist's experience with earlier light projects to the profound expertise of the research centre, including electronics and carpentry workshops. This helped to reduce costs, mainly on the cost materials, and also brought various parts of the institute together in the project[7].

Although the cosmic mirrors housing the high power light sources look like a purely aesthetic solution, the design resulted from various pragmatic and technical considerations. Favouring high power strobes as light sources, the question was how to direct the bright flashing light and how to design the housing. The cosmic mirrors are a robust construction to protect the strobes not only against rain, but also from careless visitors. The strobes hang between two round plates (diameter, 95 cm), which are completely covered with blue mirror

Figure 2. KASCADE field during the winter. Credit: KASCADE collaboration.

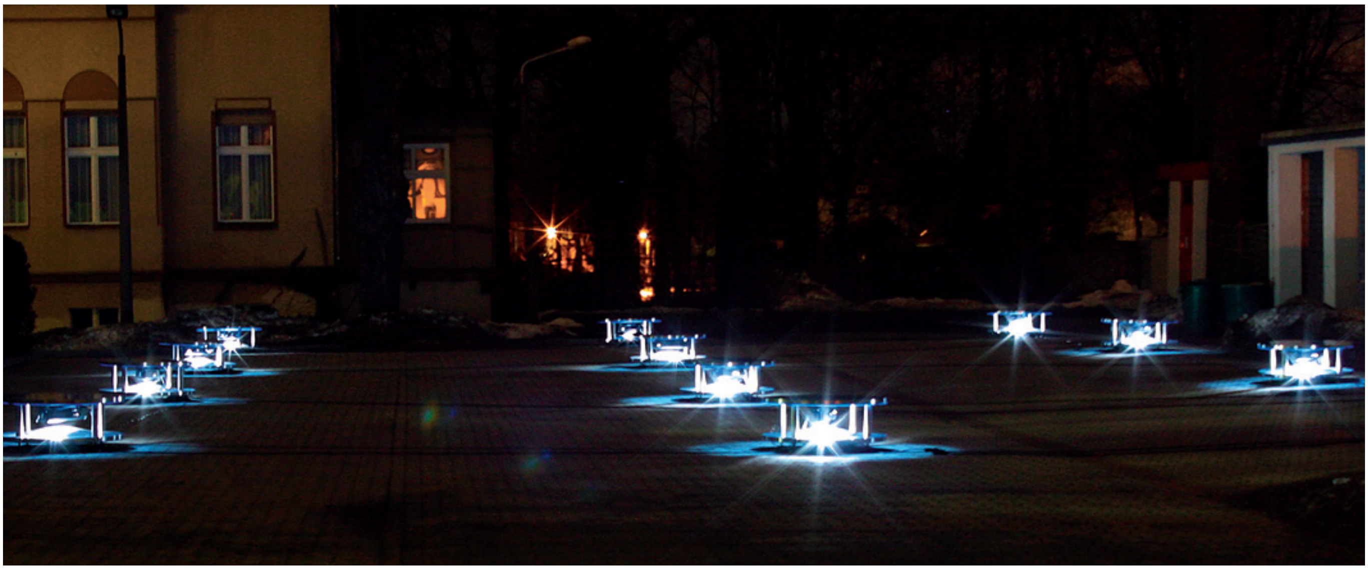

Figure 3. Cosmic Revelation *at DESY Zeuthen, 25 February 2010. Credit: S. Niedworok/DESY Zeuthen.*

foil, and a convex mirror to spread the narrow beam of light. Four adjustable stainless steel feet give stability on the uneven ground. The blue back-reflecting foil on top gives an extraordinary and dynamic appearance to the sculptures, even during the day when the strobes are out of action.

The 16 cosmic mirrors used stroboscopes with 1500 Watts of power as a light source. The strategy was to use relatively inexpensive strobes commonly utilised by the event industry and to adapt them to the needs of the project. The strobes were controlled via the DMX512 protocol, a standard for digital communication networks and commonly used to control stage lighting and effects. The protocol is easily modified because it is based on an industrial standard also used in science. Finally the electronics were modified to improve the synchronisation. The control computer uses the KASCADE online display and analysed the data of the gauging stations in real time. When detecting an event the control software sent signals to the corresponding flash units. The signal carried not only the digital information of whether it was hit or not, but also information about how many detectors were triggered per station and the time sequence of the fired clusters. This information was used to adjust the brightnesses of the individual flashes. The online control software also allowed us to present the project in remote places, as for the premiere at the Karlsruhe University Forum (Germany) or recently in the winter of 2010 at the Deutsches Elektronen–Synchrotron DESY in Zeuthen close to Berlin on the occasion of the 6th Astroparticle Workshop discussing the status and perspectives of astroparticle physics in Germany.

Work on the first prototype started in July 2008. Finished two months later, the prototype attracted a lot of attention. People passing by the carpenters' workshop wondered about the UFO in there, and even the physicists were excited about the sculpture design. On 10 November 2008 the project premiered as a remote installation in the city of Karlsruhe at the inauguration symposium of the KIT Centre for Elementary Particle and Astroparticle Physics[8]. During the day the bluish shimmering cosmic mirrors looked like they were from another star on the autumnal lawn of the Karlsruhe University Forum. Nightfall signalled first light for the whole cluster of 16 light sculptures — and it looked great! But the premiere revealed many surprises. Interestingly the machine eyes of video and photo cameras had more problems capturing the light play than human viewers. The CCD webcam failed completely to record the scenery with its fast-changing contrasts.

Finally, the major challenge was the realisation of *Cosmic Revelation* in the KASCADE field on the occasion of the closing symposium at the end of March 2009. After the difficult test at the University Forum, a couple of improvements were made in the electronics. But the unknown element was the final effect of the light sculptures on the KASCADE field, which is at least 20 times bigger than the University Forum. After a successful light test at the beginning of March, with four light sculptures in the detector field, the atmosphere was quite optimistic: the detector housings reflected the light of the nearby sculptures and drew attention to their presence.

On 31 March *Cosmic Revelation* made the final point of the closing symposium, presenting the experiment's results and giving insight into the history of KASCADE. About 200 guests from all over the world could follow how, after a sunny day, the flashing cosmic rays gained more and more power as night fell.

Although the project could be watched by only a relatively small number of people, the project received a lot of media attention. "*A new art encodes a new science*," summarised Martin Kemp in his review in *Nature* in April 2009[9]. Further articles appeared in *Symmetry Magazine*[10] and *Leonardo Magazine*[11]. An audio and a video podcast were produced by *Welt der Physik*[12].

The resonance is also due to its novelty. The cosmic mirrors create a new kind of display that lets people experience cosmic energies not just as a flat picture, but in time and space. The novelty of this unique art and science project is not just to illustrate the invisible effects of cosmic radiation, as in previous art projects. What makes *Cosmic Revelation* so different is that it makes not only single events visible, but also the air showers and their direction[13]. This pictorial reflection distinguishes *Cosmic Revelation* as an art and science project from pure science events. For instance the Opéra cosmique ignored the spatio-temporal relationship of cosmic rays in autumn 2009 when sending a laser beam over Paris that depended on quite arbitrary muon measurements on the Montparnasse tower[14]. In *Cosmic Revelation*, sometimes a light wave passes through the field, following the track of a strike. This originality was awarded an honorary mention in September 2009 by the Ars Electronica in Linz, the world's biggest festival for media art. *Cosmic Revelation* was represented in the festival's exhibition by two flashing light sculptures connected online with KASCADE[15].

Finally there are parallels between a physics experiment like KASCADE and so-called land art. Larger physical and astronomical experiments have artistic and architectural components. Observatories appear like cathedrals in the void of a desert[16], like the big brother of KASCADE — the Auger experiment, which opened recently in the Argentine pampas[17]. But it is generally the playful approach to the ephemeral in nature that connects the cosmos-related scientific projects to land art experiments like the Roden Crater project by James Turrell[18], who is turning an old volcano crater in the Arizona desert into a naked-eye observatory for certain celestial phenomena.

As seen with KASCADE, you don't necessarily need an "earthwork as artwork"[19] or sublime nature as surroundings to be connected with the ephemera of the cosmos. So in a way *Cosmic Revelation* brings a new form of invisible land art even to an urban space by using light as a plastic medium of expression. The sky is everywhere all the time — this opens up new forms to bring the miracles of astroparticle physics to the public, also in forms beyond the museum and high quality glossy brochures.

The Americas might also be an option for *Cosmic Revelation*: recently the Pierre Auger Observatory South has opened its doors in Argentina. Its counterpart in the northern hemisphere is currently at the planning stage for Colorado (USA). These two giant cosmic ray experiments give a new dimension to the exploration of cosmic radiation and open a new window to the Universe. *Cosmic Revelation* could draw back the curtain on that cosmic spectacle, by adding light to an interaction of land and nature.

Notes

1 *Cosmic Revelation* is the second successful collaboration by KASCADE and Tim Otto Roth. *With I See What I See Not* Tim Otto Roth created a walk on the retinas of the extreme sciences by changing the 76 neon light panels of a light façade in Munich into a cosmic matrix, showing the most advanced results of the imaging machines in astronomy and elementary particle physics. In the winter of 2004–05 the data of KASCADE's central calorimeter were transmitted in real time to the public light wall of the Art Façade at the House of Communication in Munich. See: http://www.kunstfassade.de/tor/i-see-what-i-see-not.html (retrieved on 4 June 2010)

2 The European Organization for Nuclear Research CERN (2008). The highest energies of cosmic radiation are a million times higher than the energies produced currently in the largest particle accelerators on Earth. This is why the concerns raised in the debate in autumn 2008 about mini black holes at CERN in Geneva are unfounded. If the postulated mini black holes resulting from collisions in the new Large Hadron Collider (LHC) at CERN were really so dangerous, such a mini hole would have been created by a cosmic particle long ago and sucked up the whole planet.

3 KASCADE started operations in 1996 and will be discontinued in 2010 after 14 years. KASCADE was the first experiment reconstructing the energy spectra of individual primary cosmic ray particle types showing that the so-called "knee" in the cosmic ray energy spectrum is due to a decrease in the flux of low-mass nuclei accelerated in the Milky Way. The knee is a puzzling kink in the power law that is otherwise structureless over many decades. KASCADE (2009) http://www-ik.fzk.de/KASCADE_home.html (retrieved on 4 June 2010)

4 In 1910 Theodor Wulf measured an increased ionisation of the air on top of the Eiffel Tower in Paris. Then, in 1912, Victor Hess proved, using high altitude balloon flights, that this increased radiation — which he named *Höhenstrahlung* — must originate from space.

5 *The Lightning Field* creates a spectacular sculpture to observe the phenomenon of lightning in the high desert of New Mexico. It consists of 400 polished stainless steel poles about 6 metres in height distributed on an array of about 1.6 square kilometres. Dia Art Foundation (2009), http://www.lightningfield.org

6 Gurevich A. V. & Zybin, K. P. 2005, *Runaway Breakdown and the Mysteries of Lightning*, Physics Today 58, 5, 37, http://www.phy.olemiss.edu/~jgladden/phys510/spring06/Gurevich.pdf (retrieved on 4 June 2010)

7 Acknowledgement: without the quite sceptical, but basically positive attitude of the entire environment at KIT and the KASCADE collaboration — the institute, the workshops etc. *Cosmic Revelation* would not have been possible. Many thanks for all the help, in particular to Johannes Blümer, Bernd Hoffmann, Andreas Theel and Hans Pohlmann.

8 The KIT Center for Elementary Particle and Astroparticle Physics combines experimental and theoretical research and education at the interface between astronomy, astrophysics, elementary particle physics and cosmology.

