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Communication with the General Public

Conveners: R. Michael Barnett, K. Cranmer

50.1 Introduction

Modern physics like ancient physics is driven by a collective curiosity about the nature of our universe and of the world around us. By engaging the broader community in our research, we share this curiosity beyond the bounds of active physicists. The word "engage" is central; we need to do more than inform the public; we need to engage them. It is critical that the public recognize the value of science to society enabling informed decisions.

The general public audience is also contextual glue between the other audiences. Many of the concepts developed for the general public apply to other audiences. Successful communications to the general public will reinforce communications to other audiences. To the extent we are successful at our general public goals, they will share their knowledge and enthusiasm with students, teachers, policymakers, news media, and others.

Successful engagement with the public must be tailored to the audience. We have identified representative audiences meant to cover the range of situations where different engagement strategies and tactics are appropriate. Our messages have been categorized as follows: scientific goals, direct applications, and spinoffs and technology transfer. Each of the three message categories has a role to play spanning the range of human curiosity to economic impact.

The experiences of the 697 physicists responding to the outreach survey indicated that the public is most interested in the potential applications of discoveries, followed by our scientific goals. Similarly, the public apparently feels that the potential application of discoveries and the spin-off applications best justify the cost of particle physics research. While the field is very comfortable communicating the overarching scientific goals of particle physics, we are less comfortable in communicating the messages that are considered most interesting and which best justify the cost of particle physics research.

Within our community, many individuals and groups bring their enthusiasm for particle physics and its fundamental concepts to a wide range of audiences including the general public. They are aided by resources created and made available by their colleagues and communication professionals. These resources also have impact with other audiences including policy makers, other scientists, teachers, and students.

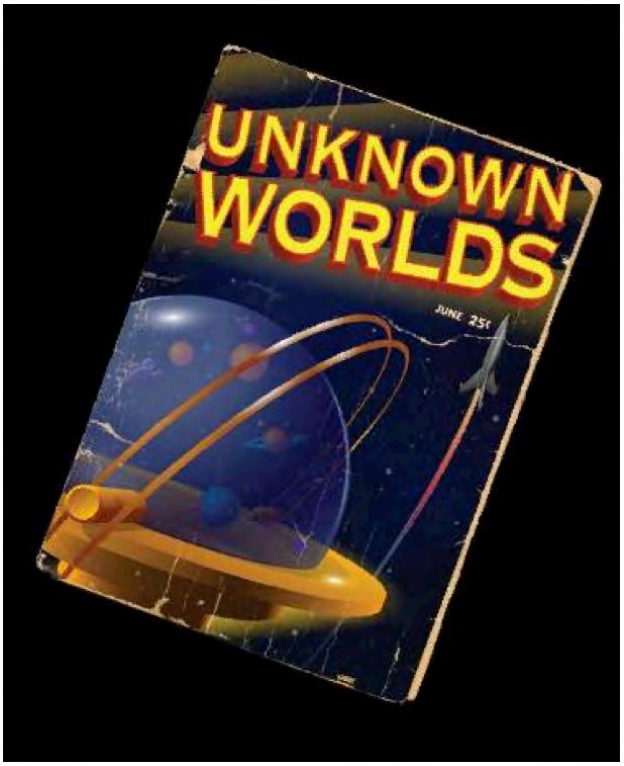


Figure 50-1. *Unknown Worlds*

50.2 Existing communication and outreach activities

The existing activities are extremely broad but with varying levels of support. The single most common activity (perhaps because it requires limited financial support) is public talks. These occur in schools, clubs, university and lab events, scientific cafes, speaker bureaus, and science theater-type events.

Another common activity is participation in open houses and related events such as science festivals, lab and department tours, physics day shows, alumni weekends, and workshops for the public. These require further effort but for limited periods.

Other activities may take more time and require more resources, but also can have much more impact. These include contributions to external publications and shows. Examples include writing magazine articles and op-ed pieces in newspapers, participating as consultants to radio and television programs and even movies, and working with the news media. Individuals and institutions have collaborated with museums on exhibitions. In some cases these have included opportunities for the public to try simulated analysis of data. CERN has created an interactive tunnel and other exhibition displays.

An important aspect to existing activities has been the production of materials of various sorts such as printed products, web-based materials, and multimedia products. The printed materials include books, brochures, and posters. Websites can deliver news, background information, activities, images and video. The social media (blogs, Facebook, Twitter, YouTube) are an important aspect of a web presence. Labs, experiments, and others have developed many videos, photo and image collections, smartphone apps, murals,

and even a 9660-piece LEGO model. All these become valuable and heavily used resources for physicists in their individual efforts.

The current and past activities carried out by particle physicists are quite extensive. The section at the end provides an overview of the current US particle physics communication and outreach landscape as it pertains to the General Public. Many categories of activities are listed with some examples shown.

50.3 Opportunities and challenges in general public outreach

Communicating with the general public not only has great opportunities, but also some challenges. Much as we might wish to engage everyone in the general public, our reach is more generally limited to the 20-30% of the public who are generally interested in science. Among this population, they come to us with very mixed backgrounds ranging from limited science literacy (generally with knowledge similar to that of a 14-15 year-old) to others who have read significantly about science and have a real foundation. Many come with broad misconceptions about the facts of physics, the nature of our research, and even the basic principles of science. Others come with some strong skepticism that challenges our communication skills.

We usually have access to our audiences for very limited times, not the semester of lectures we have in universities. There are therefore strong limits to how much physics we can teach. We can be good at communicating the excitement and the impact of our research. We need to communicate the collaborative nature of modern research and the broad groups that come together to do experiments. The experiments frequently have collaborators from tens of countries who work together intensively and harmoniously with common goals. Some people are fascinated by the bottom-up nature of a 3000-person experiment, the opposite structure of corporations such as Bechtel (which also builds massive projects).

