Italy faces challenges of reform

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Italy has a proud tradition in physics, but 100 years after the birth of Fermi, bureaucracy and underfunding make it difficult for universities to attract the best young physicists and for the country to compete with other nations in applied areas of science. **Edwin Cartlidge** reports

Physicists will gather in Rome at the end of this month to celebrate the 100th anniversary of the birth of Enrico Fermi, one of the outstanding scientists of the 20th century. Awarded the Nobel prize in 1938 for his pioneering work in nuclear physics, Fermi also made notable contributions throughout many other areas of physics. And in Italy, the work of Fermi and his collaborators – known collectively as the School of Rome – paved the way for half a century of success in physics. But this success is under threat because bureaucracy and cronyism hold back many of the country's best young researchers.

The biggest problem is that university appointments tend to be made on the basis of who knows whom, rather than on the basis of merit alone. This, together with huge under-investment – Italy currently spends only around 1% of its GDP on research, about half the European average – has left Italian science struggling. Although physics has fared better than most other areas of science, it has suffered from the near absence of interdisciplinary collaboration, and there has been very little technology transfer. And even the most highly funded and best organized subfields – nuclear, particle and theoretical physics – are under threat because about half of the researchers in these fields are due to retire within the next decade.

At the end of July, the newly elected government of media tycoon Silvio Berlusconi promised to bring Italian spending on research into line with EU levels and to reform the appointment system for universities. But the success of these reforms remains to be seen – the previous government started to reform the university-appointment system, but the corruption remains.

Particle power

There can be no doubting Italy's strong tradition in nuclear and particle physics. There has been a world-class accelerator laboratory at Frascati near Rome since 1959, and the Gran Sasso lab is unique in being a purpose-built underground facility for highly sensitive astroparticle-physics experiments.

Italy is also a big player at CERN and other major particle-physics labs around the world. This is a testament to the breadth of its scientific programme, which produces excellent researchers. Combined with its financial clout, this probably makes Italy the most active country in Europe when it

Strength in depth – the Borexino neutrino detector at the Gran Sasso underground laboratory

comes to particle physics.

Central to this success has been the Istituto Nazionale di Fisica Nucleare (INFN), which was created by one of Fermi's students, Edoardo Amaldi, and has always been highly effective at securing state funding. "The INFN is quite unique because it is governed by physicists with little interference from either politics or bureaucracy," says Nicola Cabibbo, a particle theorist at the University of Rome, *La Sapienza*. "My impression is that Italian politicians, independent of their political inclinations, appreciate the role that the INFN has acquired in the international physics community, and respect the work being done."

Copying a winning formula

In recent years, other areas of physics have attempted to imitate the INFN. In 1994 condensed-matter physicists set up the Istituto Nazionale per la Fisica della Materia (INFN), and last year astrophysicists established the Istituto Nazionale per l'Astrofisica (INAF). The INFN, says its founder Carlo Rizzuto, has succeeded in strengthening Italy's research base in condensed-matter and materials physics. It has also launched new initiatives in applied research and technology transfer, supported areas of new research, and has provided access to large facilities, such as parallel-computing facilities and synchrotron-radiation sources.

The INAF, meanwhile, has taken over Italy's existing network of astronomical observatories, and also manages large projects, such as membership of the European Southern Observatory. Another highlight of Italian astrophysics is Beppo SAX, a space-based gamma-ray telescope.

Nicola Cabibbo thinks there have been several improvements in Italian physics in recent years. "The good ingredients in re-

cent decades have been diversity," he says, "with different centres having their recognisable flair, such as Pisa, Rome, Milan, Catania, Turin, Naples and so on, and also unity, which has allowed different centres to co-operate and compare strategies at a national level."

Areas of weakness

But there are significant areas of physics in which Italy has fallen behind, according to Rizzuto, who is now head of the Elettra synchrotron facility in Trieste. "Physics in Italy can compete in very well defined fields, such as high-energy or computational physics," says Rizzuto, "but it lags in emerging and increasingly important interdisciplinary areas such as medical physics and environmental physics." Rizzuto also criticizes the divisions between theoretical and experimental physics in Italy. "This rigidity impedes the mobility of physicists and is part of a crisis that is set to hit physics in the next few years," he warns.