9 Kemp, M. 2009, *Flashes of cosmic brilliance*, Nature, 458, 836

10 Kunz, T. 2009, *Cosmic rays spray art across a lawn*, Symmetry Magazine, 6, 1, 5

11 Roth, T. O. & Haungs, A. 2009, *Cosmic revelation*, Leonardo 42, 3, 288

12 *Welt der Physik* on Youtube: http://www.youtube.com/watch?v=Pz79JqgQ3l8 (retrieved on 4 June 2010)

13 In the context of the KASCADE experiment CORSIKA was developed to simulate the development of air showers in the atmosphere. The project page provides illustrations and animations of air showers. CORSIKA (2008) http://www-ik.fzk.de/corsika

14 Opéra cosmique 2009, http://www.opera-cosmique.fr (retrieved on 11 June 2010)

15 Ars Electronica Linz, Cyber Arts 2009, http://www.aec.at (retrieved on 11 June 2010)

16 For instance the architecture of the Paranal Observatory of the European Southern Observatories (ESO) interacts in a very special way with the void of Chile's Atacama Desert. Whereas the telescope buildings on the mountain appear more like techno cathedrals, the monastery-like Residenzia in the base camp built by the German architects Auer+Weber integrates fully into the landscape. ESO (2008), http://www.eso.org/public/images/eso-paranal-02/ (retrieved on 4 June 2010)

17 Pierre Auger Observatory: The Pierre Auger Observatory South extends across a terrain of 3000 square kilometres in the Argentine pampas. The Auger Observatory is a "hybrid detector", employing two independent methods to detect and study high energy cosmic rays. One technique detects high energy particles through their interaction with water placed in surface detector tanks. The other technique tracks the development of air showers by observing ultraviolet light emitted high in the Earth's atmosphere. Whereas KASCADE measures galactic cosmic radiation, Auger focuses on higher energy radiation originating from regions beyond our Milky Way. http://www.auger.org

18 Turrell, J. 1986, The Roden Crater Project, exh. cat. (Tuscon: University of Arizona Art Museum)

19 Jori Finkel, J. 2007, *Shh! It's a Secret Kind of Outside Art*, New York Times, 25 November 2007 http://www.nytimes.com/2007/11/25/arts/design/25fink.html?ref=arts (retrieved on 4 June 2010)

Biographies

Tim Otto Roth is known for his large art and science projects in public space. He has collaborated with various scientific institutions around the world, for instance with the Max-Planck Institute for Radioastronomy (D), Bibliotheca Alexandrina (EG), High Altitude Research Station Jungfraujoch (CH), Brookhaven National Laboratory (US), Fermilab (US) and KEK Tsukuba (JP). He has received numerous awards, including the International Media Art Award by the Centre for Art and Media ZKM Karlsruhe and the German Light Art Award in Lüdenscheid. He lives in Cologne and Oppenau (Black Forest).

Andreas Haungs is the representative of the KASCADE cosmic ray experiment and group leader at the Institute of Nuclear Physics at the KIT. He works on the development of detection techniques and data analysis in the field of high energy astroparticle physics and is also member of the Pierre Auger Observatory. He chaired in 2008 the working group on cosmic rays for the Roadmap Astroparticle Physics in Europe.

Harald Schieler is operations manager of the KASCADE cosmic ray experiment and member at the Institute of Nuclear Physics at the KIT. He works on the development of detection techniques and data acquisition systems in the field of high-energy astroparticle physics and is also a member of the Pierre Auger Observatory.

Andreas Weindl is a member of the KASCADE cosmic ray experiment and member at the Institute of Nuclear Physics at the KIT. He works on the software development of data acquisition systems in the field of high energy astroparticle physics and is also a member of the Pierre Auger Observatory.

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When I Heard the Learn'd Astronomer: From Natural Philosophy to Communicating the Cosmos

Opinion

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Key Words

Astronomy Communication
Two Cultures
Arts
Poetry
Literature
History

Summary

More than 50 years after C. P. Snow's Two Cultures lecture that described a chasm between literature and science, McCool & Russo look back to the source of this separation, provoking a re-examination of modern science communication.

The assumption that science can and should be shared with the public dates back only to the 19th century. Before that, scientists, then referred to as "natural philosophers", considered their work as an art that had more in common with literature than logical deduction and the scientific method. Understanding how the literary scientist of the 19th century became the 21st century grant-writing bench scientist is critical for modern science communication. Astronomy works as a perfect case study to examine how science and science communication reached its current status.

The exact philosophical and empirical methods to finding truth have changed over time. Today, scientific rigour is attached not merely to the statistical laws of quantitative research, but also with the qualitative social sciences. One can now step beyond the lab to test things, people and concepts in the field. Results are validated empirically through evaluation by external and independent peers. And the acquisition of new knowledge is a global and open-source process, blurring the boundaries between language, culture, politics and economics. It is an exciting time, to be sure, but it may surprise some people that the awesome advances of science used to have more in common with the canonical assumptions of literature.

In the early 1800s, art and science had much in common. The literary author and prose writer were just as likely to have been inspired by science and not merely by the beauty and elegance of the natural world. Periodicals and magazines featured articles on technology and science alongside fiction and poetry. Scientists who wanted to reach the general public appealed to their audience not through dry facts, but through the arts. It was common, even necessary, for the 19th century scientist to quote from the literary canon. The sign of an educated scientist was not only the application of the scientific method, but also the knowledge and use of popular literature. An inability to invoke the assumed cultural prestige of the arts could condemn a scientist to anonymity. In the words of English poet Matthew Arnold, "literature is a large word", and science was in service to a higher realm of individual excellence.

All of this began to change in the 1830s in England. At a meeting of the British Association (today the British Association for the Advancement of Science), William Whewell proposed the term scientist to apply to one who studies the "natural world". Religion was the precursor to natural philosophy, which itself was a precursor to science. The arc from religion to natural philosophy to science describes increasing logical rigour and an ability and desire to determine causal relationships.

The split between art and science intensified with the birth of the industrial revolution. Instead of learning Latin and Greek, which was the hallmark of culture during the agricultural revolution, it became increasingly important to study engineering and science, "practical pursuits" that replaced literature and the arts. This shift underlined the change in the assumption that intelligence, cultivation and prestige had anything to do with individual human excellence. This antiquated model became increasingly irrelevant as the forces of the industrial age propelled huge advances in scientific and technological fields.

Change came quickly. Better technology, greater knowledge of the world, and refined scientific methods resulted in a fracture. Humanities and science, the two cultures, went in different directions. This happened long before C. P. Snow's influential talk, which outlined the split between the "two cultures" of society — the humanities and the sciences. When Sir William and Sir John Herschel were studying the stars, writers and painters were living among them. And perhaps one of the best ways to imagine this split, and the forthcoming need for communicators to deliver scientific knowledge, is through literature. Consider Walt Whitman's 1865 lyric poem *When I Heard the Learn'd Astronomer:*

When I heard the learn'd astronomer;
When the proofs, the figures, were ranged in columns before me;
When I was shown the charts and the diagrams, to add, divide, and measure them;
When I, sitting, heard the astronomer, where he lectured with much applause in the lecture-room,
How soon, unaccountable, I became tired and sick;
Till rising and gliding out, I wander'd off by myself,
In the mystical moist night-air, and from time to time,
Look'd up in perfect silence at the stars.

At a mechanical level, the poem is written in free verse. The writing is lean and fluid. Whitman begins the first four lines with the same word, creating a sense of continuity. After becoming "tired and sick" he ventures out into the "mystical moist night-air" to look up "at the stars". At first glance this seems like a poem about nothing more than a lecture on astronomy. Desiring more than numbers or charts or diagrams, Whitman takes to the open skies for a first-hand experience. This could be anyone's response to a technical lecture on the night skies. But the truth is more complex. Whitman wrote this verse during a period in which man, a literary ape, became scientific. And the change was difficult to absorb.

But there is something far more important going on in this poem. It is the difference between proofs and figures and the awesome power of the night sky. In 1865, the year this poem was published, Whewell's declaration that the word scientist be used for those natural philosophers who took to empirical research had already been circulating for more than three decades. Whitman's poem can be seen as a backlash against this shift in knowledge.

Whewell's declaration and Whitman's poem say a lot about both science in general and astronomy communication in particular. In the 19th century, there was no need for the science or astronomy communicator. The scientist or astronomer simply did they best they could, assuming they wanted any kind of audience, in reaching out to the general public. These people used literary magazines to share their work, an indication of their education as students of literature. But as knowledge increased, the wish to toss those values aside in favour of a new science grew irresistible.

The advances in telescope design throughout the 19th and 20th centuries resulted in continuous streams of data drawn from the sky. Better analytical and statistical techniques led to improved analysis of that data. We quickly crawled out of our little corner of the Universe to witness the vast expanse of the unknown, and it has been inspiring. Trying to communicate the awesome power of the Universe has become a challenge not only for the astronomer, but for the dedicated communicator versed in modern astronomy. As astronomers lead us into new vistas of exploration, communication becomes indispensable for sharing the expanding map of our Universe. This is of the utmost importance to a public that continues to look up, through the words of Whitman, "in perfect silence at the stars".

Further information

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- Various, *Are We Beyond the Two Cultures?,* Seed Magazine http://seedmagazine.com/content/article/are_we_beyond_the_two_cultures/ (retrieved on 14 April 2010)

Biographies

Matthew McCool studied neuroscience at the SIU School of Medicine, literature at the University of Illinois, and intercultural pragmatics at New Mexico State University. He currently teaches at Southern Polytechnic State University in Marietta, GA, USA.

Pedro Russo is the Global Coordinator for IYA2009 working at the European Southern Observatory for the IAU.

Exploring the Invisible Universe: A Tactile and Braille Exhibit of Astronomical Images

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Key Words

Public Outreach
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Astronomy
Materials for the Visually Impaired
Braille
Tactile

Summary

A tactile/Braille exhibit for the visually impaired community in the USA was launched in July 2009. The exhibit is part of the global From Earth to the Universe (FETTU) project, a Cornerstone of the International Year of Astronomy 2009. The science content of the travelling tactile/Braille exhibit includes explanations of our Sun, Eta Carinae, the Crab Nebula, the Whirlpool Galaxy and the electromagnetic spectrum, and was adapted from the tactile/Braille book *Touch the Invisible Sky*. We present some of the early observations and findings on the tactile/Braille FETTU exhibit. The new exhibit opens a wider door to experiencing and understanding astronomy for the underserved visually impaired population.

Introduction

Astronomy is considered by many to be one of the most visual of the sciences. Many people have some experience with visually processing and reacting to astronomical information, beginning with gazing at the night sky. Today, however, astronomy and astrophysics extend far beyond what is detectable with the human eye. Researchers explore the Universe through a modern "tool kit" of space-borne telescopes and ground-based observatories that cover the entire electromagnetic spectrum. It is the combination of these different types of light — from high energy X-rays and gamma rays to low energy microwaves and radio waves — that has enabled numerous exciting discoveries. Without multi-wavelength astronomy that includes "invisible" light, we would know much less about such exotic cosmic phenomena as black holes, planetary formation, galaxy growth and even the Big Bang.

Astronomy is now simultaneously a visual science that must also be communicated in ways that include information about non-visual phenomena. It is this inherent duality in modern astronomy that positions the subject matter uniquely to serve both the sighted and non-sighted communities. Astronomy can capitalise on how the Universe is studied in non-visual ways to help various audiences in the general public engage in and interpret the wondrous discoveries of the cosmos.

Background

The From Earth to the Universe (FETTU) project is an exhibition of astronomical images that showcases the most dramatic views of our Universe, bringing the science of astronomy to a diverse and worldwide audience. The images, which represent the incredible variety of astronomical objects that are known to exist, are being exhibited in over 850 locations throughout the world in 2009 and 2010 as part of the International Year of Astronomy 2009. In the United States, over 40 FETTU exhibits (approximately half of which are funded by NASA) are occurring in non-traditional astronomy outreach locations such as airports, libraries, parks and college campus greens. The goal of the FETTU project — run by the Chandra X-ray Center (CXC) — has been to engage the largest number of people possible. In July 2009, a NASA-funded tactile and Braille exhibit was launched for the visually impaired community as part of the FETTU programme. We present some of the early observations and findings on the tactile/Braille FETTU exhibit.