We need to portray the scientists who do these experiments as real and ordinary caring people. Communicating the impact of our research beyond particle physics is also essential. The technology transfer of modern physics has transformed the world and impacted everyone alive.

We have great stories to tell and should celebrate our successes and accomplishments. The discovery of the Higgs is a great story of three almost miraculous accomplishments, and U.S. physicists played vital roles in all three. The first was the development of the theory of the Higgs mechanism almost 50 years before its discovery; it is an inspirational example of the power of science to analyze complex problems. The second was the development of a 17-mile-long accelerator using revolutionary technologies; this accelerator then achieved a fantastic rate of collisions that was essential to make possible this discovery. And finally the enormous detectors achieved incredible levels of precision almost from the beginning, so that they could extract this discovery from the complex phenomena. The computing power required was also quite remarkable. In all aspects, U.S. physicists joined forces with physicists from dozens of countries in a wonderful example of global cooperation in peaceful ventures.

There are real challenges to an effective program of communication and outreach. These cannot be met without meaningful funding support. The European Strategy Report emphasized: "Outreach and communication in particle physics should receive adequate funding and be recognized as a central component of the scientific activity."

50.4 Strategies to achieve our overarching goals in communication, education, and outreach

The following strategies have been proposed in order to achieve our overarching goals in communication, education, and outreach:

1. Engage the public in a wide range of outreach activities.
2. Make the public aware of direct and indirect applications of research, both historical and potential.
3. Communicate the role and stories of U.S. physicists in particle physics, particularly in major discoveries and in the context of our international collaborations.

50.5 Definitions of Message categories

- Scientific Goals: The quest for knowledge and understanding of the universe, including both the theoretical mysteries and the experimental challenges.
- Applications: What applications might these discoveries have? Historical examples of unexpected applications of fundamental physics discoveries (e.g. quantum mechanics leading to the transistor and laser and special relativity leading to nuclear power.)
- Spinoffs & Technology Transfer: Broader impacts of investing in science: (eg. The web, grid/cloud based computing, accelerators, and workforce)

50.6 Implementation notes for various audiences within the General Public

The message and format we use to engage the general public depends on the individual and context of the interaction. Below we establish representative audiences meant to cover the range of situations where different engagement strategies and implementations are appropriate

50.6.1 Popular Science Enthusiasts

Popular science enthusiasts are generally already convinced that science is exciting and valuable. They thirst for more information about the science and potential applications and the interaction with those actually doing the science. Extending our current activities is the core of this effort. Additional efforts in developing plausible examples of future direct applications are in order.

50.6.2 Everyday people

Everyday people are engaged in through the natural social interaction ranging from a dinner party to an airplane flight. Being prepared with a few "bulleted" points is very useful, as are having some brochures and similar items to hand out. The personal narrative and the broader scientific enterprise are effective approaches for engagement for this audience.

50.6.3 Parents

Parents may or may not be comfortable with or appreciative of science themselves, but they are often supporting their childs interest in science and/or evaluating a scientific career path.

- A parent who is comfortable with science may wish to be more informed or have a point clarified so that they can directly educate their children.
- A parent who is less comfortable with science may wish to be informed so that can better connect with their scientifically enthusiastic child (tactics: understanding the universe, famous / great scientists, fancy gadgets, etc.).
- A parent who is less comfortable with science may not want to be engaged directly, but may collect materials for their children.

50.6.4 Science Skeptics

Science skeptics are often misinformed or have misconceptions about the fundamental scientific process. While many may be steadfast in their opinions, some have never been exposed to the counter arguments.

50.6.5 Critics of public funding of science

Critics of public funding of science are often economically conservative and unaware of the economic impact basic research. This group often is indifferent to the lofty scientific goals and seeks specific examples of historical success and future prospects. They often start by asking about direct applications, though we can pivot the discussion to spinoffs. Historical examples can be powerful in making the point of direct applications; however, additional efforts in developing plausible examples of future direct applications are in order.

A geographic audience consists of the populations near our universities and labs to which we have special access and opportunities. We are especially able to reach the first three categories above.

Figure 50-2. *Science Museum of London "Collider" exhibit [1].*

50.7 Survey Results

A survey of physicists was conducted specifically for education and outreach component of the CSS. There were 697 respondents, 62% of whom self-identified as being engaged in communication, outreach, or educational activities. While we do not know what fraction of people in the field as a whole are actively involved in such activities, these respondents are considered to be disproportionately active in communication, outreach, or educational activities.

The survey revealed that physicists think that the public are most interested in the potential application of discoveries followed by our scientific goals. The respondents reported that general public is moderately interested in spin-off applications and least interested in a high-tech workforce, both of which belong to the third message category.

In terms of justification for the cost of particle physics research, the respondents indicated that the general public is most interested in potential direct applications of discoveries followed by spin-off applications.

The respondents are very comfortable communicating the overarching scientific goals of particle physics, though less comfortable in communicating the messages that are considered most interesting and which best justify the cost of particle physics research. Keeping in mind that the respondents are likely to be more involved in outreach than the field as a whole, this result informs which areas we as a field need to improve our communication.

The survey indicates that the respondents are involved in a broad range of communication, education, and outreach activities.

