# ‘Reach the Unreached’: a perspective for public outreach in Earth and space science

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*Conducting public outreach activities for students and the general public has been an integral part of several research organizations. It is a way to communicate with common people to make them aware of the research work at any institution. However, the COVID-19 pandemic affected these activities. Even during the post-pandemic period, the response to public outreach programmes has been poor. To deal with this situation, an initiative called ‘Reach the Unreached’ has been implemented at the Indian Institute of Geomagnetism (IIG), Navi Mumbai, which has helped boost participation in public outreach activities. This low-budget programme has been well-received by many schools. Moreover, it is found to be an effective way of reaching a large number of students. In this article, we share our post-COVID-19 experiences and information about different programmes implemented by IIG to reach a maximum number of people with basic concepts in the field of space science and geomagnetism, and their applications. The public outreach team of any institution must be energetic to adopt and implement different methods to attract and motivate young minds. The experience shared in this article will be useful to public outreach teams from other institutions.*

**Keywords:** Earth and space science, geomagnetism, public outreach programme, research organizations, young students.

WORLDWIDE public outreach activities like popular talks, seminars, workshops, exhibitions, etc. are conducted at national and international levels to make common people and students aware of the current research work in various institutions and its applications. Such activities help scientists and research organizations to gain public support for their research. The participation of young students in such activities exposes them to various innovative fields, enhances their curiosity and creativity, and motivates them to take up fundamental and application-oriented research, which is the most important aspect of such events. This eventually strengthens a country’s research activities by channelling the thought processes of energetic young minds.. Organizing such activities to attract more people and students effectively is challenging. The public outreach team has to develop innovative ideas each time to take science and technology to the common people in a simple form. In this context, some articles have been published earlier that describe how to reach people through effective public outreach activities[1–3]. For example, the space science comic book series by the International Scientific Committee on Solar–Terrestrial Physics (SCOSTEP) has been an innovative way to reach children with fascinating space science concepts (https://scostep.org/space-science-comic-books).

For the last several years, the Indian Institute of Geomagnetism (IIG), Navi Mumbai, has been engaged in popularizing space science and geomagnetism[4]. Such public outreach programmes in the field of astronomy, solar physics, planetary science are being run by multiple other research institutes in India (e.g. ARIE, PRL, IUCAA, TIFR, etc.). IIG is an autonomous research institution under the Department of Science and Technology, Government of India. It is a leading organization in the country and known internationally for its research contributions in the fields of geomagnetism, geophysics, space weather and atmospheric sciences that cover several phenomena from the surface of the sun to the interior of the Earth (www.iigm.res.in). Recently, the research activities at IIG have been extended to planetary ionosphere–magnetosphere systems as well[5]. IIG operates three regional centres, namely Dr K. S. Krishnan Geomagnetic Research Laboratory, Prayagraj, Uttar Pradesh; Equatorial Geophysical Research Laboratory, Tirunelveli, Tamil Nadu; and North-East Geophysical Research Laboratory, Shillong with 12 magnetic observatories nationwide to monitor the geomagnetic field. In 2022, IIG had achieved a milestone of completing 50 years. It holds the world-famous Colaba–Alibag Magnetic Observatory and has the heritage of over 181 years of continuous magnetic observations[6]. Notably, from this observatory, magnetic field records are available to witness the most intense historic

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geomagnetic storm of 2 September 1859, known as the Carrington event[7,8]. It is the strongest (or super-intense) geomagnetic storm known to mankind, and an unique event available for the researchers to understand severity of the space weather related phenomena.

Like other research institutions worldwide, the public outreach-related activities at IIG dipped to the lowest level during the COVID-19 pandemic. Though the regular functioning of IIG started around October 2021, the visits of school and college students to the institution had stopped till May 2022. In spite of enthusiasm among the students, the school and college authorities were reluctant to bring students to public outreach-related activities due to the pandemic. To deal with this situation, IIG implemented a programme, viz. 'Reach the Unreached', which has been well adopted by the educational institutions. This programme has played a key role in connecting with people who could not only do so due to fear of the pandemic but also for other reasons like finances, exams, language problems, distance, etc.

The 'Reach the Unreached' programme has been appreciated by several schools and colleges, and was found to be most effective in reaching a large number of students. Our experiences with public outreach activities during the post-pandemic period of June 2022 to May 2023 have been elaborated in this article.