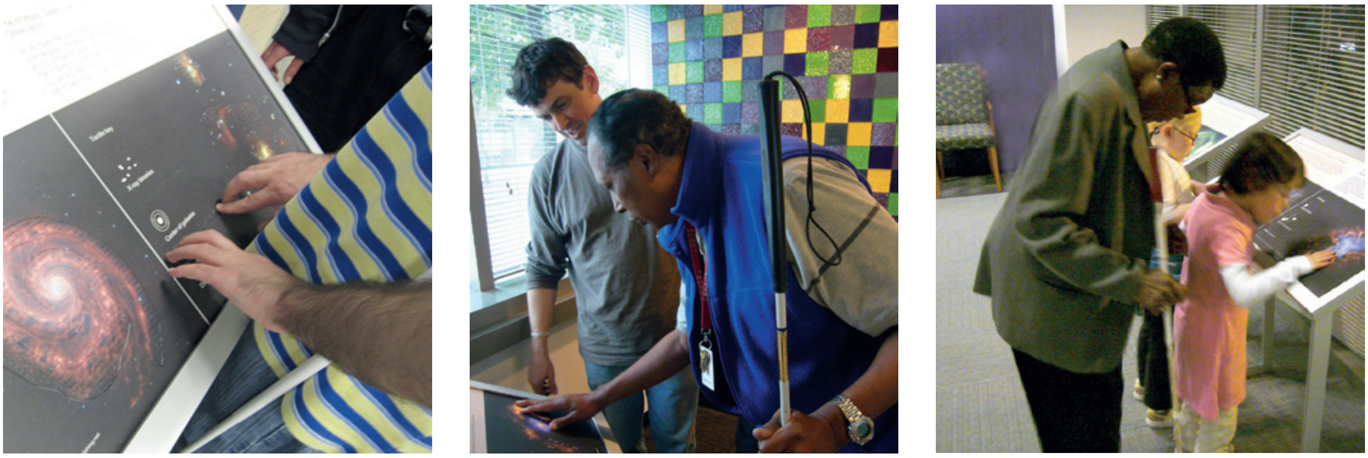

Figure 1. Left: The tactile exhibit in Washington, DC. Credit: James Timony. Middle: Professor Chris DePree (left) of Agnes Scott College, discusses an exhibit image with Lafayette Wood (right), former Center for the Visually Impaired (CVI) client and member of the CVI Alumni Club. Right: CVI staff member and current CVI youth at the tactile exhibit in Atlanta. Credit: Liz Hayes.

Exhibit design and dissemination

The science content of the tactile and Braille exhibit includes explanations of the Sun, Eta Carinae, the Crab Nebula, the Whirlpool Galaxy and the electromagnetic spectrum. There are four 45 cm x 90 cm tilted four-legged aluminium stands (each about 95 cm high), built to Las Vegas safety standards. The "desktop faces" of the exhibit stands consist of large-print text underneath a complete overlay of Braille for the image captions and keys, as well as specially developed textures for the images (Figures 1 and 2). Four copies of this tactile/Braille exhibit were produced, as the printing technology used to create it requires multiple print runs of the tactile process[1]. The tactile/Braille content of this exhibit was adapted from the NASA-funded tactile/Braille book *Touch the Invisible Sky* written by Noreen Grice, Doris Daou and Simon Steel, and published by Ozone Publishing Corp. Methodologies and material that had been pilot-tested at the National Federation for the Blind Summer Science camp and at the hands-on stations at the book launch were adapted by Steel to develop accompanying educational activities for the visually impaired community and informal education providers. These activities present fundamental concepts of modern astronomy designed to put the FETTU images into a broader context of how the Universe is structured and evolves.

Multiple geographic locations and venue types were targeted for the tactile/Braille displays, including public spaces that specialise in handicapped materials, schools for the blind, as well as the same public locations that the full-size, travelling FETTU exhibit reaches (Figure 3). The first tactile exhibit was displayed on 18 July 2009 at the Martin Luther King Jr. library, the main branch of the DC Public Library (Figure 1). The tactile/Braille FETTU exhibits have also been displayed at Yerkes Observatory (Williams Bay, Wisconsin), the Center for Science and Industry (COSI; Columbus, Ohio), the Atlanta Center for the Visually Impaired (CVI; Atlanta, Georgia), the UMass–Boston campus, the Perkins School for the Blind (Boston, Massachusetts), the University of Arkansas at Fayetteville, the Interamerican University at Bayamón (Bayamón, Puerto Rico), as well as the Eugene Francis Hall of the University of Puerto Rico, Mayagüez Campus (Mayagüez, Puerto Rico).

Figure 2. Braille/texture and large print/image overlays illustrating the Crab Nebula.

For each of the exhibit locations, supplementary content is provided to the community, including copies of the *Touch the Invisible Sky* Braille book, audio podcasts of the material from the book and the set of educational activities.

Location: Perkins School for the Blind, Watertown–Boston, Massachusetts

The Perkins School for the Blind hosted the tactile/Braille FETTU exhibit from October through December 2009. This exhibit was placed in the lobby of the Howe building, a towered stone structure that houses the school's museum on the campus just outside Boston. The single full-time science teacher on staff at the school arranged for her class of advanced science students to visit the display on 2 December 2009. A short astronomy presentation was provided by Megan Watzke from the Smithsonian Astrophysical Observatory. The discussion was attended by a former student of the Perkins school, and also a current visually impaired Perkins faculty member. One of the exhibit guests, a girl with low vision who reads large print, bent close to the images and remarked on their bright (high contrast) colours and commented how pretty the visuals were. She later communicated to her teacher that she "had learned that the Sun is like 5 billion years old". A male student, who is blind, felt through the entire exhibit and then exclaimed: "This is awesome." The teacher, however, seemed to most appreciate the panel on the electromagnetic spectrum that demonstrated different kinds of light, as it can be applied to their other science class studies such as in chemistry and biology.

The group discussed relatively straightforward issues with the exhibit, such as the corners of the exhibit being too sharp for non-sighted students (especially younger

Figure 3. Teenage students at the Perkins School for the Blind experience the tactile exhibit in December 2009. Credit: Kimberly Arcand.

ones) to bump into, the Braille lines being slightly too long, or the separation ridge between image panels being slightly too small. They also discussed more difficult topics, such as how much the lack of visual memory affects the students' learning, and how difficult it is to acquire the spatial skills that are referenced so often in sciences like astronomy. Such "given" concepts for sighted students — large physical scales, complex shapes, navigation and measurement — are often very challenging for those in the non- or low-sighted communities.

Location: Atlanta Center for the Visually Impaired, Atlanta, Georgia

The Center for the Visually Impaired in Atlanta hosted the tactile FETTU exhibit from mid–October through December 2009. The tactile FETTU exhibit was located during this time in the publicly accessible lobby of the CVI facility in the heart of downtown Atlanta. Annie Maxwell is Director of the Social Therapeutic and Recreational Services (STARS) programme, which is an after-school programme specifically for youth aged 6 to 21. Ms Maxwell, who is visually impaired, commented that: "The exhibit is a wonderful eye-opener for persons with vision loss, and a great way to connect with a touch method of viewing the Solar System." In addition, she wrote, "During the school day in a regular science class the panel display should work fine in its present form; it would illustrate exactly what the sighted students are viewing, thus involving the visually impaired student completely in the learning process. However, a number of improvements could be made to the exhibit including hand-held items discussed in the panels such as the Sun or a star, and having a review question/answer and comments section at the end."

Chris De Pree of Agnes Scott College worked with a group of younger STARS students as part of the after-school programme in early November. At this time, he added to the exhibit two meteorite samples that were discussed and passed around to students. One of the students requested "tactile" constellation maps, asking what Orion "looked like". Ms Maxwell also hosted other groups of students with the installation, including a group of middle and high school aged students. She guided a class of middle and high school students on a tour of the exhibit, as well as an elementary group. She noted that, "Students were deeply engrossed in the display for the first couple of panels, however, about halfway through, they grew restless and inattentive." There is extensive reading on some of the panels, and they can take a long time to read for younger and/or inexperienced Braille readers. The audio files of the material that are available should help address this, but adding a better mechanism to have direct audio from the exhibit (which was meant to be ultra portable and not reliant on electrical outlets) is something to consider.

Broader dissemination

The NASA-funded project at the CXC has recently produced a set of tactile/Braille wall posters containing a subset of the same image panels as the tactile/Braille exhibit. Two thousand sets of this texturised poster series have been produced, which will enable a larger means of dissemination as programme resources for the visually impaired community to further enhance the longevity and sustainability of the science outreach

Conclusion

Millions of people in the United States are legally blind (1.3 million), have low vision (3 million) or have a degree of visual impairment that cannot be corrected by glasses (12 million)[2]. The FETTU-tactile exhibit expands access for the blind and visually impaired to information about the Universe by presenting these panels in public and non-traditional learning settings. It "opens a wider door to understanding and experiencing what sighted students have been looking at and experiencing all along, which bridges another gap in learning and levels the playing field even more". (Annie Maxwell, STARS director). Yet this is just a first step in improving the opportunities for the visually impaired community to become more involved in topics like astronomy. Additional means of accessibility such as 3D modelling of objects and processes, and improved text-to-audio awareness, as well as a better understanding of how the visually impaired community learns science, are keys to the creation of "inclusive science learning" environments that will stimulate interest and help the community become more comfortable and confident in their relationship with science (Bell et al., 2009).

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Acknowledgements

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Notes

[1] More information on the exhibit: http://www.fromearthtotheuniverse.org/tactile.php

[2] http://www.lighthouse.org/research/statistics-on-vision-impairment/prevalence/#national

Biographies

Kimberly Kowal Arcand is the visualisation & media production coordinator for NASA's Chandra X-ray Observatory. Along with Megan Watzke, she is co-chair for the IYA2009 From Earth to the Universe Task Group.

Megan Watzke is the press officer for NASA's Chandra X-ray Observatory. Both she and Kim Arcand are based at the Chandra X-ray Center at the Harvard-Smithsonian Center for Astrophysics in Cambridge, Mass., USA.

Chris De Pree is Professor of Physics & Astronomy at Agnes Scott College and Director of Bradley Observatory in Atlanta, Georgia, USA.

Reading About Science Communication

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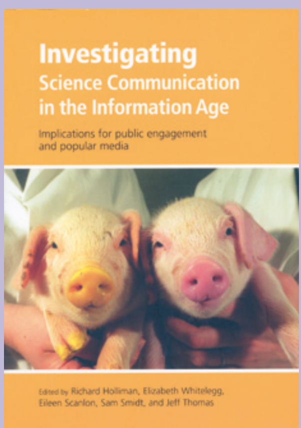
Key Words

Science Communication
Books

Summary

Lately the science communication book market has become quite lively. Several books have been published over the past few years. Covering topics from more formal science communication to practical writing, these books are important resources for everyone.

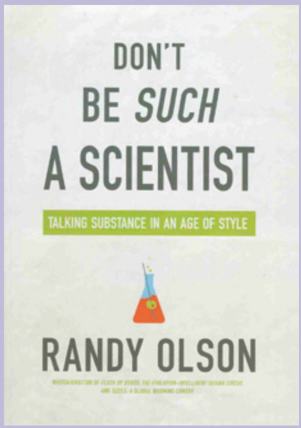


Investigating Science Communication in the Information Age: Implications for public engagement and popular media
OUP Oxford
320 pages
ISBN 978-0199552665

Practising Science Communication in the Information Age: Theorising professional practices
OUP Oxford
264 pages
ISBN 978-0199552672

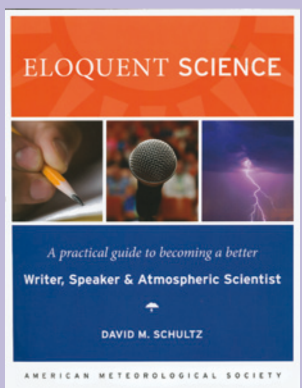
Investigating and Practising Science Communication in the Information Age is a two volume collection of commissioned chapters by well known science communicators and scholars. This makes the books a valuable resource for teaching, researching and practicing science communication.

