# POPULARISATION OF PHYSICS IN THE WILD

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## Abstract

Science popularisation is important to inform tax payers on how their money is used and to inform the general public of the progresses of research. The web 2.0, comprising the 3D virtual worlds, offers science and physics popularisation new communication channels and tools constituting, as a whole, a large part of "learning in the wild", with the consequent *citizen science* projects.
Tags: physics popularisation, informal learning, web 2.0, virtual worlds, Second Life.

## 1 Introduction

Science and physics popularisation is important as a means to promote further investments through the information of the tax payers on how their money has been used and on the improvements that scientific research can bring in their lives, so the communication of scientific knowledge to the general public is both a consequence and a precondition for the ongoing scientific-technological progress. Science popularisation gives the non-scientists an up-to-date knowledge, resulting in the constitution of a cultural environment where science is valued and supported.
The web 2.0 has not just quickened or simplified the existing procedures, it has opened new domains to science popularisation and to the active involvement of the non-scientists. Seminars, lectures, science museums, etc., are the traditional formats for science popularisation, while the web 2.0 provides tools that make it accessible to everybody. The cultural revolution of the Internet and the web 2.0 is expressed in the triad of information-communication-sociality. The multimedia on the web, with music, videos and games has made it predominant for sociality, knowledge and learning.
In this paper, we will describe in particular the experiences of physics popularisation in the virtual worlds. These are a specific instance of the cyberspace, true 3D social networks where the users interact directly through their graphical representation, the avatar, and "build" the world. Though they may appear like videogames, they constitute places where new forms of science popularisation are experimented.
The definitions *learning in the wild* and *citizen scientist* – not created, but made popular by *Nature* – summarize the change in progress in learning and the popularisation of science: "Much of what people know about science is learned informally" (*Learning in the wild*, 2010)[1]. In this context, wild stands for *informal* learning, without fixed schedules and programs. The result of this diffused learning mode is the *citizen scientist*, contributing to the *citizen science* projects with observations and data gathering, mostly thanks to the digital technologies.

## 2 Learning in the wild and citizen science

*Learning in the wild*, made up of freely chosen experiences without an express formative aim, is "often much more effective [than formal learning] at getting people excited about science" (*Learning in the wild* 2010) and involves people of every age, so it can be the foundations of school learning and of lifelong learning.
Forms of science popularisation and citizen science have existed since the XVIII century, but the web 2.0 has given the *science enthusiasts* the tools to communicate among themselves wherever they are based in the world, in a continuous junction between the physical world, where the facts

[1] Learning in the wild, Nature, International weekly journal of science, Apr 8th, 2010, http://www.nature.com/nature/journal/v464/n7290/full/464813b.html

are observed, and the cyberspace, where the data are stored and discussed, strengthening free learning through sharing and giving a sense of accomplishment and participation.
The wilderness is rich of engaging events, science festivals, plays like *Copenhagen* (Frayn 1998)[2] and *The Children of Uranium* (Greenaway 2006)[3], popular essays and fiction of science. The web hosts an amount of scientific sites, blogs and magazines. *Symphony of Science* (Boswell 2011)[4] presents famous scientists "singing" lyrics inspired to various aspects of scientific knowledge, Wikiversity collects resources for formal and informal learning.
Yet the direct participation of the general public to experiences of science popularisation is fostered by the citizen science projects. The oldest of these is *SETI@home* (SETI 2011, *a*)[5] - since 1999, 2,000,000 members in the world, almost 500 in Italy (SETI 2011, *b*)[6]. SETI analyzes the narrow-bandwidth radio signals from space, which do not known occur naturally, "so a detection would provide evidence of extraterrestrial technology". It covers "greater frequency ranges with more sensitivity" exploiting the virtual super computer composed of the members' computers connected to it. *Galaxy Zoo* uses the collaboration of the citizen scientists to classify the galaxies. The participants watch images of galaxies and choose among some features that mark out different types of galaxies (Galaxy Zoo 2011)[7]. *GridRepublic Volunteer Computing* is a container of citizen science projects (GridRepublic 2011)[8]. The members install a software on their computer, through which it works on research when the machine is not in use. The *NASA* recognises that they the citizen scientists "have helped to answer serious scientific questions" (NASA *a*)[9] and confirms the importante of constituting a supporting environment for the promotion of further investments.
The radon gas measurement is a precursor example of citizen science in Italy. As the decay product of radium, radon is present in the whole earth's crust and in the building materials taken from it. This natural source of radiation needs constant testing, in public and residential buildings, where the measuring kits are installed (ISPRA 2004)[10]. The *School Radon Survey* of Trieste university with INFN (Università di Trieste 2004)[11] in the years 2003-2004 engaged 4 schools in the region Friuli Venezia Giulia and about 200 students to test radon outdoor and in their homes. The *ENVIRAD-SPLASH* experiment of the INFN involved 110 schools all over Italy from 2002 to 2009. The students tested the schools for radon, calculated the concentrations on the basis of the readings of the detector, prepared the introductory sessions for new participants and ran the internet connection (Roca 2010)[12].
The *EEE-Extreme Energy Events Project*, began in 2005 by the Centro Fermi with the CERN, INFN, MIUR and EMFCSC, studies the cosmic rays with the involvement of students from all over Italy (Zichichi 2005)[13]. So far, 32 schools have participated. After the preliminary visit at the CERN, to assemble the telescope MRPC detector for the observation and the measurement of the cosmic muons, the engagement of the whole school is necessary, with turns to monitor the apparatus. The Liceo Cagnazzi at Altamura, Bari (Liceo Cagnazzi 2011)[14] is a positive example: information on the