## Public outreach activities

The Earth is a giant magnet whose magnetic field forms a protective shield around the planet (known as magnetosphere). Multiple observations have been reported showing that the Earth's magnetic field strength has been slowly decreasing with time, which indicates a weakening of our protective shield[9–11]. In addition, several physical processes operative in the magnetosphere are influenced by solar activity, which determines the space weather for any given planet. For us, space weather includes phenomena that occur on the surface of the sun and their influence on the near-Earth environment, including the atmosphere–ionosphere–magnetosphere system. Constant efforts of the scientific community to understand various physical processes in this coupled system through observations, theory and simulations have been a key factor in developing knowledge to deal with any adverse effects caused due to severe space weather conditions. Today, we are highly dependent on technology. Satellite communications, power-grid systems, spacecraft, and in extreme cases, the survival of living species are directly affected by space weather conditions and geomagnetism[12–14]. For example, the strongest geomagnetic storm known to us thus far is the Carrington event of September 1859. It has been estimated that if a similar geomagnetic storm were to occur today, a large portion of the North American electrical system would become non-functional, with financial loss of hundreds of billions of US dollars, and recovery in months to years[15]. Moreover, such large-scale geomagnetic storms affect the low-inclination satellites orbiting around the Earth, which can cause huge economic losses to several low–mid latitude countries, including India. Therefore, understanding and quantifying the effect of severe space weather conditions is important. Simultaneously, emphasizing the significance of space weather and geomagnetism to common people is equally important. In 1600, William Gilbert proposed that the Earth itself is a giant magnet[16]. However, untill today, many people are not familiar with this aspect of science. It is noticed that basic concepts like the Earth being a giant magnet and geomagnetism being our protective shield are most fascinating and popular among students and common people. At IIG, these concepts are popularized along with magnetic-field observations, the importance of magnetic observatories, and their applications in geophysics, space physics, geology, etc.

### *'Reach the unreached' programme*

After the onset of the COVID-19 pandemic, the normal science outreach activities at IIG (and probably almost everywhere) came to a complete standstill. Such outreach activities took nearly two years to return to normal. Our public outreach team's biggest challenge was achieving the pre-COVID level for these activities. The number of requests from schools and colleges for visits had been low compared to the usual pre-COVID period. Multiple factors were responsible for this situation. One of the most obvious ones was fear due to the pandemic among students, parents, teachers and the school administration. Another factor was the socio-economic consequences of COVID-19. Most schools and colleges in rural areas tried to avoid the expenditure associated with visiting research facilities for such outreach programmes. Despite the vaccination and decreasing COVID-19 cases, people were not fully prepared to participate in science outreach events. To overcome these issues, we came up with the 'Reach the Unreached' programme. The idea was straightforward: if students and people cannot reach us for various reasons, then we will reach out to them.

In this regard, we contacted various schools and colleges, and started arranging lectures, quiz contests, display of rocks and comic books, etc. Initially, we had to put extra effort into convincing the school administration to get proper appointments for our visits. At times, members of our teams had to make multiple personal visits to schools, but all the extra work was worth the enthusiasm and excitement that we could see on the faces of the students during the outreach programmes. Gradually, the programme gathered steam and was well appreciated by the school and college authorities. Slowly, we started receiving more requests for such visits. This is because (i) a knowledge hub in the form of the science outreach team was at their doorstep,

(ii) maximum students benefitted through this programme, (iii) enthusiastic students wanted to participate in such programmes after the long pandemic, and (iv) schools and colleges did not have to make any extra effort or bear the cost related to travel, logistics, etc. Under the 'Reach the Unreached' programme, we have completed 14 school and college visits. Apart from this, there were 39 visits by students to IIG during June 2022–May 2023. Overall, we could reach over 4000 students in 12 months. In addition, over 1000 students from 20 schools and colleges visited IIG on National Science Day. Figure 1 shows a histogram of total school and college visits to (by) IIG, regional centres and magnetic observatories. During June–July 2022, visits were negligible due to exams, summer vacation and the admission process in schools and colleges. All details of school and college visits are available at www.iigm.res.in.

It must be noted here that people speak multiple languages in India; therefore, communication in the local language is important. In fact, in several native (vernacular) language schools (e.g. Hindi, Marathi, etc.), we arranged our science outreach activities in the local language. We prepared posters to help students understand the scientific concepts. We noticed that some schools were not adequately equipped with the basic facilities needed for visual presentation. In such cases, our science outreach team carried the required equipment and made the event successful by reaching a large number of students from the grassroots level (maximum up to 200–300 students/visit). Since our public outreach team was ready to visit schools and colleges, this increased the number of requests from them for our programme, in contrast to the traditional visit of schools and colleges to IIG.

