PROCEEDINGS OF SCIENCE

Outreach & Education Rapporteur Talk

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I collect here the presentations given in the first dedicated Outreach session at an International Cosmic Ray Conference. This serves as a reference for people and projects presented. I identify also the main themes addressed, trying to weave threads between talks and posters. The field is very lively with ideas that merit sharing.

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*Speaker

PoS(ICRC2023)037

1. Introduction

Outreach and Public Engagement are becoming more and more an integral part of the research work. Research funded with public money has an obligation to return outcomes to the public. But this is not the only goal: a project makes itself known and recognized at large, and engagement can create a sense of belonging or empowerment. Facilitate, share, train, connect, support, inspire, inform, educate, increase awareness, make accessible, give joy... These are just a few words that came to my mind while thinking about Outreach as a whole. Everyone can add their own verb, and try and fulfill it. In this edition, the ICRC hosts for the first time a session in presence dedicated to Outreach. This should be taken as a good practice and shared by other conference organizers. It helps in sharing what we do in our every-day life. We have a very powerful tool in hand that can work in many different directions and ultimately make the word a better place to live in.

The range of ideas and activities presented is vast. I have tried to identify threads both from talks and posters to better convey the whole body of material. This is my own choice, but anyone is free to pick and chose, or to rearrange them differently. I will start with the presentation by large organizations, following with activities linked to schools of different orders, and involving the public at large like citizen science. Open data and gaming, and an attempt at "sociology", are my way of collecting seemingly disparaged items. A special place, which will grow in the future, is given to virtual reality, while the artistic flair of the participant closes the collection. I discuss mainly the presentations that have been chosen to be delivered orally, but I will not forget about the many interesting posters, trying to show them next to the oral talk of the same institution, when possible.

A large and diverse congress is a precious opportunity to bring together different communities: scientists in different fields, as astronomer and physicist here, and communicators, young researchers just entered in the field, with their enthusiasm and innovating ideas, and seasoned ones, with experience and broader knowledge, just to say. It is then important to share the way we do things, so as not to spend too much time "reinventing the wheel", and also to find synergies, and, why not, companions in our adventures. I hope you can find at least a bit of inspiration, not from me, but from all the actors that have played a role in the Session.

2. Large projects

I collect here the presentation of four different organizations, linked either to various large projects in construction or to different institutes: the ‘Large High Altitude Air Shower Observatory’ (LHAASO), the ’Cherenkov Telescope Array Observatory’ (CTAO), the ’Outreach Cosmic Ray Activities’ (OCRA) of the Italian Istituto Nazionale di Fisica Nucleare (INFN), the group ’INAF for the Dissemination of Astri and CTA Observatory’ (INDACO) of the Italian Istituto Nazionale di Astrofisica (INAF).

2.1 LHAASO

We have the pleasure of having Wenli Zheng, from Institute of High Energy Physics of the Chinese Academy of Sciences, to present the Campus Cosmic-ray Observation Collaboration (CCOC), a non-profit collaboration unit composed of voluntary members from 25 different institutions.

The activities are mainly related to the large scientific infrastructure project ‘Large High Altitude Air Shower Observatory’ (LHAASO) and to the popular science journal ’Modern Physics’, and they are supported by the Institute of High Energy Physics of the Chinese Academy of Sciences [1]. The fact that LHAASO has been working hard and having so nice results recently, of course adds to the reach of this organization.

Figure 1: Left: Students on the roof using the instruments; Right: The portable detector constructed and used by students.

Therefore, they aim mainly to the observation of cosmic rays, which are plenty and easily observable, muons in particular, and the construction of instruments to detect them. They organize online presentations, that facilitate international collaborations; set up observing stations also open to students. Workshops, and training courses open to teachers are also organized. A particularly intriguing aspect is the availability of a journal for publication. The range of activities is vast.

You can find their presentation here: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-04/advanced

2.2 CTAO

Alba Fernandez-Barral is the Outreach Education and Communication Officer of the Cherenkov Telescope Array Observatory (CTAO) project. She presents the overall public engagement program, carried out internationally [2]. The Cherenkov Telescope Array Observatory (CTAO) will represent a step forward in the Very High Energy Astronomy exploration. The project involves more than thousand people, in more than 20 countries worldwide. It will be the largest ground-based gamma-ray observatory, with two observing sites, and other facilities disseminated in different continents. Data from this unique observatory will be open to the entire scientific community. It will have also a large appeal as educational content and many strategies are already in place.

The educational strategy includes several different projects, like the “Physicist On-Call” project to bring astronomy and astronomers into the classroom; the “Astrodiversity Project,” with different paths like the “Women of CTA”, inviting role model women to tell about their experiences, and the “Building from Diversity,” a monthly collection of articles to tell about figures from underrepresented groups in science (women, LGTBQIA+, people with disabilities, etc.). Both have the aim of engaging young students by offering different stories to finally enlarge participation to STEM topics and studies. The pandemic offered the chance to develop virtual material, like the Virtual

Tour of the CTAO-North (La Palma, Spain), and the CTAO virtual exhibit environment that can be used in conferences and events, bringing information at a lesser cost, both money-wise and towards a cleaner environment.

Specially interesting is the attention to color blind people: a lesser disability that we tend to forget about, but that can be eased without complex intervention.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-07/advanced

Figure 2: Left: The CTAO site in the the virtual tour; Middle: The Virtual Exhibit starting page; Right: The Women of CTA series

2.3 OCRA

The Istituto Nazionale di Fisica Nucleare (INFN) has started a large outreach project that takes the name of Outreach Cosmic Ray Activities (OCRA, which is the name of the ocher color, in Italian). Carla Aramo, from the Naples Section of INFN, presents the last activities of OCRA [3]. It counts 24 of the institute's divisions all over Italy and it represents a national framework for Public Engagement. OCRA develops several activities for the Outreach & Education. One of these is the International Cosmic Day - ICD, organized by DESY, to share the knowledge on cosmic rays and the related physics background. The latest edition of the OCRA ICD was organized at the different venues, with a focus on the educational value of hands-on measurements of the cosmic ray flux and had a few thousands participants both in-person and online. Special attention, which I deem of the uttermost importance, is devoted in reaching teachers directly, which act as multipliers to spread knowledge to their students. The group is also building a "cosmic cube": a very nice and easy to use cosmic ray detector. You can see in Figure3 one of the comment from students after a workshop: it is a tell tale sign that you have done a good work.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-01/advanced

2.3.1 Posters

The OCRA project also presented two posters better detailing their outreach activities.

