CAP journal
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Communicating Astronomy with the Public

International Year of Astronomy 2009
How are we sure that the goals were reached?

Outrageous Outreach
Unconventional Ways of Communicating Astronomy

Big Bang
Explained in 60 seconds

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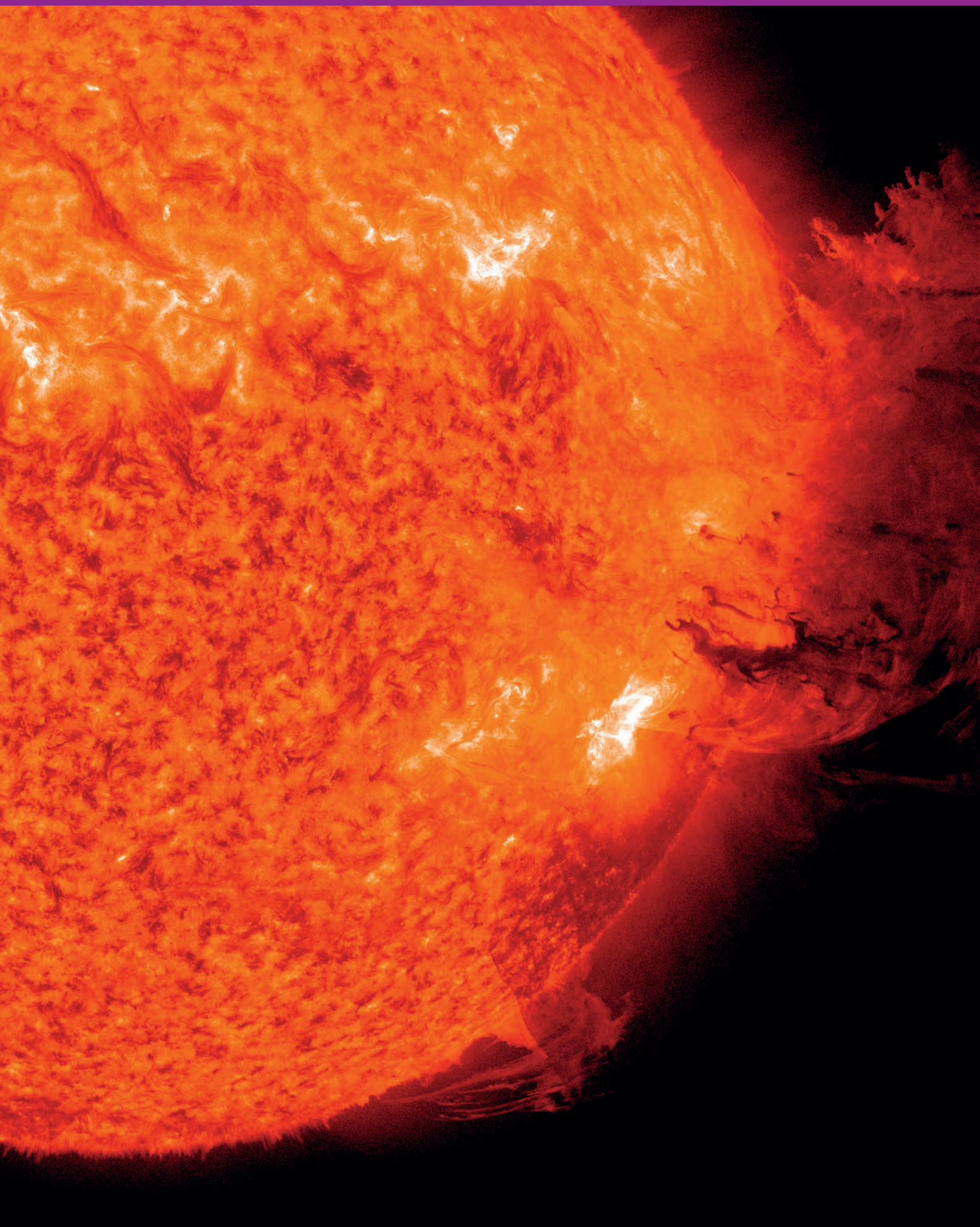
This image was taken 7 June 2011 by NASA's Solar Dynamics Observatory and shows a spectacular coronal mass ejection. A large cloud of particles mushroomed up and fell back down looking as if it covered an area of almost half the solar surface. Credit: NASA Solar Dynamics Observatory.



Contents

Cover: Stars over the South Tufa part of Mono Lake, USA, at the end of 2010. Credit: Grant Kaye

I am writing this editorial from the NEXT 2011 conference in Berlin, Germany (www.nextconf.eu). The conference has brought together a diverse mix of entrepreneurs, web activists, social marketers, web developers, scientists, engineers and journalists. The aim is to discuss the latest developments in technology that are changing the way that we handle and process data and the tools that we may be using in the years to come.

Two key topics have emerged from the presentations and discussions with other conference delegates about the future of data handling and dissemination. Firstly, that there has been a notable shift in the profile of the information gatekeepers: from being a select group of scientists, authors, journalists and editors to the new curators of knowledge: the crowd. The second hot topic has been the incredibly rapid development of new online social media tools. Services like Facebook and Twitter are extremely popular and are helping the new information gatekeepers to share knowledge. But there is room for improvement and innovation in these domains, to prevent important knowledge from being drowned out by the sheer volume of data created and acquired each day.

Astronomy communicators and educators encounter a similar problem: too much information to be communicated to the public. Large organisations, such as NASA, ESO, ESA and JAXA, have embraced the social media to reach out to new audiences. Meanwhile, citizen science projects have made scientific data accessible to the general public. But with an average of 36 scientific papers published each day on astro-ph in 2010, we have to develop new and innovative ways of steering the public through the huge amounts of new research.

Stepping away from questions about social media and technology for a moment, another topic that I feel deserves our attention is how outreach activities can be encouraged in the developing world. The International Astronomical Union, in collaboration with the South African National Research Foundation, has recently started implementing its decadal plan, called Astronomy for the Developing World. The plan builds on the success of the International Year of Astronomy 2009, and offers new challenges and opportunities for communicating astronomy across the globe, with an emphasis on the developing world.

In summary, I think the biggest challenges for astronomy communicators are to keep up with the fast pace of astronomy research and technology developments, and to reach beyond our ordinary audience. This year's Communicating Astronomy with the Public conference (CAP2011), which will be held in Beijing in October, will deal with all of these pressing issues. For more information, please visit the CAP2011 website: http://www.communicatingastronomy.org/cap2011/

I hope to see many of you in China later this year.
In the meanwhile, happy reading!

Pedro Russo
Editor-in-Chief

Faith in Science is Not Enough — People Deserve Proof

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Keywords
Education, Science Communication, Classroom

Summary

Education must be at the heart of science communication, or else we are simply asking people to "believe".

I am an evangelist. But instead of spreading the gospel or any other religious message, I spend my time trying to share the knowledge of what I believe to be humanity's greatest cultural achievement: science. There is a more mundane term for what I do — "science communication". It's a horrible term, smacking of exactly the kind of thing that turns some people off science. It covers a wide range of activities — from science film-making to working for medical-research charities to going into schools and throwing liquid nitrogen around in a desperate attempt to convince teenagers that "science is fun". Funnily enough, it's not used to describe those who teach science, even though science teachers arguably do more "science communication" than anyone else.

The UK's best known science communicator is probably Professor Brian Cox. He's doing a great job of making science seem cool and sexy to the public and, in my opinion, deserves the accolade of modern-day Carl Sagan for his contribution to the cultural status of science. I've known Brian for years and worked with him before his celebrity status went supernova. I would love to say "I told you so" to all the TV commissioning editors who rejected my suggestions to use him as a presenter. I suspect Brian finds it as ironic as I do that TV companies now regularly put out adverts looking for "the next Brian Cox".

As much as I love Brian's work, I don't think we need any more like him at the moment. Instead, we need more really good science teachers, and here's why: I don't want to see science become something that people "believe" is important and cool and sexy without understanding *why*. I don't want people to mindlessly buy into the geek scene in the same way that they might have bought into the alternative lifestyle scene, had they encountered it first in the right circumstances. But that's what I've seen happening — people attending the lectures, events and festivals organised by "science communicators" and going home convinced that science is the "right" way to look at the world, without really understanding why science is special. I've encountered people who are desperate to hang out with the science in-crowd (yes, there really is such a crowd), and even "science communicators" who struggle to explain what it is they think is special or important about science. When I ask them why they want to be science communicators they invariably talk about wanting to share their love of science with the world. Perhaps this is not so different from people who want to share their love of Jesus, Muhammad or Krishna.

It seems to me that many of these people are looking for an identity, something to believe in, and they've "found" science in much the same way that others find religion or spirituality. Some of these science groupies are scarily reminiscent of the kids who were in the Christian Union at school.

As a child, it would frustrate me that my friends would bang on about how great Islam was and how the Qur'an was this

amazing book with the Truth in it — when they had little idea what the Qur'an really said or what the details of the Islamic faith were. Recently, I've been feeling a disconcertingly similar sense of frustration when talking to people who are part of the "sceptic" movement, or the geek scene.

Sure, science by its very nature requires us to take things on faith — we cannot individually verify every scientific statement ever made, heck, few of us know how to prove that the Earth orbits the Sun and not the other way round, but without ensuring that education is at the heart of science communication, we are simply asking people to "believe" in science. If we can't do better than that, then we're no better than the religious leaders that so many self-proclaimed geeks are contemptuous of.

I have encountered priests who seemed simply to want to increase the numbers in their flocks, and I've met others who genuinely want to pass on their understanding of God. There is a parallel with science communicators — there are those who think that getting people to believe "science is fun / important" is what matters and there are others who want people to understand why this is so. It's a subtle but important distinction — the latter is more difficult to do and my feeling is that the best place to do it is in the classroom.

My friend Jonathan Sanderson, a science communicator who I admire hugely, has pointed out that it looks like I am advocating a return to the "empty vessel" model of communication. I'm not sure he's wrong, but I'd happily concede that, particularly with adult audiences, we need a range of approaches, from saying "this is how the greenhouse effect works" to "take a look at this, you might find it interesting". But Jonathan agrees with me that, "most science communicators would have a dramatically larger impact over their lifetimes if they quit the scene and took teaching jobs". I'm not disparaging the good work that many science communicators do, but some of the most talented, creative people I know work in this peculiar field and I just wish more of them would aspire to become teachers instead of dreaming of becoming the next Brian Cox.

Biography

Alom Shaha is a film-maker, science writer, and public speaker, whilst still finding time to teach physics at a comprehensive school in London, UK. He has a reputation for making science and other difficult ideas easy to understand for mass audiences, having worked as a creative consultant on projects from community arts events to children's TV programmes.

Figure 1. The Orrery *by Joseph Wright of Derby. Few of us know how to prove that the Earth orbits the Sun.*

Communicating Astronomy with the Public 2011

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- Evaluating outreach projects
- The social impact of astronomy communication
- The legacy of the International Year of Astronomy (IYA2009)

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IAU International Astronomical Union
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www.communicatingastronomy.org/cap2011

Embargoes: Stop Trying to Control the Message

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Keywords
Embargoes, Press Relations

Summary

Embargoes are tricky beasts. For every reporter who says he couldn't live without them, there's another who chafes at the control they give journals and scientific societies. For a year, I've been chronicling embargo policies and breaks at Embargo Watch: http://embargowatch.wordpress.com. The experience — and feedback from reporters, PIOs, and others — has left me with the impression that three areas in particular have room for improvement.

Don't hype

It was impossible to escape the coverage of NASA's arsenic-based bacteria study in *Science* late last year (Wolfe-Simon, 2010). As *CAPjournal* readers probably know, the trouble started when NASA put out an embargoed press release containing the following: "*NASA will hold a news conference at 2 p.m. EST on Thursday, Dec. 2, to discuss an astrobiology finding that will impact the search for evidence of extraterrestrial life.*"

That release, which led to wild — and inaccurate — speculation, should have been flagged, *Science* publisher AAAS's director of public programmes Ginger Pinholster said afterward, in a comment on my blog (Oransky, 2/12/2010). And once misleading statements from supposedly reliable organisations are out there, it's hard to unring the bell.

To be fair, a lot happened after that original press release, and scientists are now questioning the results in earnest. But the NASA release has left a bad taste in the mouths of many reporters, not to mention the public that funds it. To paraphrase a children's' book, hyping releases is just like *Jack Crying Wolf*. After a while, reporters just aren't going to believe you.

Don't embargo information that is already public

By definition, you would think that embargoes could only apply to material that hadn't yet been released to the public. Otherwise, why would a reporter agree to one? In any number of cases, however, it turns out that scientific societies are placing embargoes on abstracts and studies that are already in the public domain.

Take, for example, the recent release of a find from Hanny's Voorwerp, released under embargo in January. That result, it turns out, had already been revealed in a Zooniverse/Galaxy Zoo comic book (Beatini, 2010).

When I asked about that, the ESA/Hubble public information officer Oli Usher told me (Oransky, 10/1/2011): "*As to whether there is a new discovery here or not — we are publishing this as a picture release (not a science release), so the question of whether there is new science or not doesn't arise. The issue is rather whether or not the picture is new. (It is.)*"

The University of Alabama, Birmingham's Bill Keel, who worked on the Voorwerp, later posted a comment on my blog:

"*For astronomy results, much of the rationale I've heard for embargoes from a funding agency (as opposed to, say,* Nature *or* Science*) is that many media outlets have a better chance of picking up the story while it's still 'news', so dribbling it out without the backing of the [Space Telescope Science Institute] name would be less effective. We did worry a little bit about the comic, but funding and opening-event timetables constrained us to get it done first. I was conflicted about this whole issue at the outset, because we had made a point of talking about much of the early work as we were doing it, in the very public Galaxy Zoo forum and blog sites. For*

the sake of wider exposure (and potentially attracting more people to try out citizen science) we decided to honour an embargo when the HST results came out, resulting in my writing what may have been a slightly anguished blog post explaining why we weren't showing the images as soon as we had them processed. In the event, we did make enough of a splash to see the image on Letterman's monologue that night. Old media, meet new media, and both of you meet newer media — hey, stop that, all of you play nice!"

These are all fair points, and this situation was subtle, given that it was a new image that backed up an older interpretation. At the very least, having a discussion about what happened can inform future policy, and build trust.

What's less subtle is when scientific societies post all of their abstracts online in advance of a conference, then insist that they are embargoed, threatening to punish reporters who write about the abstract. That's what the American Astronomical Society (AAS) does at its conferences, and I just don't understand the rationale. The AAS never responded to my request for comment on the policy (Oransky, 8/12/2010).