Investigating brings a strong sociological background to science communication, examining recent trends in the theory and research of science communication. *Practising*, on the other hand, provides a thorough introduction to anyone wishing to start implementing projects and activities in contemporary science communication. Definitely two books worth reading.



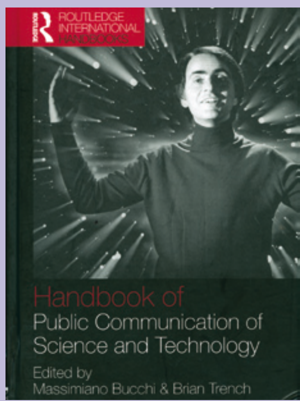
Don't Be Such a Scientist
Randy Olson
Island Press
216 pages
ISBN 978-1597265638

Randy Olson experienced a huge life change when he moved from the top of the academic tree and a tenured professorship at the University of New Hampshire to being a student at the University of Southern California School Of Cinema. This career shift gave Olson some first-hand experience in identifying the problems and solutions for modern visual science communication. For Olson, the important point to remember is that the general public don't speak science. The solution, he argues, is to stay true to the facts while tapping into something more primordial, more irrational, and more human, bridging the gap between education and entertainment. The book presents great tips and advice for scientists who want to communicate and cinematographers who want to entertain and educate with film.



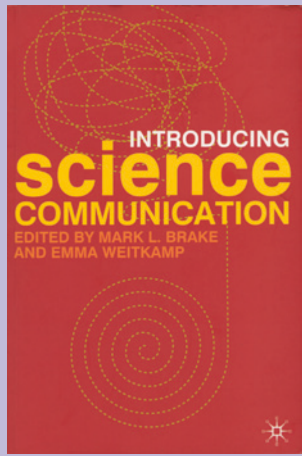
Eloquent Science
David M. Schultz
American Meteorological Society
412 pages
ISBN 978-1-878220-91-2

Following up from a communication workshop organised by the American Meteorological Society, this book is a good reference for scientists, and especially for atmospheric scientists. The book touches on different aspects of intra-community communication, writing papers, reports, preparing presentations to be delivered in conferences and workshops, etc. Even though the book covers such a wide range of topics, one shortcoming is its treatment of public and media communication, as the author only dedicates six pages out of 412 to this important aspect of modern science communication for researchers. This is a great companion for scientists who must write and present their research, but is not intended as a book for science communicators.



Handbook of Public Communication of Science and Technology
Edited by Massimiano Bucchi & Brian Trench
Routledge
263 pages
ISBN 978-0-415-38617-3

There is no need to say that the public communication of science and technology is a rapidly expanding component of communication. Combining contributions from different disciplines (media and journalism studies, sociology and the history of science), the perspectives of different geographical and cultural contexts, and selecting key contributions from well-respected authors, these original texts provide an interdisciplinary as well as a global approach to the public communication of science and technology. This handbook brings many general overviews together, balanced by a conceptual knowledge of the practical problems faced by practitioners with a thorough review of relevant research issues. It provides a useful introduction to new trends in the public communication of science and technology in various parts of the world, and is particularly sensitive to international issues.



Introduction Science Communication
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Palgrave Macmillan
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Mark Brake and Emma Weitkamp are both lecturers in Science Communication in the UK, a country with a long tradition in science communication. The UK is the birthplace of social, political and academic movements like the public understanding of science (PUS), the public communication of science and technology (PCST), and more recently the public engagement of science (PES). Mark and Emma worked with colleagues and have put together a nice introduction to science communication. With a good balance between the theoretical and practical aspects of science communication, the book discusses key methods and gives great tips for science communication in many areas, from working with science centres and museums, to the best way to approach popular science writing and broadcasting. For a book published in early 2010, it omits an important part of modern science communication: the use of new media, such as blogs, social networks, viral communication and new ways of community engagement.

Biography

Pedro Russo is the Global Coordinator for IYA2009 working at the European Southern Observatory for the IAU. He is a member of the Venus Monitoring Camera/Venus Express Scientific Team and has been working with Europlanet, IAU Commission 55: Communicating Astronomy with the Public, EGU Earth and Space Science Informatics Division and the IAF Science and Society Committee.

Interview

Robert Nemiroff: Communicating Astronomy 365 Days a Year

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Key Words

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Communication
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Summary

Few astronomy communication projects are as well known or as widely disseminated as the Astronomy Picture of the Day (or APOD for short). Since its creation in 1995, it has popularised thousands of images and helped to explain the cosmos through informative captions. Impressively, the site shows no signs of slowing down and has amassed many loyal supporters. This success can be attributed to the two astronomers behind the project: Robert Nemiroff and Jerry Bonnell. CAPjournal has interviewed Robert to discover his view of APOD, and the lesser known issues that surround it.

Figure 1. Robert Nemiroff and Jerry Bonnell at the meeting of the American Astronomical Society in 2007. Credit: Robert Nemiroff.

Astronomy Picture of the Day is probably the most successful science outreach project on the web. How do you deal with that responsibility?

Sometimes I imagine there is a football stadium filled with people who react at midnight when a new APOD is unveiled. I worry that they will jeer if I do a bad job, but more usually, and this is when I have completed an APOD that I think is really cool, I picture them cheering. Jerry and I are both extremely proud of APOD and are simultaneously delighted and humbled by its continued success.

Back in 2008 you received 3.5 million page views per week on average. Has this number increased during 2009?

It seems that APOD's page views have increased, but it is actually hard to say by how much. The local log files do indicate that the main NASA APOD site now typically serves over one million page views a day. Still, I wonder what fraction of this is really just search engine robots doing strange indexing runs and the like.

APOD is setting the standard for quality and aesthetics of the astronomical pictures. Which are the main criteria for image selection?

I appreciate the compliment, but I feel that APOD actually has little to do with the current high standards for quality and aesthetics in astronomy images. In my opinion, these standards are really related to amazing advances in digital image processing, size and stability advances in CCD technology, increased bandwidth, and price breaks on moderate-sized astronomical telescopes. APOD, in my view, just skims a little of that digital cream off the top. Criteria for selection include me (or Jerry) exclaiming "WOW!" when a great new image appears. But yes, originality is important, as is topicality, artistry, and the ability to provoke curiosity. Also, I try to keep an eye on which images might become important to astronomy in the future, and so would likely appear in a next generation astronomy textbook.

Do you try to keep up with on–going events, like meteor showers and eclipses?

Yes. And even when I forget about some upcoming astronomical event, I am usually reminded soon afterwards by proud photographers submitting their images.

The website look and feel is still old-school, resembling the basic ASCII HTML websites. Is this intentional?

The old-school look of APOD is partly attributable to laziness. I guess we just try to fix things that are broken, and we don't consider APOD's look as broken. APOD is written and edited by only two people, and keeping our day jobs limits the amount of

Figure 2. APOD website.

time each of us can spend on APOD. Also, though, Jerry and I are fans of simplicity. We are indeed proud that APOD has kept the same look since it appeared in 1995, and now consider it part of our legacy. When I was a kid, I remember once admiring the Volkswagen Beetle because even as other cars changed their designs, the Beetle always looked the same and worked just fine. Now, perhaps, the same might be said about APOD.

iPhone applications and other web aggregators "steal" some of your website traffic. Is that an issue for you?

Like most people, I don't like to see any content stolen or unattributed. However, I am neither a police officer nor a lawyer, and so I do not myself have the power to stop them. What we sometimes do is to "endorse" — and hence list as mirrors — sites that reproduce our content with proper attribution and without inappropriate advertising.

How do you see the future of APOD? Are you planning any improvements?

APOD is perhaps more of an idea than a website. My current grandest hope is that long after Jerry and I are gone and after the web itself is considered archaic, some version of APOD will still exist and inspire awe, curiosity, and interest in the next generation of humanity. So long as some concepts of "Astronomy" and "Day" remain intact and important, the APOD concept might survive even changes of medium. More realistically, however, the best guarantee that there will be an APOD even tomorrow is that the "Tomorrow" line of today's APOD is not blank.

How much does APOD impact your careers as professional astronomers? Do you find it helps or hinders?

I believe that APOD has both helped and hindered my career as a professor and an astrophysicist. Through APOD, some of my most productive graduate students have found me and have thus greatly helped my research career. Conversely however, although rarely explicitly stated, being associated with APOD appears to paint me, to some, as a fluffy populariser incapable of doing real science. This seems to be true mostly for people who are not in my sub-fields of research. Oddly, inside the astrophysical sub-specialties in which I have worked the longest, APOD appears to have had little effect on my research reputation. I guess this is because some people in my sub-specialties have expressed surprise on finding out that I am associated with APOD. (As do most people — I am not a celebrity.) After finding out my association, though, their citation patterns for my scientific works appears unchanged.

In terms of tenure, I did not focus on APOD in my tenure dossier. I have always been interested and active in research, and so it was possible for me to publish and win sufficient research grants to become promoted to full professor without it. Conversely, I have always felt that my professorial activity has given me a stable platform and a broad student-oriented perspective that has bolstered APOD.

In terms of teaching, I think APOD has the effect of causing people to think I am a better teacher than I really am. In my opinion I am a good astronomy teacher, but not great. My teaching evaluations reflect this. I frequently teach introductory astronomy, and am now proud to put my lectures freely online. Anyone who wants to see for themselves can check here[1]. However, writing APOD has actually caused me to be a better astronomy teacher than I used to be. That is primarily because writing APOD has caused me to keep up to date — and think through — current astronomy events better than I used to.

Given your experiences with APOD, do you have any advice for people wishing to start their own online astronomy communication venture? What's the best way to engage the community?

Currently I am trying to bolster APOD by creating a surrounding community called the Asterisk that is meant to encourage people to comment (like an *asterisk, get it?) on APODs. The Asterisk has recently expanded to include a rapidly updated user-generated forum of astronomy-related bookmarks, a forum of new and user-submitted space pictures that might anchor future APODs, a place where any astronomy question can be asked no matter how easy or hard, and my entire introductory astronomy course, including video lectures and PowerPoint slides, which is free and leverages the freely available Wikipedia instead of a costly textbook. In terms of the questions — and we do get a few — I invite knowledgeable astronomy enthusiasts to help us answer them! Although the Asterisk does have a positive effect on APOD, it really has only a very small following compared to APOD, which gives me a feel for how hard it is to develop and engage a large community.

Therefore, my advice for people wishing to start their own online astronomy communication venture would be twofold: be first and be simple. APOD started in 1995 and this gave it a huge "first mover" advantage. So if you have a new and great idea about how to communicate astronomy, be the first to implement it, and make your implementation so simple that new viewers can understand it intuitively. Past that, a low cost structure, a decade of perseverance, and dumb luck might also be useful.

Notes

[1] http://bb.nightskylive.net/asterisk/viewforum.php?f=24

APOD can be viewed online here:
http://apod.nasa.gov/

Biographies

Robert J. Nemiroff is an astrophysicist at the Michigan Technological University and NASA Goddard. His research interests include the investigation of gamma-ray bursts, gravitational lensing, terrestrial gamma flashes, cosmology, the generation and use of the digits of irrational numbers. Robert's personal website can be viewed here: http://antwrp.gsfc.nasa.gov/htmltest/rjn.html

Lee Pullen puts his astronomy background to good use, engaging a wide range of hard-to-reach audiences. He specialises in science education and journalism, having taught several thousand people about the cosmos and regularly writing planetarium shows. His enthusiasm is legend, as is his website: www.leepullen.co.uk.

