

Spreading high-energy physics culture

In our society, the implications of science share one characteristic with cosmic neutrinos: people are totally immersed in them but their detection and recognition are very difficult.

But while neutrinos don't care if they remain undetected, science in general, and particle physics in particular, is facing growing problems because of this invisibility. While proud to be at the vanguard of discovery, scientists are becoming increasingly aware of an ambivalent place in society. The SSC cancellation was a major signal, but similar difficulties are found everywhere.

The 20th century began as "the century of science", with great enthusiasm for scientific and technological progress, but this euphoria is now tempered by doubts and real fear. What will scientists do next... where are they taking us? Has science gone too far? The reasons for this change in attitude are not yet fully understood: surely it is related to the development of weapons of mass destruction and by industrial and ecological disasters, real or perceived. In part it also reflects a natural reaction by laymen to an unfortunate attitude of superiority and detachment shown by some scientists. There are also unfulfilled expectations, the disappointment following over-optimistic claims, and in some cases deliberate propaganda.

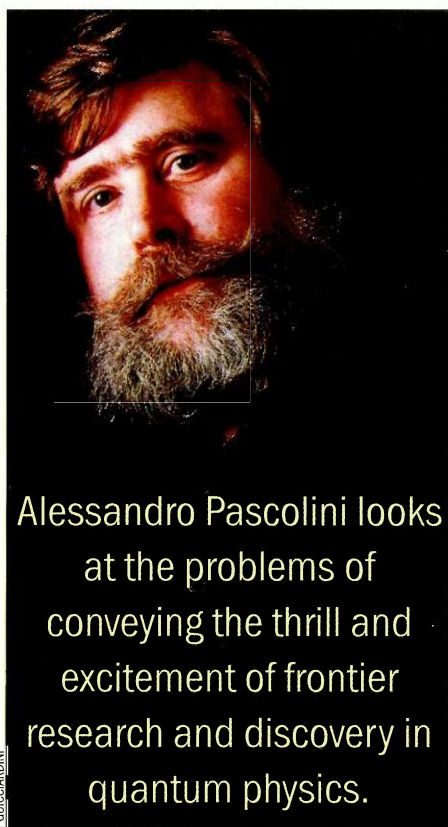
But a major reason is the scientific illiteracy and ignorance of the majority of otherwise educated people. This is due to science being excluded from specialized education, to irrational fears and to a dangerous revival of the occult. Such ignorance is one of the reasons behind the often exaggerated perceptions of health risks, one of the driving forces behind decisions on science and new technology.

Specific problems

Particle physics is a far from everyday experience, and research continually explores frontiers which are even more remote. Starting from commonsense notions, science observes and explores the world around us. In doing so it discovers apparent paradoxes and then reflects on how commonsense must be reappraised to explain these paradoxes. In turn these fresh ideas suggest new observations and more refined experiments. Thus scientific evidence and everyday experience move further apart. Particle physicists use concepts totally foreign to a layman: or for that matter even to chemists or biologists.

The paradox is that a branch of knowledge which in principle sets out to explore the most basic questions of all has become almost a closed field. We can be proud of the intellectual achievements of particle physics and the technological skills and ingenuity it demands, but from the point of view of the public and most intellectuals, these efforts are hidden behind an impenetrable curtain.

The American anthropologist Margaret Mead noted: "Scientists at



Alessandro Pascolini looks at the problems of conveying the thrill and excitement of frontier research and discovery in quantum physics.

the frontier, where the terminology and imagery are developed, speak mostly to other scientists at or near their own level of understanding... scientific language has escaped from the realm of 'natural language'."

Since Galileo, the language of physics has been mathematics, even less familiar than physics itself! Many "intellectuals" are not ashamed of their mathematical ignorance, which is not considered to be an educational deficiency or a handicap in understanding the surrounding world. Richard Feynman's suggestion to learn some mathematics and to use logic and reasoning to understand physics becomes instead an open invitation to many to give up trying to understand it.

Risky metaphors

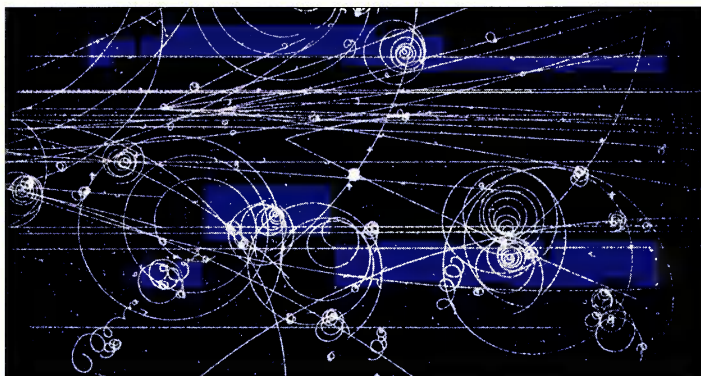
Deep knowledge and understanding is not easy, but associating concepts with images – if only symbolic – can be a powerful way of learning, boosting confidence in the concepts and allowing elaboration and increased understanding. In various fields, such collective imagery is a cultural inheritance, facilitating the transmission of ideas and giving a valuable vision of reality.