Other societies, although none in astronomy, have changed their similar policies following Embargo Watch posts: The American Thoracic Society (Oransky, 8/82010), European Society of Human Genetics (Oransky, 7/7/2010), and the American Diabetes Association (Oransky, 31/1/2011). I'd like to see more societies, including the AAS, do the same.

Be transparent

If embargoes are, for some journalists, a necessary evil, then the policies that govern them should be transparent, to build trust in the organisations that use them. Otherwise, it is easy to imagine that institutions are only using them to control the flow of information — which is hardly consistent with the image that science seems to want for itself. Keep in mind that most of physics — for example, institutions such as the American Geophysical Union — do not use embargoes at all.

Timing and the Ingelfinger Rule[1] are two issues that often make me and other journalists wonder whether the purpose of embargoes is really to help reporters. If journals and societies want more accurate coverage, how are short embargoes — particularly those that are less than 24 hours, or even less than an hour, in the case of one medical journal — supposed to help? And how does the Ingelfinger Rule — which makes many scientists nervous about talking to the press before a paper is published — help spread scientific knowledge?

With that in mind, I put forward a draft policy at a public lecture in November at the University of Wisconsin, Madison (Oransky, 3/11/2010): "*Our embargo policy is in place to ensure as much coverage of research [in our journal/by our society's members] as possible.*"

This may divert attention from other important issues in science and medicine. Provided we have a reasonable interval between the release of material and the embargo time, it may also help reporters do a better job covering these studies.

However, policies that bar pre-publication publicity of scientists' work can also have a chilling effect on the spread of scientific knowledge.

Transparency also applies to decisions about lifting embargoes early. If the point is to ensure accuracy, it really doesn't help to leave embargoes in place so that journalists can't write stories that correct misinformation. There seems to be significant reluctance on the part of many journals and societies to lift embargoes. They will twist themselves into knots saying that a story hasn't broken a particular embargo because it doesn't name the journal, or doesn't have some level of specificity about the results. One society even told me that they didn't lift an embargo early because they didn't like the approach a particular press release had taken in response to their study (Oransky, 1/6/2010). That's just wrong. It was encouraging to see AAAS' Ginger Pinholster comment on Oransky, in response to the arsenic bacteria kerfuffle (Oransky, 2/12/2010), that "*in reviewing the sequence of coverage, I can see that the research (as opposed to teaser stories) had entered the public domain prior to the reporter phone call that ultimately triggered the embargo lift.*"

Contrast that introspective approach with that of NASA, which said its scientists wouldn't engage with criticism of the arsenic bacteria paper because such critiques appeared on blogs (Oransky, 7/12/2010). It was a sort of post-publication embargo, one that does not bode well for the scientific process or for transparency. Throughout the whole episode, NASA seems not to have followed its own code of conduct (Oransky, 8/12/2010).

As Pinholster noted in her comment on Embargo Watch, "*the darned thing about people is, they're human*". PIOs, reporters, and others won't always get embargo policies right. But a thoughtful discussion of what went right, and what went wrong, is likely to improve policies the next time around.

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Notes

[1] The Ingelfinger Rule is the outgrowth of a New England Journal of Medicine policy, now taken up by a number of major journals, which said the journal would refuse to publish a study that had appeared elsewhere, including in the popular press.

Biography

Ivan Oransky is the author of the Embargo Watch blog: http://embargowatch.wordpress.com. He is the executive editor of Reuters Health and teaches medical journalism at New York University's Science, Health, and Environmental Reporting Program, and is treasurer of the Association of Health Care Journalists. The views here do not necessarily represent those of any of those organisations. In the past, he's served as managing editor, online, of *Scientific American*, deputy editor of *The Scientist*, and editor-in-chief of the now-defunct *Praxis Post*. He earned his bachelor's at Harvard, where he was executive editor of The Harvard Crimson, and his MD at the New York University of School of Medicine, where he holds an appointment as clinical assistant professor of medicine. He also blogs, with Adam Marcus, at Retraction Watch: http://retractionwatch.wordpress.com.

Book Review: Astronomy — A Self-teaching Guide

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Keywords
Book, Self-teaching

Summary

Astronomy — *A Self-teaching Guide* (Wiley, 7th Edition, ISBN: 978-0-470-23083-1, 388 pages), by Dinah L. Moché, is more than a self-teaching guide for beginners. It is also a good reference for science communicators who might occasionally need to refresh their knowledge of astronomy.

Divided into twelve chapters, this book covers general information about the main fields of astronomy, from the Big Bang to the recent scientific findings in hot topics such as exoplanets and extraterrestrial life. For those interested in testing their skills, there are lots of exercises and self-tests in each of the chapters, all with answers provided at the end of the book. About one third of the book is dedicated to the Solar System; certainly one of the subjects that best attracts the attention of the general public. The information is kept short and clear, and is easy to understand even for those without a strong math background. When talking about numbers, the author is careful in presenting physical magnitudes in both the metric and imperial systems. However, the attempt to reach international readers stops at the Equator: the explanations of the Earth's seasons and the star maps only work well in the northern hemisphere, which might confuse readers from the south.

There are a few common small mistakes here and there, such as the omission of Ophiuchus from the zodiac, the use of the word "meteorite" instead of "meteoroid" in some places and a mention of Alpha Centauri as the closest star visible with naked eye (although in the Appendix the Sun is correctly indicated).

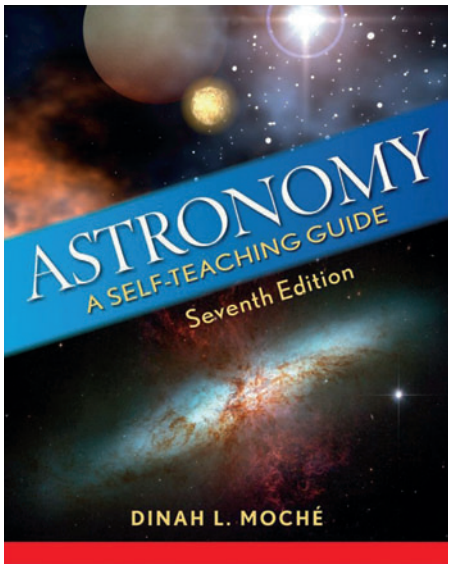

Figure 1. Astronomy — A Self-teaching Guide
Dinah L. Moché
John Wiley & Sons; 7th edition
368 pages
ISBN: 978-0471383536

The low number of colour images is compensated for by the many concise diagrams that do a good job in explaining the most important facts and by a large number of links to websites with images and more information. A few of the links are wrong, regrettably including one to this very journal, in the appendix.

However, taking into consideration the astronomical — in both senses — amount of information that this book presents, comprising more than 13 billion years of facts, the issues are relatively minor and do not diminish the value of the work. The book has a really great cost–benefit ratio and is certainly a handy tool whenever a science communicator needs an overview of some popular topic in astronomy.

Biography

Raquel Yumi Shida works as a web content coordinator for the education and Public Outreach Department at the European Southern Observatory, the International Astronomical Union and the European Space Agency/Hubble Information Centre in Garching, Germany. She holds a professional degree in architecture from the University of São Paulo (Brazil) and has previously worked doing both astronomical research and outreach in various locations in South and North America.

Book Review: Communicating Science: Professional, Popular, Literary

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Keywords
Book, Science Communication

Governments and scientific establishments have been encouraging the development of science communication. In this book, Nicholas Russell critically examines the origin of this drive to improve communication, and discusses why simply improving scientists' communication skills and understanding of their audiences may not be enough.

Avoiding specialist jargon, this book provides an insight into science's place in society by looking at science communication in three contexts: the professional patterns of communication among scientists, popular communication to the public, and science in literature and drama.

This three-part framework shows how historical and cultural factors operate in today's complex communication landscape, and should be actively considered when designing and evaluating science communication. Ideal for students and practitioners in science, engineering and medicine, this book provides a better understanding of the culture, sociology and mechanics of professional and popular communication. This book is a must as an academic introduction to science communication, but not necessarily a must-have on the practitioners' reading list.

Biography

Pedro Russo is the international project manager of the educational programme Universe Awareness. Until 2010 he was the Global Coordinator for the International Year of Astronomy 2009. He is a member of the Astronomy Department and Science Communication & Society Department of Leiden University, Leiden University.

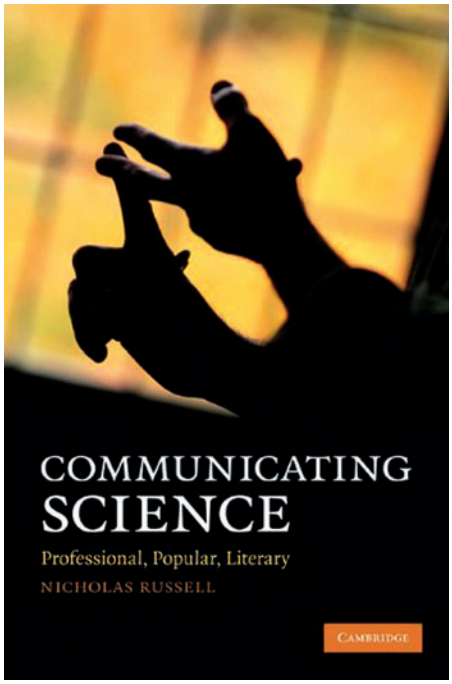

Figure 1. Communicating Science: Professional, Popular, Literary
Nicholas Russell
Cambridge University Press
348 pages
ISBN: 978-0521131728

Communicating Astronomy to Special Needs Audiences

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Keywords:
Astronomy Outreach, Public with Special Needs, Disabilities, International Year of Astronomy 2009

Summary

Our team has developed a variety of astronomical activities specifically intended for people with special needs. In particular, we have created a series of interactive talks, software with astronomical content, hands-on activities, and a planetarium show, among others, to communicate astronomy to people with different kinds of physical and cognitive disabilities. The main goal of this work is to stress the fact that working with this kind of audience is not as difficult as it might seem *a priori*. Moreover, the experience is formative and very rewarding for everyone involved.

Introduction

The International Year of Astronomy 2009 (IYA2009; Russo et al., 2009) was a great opportunity to offer astronomical activities to all kinds of audiences. It also gave the final impetus to our plans to bring astronomy closer to people with physical and/or intellectual disabilities. The IYA2009 motto, The Universe: Yours to Discover, was addressed to people everywhere, regardless of nationality, race and belief. And also regardless of physical or intellectual capacity: we all live in the same Universe, under the same sky, and therefore, we should all be given the chance to enjoy it, through our different sensory and physical abilities.

We have been arranging visits to the Astronomical Observatory of the University of Valencia (Spain) for small groups of people with cognitive problems since about 2005. These groups have helped us, along with their educators, to develop new educational material and strategies that could also be useful to other outreach groups. IYA2009 was our opportunity to expand the range of activities and the kinds of audience that we were reaching out to.

Storytelling, feeling, drawing and observing

The first activity that we planned for people with cognitive disabilities was a series of interactive talks.

Sensaciones (Sensations): A talk which links astronomical images to everyday sensations of temperature, textures or smells. We associated a sense with each slide: a radar image of the surface of Venus is viewed while touching balloons filled with warm water; images of Io are accompanied by the smell of incense, etc. Audiences usually became quite excited and really enjoyed the talk.

A second talk, *Solo Imagenes* (Just Images) is a series of slides about a journey through the Universe, leaving Earth on the Space Shuttle (not very realistic, but very effective) and travelling out from the Sun to the cosmic microwave background. Soothing music is played throughout the trip, which is particularly appreciated by those affected by autism.

We usually complement the visit with some hands-on activities, like making a constellation on a piece of black cardboard with luminescent stars and golden pens, or building a simple sundial made out of cardboard (see Figure 1).

A somewhat different concept lies behind another talk/hands-on activity that we have called “The Life of Stars”. Here we introduce the concepts associated with the formation and evolution of stars to people with intellectual disabilities. Each step of the evolution process is connected to some human experience, like being born, feeding, growing, etc., to establish a link to a common experience and the subject for the audience, making the topic more approachable.

Figure 1. Making constellations and sundials in the laboratory. Credit: The authors.

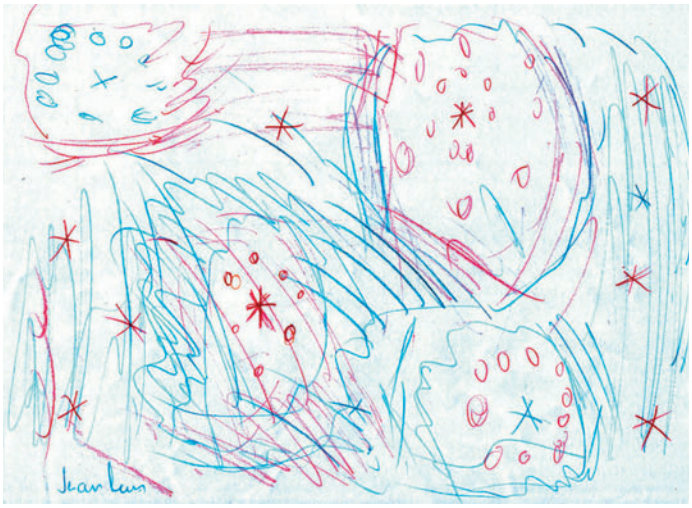

Figure 2. Stars forming in a cluster in cocoons of gas and dust. Credit: The authors.

The two main characters in the story are two stars, one a Sun-like star named *Estrellita* (little star) and the other a massive star named *Grandullona* (overgrown).

The talk is structured in two parts with a break in between. During the break the public go outside to observe our closest star: the Sun. We usually project the image of the Sun through a telescope, as it is much easier for the participants to watch it this way. Many of them also have physical problems added to their mental disabilities, so for some it can be tough to put an eye to the telescope's eyepiece.

During the break the audience draws their own interpretation of star formation and evolution from what they have heard so far in the talk. The complexity of the artwork has been really impressive in some cases, with protostars shining inside their gas and dust cocoons (see Figure 2).

After the break, the audience is shown the final stages in the evolution of the two stars, which proceed according to their initial masses: *Grandullona* explodes, while *Estrellita* just fades away.

A question and answer session follows, and some of the queries are truly difficult to answer. Taking the microphone and speaking in front of their peers is a lot of fun for the participants too.

The feedback that we have received from audiences and their teachers is extremely positive. As a next step, we plan to collect this material into a little book that people can read at day-care centres or homes, using drawings from the sessions as the book's artwork.