[2] Frayn M (1998) Copenhagen, Anchor Books, New York, NY

[3] Greenaway P, Boddeke S (2006) The Children of Uranium, Charta, Milan-New York (bilingual edition in English and Italian)

[4] Boswell D, http://www.symphonyofscience.com/

[5] SETI *a*, http://seti.berkeley.edu

[6] SETI *b*, http://www.mconsult.it/seti-at-home.htm

[7] Galaxy Zoo, http://www.galaxyzoo.org/

[8] GridRepublic Volunteer Computing, http://www.gridrepublic.org/

[9] NASA *a*, http://science.nasa.gov/citizen-scientists/

[10] ISPRA, Istituto Superiore per la Protezione e la Ricerca Ambientale (2004), http://www.apat.gov.it/site/it-IT/Progetti/Legge_93_01_-_Disposizioni_in_campo_ambientale/Progetti_a_gestione_APAT/Progetto_13/

[11] Università di Trieste (2004), Progetto Radon School Survey, http://www.fisica.units.it/didattica03/download/progettoradon.pdf

[12] Roca V (2010) I risultati di un progetto scientifico didattico, Atti del 3° Convegno "Comunicare Fisica e altre Scienze", Frascati, 12-16 Aprile 2010

[13] Zichichi A (2005) Progetto "La Scienza nelle Scuole". EEE- Extreme Energy Events, http://www.centrofermi.it/eee/documents/EEE.pdf

[14] Liceo Cagnazzi, http://www.liceocagnazzi.it/. The material produced can be seen here: http://www.ba.infn.it/~regano/EEE/

school website, an article in the local magazine, discussion of the results in a public Conference. In these projects the students learn through a hands-on approach, carry out true scientific project, build the measuring tools, study radioactivity in the field, apply the experimental method, evaluate the limits and validity of the measurements. The radon projects also improve the knowledge of the territory. These projects constitute physics laboratories and excellence courses and are the junction between the popularisation of physics and formal learning. While the schools need to change programs and methods, the general public is caught in a direct participation, through the installation of the radon measuring kit at home, or being invited to a conference.

## 3 Virtual worlds

The virtual worlds, or metaverses, invented for playing, have turned out to be the most complete environments on the web to create and share culture. The features common to all of them are tridimensionality, the user present as an *avatar,* synchronous communication through text-chat and voice-based chat, but a few others are necessary to use them for the popularisation of physics: no pre-arranged storyline, no characters to interpret or levels to attain, user-created content. To the persistent base of the world designed by the developers, the users add regions (*lands*) designed by themselves - ancient Rome, Dracula's castle, islands devoted to culture, art, science - and create groups according to their specific interests, many of which active also on other social networks, websites and blogs.
The virtual worlds are fundamental channels for the popularisation of science and physics, for the users attending them. The majority belong to an age level higher than in the real games, are educated, have various cultural interests. The virtual worlds are consistent with the emerging trends, the gender asymmetry in disfavour of women reported by other projects of dissemination is absent and they are fit for the differently abled, which they foster socially and physically, solving some motor or expression difficulties, in a place where it is easier to contact people and make friends.
The social interaction with the avatars present in the same place, produces the sensation of "feeling present", just like in the physical world (Baumgartner 2008)[15]. The creativity prompted by building and scripting makes these worlds *generative* of new cultural contents. The user as the content creator and the social interaction in presence bear the *immersivity* of the environment, a positive emotion that prepares the avatar to a more active participation than in Real Life (Suler 1996)[16]. Universities, non-profit organization, scientific groups give courses, make conferences and research. All this does not replace the activities in the physical world. Rather, they are expanded and given a new presentation. The playful dimension, even when it is not the immediate aim of communication, helps the transmission of knowledge and learning (Flanagan 2010)[17].

