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Virtual Immersions in Science: the outreach program of the Scuola Normale Superiore^(*)

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Summary. — With the project “Virtual Immersions in Science: a path of excellence from Research to Outreach” (VIS), we set ourselves the ambitious goal to divulge and disseminate the latest scientific research results produced by the Scuola Normale Superiore (SNS) and by top level Italian scientists working in our country and in the rest of the world, providing an idea as to the type of activity carried out by researchers as well as how research is actually carried out, and showing the most dynamic and creative side of contemporary scientific activity. VIS has met with extraordinary public success, coverage by the major media including local and national television and newspapers, and enthusiastic feedback from all the participants, already in their hundreds of thousands.

1. – Introduction

The outreach programme Virtual Immersions in Science (VIS), launched in March 2014 and partly financed with a contribution by MIUR, the Italian Ministry of Education, University and Research (Decree Law no. 418 of 11 March 2013, as part of Law no. 113 of 28 March 1991, as amended by Law no. 6 of 10 January 2000) is the latest and most noteworthy contribution of the Scuola Normale Superiore (SNS) of Pisa in the field of outreach. Despite the limited financial resources available for this pilot project, VIS has encountered remarkable public success, coverage by the major media including local and national television and newspapers [1] and enthusiastic feedback from all participants, which can already be counted in hundreds of thousands.

Over the months VIS has made a decisive leap in quality, through the enhancement of several activities that have proven successful and the launch of new ones to promote the dissemination of scientific culture among the general public and in particular among students of secondary schools.

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The SNS, unanimously recognized as one of the highest-level Italian academic institutions and among the top ten in the world according to the Academic Ranking of World Universities (ARWU) of the Jiao Tong University in Shanghai, has great authority and reputation among all segments of the population, which makes its outreach activities particularly popular and effective. The scientific dissemination in Italy suffers from the wide gap between the population and scientific research due to the alleged difficulty of the latter, a prejudice that definitely must be overcome. Via the VIS project, the SNS has set out to help close this gap in seven key disciplines of contemporary research: Biophysics, Biology, Chemistry, Cosmology, Particle Physics, Archaeology and History, to ensure that the results of the research carried out at the SNS, which receive a great deal of recognition in the scientific community, can be appreciated by the public, contributing to the overall increase in scientific culture in our country.

VIS project manager is Andrea Ferrara, professor of cosmology at the SNS, Vincenzo Barone, Dean of the SNS Faculty of Sciences, is VIS vice-manager and Marcos Valdes, research Fellow and present author, is the executive coordinator. Moreover, VIS can count on the voluntary and enthusiastic participation of professors, researchers, Ph.D. students and undergraduate students of the SNS.

2. – Major activities of VIS

We will describe below the main activities of VIS in the above-mentioned seven research areas of the SNS. The activities are addressed to both students of secondary schools and the general public and may be either performed by participating in person or consulted by connecting to the VIS website <http://vis.sns.it>.

2.1. *Virtual immersions in science through CAVE3D and Oculus Rift.* – For this VIS activity we use, for a more effective scientific dissemination of scientific material, sophisticated technologies such as i) the CAVE3D (part of the SNS laboratory “SMART” Multidisciplinary Approaches for Research and Technology <http://smart.sns.it>), a physical apparatus of about $4\text{m} \times 4\text{m} \times 4\text{m}$ where the visitor can experience in a perceptual-sensory way the 3D representation of the visualised data, such as complex molecules, black holes in formation, collisions between particle beams, archaeological reconstructions, and neural networks [2]. This marvel of technology, of which there are only two other specimens in Italy, has never been used before for the purposes of scientific dissemination. ii) The Oculus Rift 2.0, a helmet for virtual visualisation that allows us to transmit our scientific findings directly to the school classes or to the public of scientific events throughout Italy. This weekly activity is directed alternatively to students of secondary schools or to a general audience. It begins with an introductory lesson of 30 minutes, held by graduate students of the SNS, on topics related to one of the seven areas of VIS. An immersion in CAVE3D follows (fig. 1).

During the visit to CAVE3D the public can ask questions to the young researchers of the SNS about the materials discussed as well as on the academic background necessary to enter the world of scientific research. This activity has already allowed more than 950 people (including over 550 secondary school students) to closely observe cutting edge scientific results.

With the VIS project we plan to further expand this activity as well as plan visits to CAVE3D with comments in English, along with the construction of the English version of the website. The aim is to make Pisa not only a famous town for its history and



Fig. 1. – Visit to CAVE3D, immersion in a protein.

monuments, but also a place of scientific excellence in which visitors can see the leading research produced at the SNS from a close distance.

With VIS we also have five Oculus Rift 2.0 virtual helmets (fig. 2) with their portable workstations that allow us to “transport” the experience of CAVE3D out of the SNS, giving opportunities to many groups and classes of secondary schools from all over Italy to virtually experience the extraordinary adventure of immersion in the most recent scientific data produced at the SNS, under the supervision of graduate students of the SNS.