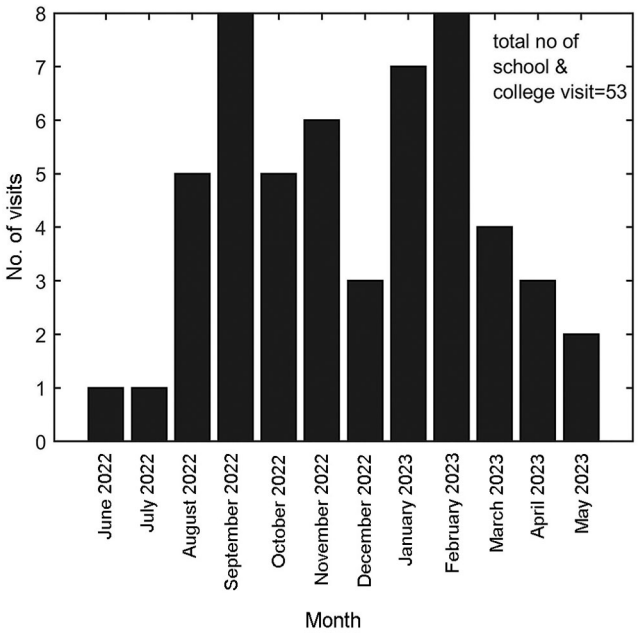


**Figure 1.** Number of school and college visits conducted by Indian Institute of Geomagnetism under the public outreach programme during June 2022 to May 2023.

Budget and resource management are an essential part of any public outreach-related activity. For the successful implementation of any such activity for a long period, we require an adequate budget and a skilled workforce (researchers, faculties, etc.). We covered schools and colleges within 15–20 km from our headquarters, regional centres and observatories. Moreover, our team, comprising 3–4 members, visited one school/college at a time, which allowed us to keep our financial and workforce requirements at a minimum level. The cost was Rs 5000–6000 per school or college visit. Few remotely located schools were visited by our scientists during fieldwork planned as part of their research. It also involved a one-time investment of Rs 3–4 lakhs to purchase a laptop, projector and printing materials.

Ours is a low-budget programme which has the potential to sustain for a long time due to the requirement of minimum resources. This programme is a continuous and ongoing activity at IIG. The research students and postdoctoral fellows at IIG have been an integral part of this programme through their active participation in making it successful. Also, it was implemented at every regional centre so that we could cover schools and colleges in different parts of India.

### *On-the-spot quiz and slogan competitions*

Apart from seminars, lectures and popular talks, students and common people always enjoy interactive activities where they can participate or compete with each other to win prizes. On-the-spot quiz competitions, slogans and crossword competitions are a part of our regular public outreach activities. We have prepared a simple on-the-spot quiz, where questions are based on the seminars, lectures and interactive poster displays. Even small prizes like simple bookmarks, comic books, stickers, etc., excite the participants because it has been received instantly through on-the-spot competitions. Although these activities appear simple, they can potentially attract a huge number of participants. We have given wide publicity to such events and winners through social media platforms.

### *Three-dimensional visual display and real-time solar observations*

Audiovisuals have been a promising way of making scientific concepts understandable and interesting to the people. The experience of audiovisual shows is long-lasting. Visualizing the dynamic sun, the Earth, atmospheric processes, earthquakes, tsunamis, etc., on a large 3D screen in a dark room makes one feel like they are real. Recently, IIG has installed the 3D globe Dagik Earth (details can be found at https://www.dagik.net/english/), with the help of the Department of Geophysics, Kyoto University, Japan. We have noticed that students enjoyed watching 3D video shows on large screens rather than photographs on the posters (Figure 2). IIG has been actively participating in the Indian

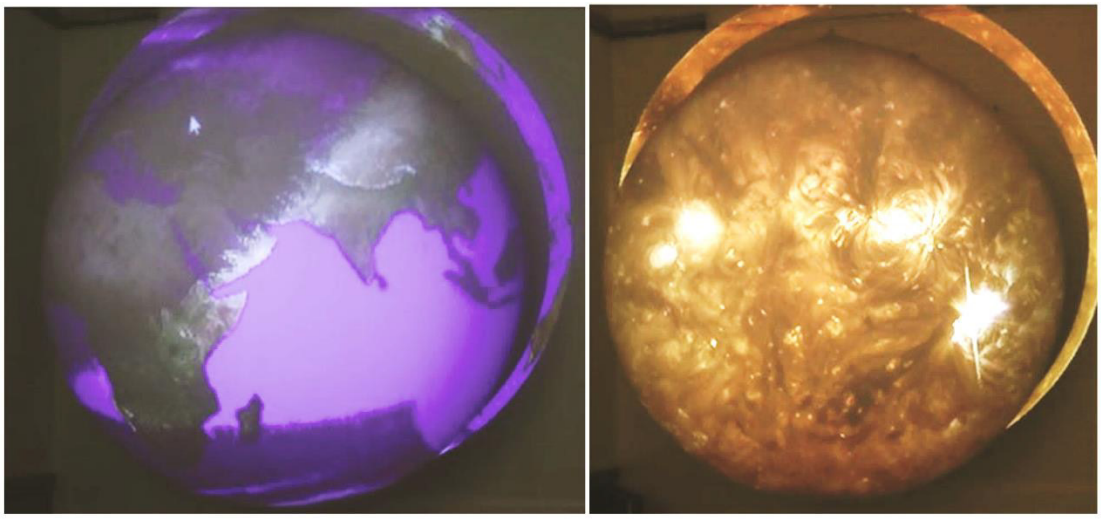

**Figure 2.** Three-dimensional video display of the sun and the Earth. This set-up has been at IIG with the help of Kyoto University, Japan.