50.8 Summary

Within the particle physics community, there is substantial experience in outreach to the general public. Whether this outreach is effective is not so clear. We have often been asked: What does this mean to the average person? It is critical that our messages be crafted carefully, while fully understanding our audiences. The best efforts are those that engage the public and encourage them to come back for more. While it is considerably more effort to create outreach that is interactive, such efforts are more likely to keep out audiences involved. The broad range of programs that are ongoing are essential, because they reach different elements of our audience and reach them again and again. The social media (Facebook and blogs especially) are wonderful ways to interact directly with parts of the general public. One must consider the audience for any given activity and adjust the approach to match that audience. It is essential to communicate why particle physics matters and what its impact on our society is. To the extent possible, it is useful to develop speakers and others who can best communicate the science and the impact. We might consider enlisting people outside our field to help, from the arts, from other areas of science, from industry, as well as from government. The future of our field depends on our ability to explain our work.

Figure 50-3. *Science Festival in the Stadium of the San Francisco Giants baseball team*

Figure 50-4. *Café Scientifique in South Dakota [2]*

Figure 50-5. *Science in the Theater – Berkeley Repertory Theater[3].*

Figure 50-6. *TED talk by Don Lincoln (also on Fermilab's YouTube channel) [4].*

50.9 Appendix: Examples of Outreach Activities:

Museums and Activities:

- Collaboration with Science Museums
- Hands-on Activities including Event Analysis

Science Talks:

- Scientific Cafes
- Public lectures
- Speaker's bureaus
- Science Theater (and, science in the theater)
- TED talks

Organized Events:

- Science Festival participation
- Open Houses
- Monthly open nights
- Physics Day shows
- Physics "Slams"
- Alumni weekends
- Lab and University Dept. Tours
- Workshops for the public

Web-based activities:

- Websites (info, news, activities, films, images, etc.)
- YouTube sites
- Social Media (Facebook, Twitter, blogs, etc.)
- PhD Comics, *etc*
- Ask the Experts

Printed Products:

- Books
- Booklets and brochures
- Charts and posters

Multimedia

- Films
- Photo and image collections
- Smartphone and iPad apps
- Murals and other art & science projects
- TV & Radio show consultants
- LEGO Model

Contributions to other publications & shows

- Magazine articles
- Op-ed pieces in newspapers
- Radio & TV programs participation
- TV & Radio show consultants
- News media consultants
- Movie and film consultants

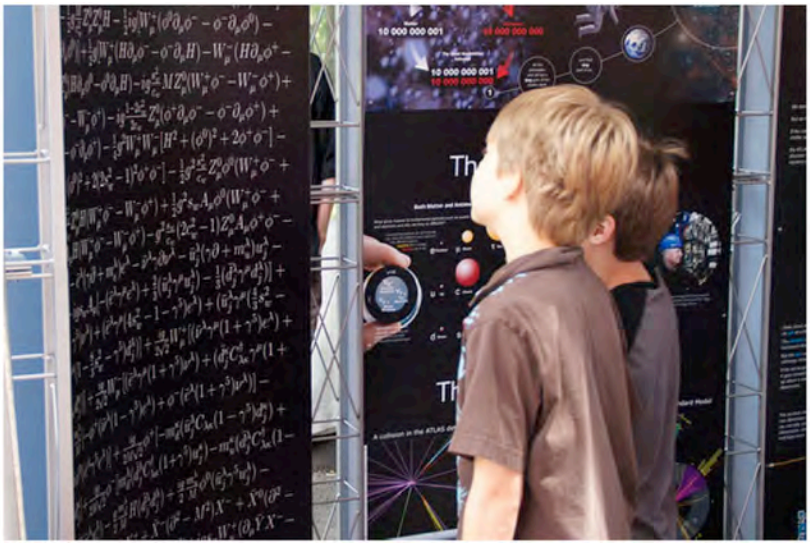


Figure 50-7. *World Science Festival [5]*

Figure 50-8. *USA Science & Engineering Festival in Washington, DC [6]*

Figure 50-9. *USA Science & Engineering Festival in Washington, DC with Fermilab's Mr. Freeze [6].*

Figure 50-10. *Open House at LBNL*

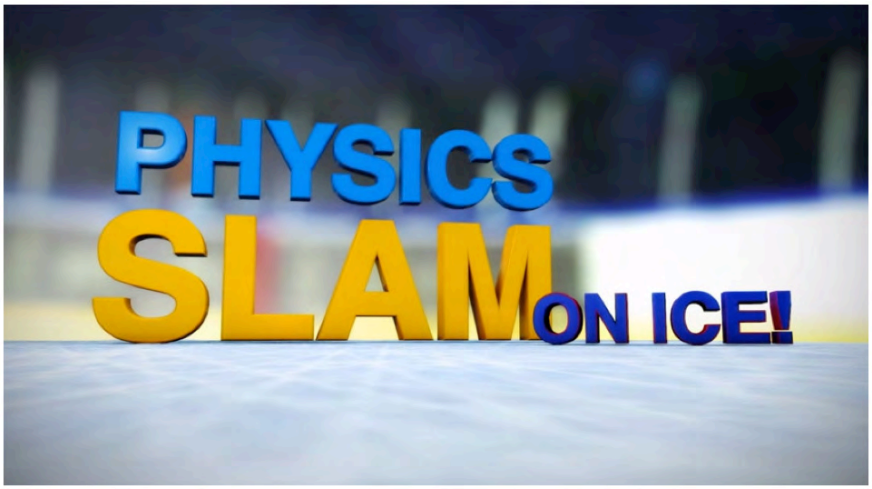


Figure 50-11. *"Physics Slam on Ice" at the University of Minnesota, August 2013 [7].*