Fig. 2. – Immersions in science via Oculus Rift 2.0.



Fig. 3. – The winners of “A day as a researcher” 2015.

2.2. *A day as a researcher.* – With “A day as a researcher” we select, on the ground of merit, five students from secondary schools from all over Italy in order to give them the unique opportunity to follow step by step one of our researchers or a research group of the SNS, accompanying them for a whole day in their routine work. This represents a concrete way for young people interested in science to directly understand what the profession of researcher means.

The students interested in participating have to send an informative article about a piece of recent scientific news that has particularly struck them. The winners, who are offered the trip to Pisa and accommodation in one of the colleges of the SNS, are chosen considering the ability to organize information in a concise and effective manner and the understandability of the information presented. The first two editions of “A day as a researcher” involved the participation of over 800 young people from all over Italy, out of whom the 10 winners were chosen [3] (fig. 3).

2.3. *Public lectures.* – The VIS lectures take place at the SNS on a monthly basis and are open to school students as well as to the general public; they are held by distinguished Italian scientists and focus on recent and potentially important discoveries or results in which they have an active role, across all scientific areas of VIS.

The lectures are broadcast in live streaming on webcast as well as recorded, stored and then made available for podcasting. This activity met with an extraordinary success of public, with already more than 2000 participants, and took advantage of the important collaboration of the Library and the Archive of the SNS, which have set up, following each public lecture, a theme exhibition with precious texts and pictures and archival documents on display (fig. 4).

The lecture series could also rely on an effective media coverage on the national daily newspaper *La Stampa*, which published a full-page article in the Wednesday insertion “Tuttoscienze”.

2.4. *Multimedia lectures and Science pills.* – As part of VIS we have created an archive of multimedia lectures for the different scientific areas of the SNS. The teachers of the SNS can find in the VIS website an invaluable tool for the scientific dissemination of a series



Fig. 4. – Public lecture in the Sala Azzurra (Blue Room) of the SNS.

of educational movies with non-technical language, that can be enjoyed by the general public interested in the subject, by school students who use them as a guidance for their university choice, and by university students who are looking for in-depth information on a specific topic. We have also created a substantial number of “Science pills”, short movies in which a researcher or professor from the SNS briefly describes in a recent scientific discovery (see fig. 5).

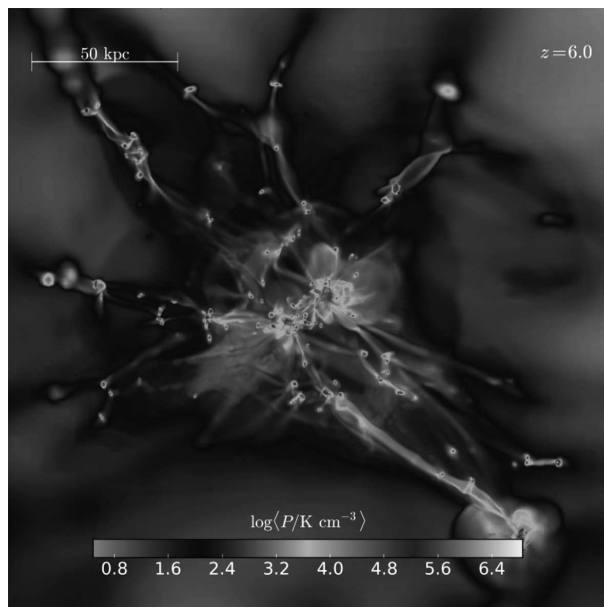


Fig. 5. – A cosmological simulation, as part of the VIS “Science pills”.

2.5. *VIS website.* – The VIS website has had over 205 000 visits in just a few months and has become one of the reference points of scientific divulgation in the Tuscany region, enabling users to register online for visits to CAVE3D and to read scientific news and reports of the VIS activities. In addition to the website we have created an SNS-Outreach Youtube account which contains recordings of all the public lectures, with hundreds of visits in both live streaming and podcast. With the VIS project we enhance the web site continuously to include new outreach areas and activities, and we will shortly add a brief section in English to make it an international scientific dissemination portal and to give also to non-Italian visitors the great opportunity to enjoy the CAVE3D experience.

2.6. *National and international networks for outreach.* – The VIS group organized, in partnership with the Confucius Institute of Pisa, an international conference [4] held at SNS entitled “Science outreach: a chance for development. Perspectives in Italy and China”. We invited Chinese and Italian speakers from prestigious institutions who have distinguished themselves for outreach activities, with the aim of creating a lasting network —the “Sino-Italian Collaboration for Outreach”, SICO— among the SNS, the Chinese University of Hong Kong and Chongqing University. We also participated in European tenders for outreach provided in the framework of the Horizon 2020 program, along with Italian and European partners.