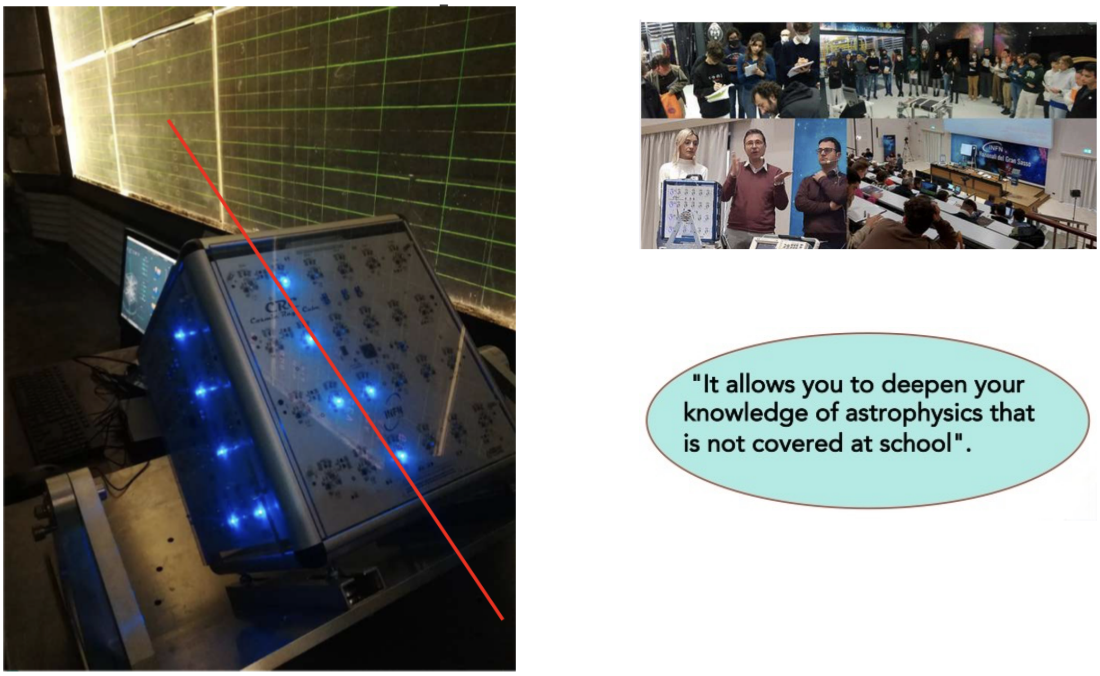

Figure 3: Left: one of the "cosmic cubes", the muon detectors constructed by OCRA; Right: Top: a collection of student activities; Bottom: the comment of one of the participants.

Figure 4: Left: A portable instrument Right: Logo of OCRA and MIRACLE experiment.

The first one, presented by Fabio Morsani (INFN, Pisa) describes a portable muon detector, the "Cosmocube" [4]. The aim is to detect cosmic rays even during school excursion, with a simple to use and light instrument that does not need to be linked to the power source, but it can be powered through the available USB port by a power bank to allow portable operations. The Arduino based structure makes it replicable, and a dedicated app can be used on a computer to remotely control the instrument. I fancy to think of all schools carrying a backpack for measure in different locations (the effect of latitude, altitude and so on can be explored, maybe with a large citizen science project aimed at all national and international schools).

For the future a nice improvement with detectors in coincidence is foreseen. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E0-05/advanced

The second poster was presented by Antoine Venturini (INFN, Pisa) [5] on the MIRACLE experiment, led by a team of Master's students in Physics in collaboration with the University of Pisa and INFN laboratories. The project is complete, going over the different phases of a "real world" project, from design, to fund collection, to construction and actual use. The apex of the activity was a balloon flight with a hut configuration that obtained data on cosmic ray counts at the peak at 22 km height, correlated to housekeeping measures like altitude and payload orientation. Data are being analysed. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E0-03/advanced

2.4 INDACO

Figure 5: Left: Science Festival, and the augmented reality roll-up; Right: On the making of Cen A; Find the differences!; the INDACO logo

I presented on behalf of INAF (Istituto Nazionale di Astrofisica) the INDACO (INaf for the Dissemination of Astri and Cta Observatory) collaboration [6]. The group has been established within INAF since 2020, in order to foster Public Engagement for two Cherenkov Telescope projects: ASTRI (Astrofisica con Specchi a Tecnologia replicante Italiana), an INAF-led project, and CTAO

(Cherenkov Telescope Array Observatory), the international project of which we already heard, in which INAF is a major contributor. About 15 people from the different INAF institutes, spread over the country, are participating in INDACO, with regular online meetings and smaller groups that tackle single tasks. We aim at making it simpler for the general public and school students to grasp how much information can be encoded in electromagnetic emission invisible to our eyes. It is also fascinating to describe how our Earth's atmosphere can be exploited as an instrument to intercept the highest energy photons that can be studied today, via the Cherenkov emission of particle showers. INDACO has a vast repertoire of outreach & education activities, from social media to the ASTRI web site, to Science Festival. I focused on a case study of a hands-on laboratory, dedicated to primary school pupils. Through "learning-by-doing" and "education through play" we present puzzles in various wavelength bands to the groups of student, to solve them in order to gain information and construction materials. The aim of the game is to recreate the Cen A radio galaxy, a well-studied nearby active galaxy, with the collected material, different for each different wavelength. In the process, they learn how looking with different eyes you can have a better view of the object under study. By playing with the various emission bands, the role of the VHE one becomes clearer. The experience has a broader impact, we believe, on every field of learning.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-03/advanced

3. Interaction with schools

Schools are the largest segment of the public for institutional outreach activity. Therefore there are many diverse ideas and themes that can relate to this theme. Many disparate activities were presented, that have as the main connecting link the direct involvement of teachers and students. They provide a large data bank of ideas on how to conduct scientific dissemination in the school context.