Pedro Russo is the Global Coordinator for IYA2009 working at the European Southern Observatory for the IAU. He is a member of the Venus Monitoring Camera/Venus Express Scientific Team and has been working with Europlanet, IAU Commission 55: Communicating Astronomy with the Public, EGU Earth and Space Science Informatics Division and the IAF Science and Society Committee.

Astronomy on the High Seas

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Key Words

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Public Outreach
Non-traditional Venues

Summary

This article describes the development and launching of a stargazing activity on two cruise ships, *Pacific Dawn* and *Pacific Sun,* which sail from Australian ports. The session included a presentation entitled "Voyage to the Stars" that gave passengers an overview of the life cycle of stars from star-birth nebulae to white dwarfs and black holes. In the presentation it was noted that ancient mariners used the celestial sphere to navigate. The presentation was followed by on-deck observing sessions in which objects shown in the presentation were viewed with the naked eye, binoculars and a small telescope. The activity seemed to be well received and resulted in numerous questions to the presenter of the activity. Many people said that the activity had kindled or rekindled their interest in astronomy.

Introduction

This paper describes the development of an astronomy activity for the P&O cruise ships *Pacific Dawn* and *Pacific Sun,* which sail out of Sydney and Brisbane, Australia respectively. The *Pacific Dawn* has a capacity of 2100 passengers. The *Pacific Dawn* has a capacity of 2100 passengers and the *Pacific Sun* 1900 passengers[1].

A major challenge on cruise ships is to provide activities for passengers while the ship is at sea sailing to and from the islands. Many activities are provided — e.g., productions in the main show lounge, art auctions, ceramic painting and many activities for children of different age groups. The rationale for developing an astronomy activity was the clear skies afforded from the ocean. Air flow across the oceans is very steady, producing good seeing — hence many of the major observatories are located on mountains close to the sea where the wind direction is from the ocean, e.g., Mauna Kea in Hawaii, ESO in Chile etc.

Over the period May to September 2008 a training manual was developed for the activity. The activity was branded as Voyage to the Stars. The activity was to include an astronomy talk and at least two on-deck star-viewing sessions. Two SkyWatcher 102 (SW102) telescopes were bought, one for each ship. The reasons for choosing this particular type of telescope were as follows. Refractors are in general more robust than reflectors. In this case the telescopes are taken from a storage facility out onto the deck and then back again. There is plenty of scope for knocking telescopes and there can be significant movement and vibration during storms.

The SW102 has a short focal length and therefore has a wide field of view so that objects will be in the field of view for longer as the ship moves. Celestial objects are easier and therefore quicker to locate with a wide field, which is an important consideration at a public astronomy event as it reduces the amount of time people have to wait to look through the telescope.

Another reason for choosing the SW102 is that it has an altazimuth mount which is easier and simpler to use compared to an equatorial mount, which would be difficult to set up and of limited benefit in view of the motion of the ship. With a short focal length tube and aluminium tripod the telescope was small and light enough to be easily carried from the storeroom to the deck. Although the telescope will only be used for a few hours a week at most, a closed tube telescope will be less susceptible to the corrosive influence of sea air. A catadioptric telescope would also be suitable, but would be more expensive than a SW102. The SW102 comes with a laser finderscope. On the *Pacific Sun,* the finderscope was set up in one of the ships corridors using an exit sign hanging from the ceiling as a pointing target. In principle it would be possible to construct a robotic telescope with a gyroscope able to track a celestial object by compensating the motion of the ship, however the cost of such a telescope would be much greater than the price paid for SW102s. There would also be safety issues with people being near a telescope that could move quickly with respect to the deck.

Thirty-five pairs of 10 x 50 binoculars were purchased — 20 for the *Pacific Dawn* and 15 for the *Pacific Sun*. The 50 mm diameter objective lens gathers a reasonable amount of light without being too heavy and unwieldy for most people to use. Two Celestron SkyScouts were bought for each ship.

Figure 1. The Pacific Dawn *about 1.6 km off the island of Ouvea, New Caledonia. This distance compared to the circumference of the Earth (40,000 km) is equivalent to the distance between the Earth and Alpha Centauri and the diameter of the Milky Way.*

Pacific Dawn

The Voyage to the Stars activity was launched on the *Pacific Dawn* cruise W825 (Sunshine Melodies) Friday 29 August to Sunday 7 September. The Voyage to the Stars PowerPoint presentation was given in the International Show Lounge (ISL) from 2–3 pm on Sunday 31 August. This was attended by a few hundred passengers. The presentation was delivered using PowerPoint on a Mac Book Pro plugged into the AV system of the ISL.

In the presentation a connection was made between sea voyages of earlier times when the stars were used for navigation. The presentation began with a photo taken from the front deck of the *Pacific Dawn* and was followed by a screenshot from the desktop planetarium Stellarium showing the view of the southern sky that would be seen from the rear of the *Pacific Dawn* as it headed in a north-easterly direction towards the South Pacific island nation of Vanuatu. It was pointed out that many of the constellations of the southern sky have names which relate to navigation and the building of the new world, e.g., Octans — a navigational instrument that was a precursor to the sextant, Horologium, the Clock — an essential tool in celestial navigation. Some of the constellations relate to building — i.e. Norma (Set Square) Circinus (the Compass — the sort used for drawing circles and arcs), Triangulum Australe (Southern Triangle). There are also Carina (the Keel) and Volans (Flying Fish).

The topics covered in the PowerPoint presentation covered galaxies, globular clusters, a comparison between the number of stars in the observable universe and grains of sand on a beach, star formation in nebulae, star clusters, the Sun, red giants, planetary nebulae, white dwarfs, supernovae, pulsars and black holes. At the end of the presentation there were ten minutes for questions. Many people asked questions, e.g., what is the difference between a star and a planet, what is a black hole, etc.

On the Sunday evening a session was held in one of the lounges for people to sign up for the first on-deck stargazing session. The first stargazing session was held on deck 10 at the rear of the ship 8:30–9:30 pm the next day. About 40 people turned up. Before the start of the session, the Stellarium and a compass were used to see what would be visible. This section of the ship has a fairly large clear area where people can assemble and is reasonably dark (Figure 2). However, most areas of the ship are light throughout the night to provide illumination for security cameras. It was necessary to have the lights at the rear of Deck 10 switched off to afford a good view of the sky. The view of the sky was about from the horizon to just over the vertical towards the front of the ship and about 180 degrees horizontally. Binoculars were signed out to passengers and then security staff switched off the lights on Deck 10, which dramatically improved the view of the heavens. P&O staff were present to learn how to conduct stargazing sessions.

In general the seeing was very good with the Lagoon Nebula being visible to the naked eye, for example. Alpha and Beta Centauri were visible intermittently between a few clouds. Topics covered in the presentation were Alpha Centauri, the closest star to the Sun at a distance of about four light-years (and so it would take four million years to get there travelling at 1000 km/h — i.e. as fast as a jet). It was pointed out that looking at Alpha Centauri was exciting, as we were in effect looking at a mirror image of the Sun since Alpha Centauri is the same colour, brightness and size as our Sun — although there are important differences — Alpha Centauri is in fact a trinary system with two stars like our Sun orbiting at a distance about equal to the distance between the sun and Saturn. A third star, a red dwarf orbits at a distance of about a tenth of a light-year away from the central stars. The Alpha Centauri red dwarf is the closest red dwarf to the Earth.

Jupiter was high overhead, close to the handle of the Sagittarian teapot. This helped with the identification of the teapot, although some people had some difficulty in trying to identify the shape of the teapot. The globular cluster Messier 22 and the Lagoon and Trifid Nebulae in Sagittarius could be seen together in the field of view of the 10 x 50 binoculars).

Figure 2. SW102 telescope and computer set up on the Oasis deck of the Pacific Sun.

The red giant star, Antares, was close to overhead. It was explained that elements such as sulphur, magnesium, silicon and iron (e.g., the iron in the ship) are manufactured in the cores of large stars and that heavier elements such as gold, silver, mercury, tin and lead are made in supernovae explosions.

Side-to-side motion of the ship was not a problem. Some passengers elected to lie on the deck to use their binoculars. (Someone suggested that P&O provide yoga mats especially for the stargazing session). The SkyScout seemed to work well if care was taken to keep at least a metre away from the metal structure of the ship. The SW102 telescope was not used on this occasion.

A second stargazing session was held on the voyage home at 8:30 pm on the Thursday. About 20 people were present. However only a very few stars were visible and conditions were getting quite rough — a message was relayed from the captain to keep the stargazing group away from the ship's railings. Most of the session was spent fielding questions from the passengers with an occasional look at various stars through gaps in the clouds. Binoculars were handed out and some people managed to have a look at Jupiter. The telescope was also not used due to the worsening conditions.

Pacific Sun

The stargazing activity was launched on the *Pacific Sun* in November 2008. This followed the same format as the activity on the *Pacific Dawn*, i.e. a presentation in the show lounge followed by two on-deck sessions later in the voyage. The experience gained from launching the activity on the *Pacific Dawn* were used to improve the stargazing activity. For example, photos taken on the *Pacific Dawn* cruise was used in the Voyage to the Stars presentation to make a stronger connection between a sea voyage and the celestial sphere.

For example, the photo shown in Figure 2 was used give people some idea of the scale of the galaxy, with the ratio of the distance of the *Pacific Dawn* from the shore of Uvea to the circumference of the Earth being about the same as the ratio of the distance between the Sun and Alpha Centauri and the diameter of the Milky Way. On the *Pacific Sun*, the stargazing sessions were held in a secluded section of the top deck called the Oasis (figure 3). This was a better location for observing the night sky than the rear of Deck 10 on the *Pacific Dawn*. The telescope was used on both stargazing sessions. The first session was held while the *Pacific Sun* was in the port of Noumea as it had to stay there an extra 12 hours for mechanical repairs, and so the view of the night sky was not as good as out on the ocean due to the city lights.

The second session was held on the voyage back to Brisbane. Viewing conditions were extremely good. Passengers were afforded excellent views of the Pleiades and Hyades clusters, Orion, 47 Tucanae and the Andromeda Nebula in Pegasus. The Moon and Jupiter were viewed through the SW102 telescope. The rocking motion of the ship was slow enough so that detail could be observed as the object passed through the field of view. On the *Pacific Sun* cruise two private stargazing sessions were also held for training two of the P&O staff scheduled to conduct the session after the launch. During both the public and private on-deck sessions Stellarium was used. The computer was placed on the covers of a jacuzzi conveniently placed in the centre of the deck. Stellarium was also very useful during the public sessions for showing passengers what to look for in the sky. They were able to look at the computer screen and then look up at the sky and effectively see the same thing. A large plasma screen or data projector would be very useful for enabling a larger numbers of passengers to view the Stellarium output at the same time.

Conclusion

There was a lot of interest in this kind of activity with many positive comments. Some people said that the stargazing sessions had kindled an interest in astronomy and they would be getting out into the backyard a bit more when they got home. One person said that they wished they had paid more attention at school. The main issues to contend with for a nautical astronomy activity are lights, wind and motion of the ship. In the case of the *Pacific Dawn* there was also some screw vibration. Warm clothing might be required for protection from the wind. Stellarium was an essential for planning sessions enabling the view of the sky to be displayed for any time and place on the surface of the Earth.

Notes

[1] For more details of these and other ships in the P&O fleet go to www.pocruises.com.au.

Biographies

Stephen Hughes is senior lecturer in Physics in the Queensland University of Technology, Australia and chair of the Education and Public Outreach Committee of the Astronomical Society of Australia

Nadia Rihani is entertainment coordinator of Carnival Australia.

Astronomy in Newspapers: Evaluation A Hands-on Guide

(Reproduced, with minor editorial changes, from IYA2009 in Newspapers: Evaluation Hands-on Guide, March 2009)

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Key Words

Astronomy in the Media
Newspapers
Evaluation

Summary

This article aims to provide basic information on how to evaluate, understand and contextualise astronomy and space science in the media.