This rigidity is due to a bizarre system of bureaucracy that organizes academic disciplines on a national scale. Individual universities are not free to hire researchers – instead they must hold a national competition for each new appointment. Physics is divided into six areas for these purposes – nuclear and particle, theory, matter, astronomy, general and physics in other faculties.

When a university position in one of these fields becomes available, all the professors in that field vote in a national ballot to elect four members of an appointment committee. A fifth member of the committee is selected by the university with the vacancy. This committee then selects three successful candidates, one of whom will be hired, while the other two are placed on a reserve list. In most cases all three candidates will already belong to the university that hires them because it is more expensive to employ someone from outside.

The system is rife with cronyism, says Rizzuto, because there will always be a group of professors within each field that holds the majority vote. This means that the candidate chosen is often not the most able, but simply the cheapest.

This system – combined with low overall levels of funding, relatively low pay and poor working conditions – means that many of the best young physicists leave the country, and that very few researchers move to

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Italy from overseas. Indeed, as a proportion of the total workforce, the number of researchers working in Italy is only about half that in Germany or France.

"The US environment is much more open and competitive," says Claudio Pellegrini, an Italian physicist who is now chair of the physics department at the University of California at Los Angeles. "For example, if there is a new faculty position available at UCLA, we look for the best candidate worldwide. This does not happen in Italy, even at the level of the European Union. In many cases there is very little mobility in Italy, and this results in inbreeding."

The difficulty of reform

As part of the government's reform plans, education and research minister Letizia Moratti has said that her new administration will change the recruitment procedure by dropping the list of chosen candidates. However, researchers remain to be convinced.

"In the past some significant steps have been undertaken by the government to improve the quality and quantity of research," says Lorenzo Pavesi, an experimental physicist at the University of Trento. "Funds are now distributed following national calls for proposals, and not on a diffuse base. Universities now have more autonomy, and the national institutes, like the INFN and the INFN, have been strengthened. But four critical issues remain: the need for more funds; the need for more people, especially young people; the need for a greater concentration of resources in certain centres to increase the critical mass; and the need for more applied and technological laboratories."

Indeed, much remains to be done if the Berlusconi administration is to push through

Focus needed – photonics researcher Lorenzo Pavesi believes research money must be concentrated in centres of excellence

real reform. The power in universities is held by people who are unwilling to share it, says Rizzuto. And the doubling of funding promised by the government is unlikely to lead to a doubling of researchers, he adds, because Italy only produces about half the number of graduates produced by most other European countries, and only about a third of the number of doctorates. This situation is being made worse by the fall in the number of students who are studying science.

Rizzuto also points out that changes to the structure of university degrees are having an adverse effect on the number of university research posts in Italy. With a new three-year degree plus a two-year masters qualification replacing the old five-year degree, Rizzuto predicts that university engineering and medical faculties will reduce the number of physics-related courses on offer.

Industrial shortcomings

Another problem is that there are few opportunities for physicists to collaborate with industry, and the shortage of researchers means that few can devote their time to technology transfer. Moreover, many companies have been privatized and have then closed their research labs. Lorenzo Pavesi blames Italy's relatively poor standing in the growing area of photonics on a lack of researchers, money and technology transfer. "We are suffering because of the underdevelopment of the past and it will be difficult for us to catch up with what has been achieved abroad," he says.

Last year Pavesi and co-workers took a significant step towards the creation of a silicon laser, which would represent a major milestone in optoelectronics (see *Physics World* February pp19–20). However, he cites photonic crystals as an example of physics research in which Italy is years behind other European countries, despite the enormous commercial potential of the technology.

However, Pavesi maintains an upbeat attitude. "Physicists have to be positive in order to allow the success of the major reforms that are currently under way in Italy," he says. "Physicists can do a lot to promote excellence in research because they are already used to collaborating with colleagues worldwide."

Massimo Inguscio, director of the European Laboratory for Nonlinear Spectroscopy in Florence, is also optimistic, pointing to the enduring effect of Fermi. "His legacy has been important not only for nuclear physics, but also for the physics of matter where Fermi's presence is ubiquitous," he says. "His name still attracts the best young students to our field."