3.1 Online support for research activities by high school and junior high school students

Haruhi Enomoto, from Tokyo Institute of Technology and Accel Kitchen, presented Japan largest cosmic-ray outreach network providing support for more than 40 schools and more than 200 students, involving undergraduates for more pervasive interaction [7].

Every year they held seminars and chose a theme that will be discussed and deepened for the entire school year: students will discuss and design the project, assemble the detector, take the measures and present the results, in the end. Just as an example, detectors were used in the past to measure the cosmic-ray flux at Mt. Fuji to investigate the relationship with altitude, or to compare the cosmic-ray flux with sunspot counts observed by the school's telescope.

A great help comes from being able to both support online research and to interact with other schools, even abroad (e.g. a project involved Argentinian student, on the other side of the South Atlantic Anomaly). The outcome is sometimes worth of publication in peer-reviewed papers. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-06/advanced

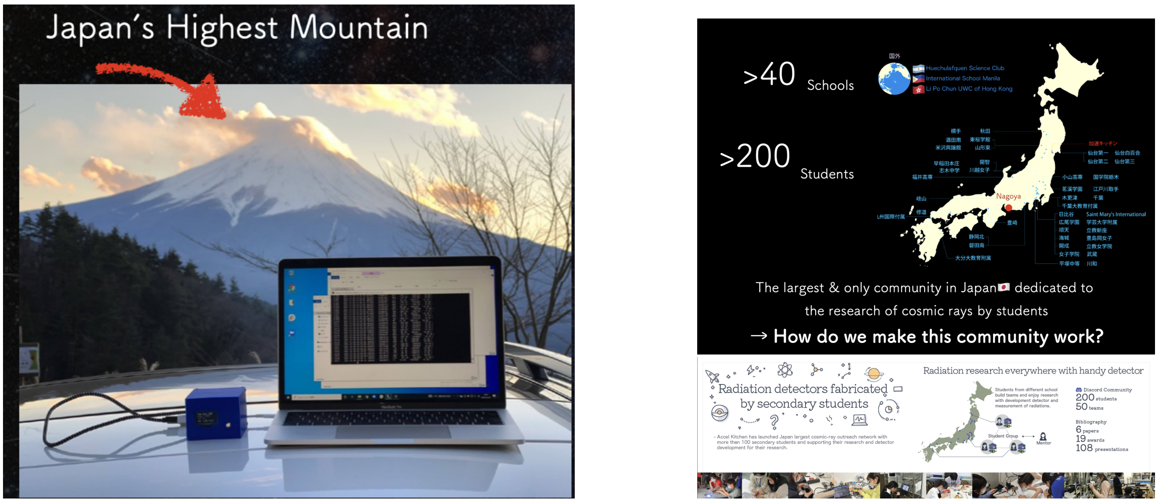

Figure 6: Left: Cosmic ray measures at Mount Fuji; Right: Support to students in assembling and using detectors

3.1.1 Poster

Support for schools is important and many different instruments have been presented (see later Section3.6). I discuss this here because of the connection with the previous presentation.

Kazuo Tanaka (Accel Kitchen, Japan) describes the online support offered to over 100 secondary students in the construction of different kinds of detectors [8]. The development of the instruments and the results are described, beside the way the remote support to the class radiation research is obtained. The presentation: `https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-11/advanced`

3.2 STEAM Program, promoting interest in Cosmic Rays and Neutrinos

Magdalena Waleska Aldana Segura of the Universidad de San Carlos de Guatemala presented the STEAM program promoted jointly by the Universidad de Guanajuato, the Universidad de San Carlos de Guatemala and Universidad Galileo, with the support of U.S Embassy in Guatemala, with the main aim of reaching a large audience by involving teachers, and promoting conferences and workshops [9]. They have developed a broad range of activities that focus on cosmic rays and neutrinos to foster interest in scientific themes and to ameliorate the understanding of science.

STEAM conferences make the student protagonist of the discussion, participating also to a STEAM Club. The pandemic was the opportunity to devise an online program allowing them to strengthen the mentorship programs and participation in International Conferences and seminars. In particular it was possible also to establish an Online Seminar Series, the Leon Lederman Seminar, that, from June 2020, working with at least 45 international Institutions and almost a hundred speakers, has reached the astonishing number of mote than one million people!

These seminars were held in Spanish, suggesting that the production of material in the language spoken in each country, and not in the usual "global English", can have a broader impact.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-06/advanced

Figure 7: Left: Detectors build in the STEAM program; Right: the Leon Lederman seminar series

3.3 "Fun-Q" project : muography of Japanese ancient mounds by high school students

Miki Ohtsuka, a teacher at Honjo Senior High School, presented the "Fun-Q" project, held in collaboration with Waseda University. This project exploits muography (muon tomography) of Japanese ancient mounds (in particular the Akiyama Koshinzuka Kofun, near the school) performed by high school students in an interdisciplinary collaboration [10].

Figure 8: Left: The mound analysed by students; Middle: Student at workshops; Right: The original name of the project, which translates to "Fun-Q"

Cosmic muon detectors have been used in diverse experiments, the most famous of which is probably the analysis of Egyptian pyramids to study the presence of unknown chambers (voids). The school, under the guidance of Prof. Ohtuska, has collect a large team with different competences, from scientists to engineers, from archeologists to curators, creating a synergy between both student and teachers and between experts. First the students have assembled the detector: a plastic scintillation muon device called OSECHI (Outreach & Science Education Cosmic-ray Hunting Instrument) under the supervision of the scientist that have devised it. Then, they have put it at work by analyzing ancient mounds in the Honjo City, in particular the Ko-fun mound close to the school.