Introduction

To demonstrate how to evaluate, understand and contextualise astronomy and space science in the media, we will use newspapers as an example. According to the academic literature about science and technology in the media, newspapers are representative of the whole media spectrum in science and technology topics (Hansen & Dickinson, 1992).

This basic evaluation methodology will allow a standard analysis of newspaper articles concerning astronomy and space science topics.

Why evaluate?

Many organisations, particularly in the public and voluntary sectors, are turning to evaluation as a source of learning, as well as to justify their use of funds. Through evaluation, you can:

- determine if the objectives of a project were reached;
- obtain information on the outcomes of a project, along with suggestions for improvements;
- identify changes in perception resulting from the implementation of the project;
- identify ways in which the project could have been more effective and efficient;
- identify unexpected results;
- crystallise ideas about the project and what it is intended to achieve;
- find out who attends events, along with suggestions for improvement; and
- provide encouragement by demonstrating that the effort has been worthwhile.

Methodology: how to evaluate?

The collection of an exhaustive number of newspaper articles concerning astronomy and space science would allow a powerful analysis of the impact of astronomy in the media. However, this task is too big to be carried out by simple press information offices or public outreach departments. As such, we describe here a more basic, standardised and simple methodology to be used in different countries or regions.

Newspaper articles should be gathered from, at least, the most important daily newspapers sold regionally or nationally. To obtain a good sample it is important to have one "quality" and one "popular" newspaper, which together form the accepted definition of "dominant media". These newspapers will be the ones that set the social and political agenda and whose news selection criteria and style are followed by the other media, who reproduce their opinions, style and contents, in the search for larger audiences.

With the help of standard software (Excel, Statistical Package for the Social Sciences (SPSS) etc.) samples should be selected for each weekday over a specific period of time (e.g., one or two years). Newspaper companies may also provide back issues. But where this is not possible, please note the start date. Using the same software, five publishing days per week should be randomly selected to be used for the analysis.

The entire publication must be checked, since astronomy and space science articles do not always appear in a specific newspaper section.

What kind of information is important for us?

The full analysis of a newspaper article can provide us with a very rich and complex dataset, but for this task we just need to analyse a few features.

It is very important that the coder, i.e. the person updating the database, only considers the content of the analysis unit. By analysis unit we understand the texts, illustrations or texts and illustrations that by themselves form a unit distinct enough to be clearly limited and that constitute an object of study itself.

The coder should not use his/her general knowledge about the subject to presuppose informative elements not explicitly stated in the article.

For the analysis, the coder should select all newspaper articles concerning astronomy and space science topics in the publication.

The coding frame is divided into seven different features:

- characterisation;
- scientific content;
- actors;
- scientific events;
- location;
- source; and
- news play.

The goal of the **characterisation** feature is to formally characterise the newspaper and the article under consideration. It includes the following items:

- Type: The newspaper source should be classified as "Popular" or "Quality";
- Day: The day on which the newspaper was published (e.g., 27);
- Month: The month when the newspaper was published (e.g., February);
- Year: The year when the newspaper was published (e.g., 2010);
- Newspaper title: The name of the newspaper (e.g., *The Times*);
- Article title: The title of the article. This is almost always at the beginning of the text, and uses larger letters;
- Location: Whether the article is on the upper half or in the lower half of the page. If the article is mainly in the lower half of the page but the top of the article is in the upper half, we should consider it as an article in the upper half of the page;
- Main illustration content: Illustration content can be classified as: people, planets, stars, galaxies, nebulas, space vehicles, satellites, telescopes, landscapes, buildings, symbols or other illustration content. If there are several different items featuring in the illustration, only the bigger one should be considered;
- First page highlight: Whether the article has a highlight on the newspapers first page (yes/no);
- Prominent page: Whether the article is on a prominent page: first, second, third or last page. The page should be identified (first, second, third or last page);

Given that astronomy and space science are science and technology topics, the **scientific content** feature, is very important in this analysis. The coder should be able to identify elements matching the following list of features expected in a piece of scientific writing:

- Scientist(s)/ expert(s) quotations: Whether there is a quotation from a scientist/expert (yes/no);
- Theory mention: Whether the article makes any mention of the theory (yes/no);
- Methodology mention: Whether the article makes any mention of the scientific methodology (yes/no);
- Technical language/ jargon: Whether the article uses any technical language/ jargon (yes/no);
- Bibliography: Whether the article makes any reference to a bibliography (yes/no);
- Data/results presentation: Whether the article shows any research data or results (yes/no);
- Scientist(s)/ expert(s) name(s): Whether the article contains the name of any scientist/expert (yes/no);
- Scientific Index: This is an index built to evaluate "how scientific" an article is. This index is determined by the expected features in a scientific article (scientist quotations, theory, method, technical language/ jargon, bibliographic references, data and results, names of scientists). The coder should give one point to each of the features that appear in the article. The total score will determine the article's Scientific Index, the overall level of scientific content:
    - From 0 to 2 points: low scientific content;
    - From 3 to 4 points: medium scientific content;
    - From 5 to 7 points: high scientific content.

Actors constitutes a rather important feature in newspaper articles. The coder should code the main actor type. If the article has more than one actor, only the most important should be considered.

Actors can be classified as: man on the street, scientist/ expert, authority, worker, celebrity, consumer, national (military), European Union, Press Officers, IAU, other astronomy societies, other scientific institutions, government or other actors.

The Scientific Event feature provides us with information about the kind of event covered by the article. It has two variables: main scientific event and scientific area.

To code the main scientific event, the predominant scientific event mentioned in the article should be chosen. Events can be classified as: astronomy in general, education or public outreach, local or national project or others. To code the scientific areas, the predominant scientific area of the scientific event should be chosen. Areas that can be classified include: astronomy in general, astronomy communication, astronomy education, Solar System exploration, stellar astrophysics, galactic anthroponomy, extragalactic astronomy, X-ray astronomy, infrared astronomy, radio astronomy, instrumentation.

The location feature allows us to place the event geographically. It has two variables: region and country. In the location (region), the coder must choose one of the locations where the scientific event happened or the location of the institution involved in the event. The regions are: European Union, other European countries, North America, Central and South America, Asia, Africa, Australia, Antarctic, Arctic. In the location (country) the coder should write the name of the country where the scientific event happened or the country of the institution involved in the event.

Source of information is another analysis feature. This will allow us to know where the information came from. Different information sources can be chosen. They can be: national news wire service, foreign news wire service, other national newspapers, foreign newspapers, national scientific magazines, foreign scientific magazines, non–governmental organisation (NGO), scientific institutions, scientists, public enterprises, private enterprises, scientific/ technical reports, books, IAU, the publication itself, without information or others.

The news play feature, is based on the Budd score (Budd, 1964). This is a score that gives a news play measure, allowing the understanding of the highlight of the article within the newspaper context. The higher the Budd score, the higher the news play. The Budd score is composed of a combination of a few features: highlight on first page, location on prominent page, location on page upper half, illustrations, title size above average (each one of these features counts one point). The news play can be classified as: very low news play (1 point), low news play (2 points), average news play (3 points), high news play (4 points) and very high news play (5 points).

Potential results

Once this data has been collected there are a few results that we can extract, for instance: the correlation between some global/national events, the correlation between press releases and the number of astronomy news pieces; the trend of the number of news articles related with astronomy throughout the period. If previous data is available the new results can be compared with the results from previous periods or for other sciences. Once again, these studies will provide important information about the real impact of a communication strategy.

Conclusion

We understand that this is a big task, but it can give very interesting results and useful data for a proper evaluation of your efforts. A piece of advice: it can be an advantage to establish a partnership(s) with one or more universities with experience in evaluation in order to set up a centralised data coordination and analysis centre. We hope these guidelines can help you with the evaluation of your astronomy communication.

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Notes

[1] According to the literature, "popular" newspapers are those whose contents are soft, less profound and mainly sensationalist, targeting a less educated and less demanding public". The "quality" newspapers are those whose contents are more profound and sober, mainly about politics and economics, targeting higher educated publics and cultural and power elites.

[2] List of science communication research groups/ departments: http://www.communicatingastronomy.org/training/index.html

Biographies

Rui Brito Fonseca has a degree in Political Science and a master's in Labour Sciences. He is now working on a sociology PhD looking at science and technology in Portuguese newspapers between 1976 and 2005. A researcher at CIES/ISCTE-IUL, Lisbon, Portugal since 2000, his main area of study is the public understanding of science, media studies and communication.

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Astronomy and Space Science in Portuguese Popular Newspapers at the End of the 20th Century

Opinion

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Key Words

Astronomy in the Media
Newspapers
20th Century

Summary

This article is a short, and inevitably incomplete, account of articles on astronomy and space science in Portuguese newspapers during the last quarter of the 20th century. It gives some insight into the social and science policy at that time and helps explain and put in context the changing patterns in newspaper coverage of astronomy and space science in Portugal.

Introduction

Science and technology are an integral part of everyday life, inextricably bound to our increasingly complex society. Our future is already framed by scientific advances in the environment, biology, communications, astronomy and more. The presence of science and technology in contemporary society stimulates discussion and reflection about the interaction between science, technology and society, and encourages studies that observe how they behave in relation to each other. After World War II, and in particular since the mid-1980s (Royal Society of London, 1985), these studies have reached new heights in accuracy and relevance. Following internationally developed studies (Dornan, 1990; Lewenstein, 1995; Fonseca, 2006) about the public understanding of science, the aim of this article is to understand and put in context the changing patterns in the newspaper coverage of astronomy and space science in Portugal.

Methodology

Following the traditional assumption made in research that newspapers are, to some extent, representative of the entire traditional media landscape when it comes to science and technology coverage, we have decided to focus this research on quantifying and characterising newspaper articles that concern astronomy and space science in the Portuguese press between the years 1976 and 1999.

This research is based on the phased application of a varied set of methods and techniques, using quantitative and qualitative methodologies. The methodology was developed after newspaper articles on astronomy and space sciences were collected systematically and comprehensively, forming a longitudinal section of articles on this theme. The analysis unit used is the article.

The newspaper articles were collected manually from paper copies of the newspapers. In this article we present the results of considering five variables. As well as presenting some annual frequencies, we also present some indices that allow specific questions to be analysed.

Articles from the newspaper *A Capital* were gathered for the period between 1976 and 1999. The choice of this time span was linked to the need to study the development of the appearance of astronomy and space science in Portuguese newspapers since Portuguese democracy stabilised, in the period after the Constitution of the Portuguese Republic was approved in 1976. Because a longitudinal analysis like this should not be carried out without considering the social, political and historical framework, the qualitative and quantitative analyses are first put in context.

As in other international studies, we have chosen one of the main commercial daily newspapers with a national circulation. The newspaper *A Capital* was one of the most regular periodicals over the period studied.

The intention was to focus on a periodical that is widely read by the Portuguese population and not exclusively by the intellectual elite. Although the media are not always so easily categorised, we opted to analyse a "popular" newspaper as defined by Correia (2006). A "popular" newspaper has a lower information content, is more sensationalist, directed towards a less well-educated public, and with less demanding standards than the top-end publications.

In selecting which publication days to analyse, it was necessary to take into account a set of criteria that ensures uniformity for the study. Thus, a database that included all workdays from 1 January 1976 to 31 December 1991 was constructed using SPSS (Statistical Software Package for the Social Sciences). The decision to restrict the analysis to workdays only was made after considering how the content differed in newspaper editions between workdays, weekends and holidays (Bauer et al., 1995). We then randomly selected editions for two days of publication for each month between 1976 and 1999. The whole newspaper edition was then analysed (including the many themed supplements and magazines). We excluded content such as obituaries, ephemerides, announcements, job offers, non-scientific meetings, advertisements, reader comments and letters to the editor.

To minimise mistakes in coding a random selection of 25% of the sources was made and read a second time. All the coding was developed by a single researcher to minimise subjective effects.