An astronomy book in Braille for the visually impaired

This initiative was started by the Astronomical Observatory of Padova in 2000 (see Benacchio et al., 2000), when they published a website with a comprehensive astronomy course for non-sighted people. The website[1] has a very clean layout, so that the text can be read by a computer's voice processor, and the drawings can be printed with thermoform or Braille printers. These drawings have been specially designed to take into account the way people with visual disabilities interpret images.

We contributed to the project by translating the website into Spanish, and printing about 50 copies of the contents as a Braille book, *Volver a ver las estrellas*. It has been distributed to the libraries of non-sighted associations and universities, as well as to astronomical outreach organisations and individuals, both in Spain and in the United States.

The book was also our little contribution to a fantastic exhibition organised by the University of Puerto Rico, where it received very good reviews, mainly because of the quality of the engraved images, and the clarity of the Braille employed.

A planetarium show for the non-sighted

This is probably the "strangest" of our projects, as a planetarium show is largely a visual experience. But the pioneering work by Dr Sebastian Musso in Argentina had shown already that it can be done, and we started to develop the programme *El cielo en tus manos* (The Sky in your Hands), which could be shown at the Hemisferic, the planetarium at the Arts and Sciences City in Valencia, Spain[2].

We developed an original script about a journey through the stars, visiting different regions of the sky with famous constellations and objects on the way. Each region of the sky was associated with a particular sound in the programme's soundtrack. The company Abac Estudis composed the soundtrack in five different channels to be fed into the multiple speaker system of the planetarium.

The projection of the night sky on the dome is scheduled so that when the narrator is talking about a particular constellation, the sound associated with that constellation is heard coming mainly from the speaker closest to the place where the constellation is being projected, thus giving information to the public about the relative positions of the objects in the sky above them.

Obviously, this method only helps to place the constellation on the sky, so how do we convey what the constellations look like? To help with this, we developed a hemisphere

Figure 3. Hemisphere used as a tactile support for the soundtrack of the show. Credit: The authors.

made of fibreglass, with different kinds of engravings (see Figure 3). Bumps represent stars, and they come in two different sizes, according to a star's brightness. Continuous lines delineate the shapes of the constellations, and the dashed lines guide the way from one constellation or object to the next, according to the show's script.

A prototype of the hemisphere was developed and then tested with the generous help of the Spanish Association for the Blind (ONCE), and we came up with the final, fully tested version that was used in the show. Each totally non-sighted person in the public held his or her own hemisphere, so they could easily explore it at will. We made sure during the tests that the system of using different kinds of engravings was also appropriate to guide the audience through the whole show, so that no one was "lost in space".

To combine the sounds and the sphere, the soundtrack had two different narrators, one for the astronomical content, the other to guide the public through the tactile hemisphere at the pace dictated by the astronomical script.

The show has been successfully presented twice at the Hemisferic. The audience was really excited by the experience. Some were deeply moved because they had never before been able to understand what a constellation was, and now they finally understood it. Others remembered that they had been able to see the stars long ago and the show brought back sweet memories.

The programme has also been shown at smaller planetariums with less sophisticated sound systems, like the one at the Science Museum of Castilla-La Mancha in Cuenca (Spain). A very interesting experiment was conducted at the portable planetarium of the Principe Felipe Science Museum in Valencia, with the audience initially following the programme in complete darkness, with the only help of the hemispheres, and then afterwards with the usual projection of the sky turned on.

The hemisphere has been selected by the International Node of IYA2009 as one of the items that will be part of the IYA2009 Legacy at the Science Museum in London.

Astroadapt: Astronomical software for people with motor impairment

In our on going collaboration with centres for the disabled, we met people with unimpaired intellectual capacity, but severe central nervous system damage that limited their mobility and ability to communicate verbally to a greater or lesser extent. Their usual method of communication with the external world is through a computer attached to their wheelchairs. This computer contains communication software, which essentially consists of a set of drawings or words that are sequentially highlighted in a coloured window. The user selects the currently highlighted image by stroking any key, or by making any other slight movement to activate the computer, as appropriate to their individual capacity. In this way the user can communicate hunger, thirst or readiness for a walk outside, for example. This software is also quite expensive and is too dear for many families.

After talking to these people and their carers, we began to develop a free source, Creative Commons Non-Commercial License code with similar characteristics, so it could be used both to communicate and to enjoy astronomical content.

The first version of Astroadapt is quite simple, and with limited astronomical content. This is largely deliberate, as we are still running tests with users. The software allows new content to be created easily, and therefore, the communication content, for example, can be created by the carer and tailored specifically for each particular user, as some prefer drawings, and some work better with words. There are other settings that can be adapted to each user's individual needs, like the speed at which the sequential highlighting works, or the colours employed by the interface.

For the astronomical content, if the user selects a document, a few choices show up, indicated by large astronomical images related to their content. These images are highlighted sequentially by the software (see Figure 4). When one is selected, it pops up in a larger window, showing the image and an accompanying text. Audio material, such as a spoken version of the text, can be either pre-recorded or read directly by the computer's voice system.

The software has been written in Python, and versions in Spanish, English and Italian are already available. It has been tested so far in Spain and Italy. We would welcome hearing from anyone who wishes to collaborate by translating the existing content, or by incorporating new astronomical content, or improving the software.

Sharing the material

The main goal of this project is to pave the way for other people involved in outreach and education to work with groups of people with special needs. We have created this set of tools to make the start a bit easier, and therefore all these materials are freely available under the conditions of the Creative Commons Non-Commercial License.

The slides from the talks *Sensaciones* (Sensations), *Solo Imagenes* (Just Images), and *La vida de las estrellas* (The Life of Stars, Spanish version only), and the Astroadapt software can be downloaded from observatori.uv.es/ under *Divulgacion/Actividades divulgativas*.

The soundtrack of the planetarium show is freely available upon request from A. Ortiz-Gil, although only a Spanish version is available at the moment. We can also can lend the hemispheres or provide any kind of help to those who wish to make their own.

The Touch the Sky website is online[1], in several different language versions, and we can still provide interested parties with a copy of the book (only in Spanish).

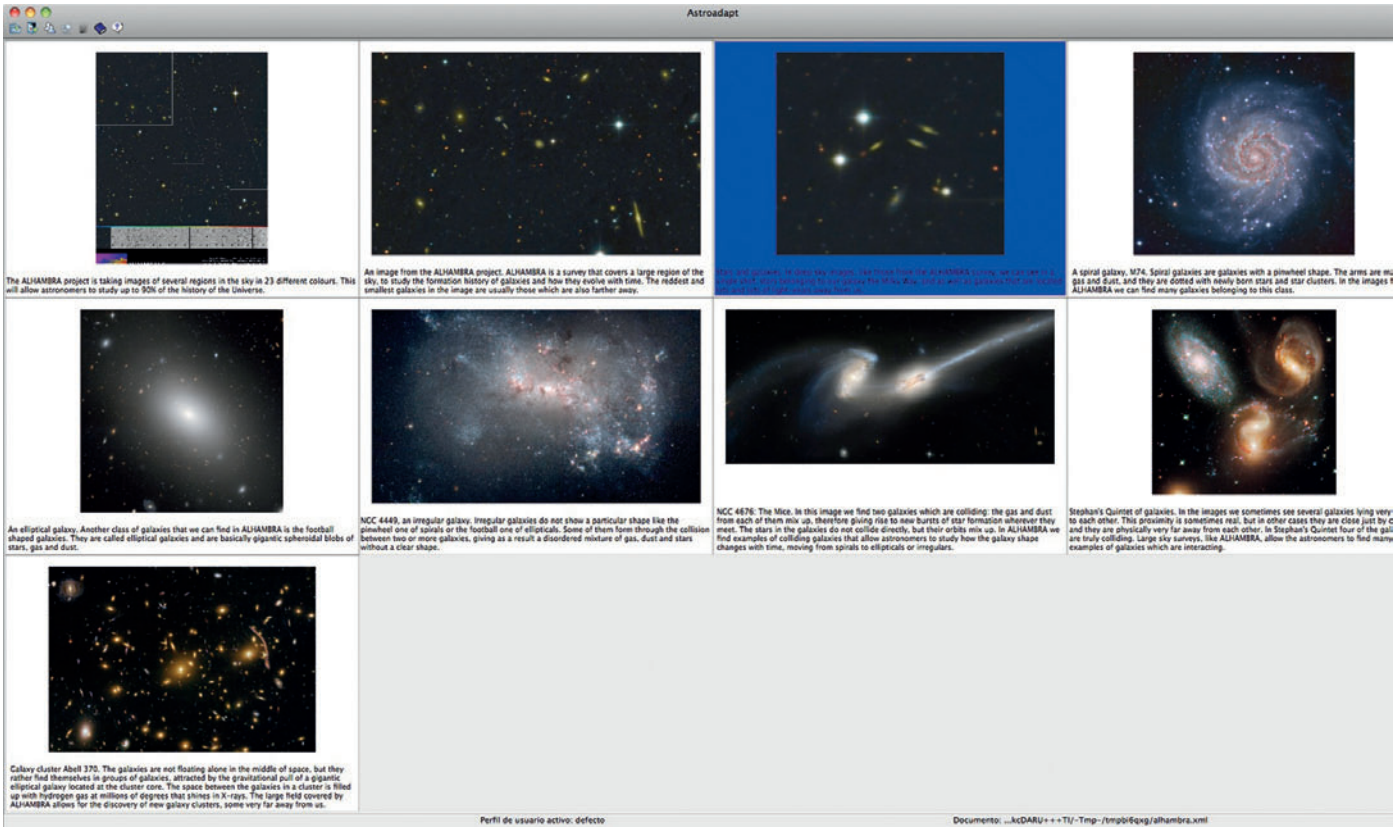

Figure 4. In the Astroadapt software the images are highlighted sequentially. When one of them is selected, it pops up in a larger window, showing the image and the accompanying text. Credit: The authors.

Pictures of the IYA2009 activities can be found at our flickr page[3] or the IYA2009 page[4].

Conclusions

With these few activities we want to show that we can bring the beauty and fascination of astronomy to people with various kinds of special needs. We hope that these examples will serve as a guide and inspiration for other educators and outreach agents to embark on this adventure.

Acknowledgements

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We want to thank also Dr Monica Sperandio, at the Brera Astronomical Observatory, for taking care of the translation into Italian of the Astroadapt software.

These projects have also been made possible thanks to the collaboration of different institutions and associations: the Hemisferic planetarium at the Arts and Sciences City in Valencia, the Generalitat Valenciana, the Confederacion Española de Personas con Discapacidad Intelectual (FEAPS), the Organizacion Nacional de Ciegos de España (ONCE), the Universidad de Alicante and the Planetari de Castello.

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Russo, P., Cesarsky, C. & Christensen L. L. 2009, Highlights of Astronomy, 15

Notes

[1] http://www.touchthesky.eu

[2] http://www.cac.es

[3] http://www.flickr.com/photos/iyaval09

[4] http://www.flickr.com/groups/iya2009/

Biography

Our team combined our separate efforts in developing activities addressed to people with disabilities in 2008, when the Spanish IYA2009 SPOC, Dr Montserrat Villar, asked us to create some activities and educational material specifically addressed to people with special needs to be used during IYA2009 in Spain.

Keys to the Stars — A Unique Experience

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Keywords
Science & Art, Music

The International Year of Astronomy 2009 saw the birth of a remarkable arts and science collaboration, between a piano duo and an astronomer. Since 2009, the Dutch Grieg Piano Duo, consisting of the professional pianists Elles van der Heiden and Siebert Nix, and the author have performed together in their project Keys to the Stars. The astronomer accompanies the four-hand piano music played by the Duo with an astronomical video, projected onto a large screen behind the grand piano. The trio has performed compositions by the Estonian composer Urmas Sisask (born in 1960) and Franz Schubert (1797–1828) in several concert halls in the Netherlands during 2009 and 2010 with great success.

The astronomer Peter Barthel led the Groningen University team that won a national Dutch science communication contest in 2008. Their winning project, Discover the Invisible Universe, which focussed on the invisible, but nevertheless exciting infrared Universe, infrared radiation, its discoverer William Herschel, and the Herschel Space Observatory, caught the eye of the pianists, who had just recorded a new CD with astronomy-inspired music by Sisask. They contacted the astronomer, who is also an enthusiastic amateur pianist, and the initial plans for collaboration were soon laid out.

The composer Sisask (more on him and his music below) provided extra stimulus for the collaboration when he agreed to write a new composition for the trio: entitled *Sombrero Galaxy*. After his opus 24, the *Milky Way Sonata*, and his opus 68, *Spiral Symphony* (both works recorded on CD by the duo), his opus 119, *Sombrero Galaxy*, marks Sisask's third composition for four-hand piano. For inspiration the composer used the poster of the well-known Sombrero Galaxy, Messier 104, published by the European Southern Observatory in 2000, from the Very Large Telescope (VLT) multi-band images obtained by the author and his colleague Mark Neeser earlier that year[1].

The Grieg Piano Duo and the astronomer presented the world premiere of the *Sombrero Galaxy* at a special concert in September 2009, with the composer and the Estonian ambassador to the Netherlands attending. Before that concert they had already performed Sisask's *Milky Way Sonata* at the Dutch launch of the International Year of Astronomy 2009 in Amsterdam, and his *Spiral Symphony* at a concert as part of the Peter de Grote (Peter the Great) Festival in the north of the Netherlands. The Piano Duo and astronomer generally combine the three works of Sisask with a well-known piece by Franz Schubert, his 1828 *Lebenstürme (Storms of Life) Allegro*. Together these four compositions make up a unique experience in a complete concert-with-video programme, which has been performed in December 2010 at various venues and is generally highly appreciated by the attendants. For the astronomical video Barthel uses public images from the VLT, Hubble, Spitzer, and other telescopes: the video scenes are projected in phase (to the second) in a continuous sequence with the live piano music.

A trailer of *Keys to the Stars* can be found online[2] and information concerning performances, bookings, technical requirements, costs, etc. can be obtained from the author[3] as well as from the pianists[4].

Figure 1. The professional pianists Elles van der Heiden and Siebert Nix, have performed together with Dutch astronomy professor Peter Barthel. Credit: Elmer Spaargaren.

Figure 2. The Sombrero performance in Groningen, the Netherlands. Credit: Antoinette Borchert.

Urmas Sisask's Universe

Urmas Sisask's compositions are strongly influenced by his own astronomical observations in his home country Estonia. His works are eclectic in style, and at the same time infused by strong symbolism, giving them a meaningful sound and effect. His starting point is often a combination of professional shamanistic meditation together with the influence of galactic relationships at that particular moment. This approach has lead to a unique musical system, known as astro-music. This system gives his four-hand piano works with two pianists at one instrument a totally new approach to the piano, involving playing techniques like plucking and muting strings, glissandi on strings and keys, and very frequent use of the right pedal. Pressing down a series of keys simultaneously with an elbow in combination with staccato playing opens up sound possibilities with the upper tones. These playing techniques reveal the true spatial resonances that are hidden in the piano, thereby becoming an instrument of cosmic and musical harmonies. The pianists become very close to their instrument. Urmas Sisask's compositions are published by Edition 49 in Karlsruhe, Germany.