The final step was the presentation of the work done, at two national meetings, summarizing results from both archaeological and geophysical perspectives.

The aim of this multidisciplinary activity has been to learn about the place in which they live, their history and especially to learn how not to worry about barriers in different areas of culture, as some of the students summarized the result. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-02/advanced

3.4 International Masterclasses as part of the Pierre Auger Observatory program of Outreach and Education

Raul Sarmento (Laboratório de Instrumentação e Física Experimental de Partículas, Braga, Portugal) presented on behalf of the Pierre Auger Observatory the International Masterclasses held with the aim of bringing education and knowledge of cosmic rays to schools and students [11].

The astroparticle physics is a vast subject in which the Pierre Auger Observatory has been collecting information for years. In the interest of publicly opening the Auger dataset (see also later 5.1) the collaboration has developed novel tools to better approach the data, constructing also an interactive 3D event display. The students in the Masterclasses, that reach more that ten thousands students in 60 different countries each year, had then the possibility of becoming "Auger scientists" for a day. With hands-on activities, after learning about particle detection and the related physics, they could analyze event, reconstruct the particle path and reproduce the overall sky map of the events. Even if at low significance, due to the limited number of events, their results mimics the well known dipole pattern in the exposure-corrected sky map of arrival directions that experts finds from the whole database.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-03/advanced

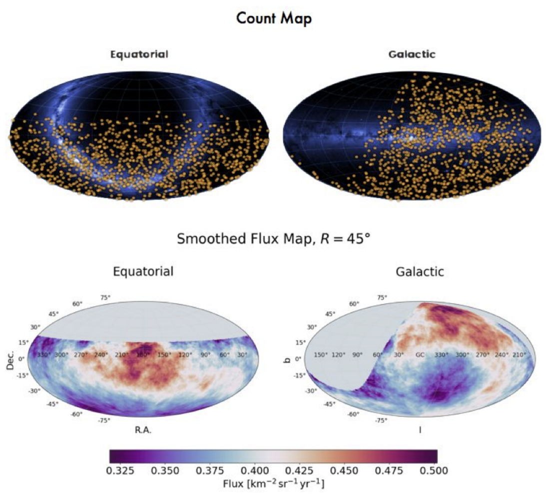

Figure 9: Left: The resulting dipole map; Right: Students at the Masterclasses

3.5 What is learned from the IceCube virtual reality game a case study with Thai students

From Thailand, Waraporn Nuntiyakul (Department of Physics and Materials Science, Chiang Mai University, Thailand) presented a virtual reality (VR) experience of IceCube developed by an interdisciplinary team at the University of Wisconsin-Madison and then translated in Thai [12].

The VR is an immersive enviroment in which the viewer is transported to the IceCube Neutrino Observatory at the South Pole to learn about the physics of the neutrino and its observational difficulties. The student then embarks on a journey into space, following the neutrino path, to reach one of the particle sources, a black hole. The aim of the experience is to engage students in a fanciful flight to ultimately learn about multimessenger astrophysics and extreme sources. The activity was also testing the impact of VR, used with a single device like the Oculos, with respect to more conventional means, like a projection of the VR tour in a 360^{deg} view.

By administering tests (questionnaries) both before and after the experience, a gain in knowledge was appreciated in both paths, with a hint of a better experience with the Oculos, which however is less reaching in terms of numbers. The Thai distributed VR tour certainly sparked curiosity in science and neutrino physics amongst participants. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-02/advanced

Figure 10: Students immersed in the Oculus VR activity

3.6 Posters

A number of posters address the construction of particle detectors, apparently the easiest way to involve directly students with a hands-on experiment, which might also teach them both physics and engineering. They require a careful design to be made simple both for construction and use by students. Since the different proposals tackle different aspect, I suggest that putting together the various experiences might produce and even better and more performing instrument design.

Takeshi Nakamori (Yamagata University, Japan) presented the Cosmic Watch, a USB bus-powered cosmic ray muon detector that uses a plastic scintillator and a silicon photomultiplier (SiPM) [13]. In Japanese schools it has been used to study various parameters of cosmic muon events, by using for instance different configurations and spatial orientation. The ease of assembly and data gathering (it produces also a spectrum that can be used for muon selection) make it a very popular instrument for teaching. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-09/advanced

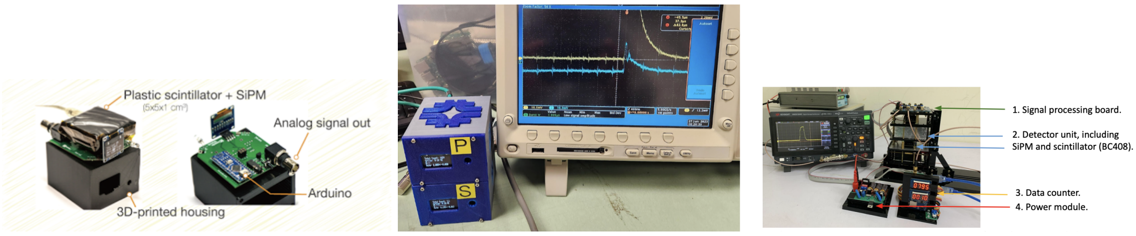

Figure 11: Left: The Cosmic Watch; Middle: The Quark Net program at work; Right: Locomote detector

Kenneth William Cecire (University of Notre Dame, Indiana, USA) presented QuarkNet, a particle physics outreach and education program that makes use of the Cosmic Watch detectors and their experience at home and abroad, especially in Japan. [14]. The two-fold coincidence, the low cost and simple use, make it a versatile instrument to be used in the class-rooms for well known or new experiments. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E0-04/advanced

Nai Cheng Huang (Institute of Physics, National Yang Ming Chiao Tung, Taiwan) presented LOCOMOTE (for Low Cost Muon Telescope), a low-cost charged particle detector [15]. The low-cost is relative: at approximately 200 US dollars it is affordable in small numbers for most schools. The detector includes scintillator and SiPM. The authors investigated the possibility of measuring the muon flux at sea level and the effect of different incident angles. In the future, the possibility of muon tomography in a modular structure with many channels. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-14/advanced

4. Citizen Science

Citizen Science, or research with the participation of the general public, has become a staple of the Public Engagement activities in the last decades, also thanks to large and well constructed platforms like "Zooniverse", after the Galaxy Zoo project. Although I personally question myself about some of the realizations, which might either trick participant in thinking they know more than they really do, just because they are citizen scientist, or, on the other hand, exploit an unknowing and unpaid work force, I see the many merits of spreading knowledge in a participative environment. I discuss here the project presented, that have indeed many successful points.