The political, social and scientific contemporary context of Portugal

As we cannot analyse newspaper content without understanding the main elements of the political and social reality in Portugal, the articles were divided into three time periods that marked the distinct phases in the political, social and scientific contemporary history of Portugal:

1. Infant democracy: 1976–1985

During most of the 20th century, Portugal was a country with almost no investment in science and technology. During the years of dictatorship, Portugal had a poor and closed culture that condemned the country to decades of economic and scientific delay.

After the revolution on 25 April 1974 and the subsequent process of democratisation, Portugal was still behind when compared with other European countries.

Portugal started to take a new path towards science. However, this was a period of great political instability. It was marked by the reorganisation of the scientific research system and by the redefinition of public policies in the area of science and technology.

It was not until 1984 that the first degree programme in astronomy was available in Portuguese universities.

Portugal was very dependent on technology provided by third parties, with a weak economic sector and closed to innovation and investment in research and development (Caraça, 1980, 1983; Gonçalves and Caraça, 1984a; Gonçalves and Caraça, 1986).

2. Europe and stability: 1986–1995

1986 saw the beginning of a new political period marked by the first decade of Portuguese European integration. The mechanisms for financing science and technology were reformed to allow cooperation between European research institutes and Portuguese institutes.

The government committed itself to increasing national expenditure in research and aimed to increase the number of workers in the scientific community, as well as providing incentives for entrepreneurs to encourage investment in science and technology. The first State Secretaries were appointed, with responsibilities specifically for scientific research and, later for science and the technology, triggering changes in public policy for science and technology.

The integration of Portugal into the European Economic Community (EEC) in 1986 brought new expectations to the country.

3. Science as a national odyssey: 1996–1999

In 1995 the government changed hands. With the establishment of a Ministry of Science and Technology, the new government formally raised the status of science and the technology. The general goals of these policies were to promote high quality scientific research, the creation of independent evaluation systems, the promotion of international scientific cooperation, providing the incentive for scientific development and its necessary diffusion through the economy and society.

In 2000, Portugal became a member of the European Southern Observatory (ESO) and the European Space Agency, taking its first steps towards a national policy for astronomy and space science.

Regarding astronomy and space science, the first nationally driven initiative to popularise astronomy in Portugal, known as "Summer Astronomy" began in 1996.

Results

Our sample of articles from *A Capital* covering astronomy and space science between 1976 and 1999 contained 1971 articles concerning science and technology and 254 articles on astronomy and space science (around 13%).

Frequency of articles

Changes in the frequency of appearance of relevant articles throughout the period allowed us to verify some trends and connect them to the contemporary context outlined above.

During the first period (1976–1985), articles about astronomy and space science were few, but numbers did increase over time. This trend applied to all areas of science and technology. At this time, Portugal was in political turmoil, so newspapers were concentrating on political issues. Science topics, and astronomy and space science in particular, were not seen as important issues. With the exception of a daily column, "Halley's Comet", written by a Portuguese astronomer, all the astronomy and space science topics concerned international issues like Soviet and American astronomers fighting for "pole position" in terms of their knowledge of astronomy and space science, research on Venus and Jupiter and speculation about life on Mars. It was at the end of this period, in 1984, that the first degree programme in astronomy was offered in Portuguese universities.

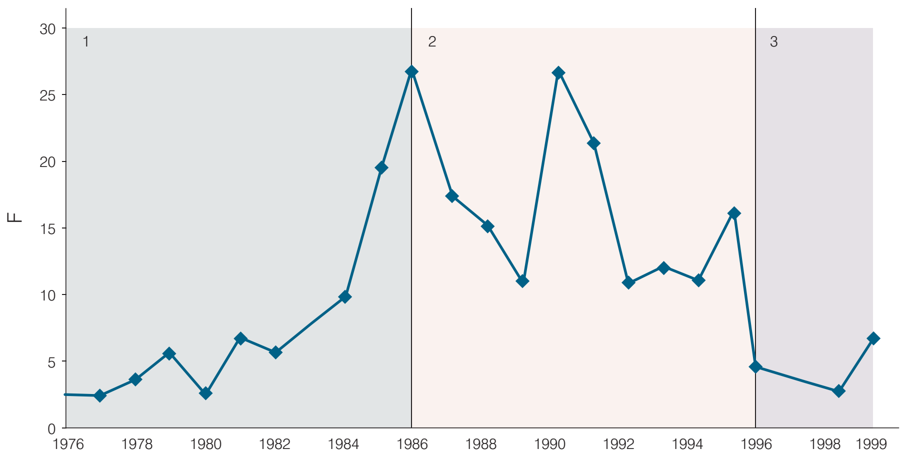

Figure 1. Articles about astronomy and space science appearing in A Capital between 1976 and 1999.

The second period (1986-1995) was rather unstable, with two peaks in coverage: 1986 and 1990. 1986 is explained by the daily column about Halley's Comet and by the Cold War space race. 1990 is explained by the approaching end of the US-USSR space race, and by the emergence of new countries competing in the field of astronomy and space science, such as the European Union countries and Japan. In 1990, Portugal became a candidate member state of the European Southern Observatory, and this alerted journalists to astronomy as a topic. This also made Portugal look at astronomy and space science differently, and take its first steps towards a national policy concerned with these matters.

After 1990 there was a global downward trend in terms of science and technology that is unexplained, but is a possible consequence of the disappearance of the communist bloc.

The third period (1995–1999) shows a downward trend, although it ends with a small increase. The trend in astronomy and space science is against that in science and technology overall, probably because of the rapid pace of developments in science and technology, such as those related to medicine and health, that attracted more attention from journalists and editors. 1996 saw the first Ministry-driven initiatives to popularise astronomy in Portugal, with projects like: *Astronomia no Verão* (Summer Astronomy) and the Porto Planetarium. If the second period was a time for bureaucratic and legal developments, the third was the period of popularisation. After the year 2000 the trend may well again be upwards.

Position in the newspaper

The section where the articles appear is an important indicator, and gives a measure of how the newspaper specialises relative to specific themes. Just as everyday life is ever more compartmentalised with "boxes" for every dimension of our life, so newspapers follow the same pattern, and create specific sections for specific issues. We choose what to read by sorting the sections we want and excluding those we don't want to read.

Astronomy and space science stories in *A Capital* appear mainly in two sections: *Ciência sem fronteiras* (a science page) and *A Capital dia a dia* (a sensationalist, bizarre or lurid news section known as the *faits divers* page). Almost 18% of the articles do not appear in a specific section. Regarding astronomy and space science, the section *Viagens no tempo* (Travels in time) was quite important, too. It was written by the same astronomer who produced the *Diário do Cometa Halley* (Halley's Comet Diary).

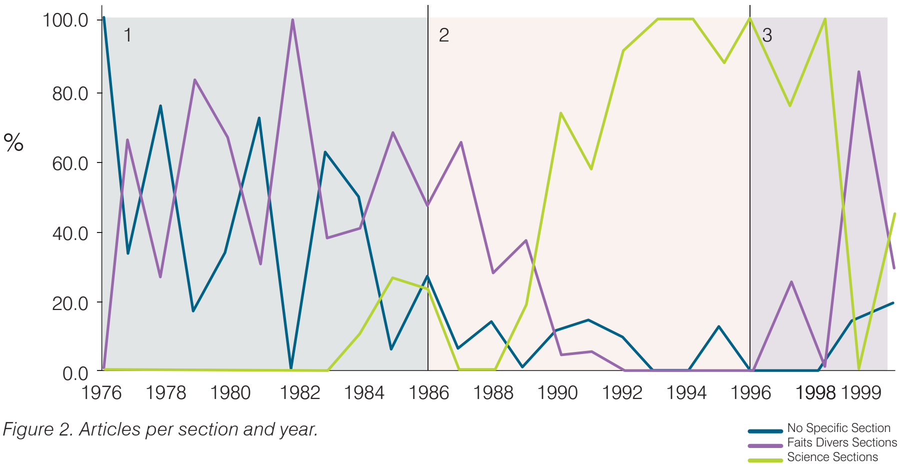

Figure 2. Articles per section and year.

In the first period, we can see that the distribution of articles was dominated by articles spread throughout the newspaper, and by the *faits divers* section *A Capital dia a dia*. Science and technology as a whole followed the same trend. This *fait divers* page had small and more trivial articles about astronomy, appearing side by side with cartoons, cookery articles, natural catastrophes, bizarre people, fashion or the weather forecast.

In the second period, we can see that these sections become less important and that the astronomy section *Viagens no tempo* and the science page *Ciência sem fronteiras* become more important. In the science page *Ciência sem fronteiras*, the articles were long and profound. Astronomy and space science were no longer marginal topics there for entertainment or to pique the curiosity. Science and technology as a whole followed this trend.

In the third period, we can observe some diversification. There is a decline in appearances on the science page *Ciência sem fronteiras* and a growth in appearances on the health and wellbeing section *Viver* (Living). Science and technology as a whole followed this trend, too.

Level of the articles

In order to understand the scientific level of the articles about astronomy and space science a scientific index was constructed by selecting a set of the elements that were expected to be included in scientific writing: quotes from scientists, mention of the underlying theory, mention of the methodology, use of technical language and jargon, mention of bibliographic references, data and results and the scientists' names. The newspaper articles were classified according to these expected elements. The results found in each period are clear: there is a decrease in articles with a low scientific content and an increase among those with medium and high scientific content as time goes on. In general, these results are consistent with more general articles about science and technology.

Level of news play

Science and technology issues, and astronomy and space science in particular, are an easy target for sensationalism. To understand how sensationalist an article is, some formal features of the article

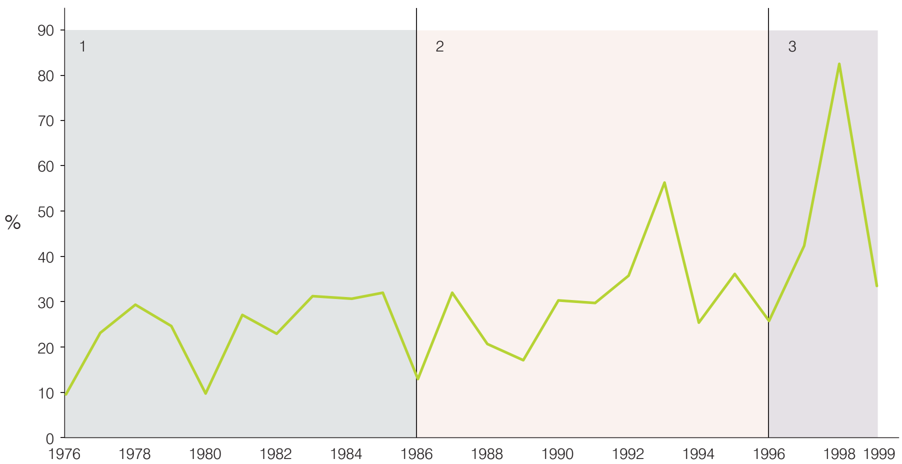

Figure 3. Scientific level of the article per year, as measured by the scientific index.

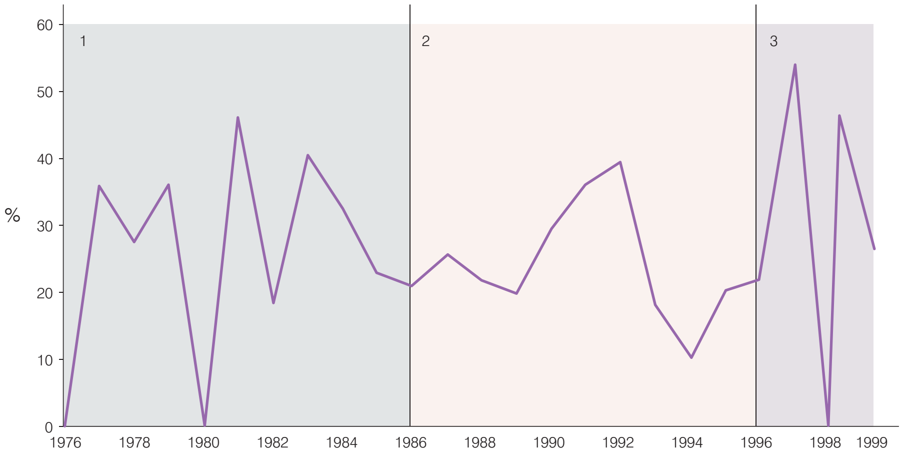

Figure 4. Budd score index.

were selected and a Budd Score was constructed (Budd, 1964), based on the following criteria: highlight on first page, location on prominent page, location on page upper half, has illustrations and title dimension above the average.