Notes

[1] http://www.eso.org/public/news/eso0007/

[2] http://www.griegpianoduo.com

[3] pdb@astro.rug.nl

[4] griegpianoduo@home.nl

Biography

Peter Barthel is astronomy professor at the Kapteyn Institute, University of Groningen in the Netherlands. In 2008, together with his team, he won the national Dutch science communication contest. During the International Year of Astronomy 2009 he collaborated with the professional pianists Elles van der Heiden and Siebert Nix to bring together a project merging astronomy and music.

Raising the Prestige of Public Engagement within the Planetary Science Community in Europe

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Keywords
Planetary Sciences, Public Engagement, Career Development

Summary

We describe the outreach programme of the Europlanet Research Infrastructure (RI), a four-year project funded by the European Union under Framework 7 and designed to maximise planetary science output in Europe. Outreach is a key activity within Europlanet RI and we have put in place a programme to build channels of communication between the planetary science community, the public and the media. One of the major challenges that we have identified is the low value that some parts of the research community place on outreach activities. We describe how we hope to change attitudes and raise the prestige of public engagement in planetary science by establishing an annual prize and a funding scheme. Both schemes are now in their second year, with the third round due to be announced at the EPSC–DPS Joint Meeting in October 2011.

When identifying new priorities in the 2008 European Space Policy progress report, the 5th Space Council underlined the value of space exploration for inspiring young Europeans to choose a career in science and technology and to strengthen these capabilities in Europe[1]. European-wide initiatives such as the *ASTRONET Infrastructure Roadmap*[2] are making increasing efforts to foster a more proactive culture in public engagement within the European astronomical community. However, a common complaint from many individual researchers is that, on a departmental level, they receive little support and encouragement — and sometimes even active discouragement — in pursuing outreach activities. In a 2006 survey of factors affecting science communication by scientists and engineers, published by the Royal Society, only 50% of respondents described their department as supportive of those who took part in public engagement activities[3]. Even those who have developed highly successful public engagement programmes often feel that their efforts are given little credit and recognition compared to academic achievements. Tightening budgets and the need for increasingly complicated paperwork can make departments see outreach as a luxury (both in terms of time and financial resources), rather than part of their remit and core responsibilities.

The Europlanet project is the initiative of a group of European scientists who worked on the Cassini–Huygens mission to Saturn and Titan. In the initial project, funded under the European Union's Framework 6 programme from 2005–8, Europlanet provided a network for European planetary scientists that enhanced the community's ability to define key science goals, exchange ideas and personnel, and build a prototype interactive database.

In a second four-year phase that began on 1 January 2009, Europlanet received six million euros of funding under the European Union's Framework 7 Research Infrastructure programme. The Europlanet Research Infrastructure provides transnational access to Europe's leading research facilities and organises highly focused joint research activities, while maintaining the momentum of the networking activities developed under Framework 6[4]. The Europlanet RI is a large and complex project involving 27 participants and more than 70 associates from 20 European countries, Brazil, Japan, the USA and the Russian Federation. It supplies access to 20 different laboratory facilities, six field sites and access to the world's largest data bank and modelling consortia in planetary science, creating a European structure greater than the sum of national and local activities and facilities.

Outreach and communication are key components within the framework of Europlanet RI's activities. Our outreach team consists of three part-time staff, Thierry Fouchet (Activity Co-ordinator), Eleni Chatzichristou

Figure 1. Participants in outreach sessions at EPSC 2009 in Potsdam, Germany. Credit: Lee Pullen.

and Anita Heward, working on outreach and media activities, plus a web manager, Olivier Marco, for the Europlanet outreach website. The outreach programme is overseen by the Activity Deputy Co-ordinator, Steve Miller of University College London, and Jean-Pierre Lebreton of ESTEC, together with the Outreach Steering Committee, which comprises seven members with strong track records in outreach and media communications who have agreed to act in an advisory capacity.

Europlanet RI's outreach and media strategy is based around a network of national nodes in the European countries with institutions participating or associated with Europlanet. The role of the nodes is to respond to queries from the general public and the media about planetary science in their country and to be aware of outreach and media opportunities where planetary science could be highlighted. In addition, the nodes are responsible for translating, expanding and maintaining their national page on the Europlanet outreach website[5].

To date, we have activated a network of 14 nodes. With the assistance of the network of nodes, we aim to build channels of communication between the planetary science community, the public and the media that should last beyond the lifetime of the Framework 7 project.

In addition, we have set up a European Planetary Media Centre that assists in promoting the latest planetary science research through the media. As well as providing a media distribution service and communication training for European planetary scientists, the Media Centre can put journalists and broadcasters in touch with local planetary scientists, who can provide comment and give a regional viewpoint on planetary science stories.

In developing our plans for public engagement by Europlanet, one of the greatest challenges that we have identified is how to change the culture towards outreach and media activities within the more reluctant institutions and departments.

We are looking to tackle this in five ways: firstly by building up the outreach sessions (see Figure 1) established at the European Planetary Science Congress (EPSC) during the Framework 6 project, and by increasing the visibility of outreach during the meeting. We aim to do this by ensuring that outreach sessions are scheduled within the timetable for the scientific session rather than being regarded as add-ons for a separate community, by funding the national nodes to attend the Congress and take part in networking events with the wider planetary science community, and also by building up an outreach poster session to increase awareness of outreach initiatives beyond those people attending the oral sessions.

Figure 2. The Austrian Space Forum, winner of the 2011 Europlanet Prize for Excellence in Public Engagement with Planetary Science. Credit: OEWF (Paul Santek).

The EPSC is one of the biggest events in the planetary community's calendar (more than 700 scientists from Europe and around the world attended EPSC in 2010), making it an important opportunity to showcase public engagement and raise awareness of what can be achieved by proactive departments and individuals. Three outreach sessions were held during EPSC 2010 and these included 26 talks and 15 posters. As well as highlighting public engagement in Europe, the sessions to date have also provided a perspective on what is going on in the international outreach community, e.g., with talks by JPL on the Cassini Scientist for a Day programme[6]. EPSC in 2011 will be a joint meeting with the Division for Planetary Sciences (DPS) of the American Astronomical Society. EPSC–DPS 2011 will take place in Nantes, France, from 2–7 October 2011[7].

Secondly, we aim to encourage a high-level commitment to outreach from institutions involved in planetary research. At Europlanet's General Assembly, held during EPSC 2010, the outreach team announced its goal for every associate and participant member institution of Europlanet RI to endorse the IAU Washington Charter for Communicating Astronomy with the Public[8]. The network of outreach nodes has now been tasked to follow this up with each Europlanet institution in their home country. As well as promoting the admirable recommendations of the Charter, this exercise should help the outreach nodes to build links with the Europlanet community, hopefully fostering a bottom-up culture of outreach in institutions, as well as top-down.

Thirdly, we launched the Europlanet Prize for Excellence in Public Engagement with Planetary Science[9] at EPSC 2009. Europlanet RI is awarding the prize of 4000 euros annually during the Framework 7 phase of the project to recognise outstanding initiatives to engage the general public with planetary science. Individuals or groups can be nominated by third parties or nominate themselves, supported by three letters of reference.

As well as showing appreciation for the work involved in public engagement initiatives and providing some funding to support ongoing activities, we hope that the prize, in particular among Europlanet's

outreach initiatives, will be effective in raising the prestige within the science community associated with public engagement and media activities.

The inaugural prize was awarded to Jean Lilensten of the Laboratoire de Planétologie de Grenoble during EPSC 2010. For more than ten years, Dr Lilensten has worked to share the magic of planetary aurorae with school children and members of the public across Europe, using his 'planeterrella' experiment. The planeterrella[10] is inspired by experiments carried out at the turn of the last century by the Norwegian physicist, Kristian Birkeland, who first described how the northern lights were caused by the solar wind's interaction with the Earth's magnetic field. In a series of experiments, Birkeland aimed a beam of electrons at a magnetised sphere (terrella) inside a glass vacuum chamber and succeeded in recreating the ethereal glow of the aurora at the sphere's poles.

Dr Lilensten has developed a portable, flexible version that can be used both as a scientific tool and for public demonstrations.

He has trained colleagues and students in demonstrating the planeterrella and the Laboratoire de Planétologie de Grenoble hosts approximately two shows per month. Observatories in Toulouse and Paris-Meudon now have their own copies of the planeterrella and another will go on display in the Palais de la Découverte in Paris later this year. Dr Lilensten is working with groups in the UK, Italy and Switzerland who propose to build their own versions.

The 2011 Europlanet prize will go to the Austrian Space Forum, a national network for aerospace specialists and space enthusiasts. It is a volunteer organisation led by space professionals, focusing on space research including human-robotic Mars exploration (Figure 2). Since 1998, it has developed an outreach programme that targets schools, teachers, the general public and the media. The spectrum of its outreach activities includes simple classroom presentations, space exhibitions reaching 15 000 visitors, schools competitions to design Mars missions, and the development of planet-themed outreach kits, e.g., a set of spacesuits, a Martian landscape and a remote-controlled Mars rover, complete with cameras and a robotic arm. The award will be presented to the Austrian Space Forum at the EPSC–DPS 2011 Joint Meeting in October.

Figure 3. The launch of Rosetta's Comet Touchdown. Credit: The authors.

Fourthly, we launched a funding scheme[11] at EPSC 2009 aimed at developing new ways of bringing planetary science to audiences of the general public across Europe. Applications are judged on criteria of innovation, the potential legacy of the proposed project and the possibilities for wide European participation.

Although we do not have large sums to allocate (approximately 15 000 euros per funding round) we believe that the grant scheme has the potential to make a significant European-wide impact through the development of pilot activities or by providing seed-funding that could be matched by other funding bodies. As with the prize, we encourage successful applicants to share experiences and lessons learned through Europlanet's node newsletter, outreach website and the outreach sessions at EPSC. Evaluation reports will be made accessible online for the wider outreach community.

In 2010, Europlanet awarded grants to two projects: 5000 euros to Rosetta's Comet Touchdown, an educational kit to build models of the Rosetta Lander using LEGO Mindstorms®, and 10 000 euros to the Space Eyeful: Virtual Microscope for Extra-Terrestrial Rocks. The Rosetta's Comet Touchdown project[12], produced by Lightcurve Films and co-funded by the LEGO Group, LEGO® MINDSTORMS®, the European Space Agency and the German Aerospace Centre (DLR), was launched at EPSC 2010 (Figure 3) with a group of engineering and art students from the University of Rome testing a prototype of the kit. Further, longer-term trials have been carried out in 2011 with schools in Setúbal, Portugal and Sopron, Hungary[13]. Feedback will be used to refine and develop the kit. The Space Eyeful is a pilot project to adapt an online virtual microscope and give members of the public the opportunity to interact with samples of extraterrestrial rocks. The project is a collaboration between the Open University in the UK and the Natural History Museum in Vienna, Austria. A prototype library of extraterrestrial samples[14], including three lunar samples, one Martian meteorite and two chondritic meteorites, has been created. This will be expanded and developed as a public engagement tool during 2011.

Europlanet is also pleased to announce that in the 2011 round of the funding scheme, it has awarded a grant of 12 000 euros to the Virtual Mars Rover (VMR) Mars Life Challenge, a multiplayer game for mobile phones, created by members of the Mars Society Polska. It has also awarded 4000 euros to the Astronomical Observatory — University of Valencia to develop 3D tactile models of the Moon for use in planetaria[15] The call for nominations and applications for third round of the Europlanet prize and funding scheme will be announced at EPSC–DPS 2011 in October.

Figure 4. Trainees and trainers at the Europlanet science communication training workshop at the Observatoire de Paris-Meudon in June 2010. Credit: the authors.

Finally, Europlanet has undertaken to hold two science communication training workshops during the Framework 7 project, which aim to enable planetary scientists to engage with lay audiences, either directly or through the media. The trainers for this workshop are provided by ESConet, the European Science Communication network[16]. Workshop sessions include talks and practical exercises on writing press releases, being interviewed and designing web pages. The first workshop took place from 17–19 June 2010 at the Observatoire de Paris-Meudon (Figure 4). It was attended by 16 participants from seven countries. A second workshop will be held during 2012. The Europlanet outreach team also holds short workshops on writing for the media during EPSC, which are regularly attended by around 20 participants.

Europlanet's approach to outreach has changed significantly from the Framework 6 project, where the focus was on producing materials and developing initiatives in-house. The emphasis for Europlanet RI is on people: the nodes acting as a hub for planetary outreach in their respective countries; the Media Centre staff building links between the research community and journalists; the scientists obtaining access to training in order to develop their communication skills; the best communicators and outreach providers gaining proper recognition and opportunities to share their expertise. The project now approximately mid-way through. We are evaluating the progress on a regular basis and look forward to updating you in the future.

Notes

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[12] Rosetta's Comet Touchdown Educational Kit: http://www.vimeo.com/channels/rosettascomettouchdown

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Biographies

Anita Heward is the Press and Outreach Officer for Europlanet RI. As a freelance science communicator, she has worked for more than ten years to raise awareness of Europe's involvement in space and astronomy. She was formerly the curator at the National Space Centre in Leicester, Director of the British Festival of Space, Co-ordinator of the UK goes to the Planets promotional campaign and Press Officer for the Royal Astronomical Society.

Thierry Fouchet is the Outreach Co-ordinator for Europlanet RI. He graduated from the Mining School of Saint-Etienne in 1994, and received a Master degree from Paris 6 University in 1995. He obtained his PhD in 2000 on the Physics and chemistry of Jupiter's atmosphere from ISO observations at Paris Observatory. After two years and a half at Oxford University, he was appointed university lecturer at Paris 6 University in 2003.

Outrageous Outreach — Unconventional Ways of Communicating Science

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Summary

The golden rule of communication, advertising, public relations and marketing is "*follow your target group*". In this article, we look at how this mantra is applied in science communication and public outreach. Do we *really* follow our target groups? Do we regularly research the behaviour, interests and preferences of the individuals behind the demographic categories? Or do we just *believe* that we are following them when in fact we are "preaching to the converted" — the demographic group that is already intrinsically interested in science and actively scours the science sections of the national newspapers?