4.1 Public Kaggle Competition “IceCube - Neutrinos in Deep ice”

Philipp Eller (TU Munich, Germany) presented the Kaggle Competition “IceCube - Neutrinos in Deep ice”, a public machine learning challenge with a substantial prize [16].

To know the exact direction of arrival of a neutrino is of fundamental importance for research, especially if you want to pinpoint their sources. However the task is far from trivial. The challenge was then devised to make available simulated data (so that the "true" direction was known) and ask the public for new and innovative solution on how to determine the trajectory.

A real prize, a total of $50k, was contended by hundreds of teams from more than seventy countries, that provided more that ten thousand solutions in a three months period. I enjoyed the presentation but also the idea behind it: the exploit the best minds of people not related to the project (or maybe not?) in order to find a never-though-before solution. It is interesting to follow the unfolding of the reconstruction accuracy (measured by a well defined score) during the three months (see Figure12 *Right*) and compare it with the pre-existing code developed internally.

The next step of course will be the implementation of the new software solutions, maybe combining some of the details of the few winning ones to get a better scientific exploitation.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-01/advanced

Figure 12: Left: One of the best events that have to be reconstructed; Middle: the scoring sistem, and the prize!; Right: the trend of the results in the weeks of the competition

4.2 Citizen science "Thundercloud Project" – multi-point radiation measurements of gamma-ray glows from accelerated electrons in thunderstorms

Teruaki Enoto (Kyoto University, RIKEN, Japan) presented the "Thundercloud Project", an unusual experiment for an unusual task [17]. Are cosmic rays responsible at least in part for triggering lightning in our atmosphere? How do they interact with the electric fields in thunderclouds? These are not the most common question you would ask yourself, but indeed answering them might help us in understanding better both the physiscs of cosmic rays and the inner workings of the atmosphere. The measure relies on the bremsstrahlung effect of electrons accelerated by the strong fields in thunderclouds that produce a sort of "gamma ray glow". Detectors have to be widespread to give meaningful information, therefore about 60, quite expensive, very sensitive detectors (CoGaMo) have been manufactured and distributed to interested individuals for a mapping campaign during thunderstorms around Kanazawa, Japan. Check out also the Shinkansen travel results and the very nice graphic rendering of the concluding discussion.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E1-05/advanced

4.3 Posters

Citizen science has a wide reach, and inummerable declination. Perhaps the most imaginative activities are found under this category. A couple of posters are described here.

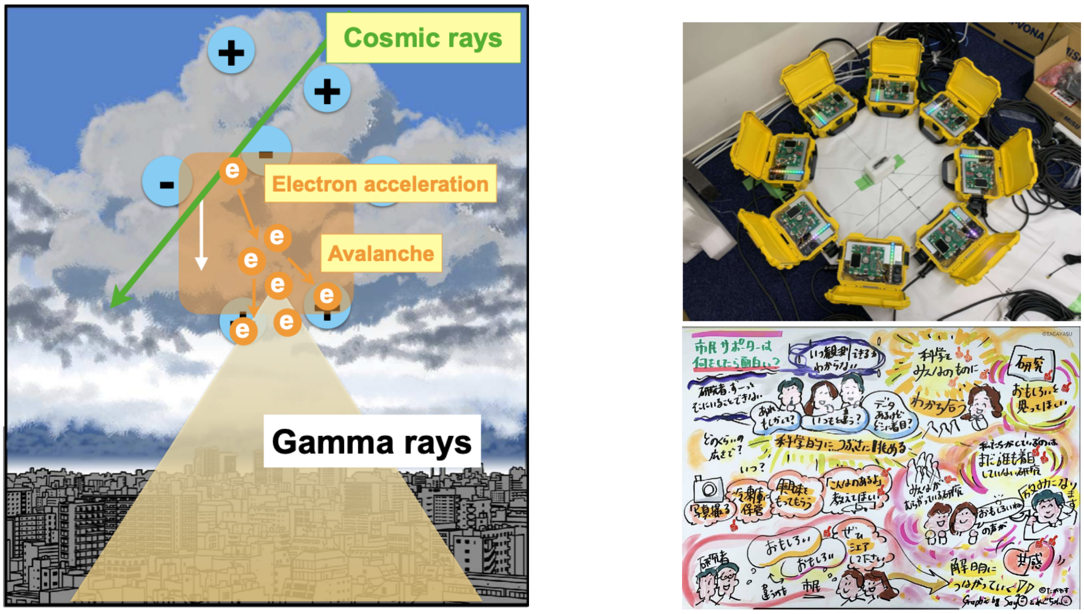

Figure 13: Left: How to explain the interaction of Cosmic Rays with the atmosphere; Right: the CoGaMo instruments, ready for distribution; the graphic interpretation of the outcome.

Massimiliano Razzano (University of Pisa, INFN-Pisa, Italy) presented GWitchHunters, a citizen science project focused on the study of the gravitational wave noise, developed on the Zooniverse platform within the REINFORCE project (Science With and For Society) funded under the EU's H2020 program [18]. Gravitational waves are the most recent window to understanding our Universe. Complex machines, like LIGO in the USA, and Virgo in Italy, have already found numerous sources. One of the problems they have to solve is to isolate good signals from the noise, and in particular from a particular shaped noise defined as "glitch", that mimics a real event but has a different light curve. The best way to discriminate them is to use machine learning algorithms, which however need to be instructed. The project has prepared various sets of data in which more than eight thousand volunteers have identified, isolated, and tentatively classified glitches. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E0-02/advanced

Wakiko Takano (Kanagawa University, Japan) presented a radiation detection application for smartphones and tablets [19]. What is most common today than your smartphone? Many people even carry more than one device. And they are equipped with a CMOS camera, sensitive enough to detect not only optical photons but also charged particles like cosmic rays and environmental radiation. The authors have developed an app to be installed to turn your smartphone into a detector. With almost 6 billion smartphones worldwide, the potential for widespread radiation detection is immense. Alas, we have installed it and were not able to detect any cosmic ray... we have to keep working on it! The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-13/advanced

Figure 14: Left: GWutchHunters; Right: How to detect cosmic rays with your phone!