In general, astronomy and space science articles have very low news play, for comparison, articles with average news play score around 20%. Articles with a high news play appear only occasionally. The last period seems to point to a new trend with more articles with a higher news play. The analysis of all science and technology articles in this newspaper shows that they also follow these trends.

Conclusions

There are some conclusions that can be drawn from this study:

- Astronomy and space science are relevant topics for newspaper editors. Although we can find fluctuations in the newspaper coverage, it seems that content is directly connected with national and international politics.
- Astronomy and space science were initially seen as more trivial topics suitable for the lightweight *faits divers* pages, but have increasingly become seen as a more serious, important and relevant topic.
- The dominant presentation of astronomy and space science in the newspapers is through visual communication, using strong and unusual images from space.
- As newspaper coverage of the topics has become more specialised, astronomers have been invited to write about the subject and to explain in more detail, so that, more scientific information about astronomy and space science is slowly becoming available.

These conclusions are just the tip of a huge, unresearched iceberg of information that, everyday and everywhere, is there for all of us: the journalist's perception of astronomy.

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Biographies

Rui Brito Fonseca has a degree in Political Science and a master's in Labour Sciences. He is now working on a sociology PhD looking at science and technology in Portuguese newspapers between 1976 and 2005. A researcher at CIES/ISCTE-IUL, Lisbon, Portugal since 2000, his main area of study is the public understanding of science, media studies and communication.

Pedro Russo is the Global Coordinator for the IYA2009 working at the European Southern Observatory for the International Astronomical Union.

Visualising Astronomy: Let the Sun Shine In

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Key Words

Visual Communication
Astronomy Visualisation

I grew up in Arizona, so I like to believe I have a natural affinity with the Sun. (Let's just say that San Francisco doesn't afford quite the same experience of our nearest star.) Even if I weren't already so inclined, however, I think the recent images from the Solar TErrestrial RElations Observatory (STEREO) and Solar Dynamics Observatory (SDO), among others, would certainly win me over.

Right now, you can get your solar imagery fix by heading over to the STEREO website[1] or its SDO counterpart[2]. The SDO homepage sports an intuitive viewer showing "The Sun Now", so you don't need to click through a bunch of separate images. Eventually, it seems that the slick Helioviewer software[3] will support SDO data, but for the moment, it's all SOHO, all the time. There's at least one truly innovative interface to some imagery, however...

3D Sun, a simple but spiffy iPhone app from the STEREO team, allows you to interact with the latest data from the twin spacecraft (Figure 1). It pretty much works as advertised on the website: "You rotate the Sun with your finger to view it from any angle. You pinch in and out to zoom in for a closer look at the Sun's ever-changing surface"[4]. The three-dimensional features become smoothed out, alas, so one loses the sense of prominences and flares and filaments and all the messiness that makes solar imagery so enchanting. I find it slightly ironic that an app promising a "3D Sun" actually flattens the Sun's most engaging three-dimensional attributes. But ultimately, I feel quite satisfied, spinning a little sphere wrapped in the latest solar data while waiting for the bus or train. Just because I can't see the Sun in the sky doesn't mean I shouldn't enjoy it on my smartphone. The 3D Sun app also provides regular announcements about solar conditions and space weather: at the time I'm writing this, a coronal mass ejection is making its way towards Earth, so folks in the northern hemisphere can mark their calendars for some impressive aurorae.

To get a real sense for the lush garden of structures that spring from the Sun's surface, it helps to seek out moving imagery. The dimensionality of the data becomes evident when you see material travelling along the magnetic field lines — or observe the slight parallax shift of relatively static structures moving with the Sun's rotation.

The first time I had this kind of experience was watching imagery from the Transition Region and Coronal Explorer (TRACE) mission back in 2000, when I sat in an SGI Reality Center (basically a high-resolution, all-digital Cinerama set-up, quite sophisticated for the time) and watched the limb of the Sun appear to rotate in front of me. Captivating. I could have sat there all day.

I had a similar feeling, albeit in a less immersive environment, when I first saw clips from the Hinode spacecraft[5]. The Sun's surface, as it turns out, appears to have been poorly executed with a CGI particle system by a second-rate visual effects house. At least that's what I thought when I first saw the movies: "Wow, that's cool. Sure looks fake." I mean, really, if I'd seen something similar in a planetarium show, I would have dissed it.

The video coming from SDO elicits a different response. Now, the spatial and temporal resolution seem sufficient to provide a sense of realism, and the hot plasma arcing along magnetic field lines has a "weight" to it that earlier, more sped-up movies lacked. (Either that, or the Sun went to a better visual effects house for its new look.) So

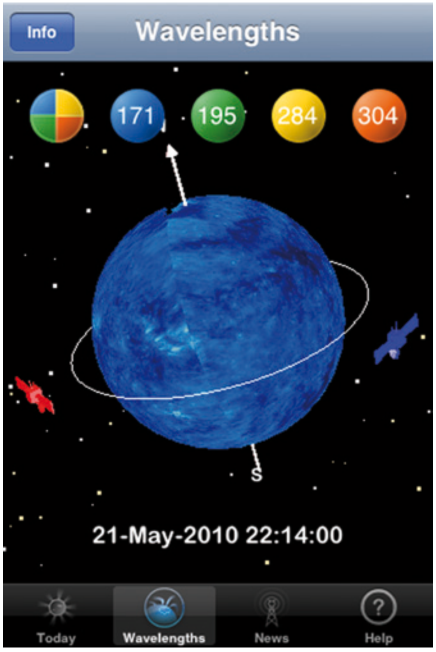

Figure 1. The simple, sweet interface for the 3D Sun iPhone app from NASA's STEREO mission. Note the option to select from four wavelengths at the top of the screen. Credit: NASA/STEREO.

run, don't walk, to your nearest computer and start watching movies! For better or for worse, YouTube seems to have become the preferred distribution mechanism for SDO movies[6]. Yeah, YouTube supports HD and blah blah blah, but the compression in the movies always bugs me, and the SDO imagery deserves better: particularly for the educational and public outreach (EPO) community, we need a high quality outlet for this extraordinary media.

The one thing that bugs me about the SDO images? The colours. If you look at the imagery offered up by the SDO "Sun Now" menu (Figure 2), the colour palette just feels weird, chaotic.

In case you don't feel similarly, take another look at that 3D Sun interface (Figure 1). The three little circles above the model of the Sun correspond to the bandpasses of the instrument at 171 Å, 195 Å, 284 Å, and 304 Å. Note that the colour-coding goes from blue to green to yellow to orange in what we'd call chromatic order, in which the choice of representative colour increases in wavelength along with the data. Most EPO imagery follows this convention. SDO flaunts it.

Of course, three or four colours spread out over the spectrum rather easily, and the STEREO approach adopts a straightforward solution. SDO's Atmospheric Imaging Assembly (AIA), on the other hand, provides continuous snapshots of the Sun in no less than ten bandpasses! (For the exhaustive list, take a look at the caption for Figure 2.) The breadth of coverage offers a serious challenge for assigning a range of chromatically ordered colours, but SDO's solution defies any logic I can discern. To complicate matters, the imagery isn't even presented in order of wavelength, so I'm left with an impression of total disorder.

The other oddity is the combination of saturated and (to use Robert Hurt's word) "pastel" colours they chose to employ. Typically, if one were creating a composite from several images, one would use a saturated colour for each bandpass. (To understand what I mean by saturated, think of the little wheel that pops up when software asks you to pick a colour: saturated colours are along the circumference of the wheel, not its interior.) Then, when you create a composite image from the various constituents, you're maximising the colour space in which information resides. Rector et al. (2007) provides an excellent (and exhaustive) introduction to image processing for EPO applications[7], or if you prefer not to delve into such a magnum opus, take a look at Hubble's "Behind the Pictures" page about the meaning of colour[8].

Whatever the motivation, the meaning of SDO's colours leaves me baffled. And although I tried to contact the folks who run the gallery, I haven't had any luck getting answers to my questions. (I may have to do a follow-up if I learn more, so watch this space.)

Here in the foggy City by the Bay, I'll take the Sun however I can get it. If not in the blinding heat of a desert sky, then in the soft glow of my computer monitor. Or my iPhone.

Notes

[1] http://stereo.gsfc.nasa.gov/gallery/gallery.shtml

[2] http://sdo.gsfc.nasa.gov/data/

[3] Available as a Java application at http://www.jhelioviewer.org/ or via an online interface at http://www.helioviewer.org/

[4] http://3dsun.org/

[5] http://solarb.msfc.nasa.gov/news/movies.html

[6] http://sdo.gsfc.nasa.gov/gallery/youtube.php

[7] T.A. Rector et al. 2007, *Image-Processing Techniques for the Creation of Presentation-Quality Astronomical Images*, Astron.J., 133, 598 (available online at http://arxiv.org/pdf/astro-ph/0412138)

[8] http://hubblesite.org/gallery/behind_the_pictures/meaning_of_color/index.php

Biography

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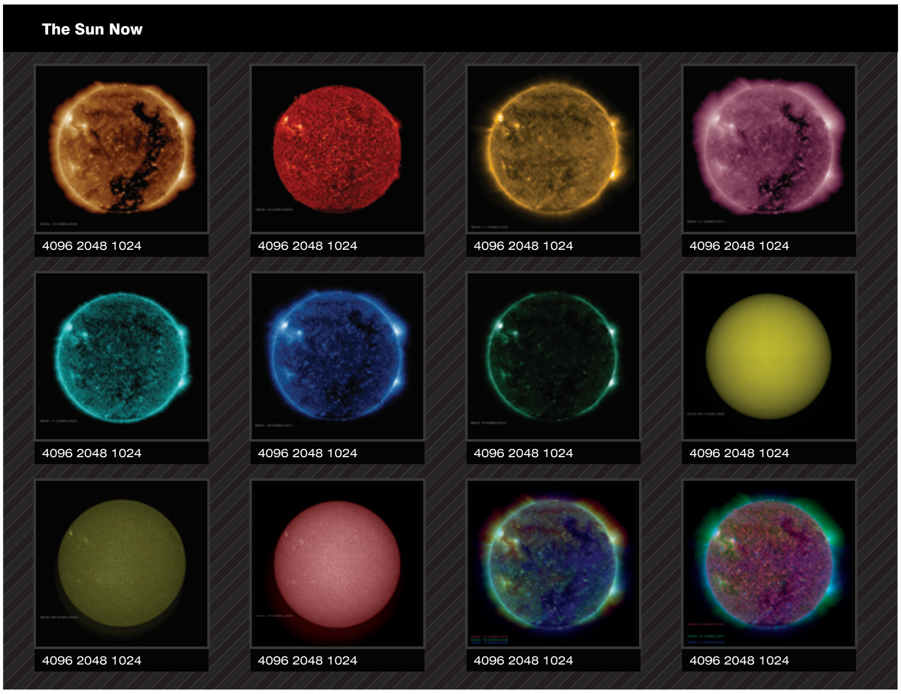

Figure 2. A screenshot from the SDO website, serving up the latest mission data. The dozen images, from upper left to lower right, represent data at 193 Å, 304 Å, 171 Å, 211 Å, 131 Å, 335 Å, 94 Å, 4500 Å, 1600 Å, 1700 Å, composite (211 Å, 193 Å, 171 Å), and composite (304 Å, 211 Å, 171 Å). Credit: SDO.

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