As science communicators, it is not only our social duty and moral *obligation* to communicate scientific results to laypeople, but it is also a *necessity* if we want society to approve continued funding for scientific research and also to inspire young people to become scientists. In today's fast-changing world of the new media it is no longer sufficient to walk the safe and well-trodden path. We need to ensure that our organisations "follow the target groups" by following the latest social trends, by being present in pop culture, teaming up with commercial partners, and engaging in other activities that build a bridge between the often isolated scientific world and the "real world". This article deals with these types of communication, here called unconventional or "outrageous" outreach.

Introduction

The phrase "knowing your target groups" also means trying to predict future trends in their behaviour. Looking ten years into the future, the advertising agency PHD introduces us to tomorrow's adults. Watch the video[1] or read the script excerpt below.

"[…] you'd better start upping your game. 'Cause you haven't seen anything like us yet. In just ten years from now, we'll be buying and influencing buying in ways that will confound you. We won't just watch your ads. We'll expect smart, tailored content. Based on our social graphs. Tailored for me, me, and me! We want to interact with it as we watch it, but not just with touch. With voice, gesture, with intent. You'd better embed everything that is featured with additional information. […] and we mean everything, Everything! […] Because we expect to double tap on anything to get more information. Don't worry […], we'll spread

Figure 1. *The ESO Residencia in the Atacama desert is blown up in the James Bond movie,* Quantum of Solace. *This movie brought significant visibility to ESO, and the Paranal Residencia in particular gained extensive coverage in architecture magazines and books, bringing the ESO brand to a target group that could not otherwise have been reached. A blockbuster movie reaches the global market, especially the younger audience and through such a movie, the science brand can make its way into popular culture, reaching people who are not always aware of astronomy news. Credit: QUANTUM OF SOLACE/© 2008 Danjaq, United Artists, CPII., 007 TM and related James Bond Trademarks, TM Danjaq.*

Figure 2. *Screenshot from the video "We are the future" from the advertising agency PHD, USA, February 2011. Credit: PHD, USA Source: scaryideas.com.*

it through our networks and co-create with you. And when we do buy, there are normally more of us than there are of you. We can change your business in one trade. As long as the deal is on. Augmented reality will become the new reality. AR aps will almost function like special skills to help us navigate reality more effectively. […] And you'd better get used to paying us. Our browsing influencing and purchasing data. Will make some of us … pretty rich. But don't overstep the mark; otherwise we'll block you. Mass blocks kill brands over night and keep you up all night. […] you'd better start upping your game, cause you haven't seen anything like us yet."

Are you ready to communicate science to these individuals, inform, educate and inspire them to appreciate science or become scientists themselves?

A new model of communication

Just a few years ago communicating science was relatively straightforward and linear; both the process and the flow of information were clear and well-defined. Organisations sent out press releases to the mass media, which acted as gatekeepers and decided whether to distribute the news directly to the general public or to reserve it for more specialised audiences. Consumers were then either indifferent or interested in the information offered. Everyone knew their place in this scheme and surprises were rare.

Fast-forwarding to today, we are experiencing a chaotic explosion of alternative information channels, such as RSS feeds[2], social media and other online platforms, which send waves of uncontrolled information towards us. Social media channels exist in the territory of dialogue, where any action is bound to have reactions, good or bad, that spread quickly. We are certainly long past the one-way communication of the *Mad Men*[3] era. One-way, two-way? Where are we today?

The traditional mass media channels are losing ever more ground to new or unconventional channels of communication. As an example, social media are becoming *mainstream* (and no longer just *new media*), opening a way into a fascinating territory — one where "the public" is now made up of individuals with personal opinions, ideas and preferences. Each individual connects with hundreds of other individuals and has his or her own sphere of influence. Information spreads rapidly across this complex landscape, travelling from one group to another. The power of socially fuelled word of mouth is incredible, but extremely hard to monitor (Usher et al., 2011). Through the social media the individual is empowered to become an opinion leader and a gatekeeper for his community, and sometimes for the traditional media. He can be approached directly by organisations and approaches them directly. He is simultaneously the consumer, producer, evaluator and influencer. The power is in his hands!

Communication continues to take place in the traditional public spaces, but it also happens in private, where personal experience is the key to ensuring that information is passed from one individual to another. Seventy eight percent of consumers now trust the opinion of their peers more than those of journalists or advertisers. Twenty four of the 25 largest newspapers are experiencing record declines in circulation because we no longer search for the news; the news finds us (Boxhill Institute, 2010).

In this immense chaos, we know one thing for certain. As science communicators we need to reach our target groups. But are we sure we actually know our audience? Do we read teen magazines or glossy magazines? Do we know the hottest gadgets on the market? The latest trendy leisure activity? Have we followed our target group to the places that they regularly visit? Have we checked the keyword trends of Google searches (Google Trends, 2011)? Have we checked the latest studies on consumer habits? And adapted our communication habits accordingly? Or have we — when faced with restricted budgets and manpower — just done what we have been doing for decades? Publishing press releases, making print products and arranging exhibitions for a target group that exists in our minds only as a result of our own suppositions, practical needs, likes and dislikes?

In a world where both public and private spaces are invaded by both information and noise, where the entertainment and gaming industries are the main attractions for many, and especially for the younger generation, traditional ways of communication and branding are no longer sufficient. We can no longer afford just to send out press releases, we need to adapt to the new communication landscape. It becomes vital to search for today's individuals and find unconventional channels, or at least unconventional approaches for traditional channels, in order to stand out and make our message heard.

Figure 3. *Advertising a new Audi model at ESO's Paranal Observatory. Credit: Audi GmbH.*

With tongue in cheek we have named this new type of communication "outrageous outreach", as it is often viewed with scepticism and mistrust. Since our field of experience is astronomy outreach, our examples come from this area, but the ideas can be applied to any type of science communication.

Unconventional outreach

Unconventional outreach is the process of communicating science with the public in an environment where individuals are most open to receive information because this medium is frequented by the target by choice and for pleasure, and not as a result of a call for action from the science communicator. In this context, information takes familiar forms that individuals can relate to or enjoy, while the message is integrated naturally and in context, and communicated in a language that the target understands.

There are several features that characterise unconventional outreach. These can be one or more of the following. Unconventional outreach:

- proactively goes after the target to meet him on his own "territory";
- is niche-targeted, and not addressed to the masses;
- is personalised, with a human touch and direct;
- tells a story and creates a bond;
- is interactive and engaging;
- is unexpected and original;
- is passed on by word of mouth and can often be controversial;
- adheres to the targeted individuals' beliefs (e.g., partnerships with entities that share the same values; for example teenagers who drink Red Bull associate it with energy, meaning that Red Bull's communication needs to express energy);

Why do unconventional outreach?

Science communicators have a public duty to communicate the results of scientists' work, which is most often funded with public money. Therefore, unconventional outreach should not *replace* traditional communication, but *complement* it. While traditional means of communications are still important parts of any communication plan, the fact that they are becoming ever less effective should be a strong enough reason for looking into alternative ways of engaging with the public. Scientific organisations are responsible to the taxpayers, and in principle they should not say no to opportunities that come from the outside world, unless they can be proven to be detrimental to the work of the organisation. Scientific organisations are not independent ivory towers that can decide whether science communicators (for instance, through proxies like the entertainment industry or commercial companies) "give" the taxpayers what they request. In principle Science communicators are obliged to communicate as part of our "contract", as long as it does not disturb the primary functions of our organisations.

A recent article in *Nature* (Russo, 2010) explains how the head of NASA's Mars Rover science team, Steve Squyres, handles the issue of balanced transparency. In the article Squyres explains that since the progress of the rovers would be slow as compared to the frantic pace of real life, a different and more involving process was needed. "*What our rovers do in one day, a field geologist can do in 30 seconds,*" he explained. But since the project had a budget of 800 million US dollars from the taxpayer he decided on a fully open and transparent operation for the Mars rovers. "*I didn't feel we had the option to say, 'No, we don't feel like doing media today'.*" And understandably the public-relations personnel were nervous. As Russo (2010) states: "*Admitting uncertainty could make scientists look uninformed or unprepared. But before long, they saw the value of Squyres's approach. The researchers could present a clue uncovered by a rover, offer possible explanations, and then say, 'Tune in tomorrow to see whether we can find the answers'.*"

It is important to present to the management in charge of a given organisation's image that there is a need to show the human side of science and that the process by which results are achieved is often as interesting to outsiders as the results themselves. If we engage people by making them part of the dilemmas and problems that scientists and engineers face every day, rather than presenting a perfect facade of omniscience, we make scientists look like real people, and this can help to build a bridge between the scientific world and the "world outside".

Among the flood of information and noise, unconventional outreach is necessary also to position an organisation as "a thought leader" (Weinberg, 2009) in the sector it operates in, and to transform the organisation to the number one source of knowledge in that area. For this to happen, people need to know that the organisation exists, receive relevant and timely results from the organisation and, not least, like the organisation.

- **How do we make sure that people know that we exist?** By following the trends of the target groups and constantly trying to expand the audience that we reach, while retaining the current target groups. Some of the best new methods are direct interaction via social media, exposure in popular culture and contextual interactions.

- **How do we make sure that people receive relevant and timely results?** By effectively harvesting the information available within the organisation and the closed community and by having efficient workflows for disseminating it to the target groups.
- **How do we get people to like us?** By communicating on their terms — their topics, their timing. For instance by reaching out to people and engaging in conversations with them whether through a movie, a book, a contest, a blog post, or an exchange of tweets.

Examples of effective unconventional outreach

#Meteorwatch

Meteorwatch[4] was a Twitter event organised in 2009 by the Newbury Astronomical Society as part of the International Year of Astronomy 2009 (IYA2009). Initiated as an entertaining way for people to experience astronomy at first hand by watching the Perseid meteor shower and sharing their impressions via Twitter, it quickly became a global phenomenon.

Meteorwatch started at 21:30 BST on Saturday 30 May 2009 in the UK with @NewburyAS[5] twitterer Adrian West[6] tweeting and it lasted until Sunday morning. #Meteorwatch[7] was the Twitter hashtag used by the organisers to keep track of the tweets,

Figure 4. Milky J poses in his homemade spacesuit. Credit: Maggie Masetti.

which began to pour in. After the first hour, the number of people following the event had gone beyond all expectations, and the Newbury Astronomical Society blog[8] had received over 3000 hits. People from all around the world were being encouraged to go outside and look at the sky with friends and family, and for many of them this was the first time that they had seen meteors. Thousands of messages were posted by people of all ages and from all around the globe. Nearly 300 000 followed the event on Twitter, downloading photos, commenting live, asking questions, describing what they were seeing in their own words and many of them were even excited enough to think of taking up astronomy as a hobby.

"*It was the most talked-about website in the USA, Europe and Asia and all co-ordinated from our little chunk of West Berkshire.*" said Adrian West to newburytoday.co.uk[9].

The event attracted the interest of the traditional media as well. Meteorwatch was reported nationally by the BBC, by local radio and television stations, by most of the major newspapers, as well as by websites and blogs worldwide. Just after midnight on the first evening, Meteorwatch became the most popular topic on Twitter, while on the second evening the event was still one of the top trending topics. Meteorwatch undoubtedly demonstrated that astronomy can be entertaining and accessible and that social media can create events that can go viral.

Hubble Gotchu@NASA Goddard

On 26 April 2010, *Late Night with Jimmy Fallon*, a popular talk show from NBC[10], was "interrupted" by a member of the audience, under the name of Milky J[11], who started talking and rapping about the Hubble Space Telescope, while showing famous Hubble images. The moment was organised by show producers on the occasion of Hubble's 20th anniversary and it quickly went viral, while the tag line "Hubble Gotchu" entered the vocabulary.

NASA responded creatively, by welcoming Milky J to the Goddard Space Flight Center to debate with the James Webb Space Telescope (JWST) team[12], taking advantage of this opportunity to generate awareness of the successor to Hubble. A second video[13] filmed at NASA was presented again during the night show.

According to Goddard View, 2010, the JWST Observatory Manager, Paul Geithner stated: "*I think the sketch is great for NASA and huge for JWST because it exposes us to a broader, hipper audience.*"

Racing Green Endurance@VLT

The Racing Green Endurance (RGE) team[14] and Radical Sportscars worked closely to produce the stunning SRZero electric sports car. The team drove the 400-bhp twin-motor supercar the full 26 000-kilometre length of the Pan-American Highway with the aim of communicating their core values of sustainability, education and the promotion of science, engineering and adventure to the widest possible audience.

On their way from Alaska to Ushuaia, the electric car team wanted to visit ESO's site at Paranal, where the world's most advanced visible-light telescope has its home. ESO welcomed the team to La Residencia, and gave a tour to the crew, also allowing them to drive the electric car around the four

Figure 5. The Racing Green Endurance electric car speeding away after visiting ESO's Paranal Observatory. Credit: RGE/ESO.

Unit Telescopes of ESO's Very Large Telescope[15]. The event was promoted via the social media, and mass-media representatives were invited to the site as well. Moreover, the BBC accompanied the RGE team and documented the whole trip, and as a result, ESO was featured in the BBC documentary, reaching a wide audience. The RGE team also produced a YouTube video about their stay at Paranal and wrote a delightful blog post about their experience[16].

The RGE project targeted a niche that ESO normally does not reach — ecologists, engineers interested in electric vehicle technology, and sports car enthusiasts. By partnering with them, ESO managed to create a natural link between the technology used by the electric car and the technology used at Paranal. Moreover, the ESO brand was exposed to the Chilean community and far beyond thanks to social media and the BBC.

Angels and Demons @CERN

Dan Brown's bestseller *Angels and Demons*, which was later filmed, centres on CERN in Geneva. The "bad guys", the Illuminati, steal a canister containing antimatter — with considerable destructive potential — from CERN and the "good guys" go on a dramatic chase to recover it. The book and movie are both examples of a highly successful "science in pop culture" campaign exploited by CERN[17] and of the unavoidable compromises involved in such a cross-over project, as there were inevitably scientific errors and artistic license taken in the book and movie.

Angels and Demons gave CERN impressive worldwide recognition and received no brand damage despite the fact that CERN was the identified in the book and movie as an institution that made a global disaster possible. CERN seized the opportunity to use the massive media coverage of the movie to explain to the world exactly what they are doing: they had a special website dedicated to this collaboration and ran in-school tours to explain the science background as well as facts and fiction in the movie and the book.

Other examples of unconventional outreach

Michael J. West (in a talk at the Communicating Science with the Public (CAP) Conference in 2005) describes other unconventional examples of outreach such as podcasts, music events such as the Astrocapella project, or through non-traditional movie screenings such as Sci-Fi Movie Nights: *"a monthly community outreach programme based on the premise that 'everything we know about science we learned from the movies'"*. There are more examples of unconventional outreach in West (2005).