Figure 50-12. *High school students touring ATLAS cavern*

Figure 50-13. *ATLAS and CMS experiments public websites[8, 9]*

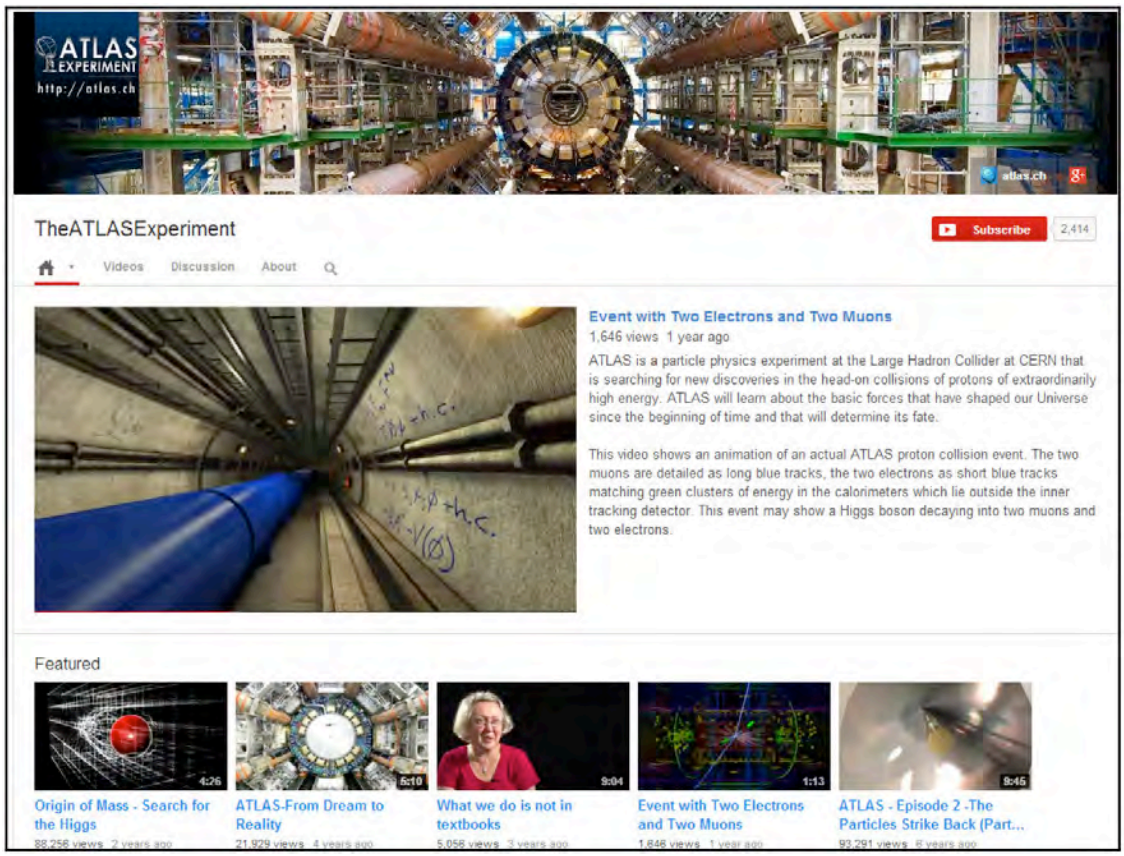


Figure 50-14. *YouTube site of the ATLAS experiment (with 43 videos)[10].*

Figure 50-15. *Facebook page of Pop-Up book about LHC and ATLAS [11].*

Figure 50-16. *Facebook page of CERN*

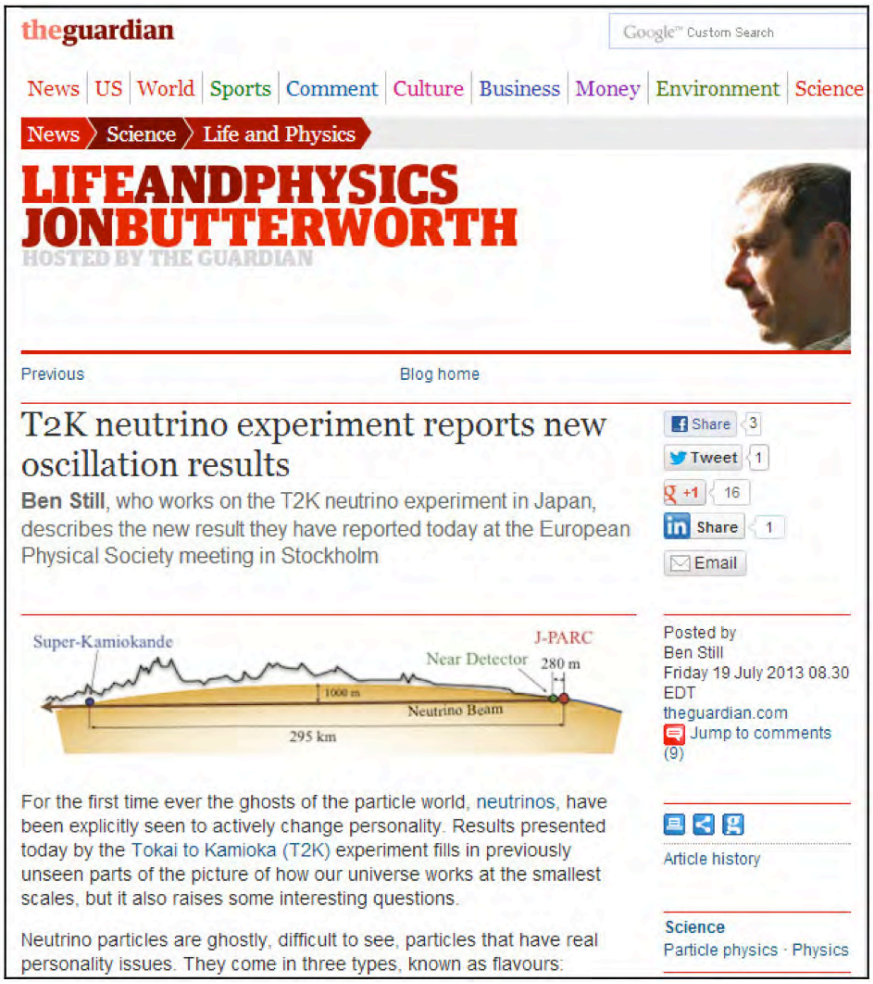