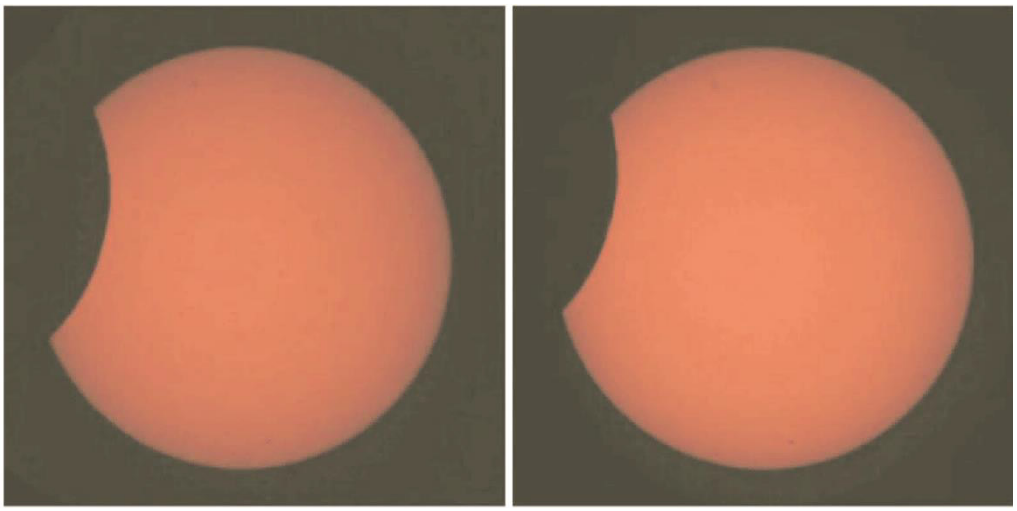

**Figure 3.** The partial solar eclipse on 25 October 2022 observed at the IIG.

Antarctic expedition since 1981. The Institute operates two stations, namely Maitri and Bharati, in Antarctica. Recently, the IIG team also participated in the North Polar Region expedition. Students are fascinated by listening to the experiences of scientists and engineers who have visited the polar regions. India is geographically located in the low–mid latitudes, where observations of aurora are rare, unlike in the high latitudes and polar regions. Hence, installing a 3D globe display has proven to be immensely beneficial for visualizing high-latitude space-weather scenarios from the students' perspective.

Many dynamic phenomena occur on the surface of our nearest star, the sun, and observing these events through the solar telescope in real-time is exciting. Often, we observe sunrise or sunset from the Earth, but observing the solar surface with a high-resolution telescope is the most popular activity requested by parents, teachers, students and the common public during various science exhibitions. People do not hesitate to stand in long queues just to get a glimpse of the sunspots. During the partial solar eclipse that occurred on 25 October 2022, there was active participation of students and staff at IIG (Figure 3). Therefore, we arrange real-time solar observations for students during some of the public outreach events.

## Summary and conclusion

In this article, we share our post-COVID-19 experiences associated with various public outreach activities. Effective public outreach is needed to gain the trust and interest of people regarding the scientific research carried out at any research institution. Today, the world is connected through the rapidly growing high-speed internet network. In such

an environment, reaching people and students with innovative and impressive activities is challenging. Therefore, sharing public outreach experiences and ideas through such articles will be helpful to teams from other institutions to conduct public outreach activities more effectively.

Overall, in the last 12 months (June 2022–May 2023), we reached nearly 53 schools and colleges in India, covering over 5000 students. Under the 'Reach the Unreached' programme, we have visited around 14 schools covering over 2500 students. This programme has been successful and appreciated by many schools. A large number of students have benefitted from it. Particularly, we could reach and motivate young students from the grassroots level by conducting events in their native language. Real-time observations of the solar surface and sunspots using telescopes, quiz and slogan competitions, display of comic books and rocks, and audio-visual shows are in high demand during science outreach activities. In future, we plan to cover more schools and colleges across India.

All the data presented in this article are available at www.iigm.res.in.


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