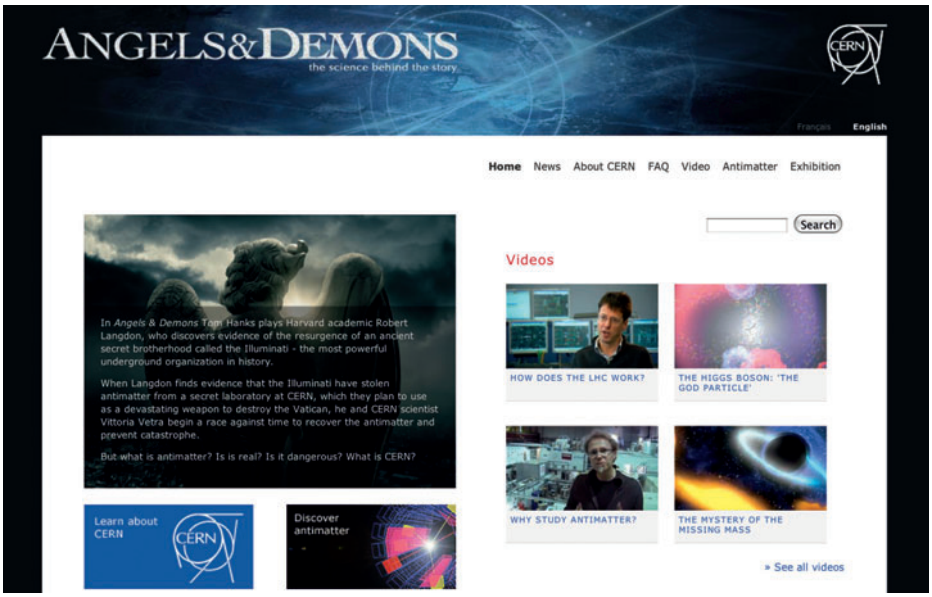

Figure 6. Screenshot from the CERN website explaining the science behind Angels and Demons.

How to reach the hard-to-reach?

We have seen that the trends in society today point away from traditional ways of communicating and we have also seen examples of how powerful unconventional outreach can be. The question remains: how do we implement unconventional outreach? How can we grab the attention of all those targets who have not yet been converted? A three-step process can be outlined:

Step 1: Know your target: research, research and research

When thinking about target groups, intuition or personal opinions are definitely not enough. Research, studies and focus groups are the core information sources. Consult your target groups to gain insights into your audience's habits: where do they spend their time, what do they eat; when, where, and which pastimes do they enjoy etc. Specialised companies can provide this information for a fee, but there is also data freely available. Consult the social media (especially for insights about young people), and look out for studies in the media/public institutions/specialised agencies for all types of target groups, and for events and magazine profiles to identify target audiences, their profiles and lifestyles.

Identify several target groups that you want to reach and make a mock-up for a representative individual in each category: The Teenager, The Young Professional, The Business Man, The Common Man, etc., and include short descriptions of lifestyle, education, leisure pursuits and interests. Include such variables as: nationality, education, culture, society, habits and lifestyles. This will improve your understanding of your audience and identify ways of reaching it in a natural context, an important feature of unconventional outreach.

Step 2: Choose the right channel: where are the target groups?

The right channel is the one *used* by your target group and not the one *you* use or you *think* they use. The right channel can be identified, based on your research and the profiles outlined in Step 1.

When communicating science with people, relying on the science sections of newspapers is no longer enough. Instead methods that we may previously have considered to be pure entertainment or superficial have

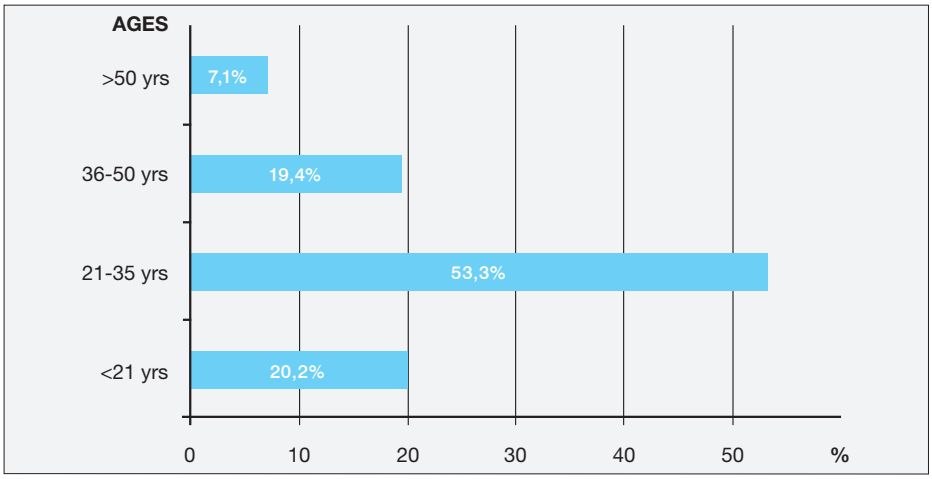

Figure 7. Age distribution for bloggers. Credit: Syomos.

a better chance of being an efficient way to reach our audience and accomplish our mission of informing people of our results. Given the incredible amount of information and noise, the competition for grabbing the attention of the public has become fiercer than ever. If we want our message to stand out from the crowd, we need to approach traditional channels creatively, and also start using unconventional channels, which have a growing audience. One such example is the social media.

A 2010 Eurostat survey[18] found that 80% of web users aged 16 to 24 years old had blogged, posted a message to a chat site or used a social network like Facebook during 2010. This proportion rose to 94% in Poland — the top-ranked nation — and hit 90% in Portugal and Slovenia[19].

As of 2011, 1 in every 13 people worldwide is a Facebook user (OnlineSchools, 2010). In February 2011, Facebook passed 637 million users globally. The top three continents that use Facebook are North America with 201 million users, Europe with 189 million and Asia with 146 million. In the three to six months prior to February 2011, there have been interesting developments in terms of how fast continents are accumulating users. The fastest was Africa, gaining more than 50% of its Facebook users in six months. The second most dynamic was Asia, whereas South America is placed third, with Brazil growing enormously (+ 7 .1 million users). The fastest Facebook growth in Europe occurred in Germany (+ 5.2 million users), Poland (+ 2.45 million users) and Spain (+ 1.8 million users), (socialbakers.com, 2011).

More than 346 million people read blogs, and 184 million people are bloggers themselves (Zarella, 2010). 53.3% of them are aged between 21 and 35 years old, 20.2% are less than 20 years old and 19.4% are 36 to 50 years old. (Figure 7, Sysomos, 2010)

At the end of 2010, Twitter had more than 175 million registered users (TGDaily, 2010), while in May 2010 YouTube exceeded two billion views a day. Twenty-four hours of video were being uploaded every minute, which means that more video was uploaded to YouTube in 60 days than had been created by all three major US networks in 60 years. The average user spends 15 minutes a day on YouTube (Website Monitoring, 2010).

Social media are not the only channels. Among other contemporary channels accessed by our target groups are: IMAX movies, iPhone and iPad applications, virtual and augmented reality, but also evergreens such as movie festivals, concerts etc.

Step 3: Choose the right approach

When in Paris, you speak French, when a mother of a toddler, you use baby talk and if you want to talk to a person who cannot hear, you use sign language. Every time we communicate with another person we seek a common channel and adapt to the status of the interlocutor. We role play in every conversation (Goffman, 1959). We should not forget this when communicating science. If we want our target groups to listen to us we need to find the appropriate language and adapt our tone to theirs. Use the words and style that your target uses, the

Figure 8. Poster used by Astroclub Bucharest to promote the IYA2009 Cornerstone project, She's an astronomer. *Despite the obvious gender-specific connotations (which also have a negative side) the poster helped to attract a new audience segment — the predominantly female readers of glossy magazines.Credit: Alex Conu for Baneasa Shopping City*

images, characters and situations that are familiar to your target group.

The AIDA principle (Attention, Interest, Desire, Action) sums this up:

- Choose the right language so your interlocutor can understand you and pay *attention* to you.
- Focus on his areas of *interest*.
- Offer him *desirable* benefits (entertainment, useful information, practical).
- Make it easy for him to take *action* (discover more, share the information, sponsor).

Managing outrageous outreach

Imagine the opening sequence of a 200 million dollar science fiction blockbuster. We see a space shuttle ready on the launch pad. The launch sequence proceeds to the climatic finish. With a rumbling roar of the engine's booster rockets the shuttle lifts off. The wing of the shuttle pans in slow motion across the cinema screen displaying a house-sized version of NASA's recognisable emblem prominently for several seconds. This scene could be from any mod-

ern science fiction movie, and the exposure that the NASA emblem gets through these unconventional partnerships with Hollywood pop culture is almost invaluable and helps to forge a close link between society and the American space programme.

However there is a flipside. Movies are reviewed and also judged on their scientific correctness. The textbook example of bad Hollywood science is *Armageddon* (see Plait, 2011, for a debunking). According to *Armageddon*'s Wikipedia article (Wikipedia, *Armageddon*, 2011) this movie contains at least 168 scientific inaccuracies and is used in NASA's management training programme. Although there are lots of fairly accurate science fiction movies using NASA's emblem this naturally presents a managerial risk.

"Outrageous outreach" is, as the name says, outrageous and controversial. Science communicators may take a while to accept it as a valid method and gain the experience necessary to spot which approaches are likely to encourage word of mouth distribution and which are likely to cause trouble. To minimise the risks and get the most out of such partnerships, a plan is needed:

- have SMART objectives for your unconventional communication: Specific, Measurable, Achievable, Realistic & Time-constrained;
- design a tool to assess the pros and cons on a case-by-case basis;
- set up a decision tree;
- implement, evaluate and record.

There are other issues as well:

- managerial buy-in;
- buy-in from colleagues who are "puritan" scientists;
- traditional methods/channels will not disappear, so the unconventional approaches effectively mean a broadening of the outreach portfolio, or palette, which translates into more work, or more pressure on staff and resources.

Managerial assessment of the involved risks is possibly the biggest obstacle for moving towards unconventional outreach. From the side of management potential legal issues obviously play a major role. In the case of *Armageddon*, NASA elegantly handles the legal aspects with a disclaimer in the end credits: "*The National Aeronautics and Space Administration's cooperation and assistance does not reflect an endorsement of the contents of the film or the treatment of the characters depicted therein.*" (movie-page.com, 2011).

When approached by the "world outside" or when coming up with ideas for how to do unconventional outreach it is vital to ensure full management support, and to involve management in the assessment process. A rigorous scheme for the assessment of positive and negative outcomes of the activity, including the potential risk of image damage is a good idea. The assessment should contain the following points:

A section with the **basic facts**. Use, for instance, the classic six "W"s to cover all areas:

- What?
- Why?
- When?
- How?
- Where?
- Who?

and be particularly careful to cover the following:

- the logistics involved;
- the number of people involved from the outside and inside;
- the costs for the organisation;
- a possible programme for the event;
- the timeframe;

Also needed is a section that takes a deeper look at the **pros and cons**. This can be done as a classic SWOT analysis (looking at the Strengths, Weaknesses, Opportunities or Threats), or simply by addressing the following questions. What is the:

- **Brand compatibility:** An indicator of the level of similarity between the values and mission of the external company and those of your organisation. Compatibility is achieved even if the means of reaching the mission might be, or often are, completely different from those your organisation regularly uses.
- **Brand reputation:** An indicator of how the general public and mass media perceive the external company.
- **Purpose compatibility:** An indicator of how closely in line the aim of the collaboration is with the aim of your organisation. A high compatibility rating indicates that by collaborating, your organisation will achieve one or more of its goals, even if the means may not be those usually employed by the organisation.
- **Potential brand damage:** An indicator of the risk that this collaboration could have a negative impact on your organisation's brand. This generally refers to visibility risks and potential negative media coverage. Note that a movie with, for instance, bad reviews, will never (or at worst, only in extremely rare cases) have a negative brand impact for one of the locations in the movie represented by your organisation. There is naturally a risk that the quality of the product would not be up to the usual standards of your organisation, but for a real negative effect to result from this exposure depends on the nature of the collaboration and on how much the two brands are associated in the public perception.
- **Possible exposure:** An indicator of the increased awareness of your organisation's brand generated by the collaboration. Since it is an "unconventional" activity, the partnership will usually generate exposure that the organisation could not reach on its own due to budgetary constraints, lack of time and/or expertise.
- **Other benefits:** An evaluation of additional benefits that your organisation could gain from this collaboration. Depending on the situation these could be: fund-raising opportunities, reaching key opinion leaders and decision makers, gaining access to valuable products such as high quality footage for your own use, funding, improving media relations etc.
- **Operational impact:** An indicator of how this collaboration affects your organisation's core operational activities.
- **Final recommendation:** A combined evaluation of the pros and cons of the collaboration and a recommendation for your management.

A score chart with values from, e.g., 1–10 is recommended to quantify the final conclusion more easily.

Agreements

When entering into a partnership with another brand, especially a commercial one, it is important to set up a written agreement addressing operational constraints, expectations on both sides and ensuring that your organisation and its real purpose do not go unnoticed, as commer-

cial partners often invest a lot in advertising and might overwhelm the smaller partner. Therefore several visibility benefits should be negotiated and included in the eventual written agreement with the partner. Examples of such benefits are:

- credit at the end of a movie both in cinemas and on the DVD;
- mention of the organisation's brand on the DVD, in the "making of" and/or in a bonus section detailing the locations of the movie;
- the permission to exploit the synergy publicly by, e.g., opening a dedicated web page for this collaboration (for an example, see ESO's Bond@Paranal site[20]);
- branding at the partner's events through banners, special displays;
- including informational material and/or branded gimmicks in the gift bag for the media or attendees of an event;
- mentioning of the organisation in the partner's press releases;
- offering information about the organisation on the partner's Facebook page;
- providing the organisation with management access for the premiere/event;
- special screening for the staff of the organisation.

