

Physics in Italy from 1870 to 1940

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The fact that, as you know, this Conference will be followed by another one dedicated to a century of physics in Italy, has induced us to present here firstly a general overview of our research, then a brief outline of our most recent findings.

Our research started in the fall of 1983 as a project limited to the pre-history of solid state physics in Italy. It began with a study of the institutional context of physical research between 1870 and 1940, with particular attention given to the four decades of our century.

The analysis of scientific production in fields that would have become parts of today solid state physics has not been completed. We have studied in some detail only five topics:

- magnetic properties
- galvanomagnetic effects
- elastic properties
- photoelectric effect and photoconductivity
- electric conductivity.

However it must be stressed that these five topics cover about 75% of the entire production concerning ‘solid state’. Moreover, it is in these fields that Italian contribution has been, for several reasons, more interesting. The results of this first effort have been described and discussed, among others, in the

publications reported in footnotes.^{1,2,3,4}

The study of the pre-history of solid state physics has found a kind of accomplishment in the organisation of a meeting on ‘The origins of solid state physics in Italy: 1945-1960’, held in Pavia in 1987. Apart from five lectures given by historians, the contributions came from physicists who contributed to the development of this field in Italy (16) and abroad (3). The proceedings have been published by the Italian Physical Society.⁵

The year 1987, marked a turn in our research: the original project was enlarged in order to cover the history of Italian physics community from political unity to the outbreak of second world war. The first step in the new direction has been the study of the reaction of Italian physics community to the novelties represented by the new radiations, quanta and relativity. The results of this study will be soon submitted for publication.⁶ This move has been suggested by the idea that the reaction of a scientific community to profound conceptual innovations appears to be a reliable test of its vitality. This step has necessarily required a deeper insight into the last three decades of nineteenth century and has prompted the last one, which remains to be done: the idea of settling in a book a comprehensive view of physics in Italy between political unity and the end of the first world war. The book will be characterised by a challenging attempt of describing the development of physics in the wider context of economical, political and cultural events.

After this introductory overview, we shall try to give an idea of the main findings of our work.

- Till the end of the eighties of the past century, Italy has been a pre-industrial country; as a consequence, there were no favourable conditions for the development of scientific research. Furthermore, starting 1887, the protectionist policy reduced the urges for technological innovations.

¹S. Galdabini, G. Giuliani, ‘Physics in Italy between 1900 and 1940: the universities, physicists, funds and research’. *Historical Studies in the Physical and Biological Sciences*, 19 (1988), 115-13.6

²S. Galdabini, G. Giuliani, ‘Early lines of research in Italy: 1900-1940’, in *The origins of solid state physics in Italy: 1945-1960*, edited by G. Giuliani, (Bologna, 1988), 1-14.

³G. Giuliani, ‘Physical research on solids in Italy between 1900 and 1940: a survey’, in *The restructuring of physical sciences in Europe and the United States: 1945-1960*, edited by M. De Maria, M. Grilli e F. Sebastiani, (Singapore 1989), 339-347.

⁴S. Galdabini, G. Giuliani, ‘Magnetic field effects and dualistic theory of metallic conduction in Italy (1911-1926): cultural heritage, creativity, epistemological beliefs, and national scientific community’, *Annals of Sciences*, 48, (1991), 21-37.

⁵‘*The origins of solid state physics in Italy: 1945-1960*’, edited by G. Giuliani, (Bologna, 1988).

⁶G. Giuliani, P. Marazzini, ‘*Italian physics community and the crisis of classical physics: new radiations, quanta and relativity (1896-1925)*’. To be submitted for publication.

- The scarce financial means that an underdeveloped country can afford, were drained by the Faculties of Medicine both in terms of funds and personnel.
- In this context, the 21 Universities inherited from pre-unitary states, were clearly redundant with respect to the needs of the newborn nation. However, the attempts at reducing them failed for the staunch opposition of local authorities and deputies.
- The industrial takeoff that started during the last five years of the past century, had a beneficial effect on courses and academic staff of engineering, but did not enhance the development of scientific disciplines of Science Faculties.
- Starting at the turn of the century, the cultural climate becomes progressively hostile to scientific values owing to the rising of neoidealistic and irrational tendencies.
- The most significant attempt at promoting a general climate favourable to the organisation and the diffusion of science was the foundation in 1907 of the ‘Società Italiana per il Progresso delle Scienze’ (SIPS).⁷ However, given the general situation of the country, it is not surprising that the main hopes of SIPS’founders have been dashed. In 1928 the then president Filippo Bottazzi, in admitting the defeats of the association, stressed with vigour that those defeats had to be ascribed to the governments and to the industries.

The charges were:

- to have tolerated the general underdevelopment of science with respect to other countries
- to have given priority to technical applications of science rather than to science itself
- to have not reduced the technological dependence of industries on foreign countries
- to have not recognised the need for a Ministry for Scientific Research

However, Bottazzi’s complaint remained unheard. In this context, it is worth stressing that:

⁷It is worth recalling that similar associations were founded in 1822 in Prussia, in 1831 in United Kingdom, in 1848 in the United States and in 1864 in France.