5. Open data and gaming

One of the fundamental necessity for a project it to be able to offer information and accessibility through online portals. I have collected in this section both "open data" portals and "gaming experiences" since they share this accessibility aim. Open data is of paramount importance to allow others to confirm our results, but also to allow findings that were not foreseen, or foresable, at the time of observations.

5.1 Portals to data of the Pierre Auger Observatory

Piera Luisa Ghia (IJCLab, CNRS-IN2P3, Orsay, France) presented the portal to open data of the Pierre Auger Observatory [20]. Open access to the data is important, but far from easy: accessibility for scientist and for interested, but not expert, users needs care, recovery and display tools, explanations, and so on. All of this under the FAIR (Findable, Accessible, Interoperable, and Reusable) principles. The Pierre Auger Collaboration has first opened a portal in 2007 with 1% of data from the surface detectors, and updated every year. The new portal, launched in 2021, now includes 10% of all data and the whole scaler and atmospheric data. It has had more than 20 thousand visits and more than two thousands downloads, showing that it can have different kinds of exploitation. It features a friendly viewer and documentation and new additions are foreseen in the future.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-04/advanced

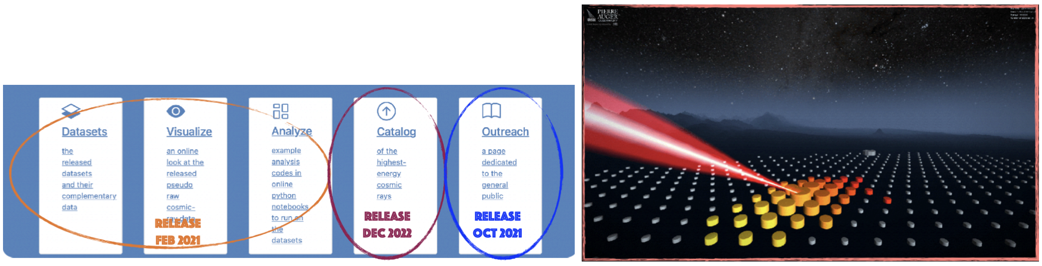

Figure 15: Left: Timeline of the characteristics of the Pierre Auger portal; Right: an example of the interactive display

5.2 An engaging solution for the outreach of cosmic-rays science? The innovative "Flashes" web-game!

Simone Iovenitti (INAF - OA Brera, Associazione culturale PhysicalPub, Italy) presented the innovative "Flashes" web-game [21].

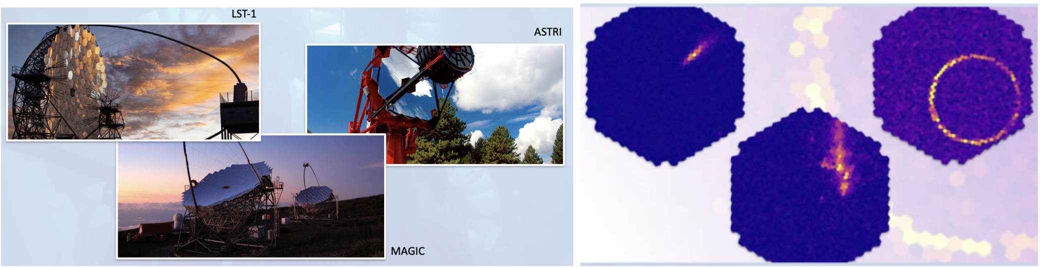

Figure 16: Left: the three telescopes providing real data for the game; Right: different shape from different showers

To make cosmic-ray science more accessible to the general public the group has devised an educational game that runs online to better understand the workings of Imaging Atmospheric Cherenkov Telescopes (IACTs). "Flashes" shows the recordings of different sources: hadron, gamma, muons or something else, each with their distinctive shape, taken from real scientific datasets from real telescopes (ASTRI-Horn, MAGIC, and LST-1, the Large-Sized Telescope prototype for the CTAO). The player is then called to classify them properly. The game supports multiple-player sessions and includes an introduction that educators may use for preparatory explanations.

The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/O_E2-05/advanced

5.3 Posters

Here a few posters to show how to mantain and share the data collected by the various collaborations.

Andreas Haungs (Karlsruhe Institute of Technology, Germany) presented The 'KASCADE Cosmic-ray Data Centre' (KCDC) [22]. Another FAIR based data managment portal, initially built to present the scientific data from the KASCADE-Grande air-shower experiment now includes data from other experiments and tools for display, C++ programs for the users to personalize and Jupyter notebooks to share. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-01/advanced

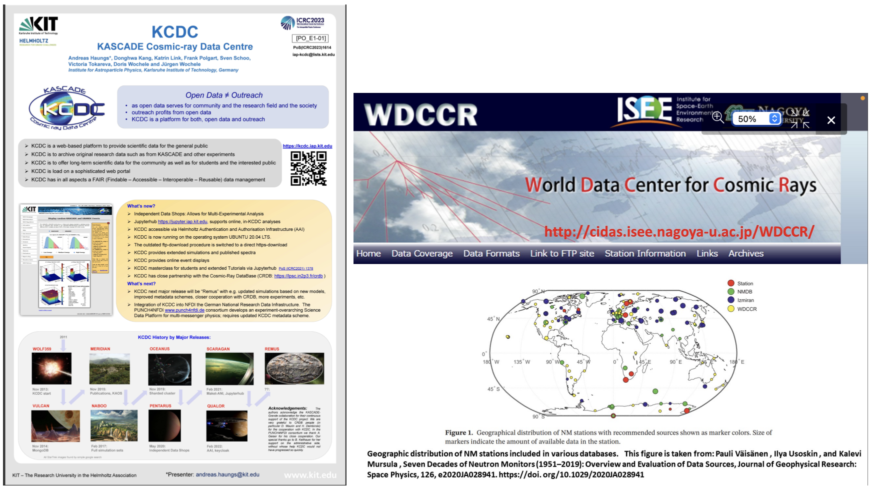

Figure 17: Left: the KASCADE cosmic-ray data center; Right: the World data center for Cosmic Rays