Figure 50-17. *Jon Butterworth blog in The Guardian [12].*

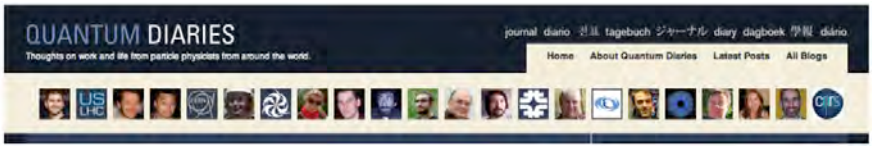


Figure 50-18. *Quantum Diaries series of blogs [13].*

Figure 50-19. *PhD comics on Higgs boson, by Jorge Cham [14].*

Figure 50-20. *Ask-a-Scientist: Monthly, Fermilab scientists answer questions over coffee and cookies.*

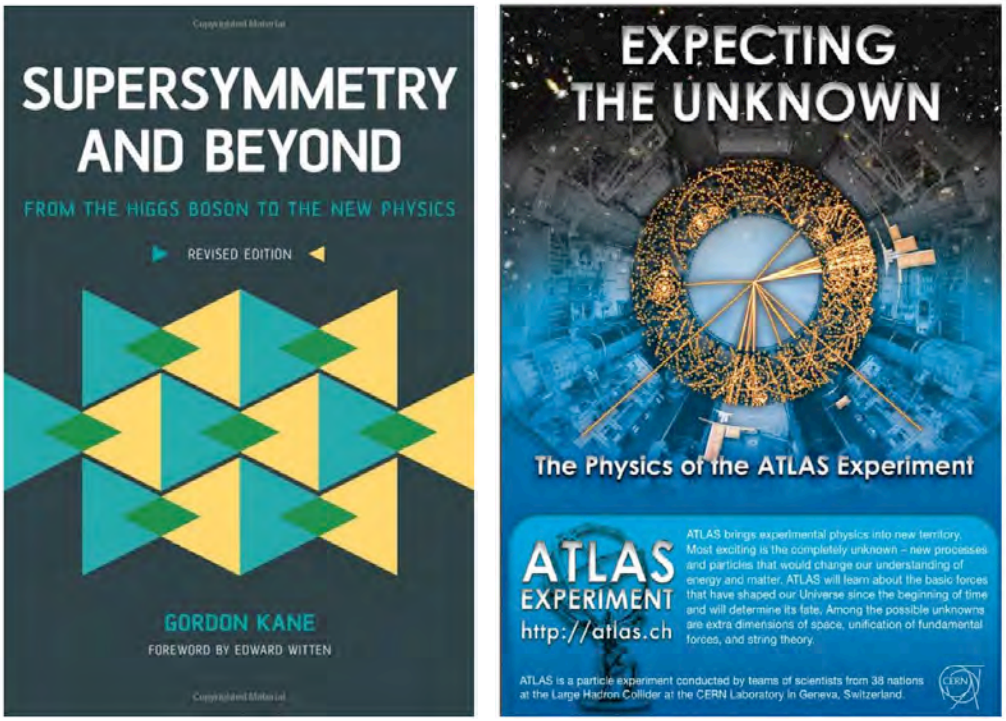
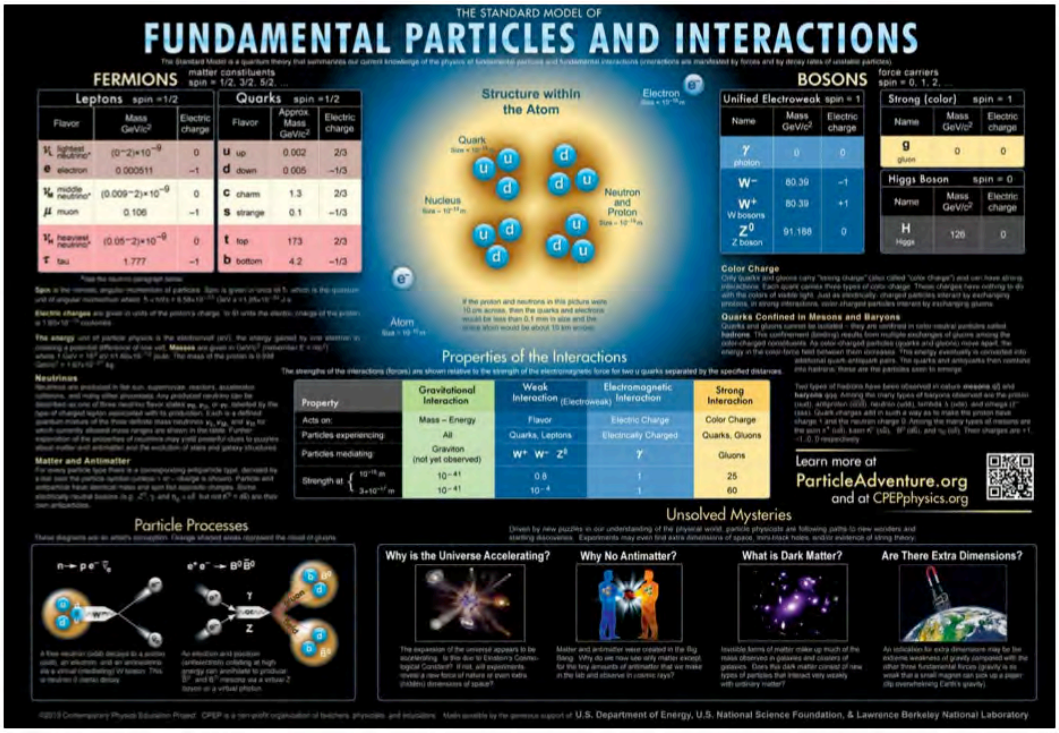