However, such iconography becomes more and more difficult and risky for fundamental physics. There are no conventional images for microsystems and moreover we have no authority to invent them. In addition, these representations are usually not self-explanatory but require their own interpretation using other metaphors. Consider the representation of the "constituent" quarks of a proton as small "coloured" spheres, suggesting an image of "particles" building a "particle" – all the words in quotes are dubious metaphors.

Human imagination and scientific creativity work by evoking sensory impressions. For the microworld, our intuition rests on formulating the visual imagery of the underlying mathematical structure of a physical theory. Bubble chamber pictures can be held up as visualizations of particle interactions, but because of the complexity of the experimental setup, such pictures are many layers removed from the "raw" mechanisms of particle collisions. The pictures show the result of particles interacting, but not how they interact.

On the other hand, Feynman diagrams provide a valuable glimpse of an otherwise highly intangible world. However, a lot of work is needed to formulate such enlightenment: but we can use them as a starting point for metaphors which are more correct than those based on classical concepts.

The main problem with metaphors, useful though they are, is that they do not give any clear indication of their areas of applicability. Using them out of context can lead to misunderstandings. They may be effective tools for informed scientists, but a straw in the wind otherwise. Metaphors can help bridge an intellectual gap, but there



Bubble chamber pictures show particles interacting, but not how they interact.

is no substitute for understanding. Ultimately we have to exploit logic, not facile pictures.

The role of science is to explain, to communicate. There are communication difficulties, but the more conspicuous they are, the more effort should go into overcoming them.

Another paradox is that the popularization of science is not always popular among scientists. Many see it as a lowering of standards, a loss of rigour. Whilst remembering Einstein's advice that "everything should be made as simple as possible but not simpler", scientists must nevertheless be tolerant of efforts to communicate difficult

ideas and help to bridge the gap between scientists and the public.

Happily, there is now an increased interest in such "outreach" activities in particle physics by individuals and institutions. In France, where most scientists are civil servants, this duty has recently been written into their contracts of employment. In the UK, research groups are allowed to devote up to 1% of their research resources in education and communication activities.

In the USA, major experiments are engaged in a broad spectrum of outreach initiatives, and in particular the ATLAS and CMS groups for CERN's LHC collider are highly productive. In Europe, an overall "European Particle Physics Outreach Group" has recently been set up, coordinated at CERN by Frank Close.

For all these initiatives, the goal is to convey emotion – the thrill and excitement of frontier research and discovery. We are fortunate that our business is to investigate some of the most interesting and fundamental issues in the history of science and of civilization itself. What better subject matter could there be?

Alessandro Pascolini, born in 1944, is Associate Professor of Mathematical Methods of Physics at the University of Padua. For the past 10 years he has been responsible for the outreach activities of the Istituto Nazionale de Fisica Nucleare, producing several exhibitions in Italy and abroad, and audiovisual materials. His research interests are in the fields of theoretical nuclear physics and nonlinear phenomena.

BIMETALLIC TRANSITION JUNCTIONS

THE T+C / CEA KNOW-HOW :

for the assembly of different
metals under stringent reliability



VARIOUS APPLICATIONS

- Class 1 • Normal Cryogenics
- Class 2 • Advanced Cryogenics
- Class 3 • Space, nuclear, chemicals

STANDARD TRANSITION ON STOCK
QUALITY ASSURANCE



CALL FOR DETAILS
A. PINET Consulting Engineer
Phone : (33) 72.02.68.00
Fax : (33) 72.02.68.01



T+C

THEVENET + CLERJOUNIE
22, avenue Franklin Roosevelt - 69517 VAULX-EN-VELIN (France)

www.metrolab.com

Global range of magnetic measurement equipments

METROLAB
Instruments SA

- NMR
- ESR
- Hall effect
- Digital fluxmeter
- from mT to 50 Tesla
- Accuracy
10⁻² to 10⁻⁸

tel : +41 (22) 884 33 11
fax : +41 (22) 884 33 10
E-mail : contact@metrolab.ch
110, ch. du Pont-du-Centenaire
CH-1228 GENEVA Switzerland

www.metrolab.com