Takashi Watanabe (NIICT, Nagoya University, Japan) presented the World Data Center for Cosmic Rays (WDCCR) [23]. Established in Japan in 1957, during the Geophysical Year, at the Institute of Physical and Chemical Research (RIKEN) was to provide and mantain the database of worldwide neutron-monitor observations. Moved to Nagoya University in 1991, it was terminated in 2008. The current WDCCR is continuing the activity summarizing results from 138 observing stations world wide. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-05/advanced

6. "Sociology"

What I put under the "Sociology" label are posters dedicated to strive towards a good working environment, in their own ways.

6.1 Posters

Fumiko Kawazoe (MPI for Gravitational Wave Physics, Germany) presented The IMPRS on Gravitational Wave Astronomy (IMPRS-GW), a long standing school in Hannover on different themes linked to gravitational astronomy [24]. More than 160 PhD student graduated in this program since 2006, that has demostrated a particulare care of the well being of the students.

Besides good background knowledge in the field, and teaching experiences, what I find most interesting is the attention devoted to team building and collaboration skills. These are token valuable in academia but also in other fields, like industry. The majority of the PhD students appears not to stay in the research field, in fact, but will have learned nevertheless, through the training offered, how to work in groups, how to communicate effectively, and how to share ideas and expertise to achieve a common goal. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-06/advanced

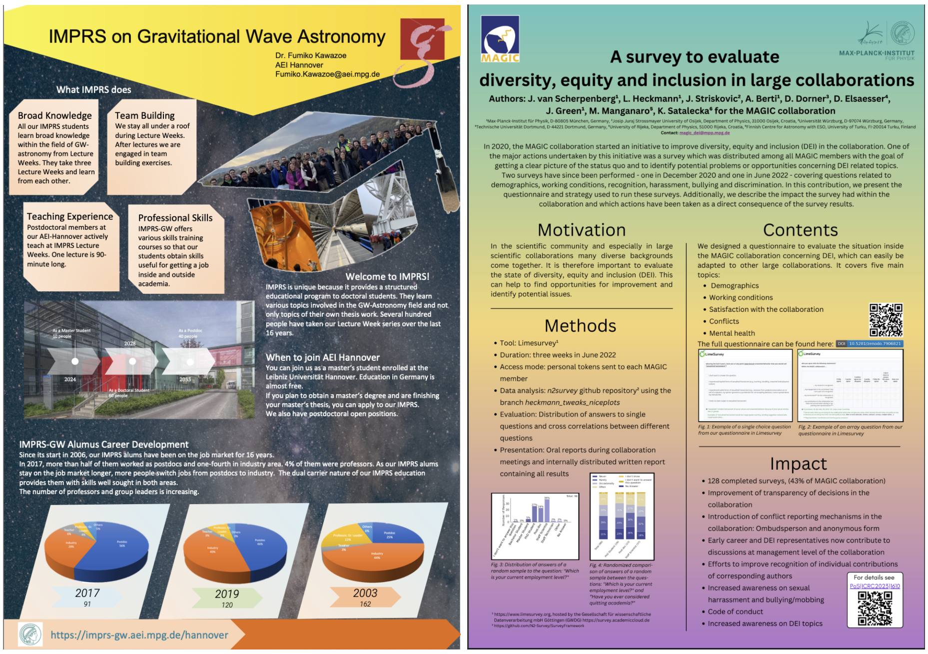

Figure 18: Left: The IMPRS poster; Right: the MAGIC collaboration poster

Juliane van Scherpenberg (Max-Planck-Institut für Physik, München, Germany) presented an initiative to improve diversity, equity and inclusion (DEI) in the the MAGIC collaboration, started in 2020 [25]. The first step in achieving a comfortable working environment is to assess the current conditions, and then to work to ameliorate what is missing, following DEI guidelines. The authors focused on a survey, distributed to all the members of the MAGIC collaboration, to evaluate topics as the demographic distribution, the working conditions, the presence of conflicts and so on. By using a secure online environment, the anonymous survey was answered by almost half of the members, and resulted in important actions taken, like the improvement of transparency in decision making, the introduction of conflict reporting mechanisms and the increased awareness on DEI themes. The questionnaire is available for use to any interested parties. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-04/advanced

7. Virtual reality

I have briefly tackled Virtual Reality before (see section 3.5) where the theme was more on the impact of VR on school students. Here I collect posters that describe projects to create VR contents.

7.1 Posters

Takayuki Tomida (Shinshu University, Nagano, Japan) presented two posters. The first consists of an interactive content that shows cosmic ray air showers in a three-dimensional global panoramic image space [26]. Since "seeing is believing", showing a real-size air shower caused by a high-energy cosmic ray might trigger interest into studying them or learning more about the science behind them. The VR experience can be used in the class, or in museums or even during educational events. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-08/advanced

Figure 19: Left: The life cycle of production of a VR event interaction; Right: A "real-life" air shower

The second poster presents a movie that shows cosmic ray air showers of Ultra-High Energy Cosmic Ray (UHECR) in a three-dimensional global panoramic image space [27]. For the exhibition, shoots were made at Nagoya University and projected air showers were imposed above it. The movie can be requested from the author. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-10/advanced