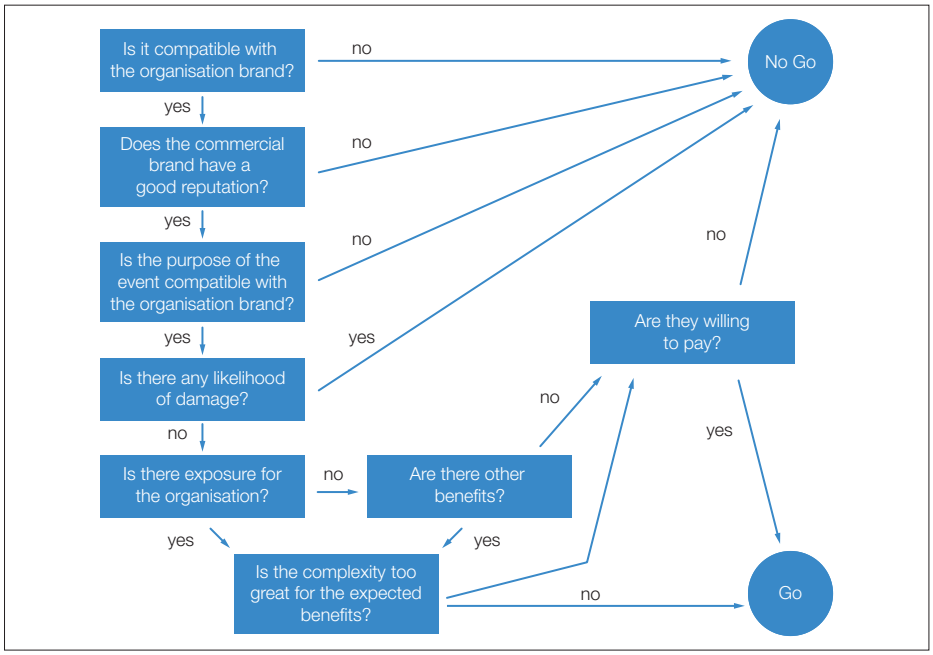

Figure 9. An example workflow for how a non-traditional assessment can work. Credit: Authors.

Evaluation

Evaluation is a highly important component of the communication process, but for unconventional outreach it is vital, as it will provide solid arguments that the methods were effective and that they are an experience worth repeating. Try to monitor anything that can give an estimate of your impact: website traffic, social media activity (number of Facebook friends, Twitter followers, number of views, comments and shares or re-tweets), attendance at an (online) event, types of audiences reached, number of blog posts gained, trackbacks[21] (one of three types of linkback methods for Web authors to request notification when somebody links to one of their documents), number of RSS subscribers, number of downloads in iTunes, views of videos posted online, search results in Google and Google News, number of movie or concert tickets sold, number of movie DVDs sold etc.

Among these indicators, the potential of viral information is enormous and hard to keep track of, but not completely obscure. There are a number of indicators that reveal results and how many resources should be invested in them in the future. Most social media platforms have integrated evaluation tools that make it easier to estimate the impact at the communicator's end. However, it is not possible to grasp the full scope of the contact generated via such channels precisely because the information is distributed through powerful individuals who act as influencers in their own online communities.

Try and monitor the evaluation status before and after an event to make sure that the influence of your unconventional outreach can be pinpointed. When monitoring social media, be sure to take a lot of screenshots as many of the things there are volatile. Also try to always calculate a cost per impression (CPI) — the price you have to pay for each individual you reach. This is obtained by estimating the total number of people reached through all your efforts, divided by your total costs. A few cents is a good CPI if you reach a mass target, but a few Euros can also be a reasonable CPI if the people are influential or high-level.

Conclusions

The new model of communication, which has unique individuals that interconnect at its core, forces science communicators to think outside the box and find complementary ways of reaching their target groups and accomplishing their duty to communicate scientific results, to educate and to inspire people.

One way to reach your target groups today is by proactively and creatively going after them and creating tailored, interactive, engaging, easy-to-access and easy-to-share experiences in places that people already choose to visit. This will often mean venturing down unexplored paths and doing unconventional communication that can sometimes be perceived as "outrageous" by your management and others. When exploring this new territory, care will have to be taken to establish clear workflows, have executive decisions by management supporting these initiatives, have a rigorous assessment process and make agreements with potential partners before starting.

In today's world, more and more people are connected, finding and generating information, influencing and being influenced by peers and opinion leaders in their communities. Every second that an organisation is not properly represented in this landscape is a wasted opportunity and every second that is not present in this new context, is a step down in the effort to climb the ladder of interest and grab the attention

of the individuals against competitors such as the entertainment and gaming industry.

Doing "outrageous outreach" is no longer an option, but a necessity. On the one hand, as science communicators it is our duty to bring science to the people that support our research and therefore we will have to learn their "language" and adapt to their lifestyle. On the other hand, the "outside world" will soon, if it has not already, arrive at our door step ever more frequently, offering non-scientific partnerships and we have no other option than to respond.

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Biographies

Oana Sandu works as community coordinator for ESO's education and Public Outreach Department (ePOD). She is responsible for the promotion of outreach products or events and the social media presence of both ESO and ESA/Hubble. With a degree in Communication and Public Relations and a Master Degree in Marketing, she worked for two years in a leading Eastern European PR agency from. As a volunteer, she was involved in projects such as Global Astronomy Month, the Space Generation Congress and World Space Week. She keeps a blog on astronomy communication at www.astronomycommunication.wordpress.com, tweets on twitter.com/oanasandu and posts on facebook.com/oana.sandu.

Lars Lindberg Christensen is a science communication specialist heading the ESO education and Public Outreach Department (ePOD) in Munich, Germany. He is responsible for public outreach and education for ESO, for ESA's part of the Hubble Space Telescope and for the International Astronomical Union Press Office. Lars has more than 100 publications to his credit, most of them in popular science communication and in its theory. He has a Master's Degree in physics and astronomy from the University of Copenhagen, Denmark.

Explained in 60 Seconds: A collaboration with *Symmetry* Magazine, a Fermilab/SLAC publication

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Keywords
Big Bang, Explained in 60 Seconds

Big Bang

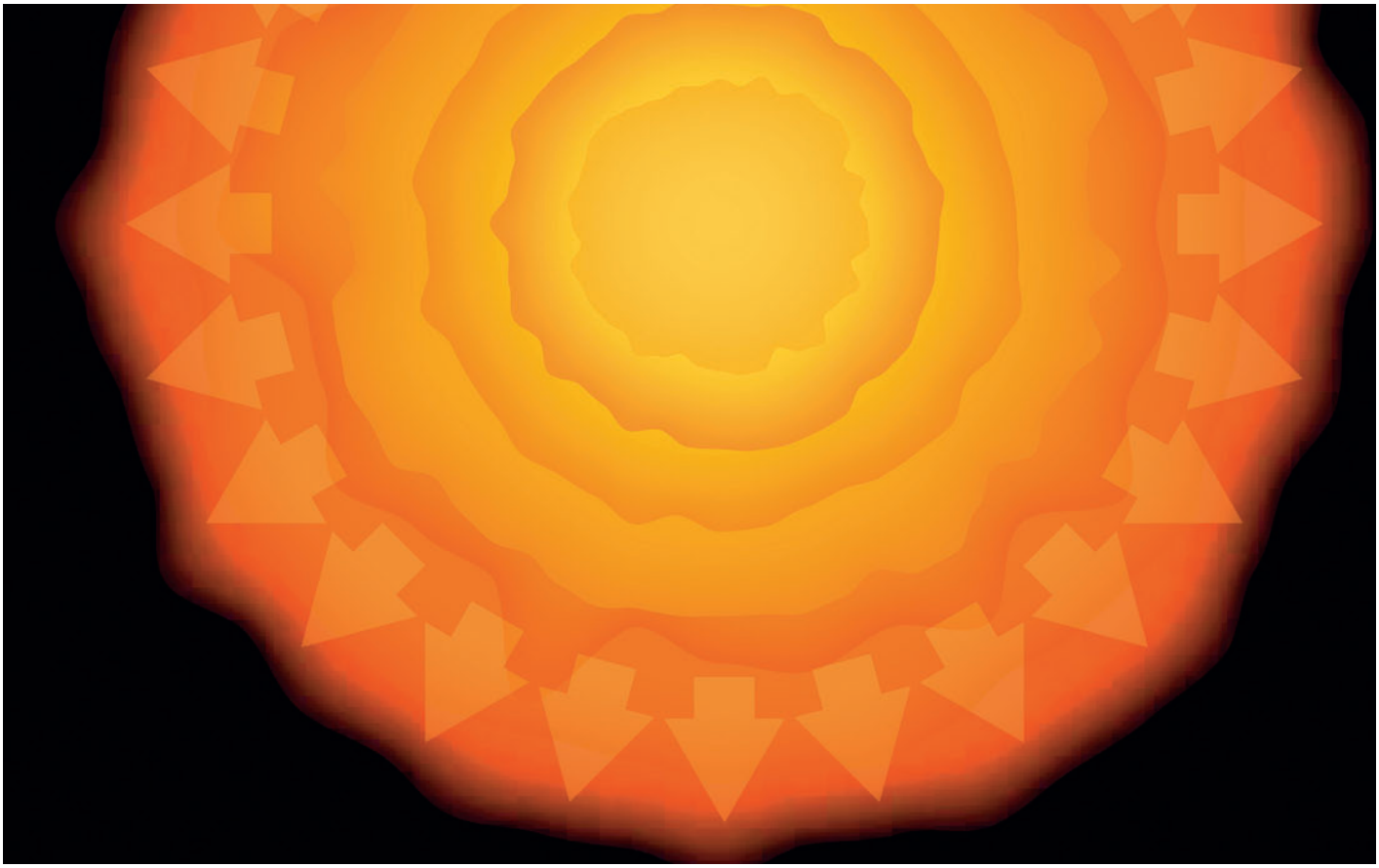
The Big Bang refers to the start of the rapid expansion of our Universe. Edwin Hubble discovered this expansion in the 1920s through observations of faraway galaxies, showing that the distances between them are growing as time passes. This stunning discovery is beautifully explained by general relativity — Einstein's theory of gravity — augmented by two new concepts, dark matter and dark energy.

If the Universe is expanding today, it must have been smaller in the past; and the matter and energy it contains must have been denser and hotter. General relativity specifies exactly how this happened, and in doing so makes some dramatic predictions. In particular, the Universe should be filled with a bath of leftover heat from the initial cosmic fireball. This remnant of the Big Bang was first observed in the 1960s and is known as the cosmic microwave radiation.

Just minutes after the Big Bang, the early Universe was hot enough to synthesise the lighter elements of the periodic table, such as hydrogen and helium, from the raw material of the cosmos, in observationally measured amounts that precisely agree with the predictions of cosmology. And tiny irregularities in the initial distribution of the hot, dense matter grew into the stars and galaxies we observe today.

These observations, and many others, make the Big Bang a remarkable and unshakeable fact of modern science.

Figure 1. *Artistic Impression of the Big Bang. Credit: Symmetry Magazine/Sandbox Studio.*



Visualising Astronomy: Visualising Exoplanet Data

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Keywords
Visual Communication, Astronomy Visualisation

Without a doubt, exoplanets represent one of the most engaging and compelling astronomical discoveries of the last two decades. How do we help our public visualise these intriguing objects — these intriguing *locations*? Earlier in this space[1], I have ruminated on the changing nature of visual evidence related to exoplanets, but this time around, I would like to consider how visualisation can help fire people's imaginations, from the perspective of both data and data-driven visuals.

First off, we have the data. The images of Fomalhaut and HR 8799 represent the most straightforward visual depiction of exoplanet data, namely light collected from a telescope. Recent images of the latter system reveal a fourth exoplanet, and the new images have improved sharpness and clarity (Figure 1)[2]. But we have a fundamental issue here: the direct images will never resolve exoplanets in a way that our Hubble-influenced aesthetic will find compelling. Telescope images of exoplanets will remain dots of light, not much more.

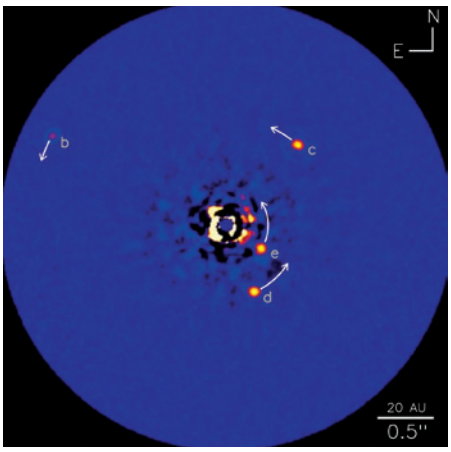

Figure 1. Infrared adaptive optics image of the HR8799 planetary system, with four observed planets and arrows showing their predicted motion over the next ten years. Credit: NRC-HIA/C. Marois/W.M. Keck Observatory.

Of course, Carl Sagan waxed eloquent about life on a particular "pale blue dot", namely Earth as seen by Voyager 1 from a vantage point 6.1 billion kilometres distant, revealing our home planet as a mere pixel in the image: "*On it everyone you love, everyone you know, everyone you ever heard of, every human being who ever was, lived out their lives.*"[3] That perspective, so at odds with our daily experience, dramatically recontextualises Earth[4]. But what of other worlds? No image we ever retrieve of an exoplanet will resolve it as anything more substantial than a lone pixel. How can we help people imagine these abstract data as actual places?

One step in this direction takes more esoteric data than the direct images and shows the Kepler mission's 1235 stars with planetary candidates. In Jason Rowe's depiction of the data (Figure 2), candidate transiting companions are shown silhouetted in front of their host stars, with all the objects properly scaled and the correct colours for each star[5]. Moreover, Rowe displays each planet at its appropriate latitude on the star, deduced from the specifics of the light curve. (Added bonus: Rowe also shows limb darkening, which influences the shape of the light curve and allows the impact parameter to be estimated, giving what I referred to as the "latitude" above.) And an image of the Sun, with Earth and Jupiter seen in shadow, provides context. Pretty spiffy. This single image allows the viewer to contemplate the sheer number and variety of systems (potentially) out there, and I admire it for its simplicity, self-consistency and accessibility.

Jer Thorpe's animated visualisation of the same data also received a lot of buzz back in February[6]. It layers a different collection of data, depicting the planetary candidates as a swarm of coloured spots orbiting an imaginary single parent star (not shown), which then splay out into a Cartesian plot, first of planet size versus distance, then temperature versus distance. The size of each spot corresponds to the planet size, and the colour to its temperature: note that "*the colour scale is calibrated so that Earth is a pale blue dot*"[7].

I have some real issues with Thorpe's choices. First off, animation of the data adds nothing except deceptive visual interest. Why deceptive? Because the absolute distance between a planet and its parent star only tells part of the story of the planet's habitability, since the stars in the Kepler dataset (as beautifully and simply illustrated in Rowe's visualisation) vary widely in size, temperature, and brightness. Thus, the little spots swirling around an imaginary central star have no intrinsically interesting meaning. Then, Thorpe's graphing exercise simply shows in a Cartesian context what the size and colour of the data already represent! Totally redundant. Rowe's more staid still image dramatically outshines the gloss of Thorpe's video exercise.