## 4 Science popularisation in the virtual worlds

In the metaverses science popularisation may happen in forms different or impossible in the physical world, with objects where the game is implicit. *Building* and *scripting* enable you to represent physics concepts or events through interactive objects that are themselves a form of play - the avatar can get into a black hole or "become" a subatomic particle, a playful dimension that is part of the appeal of science popularisationin the metaverses. The science event "within reach of teleport" encourages the participation of those who up to that moment had left it out, for want of interest or prevented by everyday circumstances. The metaverses facilitate the discovery of

[15] Baumgartner T, Speck D, Wettstein D, Masnari O, Beeli G, Jäncke L (2008). Feeling present in arousing virtual reality worlds: prefrontal brain regions differentially orchestrate presence experience in adults and children. Frontiers in Human Neuroscience, 2, 1-12, http://www.frontiersin.org/human_neuroscience/10.3389/neuro.09/008.2008/abstract, then click on fnhum 02-008_SUPPLEMENT.pdf for PDF

[16] Suler J (1996) The Psychology of Cyberspace, revised 2006. Online treatise, http://users.rider.edu/~suler/psycyber/psycyber.html

[17] Flanagan T, Delphin G, Fargis M, Lexington C (2010), Arts, Mathematics and Physics in Second Life, paper for the Aplimat Conference 2010, http://journal.aplimat.com/volume_3_2010/Journal_volume_3/Number_1.pdf

cultural fields so far ignored or considered intellectually distant. At the moment, the 3D world *Second Life* appears as the most complete and flexible for the popularisation of science. The group *Real Life Education in Second Life* has 4,800 members, educators in Real Life. Universities and institutes inworld are Stanford University, Media PlayLab (Singapore), Infolit iSchool (UK), NOOA – to mention but a few.

Among the scientific groups, physical and astrophysical topics are prevailing. The NASA land in Second Life exhibits space and terrestrial environments that illustrate its fields of research - glaciers, underwater laboratories, volcanoes. Through its website, the NASA provides a guide for the games inworld, for students of different age groups: they deal with the building of space rockets and their importance in the development of space research, or with the students working at the organization of a mission on the Moon and the study of its habitat (NASA *b*)[18]. Some of these games are suitable to promote a popular talk, as the playful dimension attracts also the adult receivers of science popularisation, who can play with the interactive objects or build some themselves. *MICA-Meta Institute for Computational Astrophysics* gathers international Real Life astronomers and astrophysicists to study the application of the virtual worlds and technologies to astronomical research. They give public lectures on Saturdays, which can be listened again from their website (MICA)[19]. *Science Friday* presents a course on the basic concepts of astronomy and optics, with interactive models of astronomical objects. It broadcasts inworld the scientific programs of NPR-National Public Radio. The avatar audience can ask questions to the guests in the Real Life studio. The anglophone *Kira Café* is a bar to socialize and discuss interdisciplinary scientific subjects. *Exploratorium* is a science museum inspired to the Real Life homonymous museum in San Francisco, CA. It hosts a presentation of nuclear physics, experiments of physics, astronomy, on perception, and an interactive Sun: the avatar travels to the Earth riding a sun ray. An installation of the Earth-Moon system shows how a solar eclipse appears from the Moon. *Second Life Physics Lab*-SLPL, founded by a physics professor in Real Life, exhibits a cannon shooting cannon balls following two different trajectories, either according to Buridanian or Newtonian physics: this shows how the tools of the virtual world can be used for science popularisation.

In the Italian community we can see the emergence of several groups that carry out extemporary activities or well established projects lasting for several years now. Italy has taken part in *Avatar Project* 2009-2011, to study the use of the virtual worlds as a classroom laboratory, co-financed by the European Commission. High school teachers and students experimented with the features of the virtual world: immersivity, creativity, learning made interactive and easier by the 3d ambient (Avatar)[20]. Italian groups dealing with teacher formation are *INDIRE* (INDIRE)[21], with courses of building, maths and Italian l2. *SecondAnitel*, association of e-tutors, with courses on teaching with the digital technologies (ANITEL)[22]. *Imparafacile* offers courses on e-learning and makes research on teaching methods in the virtual world (Imparafacile)[23]. *Immersiva.2life* is engaged in the popularisation of culture and music through live concerts and forums on topical issues. *EsplicaSL* is the virtual representative of Esplica no-profit (Esplica)[24], to link "the immersive creativity of the metaverse and the physical reality" and to promote Second Life as an aggregation place for the diversely abled. In 2010 it realized "Let's read in Second Life", a twinning with the eBookFest in Real Life (Cross-Universe)[25] and this year has presented its accomplishments at the exhibition for the 4th anniversary of Nonprofit Commons, a similar group in Second Life.