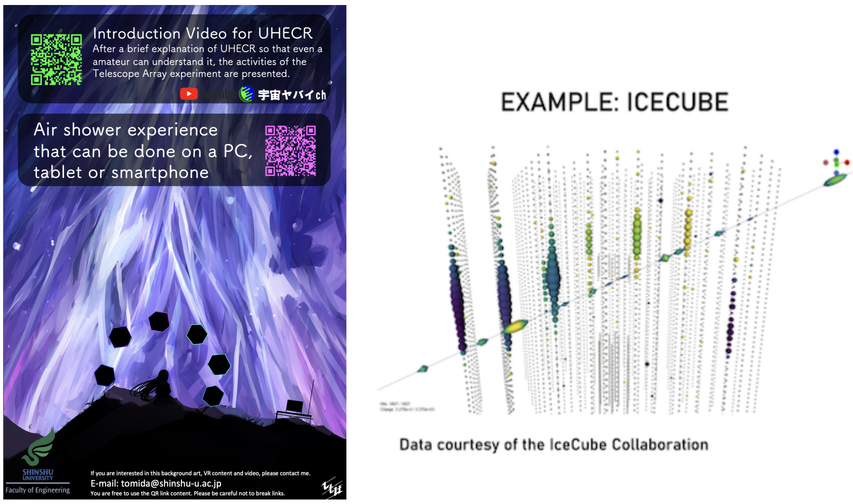

Figure 20: Left: A movie on UHECR; Right: What *Wilson* does for you

Tobias Kerscher (ECP, TU Munich, Germany) presented "Wilson", a framework for creating 3D animations in particle physics [28]. The idea is to have a complete tool in which only a few lines of Python code are needed to show your specific experiment. Extended compatibility, independence from the platform and precise documentation make it appealing. An event viewer, without need to install new software, completes the offer, making it easier to be used even outside its original field. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_EO-01/advanced

8. Art and Interdisciplinary

Last but not least, the beauty under our own eyes. A couple of posters have addressed a multidisciplinary proposal, namely sonification and light installations to open a new way of encountering the deepness of science.

8.1 Posters

Jonathan Mauro (CP3, UCLouvain, Belgium) presented the result of a cross-disciplinary collaboration involving researchers from the KM3NeT Collaboration [29]. The KM3NeT collaboration has arrays of neutrino detectors strung in the depths of the Mediterranean Sea. The project consisted in the construction of an analog sounding instrument (a sort of resonant bell, put in motion by the sea waves), called the “Bathysphere”, from which sound was recorded during the descent. When the depth is large, the sound ceases: the researcher then have devised a scheme to translate the actual KM3Net data into sound, to provide "music" that accompanies the images of the last part of the journey (this is called "sonification"). The splendid resulting video “Below the Surface” can be appreciated online and offers new, deeply phisical perspectives on the data collected by KM3NeT. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-02/advanced

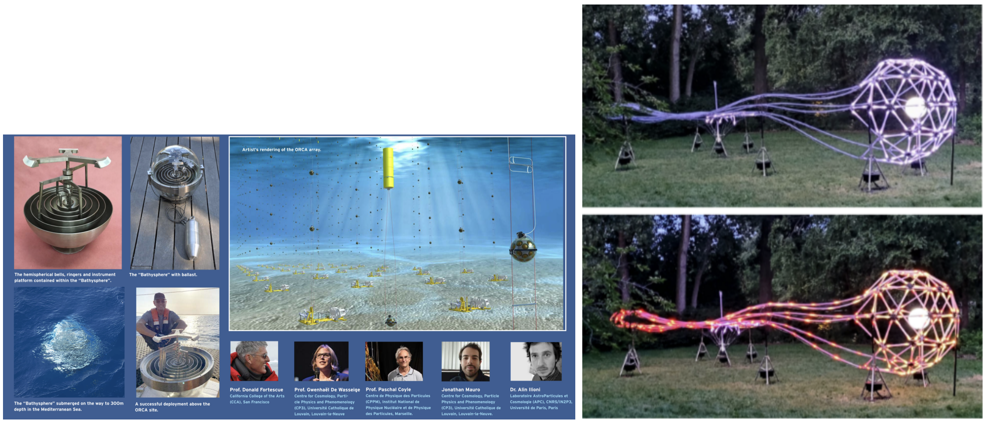

Figure 21: Left: the KM3Net project of sonification; Right: the tidal disruption event at the GLEAM event

Vedant Basu (University of Wisconsin-Madison, USA) presented “Tidal Disruption: An Unforgettable Encounter with a Black Hole", an art-science light installation displayed at the annual GLEAM outdoor art exhibition in Madison, Wisconsin [30]. Visited by tens of thousands of visitors, the exhibition lasts two months in fall. The immersive installation through light and sounds describes the death of star, spiralling in the gravitational field of a black hole in a sequence that repeats itself every few minutes: a Tidal Disruption Event. The response from the public has been overwhelming, and an expert was available to answer the many questions. The presentation: https://confit.atlas.jp/guide/event/icrc2023/subject/PO_E1-07/advanced

9. Conclusion

Figure 22: Light on all the presentations: enjoy science, and enjoy telling about it to different audiences

I have organized the presentations in a few themes, according to my knowledge, my feeling, and sometimes by questioning the authors. It is a been an engaging experience and I am sure I learned something more even by revisiting and reorganizing them. The task has not been easy since the wealth of information and nice activities and ideas is huge. I urge you all to follow the links reported and learn the details of what inspires you. Maybe you will find new ways of doing or new friends for a length of the journey you are walking in. In any case, keep doing science and keep talking and experimenting about it, to share our knowledge to a vast audience. And enjoy it.

Acknowledgments

I thank the organizers for putting together a wonderful meeting, and of course for giving me this opportunity. I thank all people that succeeded in making me look at all the posters, which I sometimes skip at conference, the laziness that comes with age. I thank all the participants to the sessions, the chairs, the speakers, the poster presenters, the audience, they made those hours special. I thank all the INDACO group that accompanies me since 2020 in this adventure in Gamma Rays. And I deeply and warmly thank Laura Paganini from INDACO that has been invaluable in helping me collecting and remembering everything and also in putting together this report.

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