Of course, with online tools, people now have an opportunity to interact with the data, and a number of sites and at least one iPhone app offer a variety of user experiences. I'll touch on a few of my favourites.

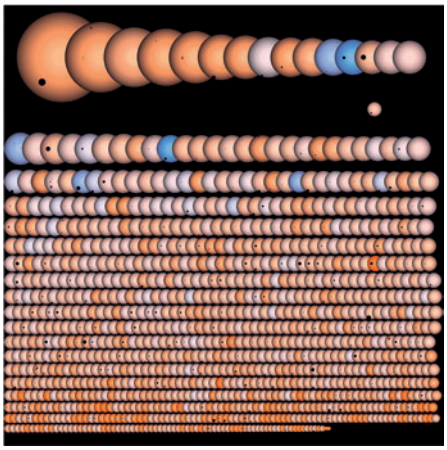

Figure 2. Jason Rowe's jam-packed illustration of the 1235 Kepler planetary candidates with their host stars, featuring accurate sizes of all objects, appropriate star colours with limb darkening, and even impact parameters for each exoplanet candidate! Credit: J. Rowe.

For some time, Exoplanets.org has offered the Exoplanets Plotter as part of their Data Explorer[8]. A slick interface allows the user to select from preset views of the data or to customise a plot in a number of ways; and the views can be saved or the graphs exported to a variety of formats. I'd call it a paraprofessional experience: a complete novice would probably have difficulties with the interface, but its intuitive design will feel comfortable to slightly savvier users.

NASA's PlanetQuest hosts the New Worlds Atlas[9], a more accessible, but less powerful data interface that gives a top-level view of planetary systems and their characteristics, so that the user can select, for example, stars visible to the unaided eye or stars with multiple planets, and so on. The site also sports a Shockwave viewer that allows the user to see the three-dimensional distribution of exoplanetary systems around the Sun; but unfortunately, the locations lack context or scale, and even worse, the data seem not to have been updated in quite some time (only 247 planets showed up when I tried it recently).

On the smartphone front, Hanno Rein has created an iPhone app[10] that offers a truly impressive user experience; in fact, he has replicated much of the functionality of the sites I described above. The app's graphing capabilities don't match the Exoplanets Plotter, but the user can create basic "correlation diagrams" that give illuminating perspectives on the data. A Milky Way tab reveals the three-dimensional distribution of exoplanetary systems through (a somewhat awkwardly-rendered model of) the Milky Way. And each exoplanet gets its own page (Figure 3), showing the discovery method, the size of the planet relative to planets in the Solar System, the location of the parent star in the night sky, and a representation of the planet's orbit relative to orbits in the Solar System — along with a table of relevant data and links to scientific publications!

Rein has also introduced a Kepler candidate app[11] that offers an (effectively) identical interaction for each object. It'd be neat if the app incorporated the actual light curves (true for the transiting planets in the general app as well), and maybe tackled a visual for the star and planet more along the lines of Rowe's approach, but I find the lack of such data-driven details easy to forgive.

Interacting with the data can, for more expert audiences, provide a much deeper connection to the research. In the informal education world, we need to consider how to expose our audiences to astronomy's rich and swiftly growing collection of data. But we also need more immediate and accessible visuals for people to comprehend the scope, the breadth and the impact of these spectacular exoplanet observations. In my next column, I want to consider a different approach to the same topic... How can space art and data-driven visual representations help people envision these alien worlds?

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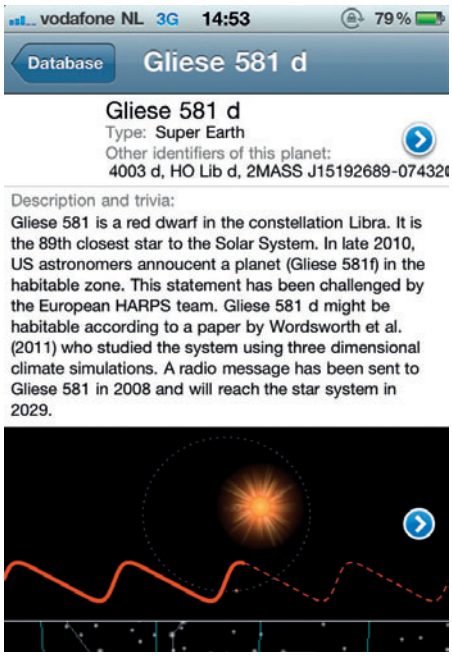

Figure 3. A snapshot of the Gliese 581d page in Hanno Rein's exquisite iPhone exoplanet app. Credit: H. Rein.

Biography

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

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Evaluating the Impact of the International Year of Astronomy 2009 in Portugal

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Keywords
International Year of Astronomy 2009, Evaluation, Science, Society

Introduction

The celebration of International Year of Astronomy 2009 (IYA2009) in Portugal offered many people their first opportunity to learn about astronomy in a relaxed and informal environment. Measuring the impact of informal learning is a difficult but worthwhile endeavour, so that the organising committees of science communication projects can learn from past successes and failures.

To assess the impact that IYA2009 activities have had on the public's knowledge of astronomy in Portugal, the country's IYA2009 executive secretariat designed and implemented the methodology that is presented in this article.

Designing the evaluation method

Operationalisation[1]

From the goals outlined by the International Secretariat of IYA2009, the following were selected as being the most relevant for Portugal:

- to promote a scientific culture;
- to promote access to knowledge;
- to support and develop both formal and informal science education;
- to transmit a modern image of science;
- to support and develop collaborative projects.

Each of these goals constitutes a latent variable that cannot be observed or measured directly. However, they can be defined from a range of other measurable variables (Hill & Hill, 2009). Thus it was necessary to operationalise each of the variables corresponding to each goal. In other words, it was necessary to formulate a set of items (factors) that could be measured and make them an integral part of the concept of each goal — our latent variable (Majchrzak, 1984).

Based on the experience of the executive secretaries of IYA2009 and directives sent by the IYA2009 International Secretariat, scales to measure each latent variable were defined. These were measured on a five-point Likert scale (Likert, Roslow & Murphy, 1993) — a type of questionnaire where the respondents specify their level of agreement to supplied statements. For example, the variable corresponding to the first goal of promoting scientific culture was measured by grading the four points listed in Table 1 between 1 and 5, where 1 is "strongly disagree" and 5 is "strongly agree". Four items, each of which is a measurable variable, were used to measure the success of the goal to promote a scientific culture.

Data and sources

The Portuguese laypeople involved in this study (all of whom had participated in IYA2009 events) were selected at random in order to obtain a cross-sectional analysis[2]. With the available resources, the sample size was as large as possible.

Data was collected using an online questionnaire. The format of an online questionnaire was chosen because it enables data to be collected from various geographical areas with ease, and it can also be completed at the respondent's convenience (Saunders, Thornhill & Lewis, 2009).

Methodology

Statistical techniques were selected to fit the aim of this study and the nature of the data. Factor analysis was used to reduce the data and to increase the consistency of the measures. This technique makes it possible to identify the sets of variables that are not directly observable, reducing and combining a wide range of variables in some components (called factors), and identifying possible associations between variables. It is possible, for example, that variations in three or four observed variables mainly reflect the variations in a single

unobserved variable, or in a reduced number of unobserved variables. In this manner, factor analysis initially enables the separate dimensions of the underlying data structure to be identified and then determines the degree to which each variable is explained by each dimension (Hair et al., 2005).

The factor analysis method can only be used when there is a correlation between the variables, so the statistical tool Kaiser-Meyer-Olkin (KMO) was used to establish that such a correlation existed before proceeding with the factor analysis. To justify continuing with factor analysis with principal components, the KMO value should be greater than 0.5 (Hair et al., 2005).

After the factor analysis, and the reduction of the number of variables through the factors, new indexes were created based on the arithmetic averages of the original items.

But first, we needed to estimate how well the new indexes reflected the original items, so we needed to evaluate the internal consistency of the factor analysis using the parameter Cronbach's alpha (α) — a statistic calculated from the pair-wise correlation between items and usually used to measure the internal consistency. If this evaluation gave a satisfactory result, the created indexes could be treated as quantitative variables and used to provide information about the initial items. The Statistical Package for Social Sciences (SPSS) version 17.0 software was used for the statistical treatment. For a detailed description of this methodology, please refer to Pestana & Gageiro (2008).

Data handling and debugging

In this section, in Table 2 we present the results of the factor analysis and the assessment of the internal consistency of the variables. These results were obtained by the method described in the previous section.

The variable Promotion of Scientific Culture was measured by a set of opinion questions using a Likert scale of five points. The principal components factor analysis revealed a correlation between the variables, with a satisfactory KMO value (0.769), so the factor analysis was continued. The four original items (see Table 1) constitute

ITEM	Promotion of Scientific Culture
PSC_a	The event(s) that I performed/participated in during the IYA2009 was (were) an inspiration for other scientific activities.
PSC_b	The event(s) that I performed/participated in during the IYA2009 motivated me to discuss other scientific themes.
PSC_c	The event(s) that I performed/participated in during the IYA2009 led me to want to learn more about astronomy.
PSC_d	The event(s) that I performed/participated in during the IYA2009 enhanced my ability to understand astronomy.

Table 1. Operationalisation of the variable "Promotion of Scientific Culture".

Variables	Dimension	Items	KMO	% Explained Variance	α
Promotion of Scientific Culture	1	4	0.769	63.544	0.808
Promotion of Access to New Knowledge	1	3	0.447	—	0.586
Support and Development of Formal and Non-formal Science Education	1	2	0.500	—	0.503
Transmission of a Modern Image of Science	1	4	0.753	60.197	0.764
Support and Develop Collaborative Projects	1	3	0.656	66.552	0.748

Table 2. Factor analysis and internal consistency of the variables.

Variables	N	Mean	Standard Deviation	Median	Mode
Promotion of Scientific Culture	453	4.299	0.571	4.250	4.000
Transmission of a Modern Image of Science	507	3.678	0.634	3.750	4.000
Support and Develop Collaborative Projects	400	3.839	0.724	4.000	4.000

Table 3. Mean and standard deviation of the variables.

Goals	Results
Promotion of Scientific Culture	Achieved with success
Promotion of Access to New Knowledge	Not possible to assess
Support and Development of Formal and Non-Formal Education of Science	Not possible to assess
Transmission of a Modern Image of Science	Achieved
Support and Develop Collaborative Projects	Achieved

Table 4. Results of the goal analysis.

a single construct explaining 63.544% of the variance for the variable Promotion of Scientific Culture. The Cronbach's alpha of 0.808 indicated that the internal consistency of the variables was good.

The analysis of the variables Promotion of Access to New Knowledge and Support and Development of Formal and Non-formal Science Education showed unacceptable KMO levels and the factor analysis was not carried out. The same was true for the values of the internal consistency, so it was not possible to draw conclusions based on this scale.

For the remaining variables, Transmission of a Modern Image of Science and Support and Develop Collaborative Projects, reasonable values of KMO were obtained (0.753 and 0.656), enabling further factor analysis. The Cronbach's alpha values of 0.764 and 0.748 indicated that the internal consistency of the variables is reasonable.

Analysis of results

The values of the latent variable for each case were obtained by applying factor analysis, and creating indexes, as previously described.

Conclusions about the achievements of IYA2009 in Portugal can be drawn from the analysis of the descriptive statistics of the obtained indexes, which are presented in Table 3.

The results of the study show that, within the observed sample, the objectives of IYA2009 were achieved. Furthermore, the objective Promotion of Scientific Culture was achieved with great success. Table 4 summarises the results.

Figure 1. Observing night in Portugal during the International Year of Astronomy 2009. Credit: IYA2009/Portugal.

Conclusions

This study aimed to analyse the impact of IYA2009 based on the set goals of IYA2009. In order to assess this, scales to measure each goal were created. Data were then collected through an online questionnaire and analysed using statistical techniques, principally factor analysis. Given the difficulty in finding scales that have already been constructed and tested in this area, it was not possible to measure all of the goals. There is a clear lack of studies in this area and it was difficult to create and define a set of items to measure the variable Promotion of Scientific Culture (see Table 1).

This study concludes that the goals that could be studied were met, namely the Promotion of Scientific Culture, Transmission of a Modern Image of Science and Support and Develop Collaborative Projects. These results have implications for the strategies that are adopted by the organising committees of other international science communication projects.

For this study, three scales were created to evaluate science communication activities. Those scales could be applied to evaluate other science communication activities in the future.

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Annex A – Operationalisation of the Variables

ITEM	Promotion of Access to New Knowledge
PANK_a	The event(s) that I performed / participated in the IYA2009 helped me to gain knowledge about recent developments in astronomy and space sciences.
PANK_b	How do I evaluate my knowledge of astronomy before the event(s).
PANK_c	How do I evaluate my knowledge of astronomy after the event(s).

Table 5. *Operationalisation of the variable Promotion of Access to New Knowledge.*

ITEM	Support and Development of Formal and Non-Formal Science Education
SDFNSE_a	I want to participate in more astronomy events.
SDFNSE_b	How would you rate the activities carried out throughout 2009 in relation to your expectations?

Table 6. *Operationalisation of the variable Support and Development of Formal and Non-formal Science Education.*

ITEM	Transmission of a Modern Image of Science
TMIS_a	My view of astronomy has changed.
TMIS _b	I learnt about new technologies and scientific advances that were developed through astronomy.
TMIS _c	I found practical applications for the development of astronomy and space sciences that have been introduced into my day-to-day life.
TMIS _d	I learned more about the astronomy that is done in Portugal and/or by Portuguese researchers.

Table 7. *Operationalisation of the variable Transmission of a Modern Image of Science.*

ITEM	Support and Development of Collaborative Projects
ADPC_a	The event(s) I performed / participated in collaborated with other entities.
ADPC_b	The event(s) I performed / participated in eased access to knowledge networks (for example: science centres, research centres, universities, etc.).
ADPC_c	I gained experience in organising and facilitating events.

Table 8. *Operationalisation of the variable Support and Development of Collaborative Projects.*

Notes

[1] Operationalisation is the process of defining a fuzzy concept so as to make the concept clearly distinguishable (in the humanities) or measurable (in the physical sciences) and to understand it in terms of empirical observations. (after Wikipedia, http://en.wikipedia.org/wiki/Operationalization)

[2] Cross-sectional analysis is a type of observational study that involves the observation of an entire population, or a representative subset, at a defined time, and is often used to describe some feature of the population (after Wikipedia, http://en.wikipedia.org/wiki/Cross-sectional_analysis)

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