2.7. *Participation in special events.* – In order to promote effective synergies for the dissemination of scientific culture at a national level, we participated in numerous outreach events, of which we mention here some of the main ones: i) the “Notte dei Ricercatori” (Researchers’ night) 2016; ii) the Internet Festival in Pisa (2014, 2015); iii) the annual meeting of the Italian Society of Physics (2014, 2015); iv) the Science Festival in Genoa (2014).

3. – Goals

Our aim is to transmit to the general public and to students (*i.e.*, the users) the passion for science starting from the attraction of its discoveries as told by those who contributed to them with their daily job. Hence, scientists themselves are involved, first of all those of the SNS, but also those from other institutes, both national and international. At the focus of attention are the most recent scientific discoveries, explained, visualized and experimented with the latest digital tools by eminent scientists: the cosmos, molecules, the vital processes and the way in which Nature has assembled these wonders that it is our task to unveil.

All our lines of activity involve direct contact of teachers, researchers and young scholars (research fellows and graduate students) with young students and the general public. This choice requires considerable organization and is a costly enterprise (albeit not in the economic sense: we estimate only 1.2 Euros per user!); we have pursued it with enthusiasm because it provides a direct relationship with those to whom we wish to explain science and its discoveries in a rigorous and in-depth manner. We are convinced that it is only by passionately involving the public, and in particular young people, that a deep and lasting interest in science can be raised.

One of the paradigms of science is its incessant request of comprehension; understanding Nature is the primary source of enthusiasm and stimulus for a scientist. We are convinced that attempting to understand a phenomenon, analyzing it, formulating hypotheses and comparing them with other phenomena (in short: the essence of scientific



Fig. 6. – Screenshot of the web page <http://vis.sns.it>.

method) is an experience that leaves its deep mark on a young person who experiences it in a direct and practical way. Scientific dissemination must thus be an active rather than a purely passive (and sometimes tedious) way of learning. For these reasons, all our activities include a great deal of innovation in their method, which can almost be said to be individualized so as to awaken interest present in each one of us.

4. – Achieved results

The VIS activities are divided into seven main lines. Virtual immersions in CAVE3D or by Oculus Rift 2.0 are on a weekly basis. For technical reasons related to the accessibility of the technological tool, the number of users per session is 20. Every month, there are three immersions for students and one for the general public. In the course of a year, we can thus share the experience of virtual immersions in science with about 1040 people, three quarters of whom are secondary school students.

The activity “A day as a researcher”, also dedicated to students, is intentionally very exclusive and involves five secondary school students who spend a day together with researchers from the SNS, sharing the everyday life of research and possibly giving them inputs and ideas to work on. Being a very self-reliant type of activity, it can bring great stimuli to the student. The total number of participants is 5 students per year.

The outreach lectures that we organize within the VIS on a monthly basis are open to both the general public and the students. Based on our experience after the first months of VIS, we can state that this kind of initiative has always been very successful, with an average audience of approximately 120 people per event. Since we envisage a monthly frequency for this activity, we expect to see about 1440 users in 12 months, evenly distributed between students and general public, in addition to others who can follow the events via web streaming.

The VIS Web Site (fig. 6) has become one of the main scientific dissemination sites in the Tuscany region, with over 205 000 pages visited by more than 60 000 different users in a few months. We intend to enhance the site with ever-increasing content, in order to make it a source of dissemination of scientific knowledge not only in Italy but also, through the English version of the site, at an international level. We ultimately hope

to attract over 50 000 visitors a year, who will be able to read news, follow lectures and register for various VIS activities.

Indeed VIS can attract more than 52 000 visitors a year, and can take advantage of the close cooperation of the SNS with high schools and the ability to divulge its activities via the Press and Communication Office. Because of these remarkable results in the field of outreach, the project coordinator —the present author— was awarded the outreach prize of the Italian Physical Society in 2015.

5. – Conclusions

The entire project of technical and scientific dissemination in the fields of Biophysics, Biology, Chemistry, Cosmology, Particle Physics, Archaeology and History, is highly innovative, also on a multimedial level. The fulcrum of the VIS project is its use of extremely advanced technologies such as Oculus Rift 2.0 and CAVE3D, by means of which the visitor can experience a perceptive and sensory 3D representation of the scientific data and interact with them by means of special gloves equipped with location sensors.

In addition to this, students involved in the activity “A day as a researcher” can experience at first hand the typical day of a researcher, find out about his/her field of research and visit the laboratories and computing centre.

All the activities are available and stored on the web portal dedicated to VIS, <http://vis.sns.it>, which has a high number of visitors, with more than 4300 new users a month; the dissemination conferences are webcast live and hence made available for podcasting. Ample use is made of the social networks to reach a wider and young audience, but also the standard diffusion media such as daily newspapers, radio, television and specialist magazines.

We have also initiated collaborations at national and international levels to ensure an increasingly efficient and synergic diffusion of scientific culture extended to visitors, so as to make Pisa a true reference place for science dissemination.

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