Figure 50-21. *(left) Book for the public by Gordon Kane [15]; (right) Physics brochure from ATLAS Experiment [16]*



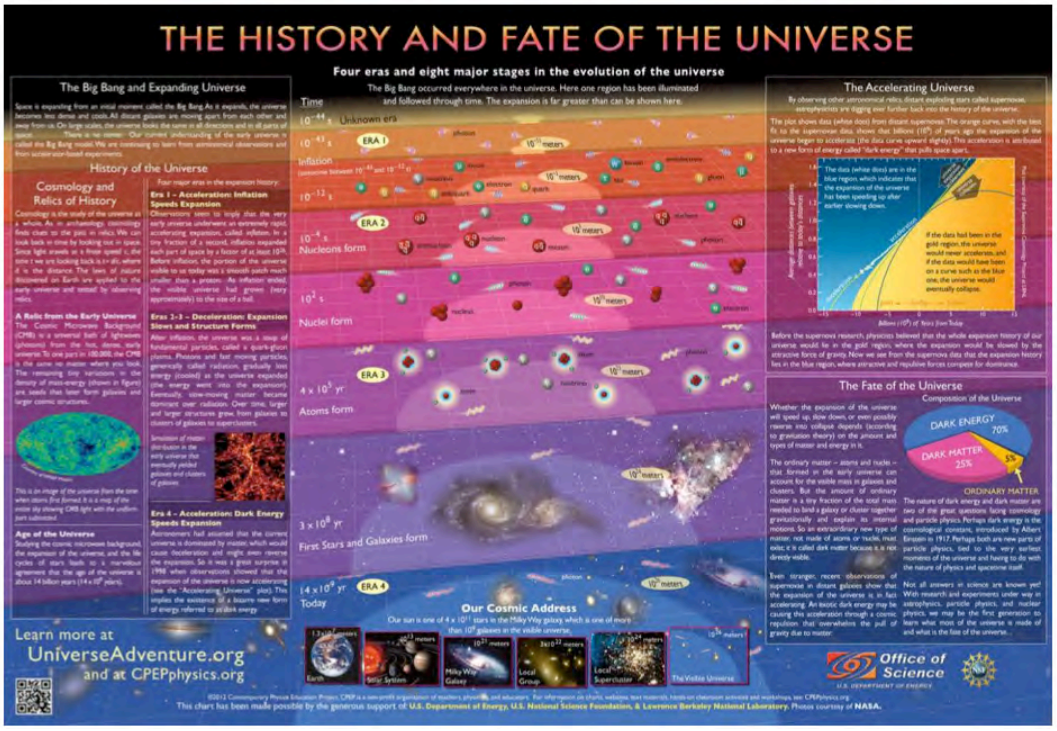


Figure 50-22. *Charts from the Contemporary Physics Education Project*

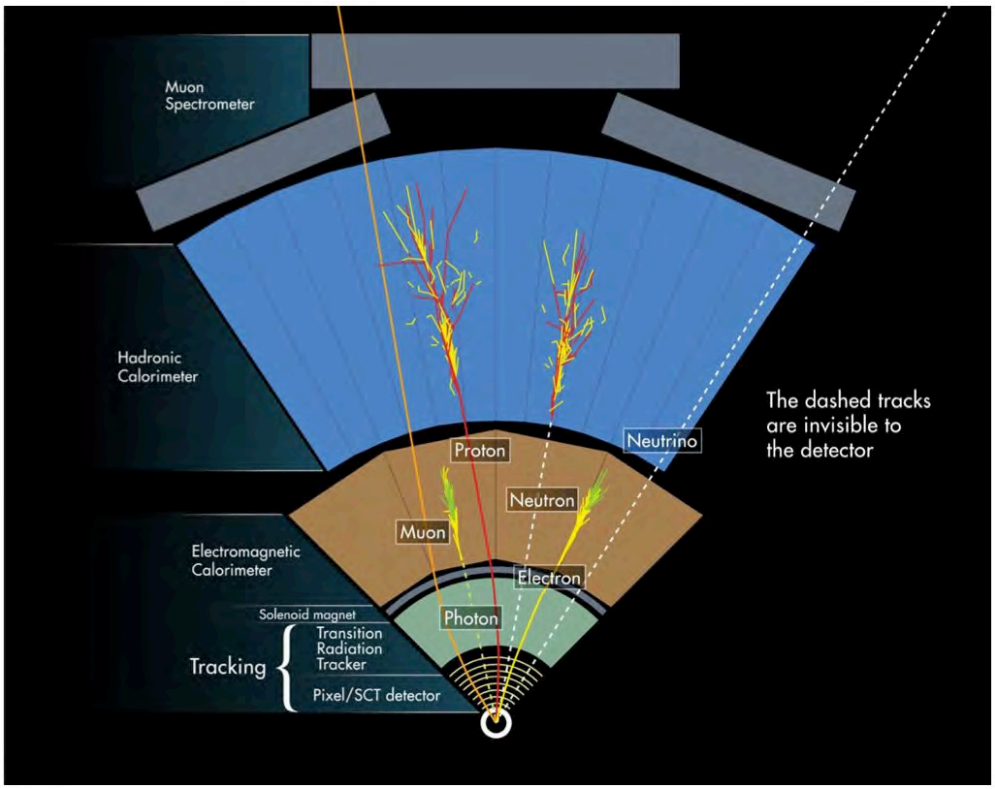


Figure 50-23. *Video showing how the ATLAS detector works*

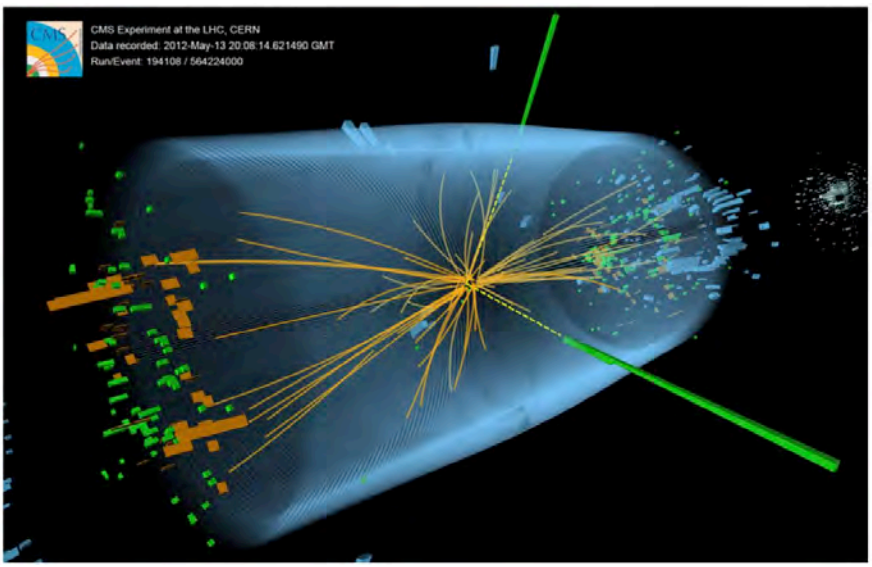


Figure 50-24. *Collision event seen by the CMS detector*

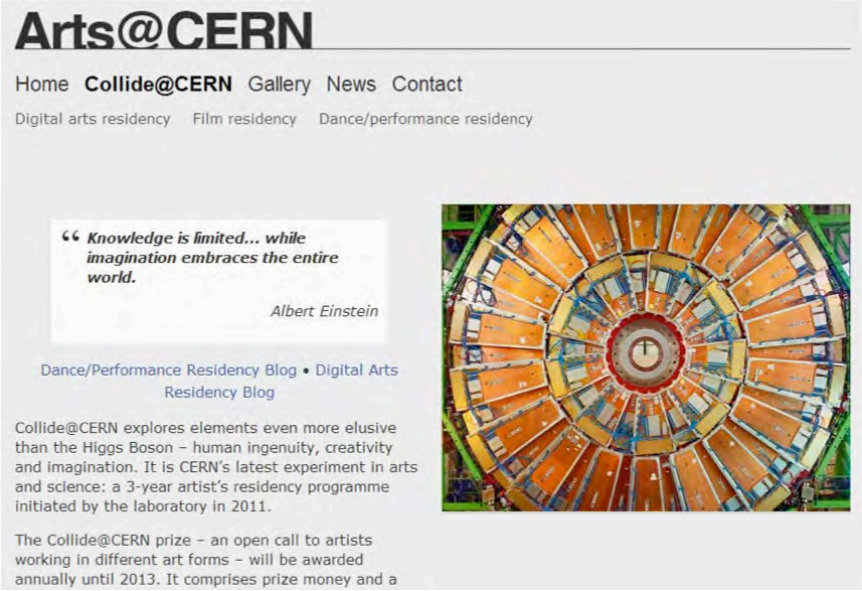


Figure 50-25. *CERN arts program: artists in residence [17].*

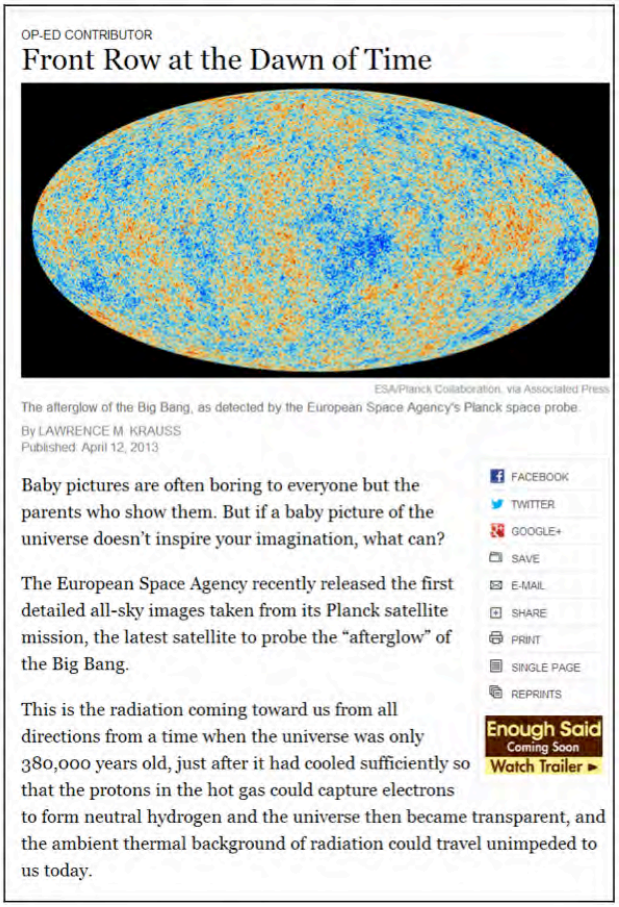
Figure 50-26. *Mural by artist Josef Kristolofetti*

Figure 50-27. *Opera setting and Muppets movie using classic photo of ATLAS as inspiration*

Figure 50-28. *Multimedia contest starting with classic ATLAS photo*

Figure 50-29. *Particles and Interactions chart by CPEP regularly used as background on Big Bang Theory TV show*

Figure 50-30. *LEGO model of ATLAS detector: 9600 pieces [18]*



OP-ED CONTRIBUTOR

Front Row at the Dawn of Time

ESA/Planck Collaboration, via Associated Press

The afterglow of the Big Bang, as detected by the European Space Agency's Planck space probe.