- The first laboratory research of reasonable size created outside the University was founded in 1935
- It was only well after the second world war that Italy transformed into a true industrial country and science began slowly to occupy a significant place in budgets and in public opinion

It is in this general context that physicists worked in Italy. Among the institutional deficiencies that have hampered the development of physics in Italy, by far the most effective have been the small number of physicists and the smallness of the ‘local groups of research’. Here, we only recall that:

- the number of academic physicists was of 38 in 1871, of 71 in 1900 and of 126 in 1927, distributed over about twenty institutes
- around 1910, the average number of physics graduates was one per University; in 1927 the average number per University was three

The smallness of the community has reduced the possibility of developing all fields of research and limited the circulation of ideas. The insignificant number of physics degrees reduced dramatically the base for the selection of new physicists. Furthermore, the few physicists were burdened by several organisation and, in some cases, political activities. Moreover, to circulate ideas one needs to produce ideas or use ideas formulated by others. From this point of view, we have tried to assess the cultural background - general and disciplinary - of Italian physicists in the last three decades of the past century. In contrast with commonplaces in this matter, we have found that:

- the picture of a scientific community (not only physical) wholly confined into a philosophic tradition of rough positivism, is untenable.
- Italian physics community faced the turn of the century with serious lacks in the ‘acquired knowledge’, both in specific fields and in general issues. The list contains electrical discharge in gases, cathode rays, black-body radiation, statistical mechanics and, more generally, the structure of matter. These deficiencies can not be ascribed to a scarce interest in theoretical aspects; they were instead connected with a partial and fragmented view of the discipline.

These two features are essential in the understanding of the reaction of Italian physics community to the crisis of classical physics. Before going into some detail, we must tell something about the sources we have used:

- We have put in a database and classified all the papers published in *Il Nuovo Cimento* from 1870 to 1900⁸
- We have scanned the papers published in ‘*Il Nuovo Cimento*’ and in ‘*Rendiconti della Reale Accademia dei Lincei*’, from 1896 to 1925
- We have scanned 56 textbooks or monographs published between 1896 and 1930

We shall now summarise the main findings of this study by dividing the subject into three sections: new radiations, quanta and relativity. About the new radiations:

- Italian researchers reacted promptly and with great interest to the discovery of X-rays; their contribution to the study of the new rays had been quantitatively relevant; the quality of their best papers was of international level. However, the fact that, after the initial burst, the quantity and the quality of Italian contribution decreased abruptly, suggests that Italian physics community was prepared to cope with the novelties at the experimental level but not to overcome the difficulties that arose when significant experiments required the interplay with theory or, at least, the capacity of conjecturing about the possible structure of matter.
- Italian scientists began to study cathode rays only when spurred by the interest in X-rays. As a consequence, they entered the scene practically at the end of cathode rays story. For that reason and for the fact that their attention was focused on X-rays, their production on this argument has been scarce.
- Italian scientists have been practically cut off from the study of radioactivity owing to the lack of radioactive materials.
- The process of transferring into textbooks, divulgation books and monographs, the knowledge about new radiations have reasonably followed the evolution of research. This process has been facilitated by three factors: the impact of new radiations on the wider public opinion; the fact that the discovery of them was deeply rooted in experimental research; the fact that the new radiations seemed, at least at the beginning, to be phenomena that, though completely new and unexpected, could be studied and understood in the conceptual frame inherited from the nineteenth century.

⁸This classification is going on in order to cover the entire period from 1855 to 1940. A booklet will be published with enclosed diskettes containing the data.

The reaction to quanta had three essential components:

- The ignorance of statistical physics rendered Planck's approach (not to speak of the subsequent development of the hypothesis of light quanta by Einstein) substantially extraneous to Italian physicists.
- The scarce interest in the structure of matter issues, led to an underevaluation of Bohr model of the atom and of its developments.
- The idea of a discontinuous variation of energy induced 'repugnance' towards all the physics of quanta.
- The process of diffusion of quantum ideas through Italian textbooks has been slow and difficult. It took place in a context characterised by a conception of the structure of matter that was, essentially, the one sketched by Righi in 1904: the 'new' particles (electrons, α particles) lived together with the 'old' aether. The only modification was the inclusion in this conceptual frame of Thomson model of the atom.
- Quantum ideas remained substantially extraneous to Italian physics community till the appearance of Fermi.

However, we must stress that this sketchy picture should be smoothed by saying that:

- Garbasso used Bhor's model of the hydrogen atom for studying the Stark-Lo Surdo effect. That does not mean that Garbasso accepted quantum ideas. As a matter of fact, Garbasso came back later to a modified Thomson model for studying the combined effect of electric and magnetic fields on hydrogen atom. Garbasso's position was clearly that of a scientist who, in a context of conceptual innovations, is ready to use the available models as far as they do their job and to choose, if possible, the more adequate. This behaviour was coherent with Garbasso's belief that models have a fundamental heuristic value.
- Corbino discussed quantum ideas around 1910 with a clear epistemological stand characterised by the evaluation of the new hypothesis on the basis of their agreement with 'facts' and of their compatibility with the 'acquired knowledge'. In the case of quanta, this led to a conflicting and uneasy situation clearly emerging from Corbino's writings.

The negative reaction to relativity was not due to deficiencies in cultural background. In this case, the attachment to classical mechanics, a rooted disposition towards a realistic interpretation of physical theories, the existence of

competing theories compatible with classical views, rendered practically impossible the acceptance of Einstein theory.

So, as in the case of quanta, relativity had to wait Enrico Fermi for gaining an outpost into the field of classical physics. However, in both cases, that did not mean a surrender of the entire community. As a matter of fact, the activity of Fermi's group and of other few young physicists (among them Bruno Rossi and Giovanni Gentile), emancipated from a peripheral condition only the fields of nuclear and cosmic rays physics and laid down the basis for the rooting of theoretical physics as a 'professional' commitment. The rest of the discipline stood on the borders of this process of integration into the international community. The unfavourable conditions - economic, political, institutional and cultural - that we have referred to at the beginning, though changed, were still there. So a rapid process of revitalisation and strengthening of the entire physics community was out of reach. Physics in Italy had to wait the difficult times of the second post-war period and to cope, in a context completely changed from the economic, political and scientific point of view, with the tremendous problems of reconstruction of the country. In the new condition, the weakness of the entire scientific structure was by no means an aid in making far-seeing choices.