*Second Physics*, group for the popularisation of physics and science, from 2008, is an example of the many activities possible in the metaverse in this field. *Scienza on the Road*, in collaboration with Immersiva2Life, is an itinerant series of one-hour conversations started in 2009. It has won

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[18] NASA *b*, http://search.nasa.gov/search/edFilterSearch.jsp?empty=true and http://core.nasa.gov/

[19] MICA, http://mica-vw.org/wiki/index.php/Meta_Institute_for_Computational_Astrophysics and http://www.mica-vw.org/wiki/index.php/Popular_Talks

[20] Avatar, http://www.avatarproject.eu/avatar/

[21] INDIRE, http://www.secondlearning.it/

[22] ANITEL, http://www.anitel.org/anitel/

[23] Imparafacile, http://imparafacile.ning.com/, accessed 2011 December

[24] Esplica, www.esplica.it

[25] Cross-Universe EBookFest, http://www.esplica.it/images/stories/IMMAGINI_ARTICOLI/leggiamo_in_second_life.pdf

fame by now, with more than 4,000 avatars attending the lectures in more than a hundred different Italian lands. At the moment Second Physics has more than 1,500 members – one of the highest number among all the scientific groups – comprising many non-Italian-speaking avatars, who receive the English translation on a special board. So far, the conversations have dealt with Physics, Astronomy, Particle Physics, Mathematics, Acoustics, Optics, Medicine, Cybernetics, Literature for Science Popularisation. The audience can ask questions and discuss with the lecturers. The conversations are broadcast in streaming web and announced in blogs, online magazines and on FaceBook. Second Physics has taken part to the conference Virtual Worlds Best Practices in Education 2010, with school and university groups active in Real and Second Life, with a poster session and an article on the Journal of Virtual Studies (Boccardi 2011)[26]. With SL Art, in 2010 Second Physics organized *Scien&Art*, a contest for the artists aiming at expressing "their creativity through scientific concepts" and the scientists trying to communicate scientific ideas in a creative way, which put into evidence the link between art and science. A 10-hour course *Beyond the Third Dimension* was held in 2009 and a course on the cosmic rays will be given in *Second Campus*, the project started this year with two 10-hour courses, on the literary fiction for science popularisation and on the graphics software *Blender*. The *Science Café* opened in 2010 at Second Physics, without a fixed schedule. On the occasion of scientific events in Real Life, an expert in the subject is invited to analyse the sense and the value of the piece of news. Besides the scheduled events, the land of Second Physics presents installations on the physicists' researches and anecdotes, as prompts for quizzes that, while attracting the visitors' attention, drive them to some googling to solve the enigmas. Other fixed installations are the optical illusions, and the presentations of past courses and exhibits. Finally, there are scientific sculptures, from Leonardo to the DNA helix to the cosmic rays.
We end this description of the activities of Second Physics mentioning the support group to the free online course on AI by S. Thrun and P. Norvig with Stanford University, set up in Second Campus Hall to discuss the lessons weekly. *Learning in the wild* arises new cultural interests and the virtual world gives a space to share them.

## 5 Conclusions

*Learning in the wild* is made up of freely chosen activities, without a direct formative aim. The web 2.0 has given the science enthusiasts the tools to contribute to scientific research through the citizen science projects making observations, collecting data, discussing with other citizen scientists online.
The metaverses are showing great possibilities for science popularisation, thanks to the direct relationship between the divulger and the receiver through the avatar, both a playful and "serious" mode, that makes learning easier.
This has changed the way we learn and formal learning, in its turn, will have to change programs, methods, evaluation systems, to keep up with tools that are not simply "technologies", but represent a true cultural revolution where sharing, playing, free choice, are the keywords.

[26] Boccardi B, Fabbri F L, Fragona M, Nardone A, Parolini G, Dos Santos R P (2011), Second Physics: Popularisation and Outreach of Science in the Italian Second Life Community, http://ejournal.urockcliffe.com/index.php/JOVS/article/viewFile/20/3