By LAWRENCE M. KRAUSS
Published: April 12, 2013

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REPRINTS

Enough Said
Coming Soon
Watch Trailer ►

Baby pictures are often boring to everyone but the parents who show them. But if a baby picture of the universe doesn't inspire your imagination, what can?

The European Space Agency recently released the first detailed all-sky images taken from its Planck satellite mission, the latest satellite to probe the "afterglow" of the Big Bang.

This is the radiation coming toward us from all directions from a time when the universe was only 380,000 years old, just after it had cooled sufficiently so that the protons in the hot gas could capture electrons to form neutral hydrogen and the universe then became transparent, and the ambient thermal background of radiation could travel unimpeded to us today.

Figure 50-31. *New York Times Op-Ed piece*

Figure 50-32. *The Colbert Report coverage of LHC and Higgs Boson*

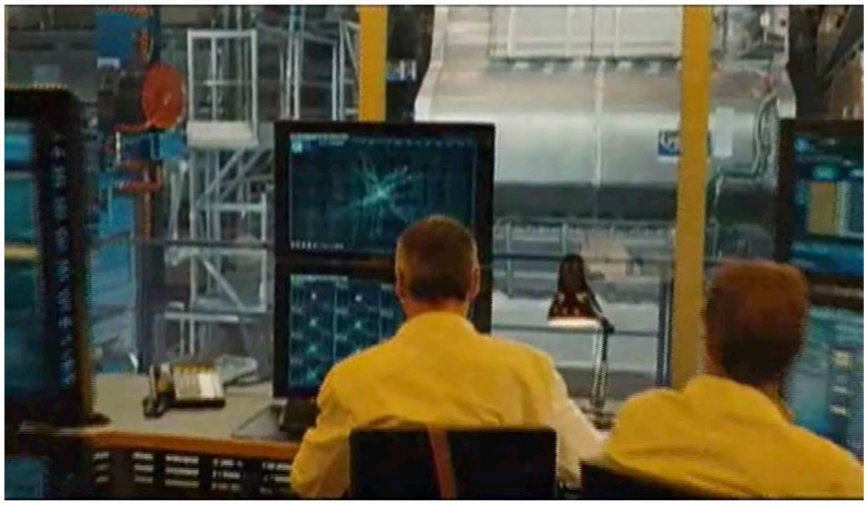

Figure 50-33. *Angels and Demons movie made with substantial physicist consultation*

Figure 50-34. *Particle Fever movie made with particle physicist input [19].*

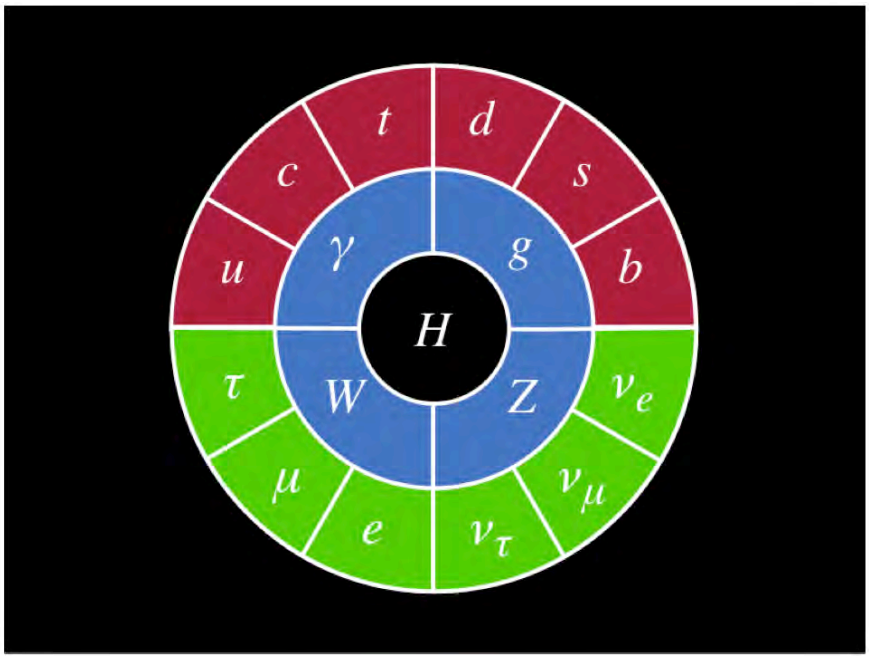

Figure 50-35. *Particle Fever movie includes this nice new graphic of the fundamental particles of the Standard Model (originally designed by Walter Murch). [19]*

References

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[2] Cafe Sceintifique http://www.cafescientifique.org

[3] "New Light on Dark Energy" http://www.youtube.com/watch?v=K171B6EvA6c

[4] Don Lincoln "The Higgs Field Explained" http://www.youtube.com/watch?v=joTKd5j3mzk

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