The Arcetri School of Physics

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Introduction

The years between the first and the second World War (broadly from 1920 to 1940) are remarkable in Italy for the achievements attained in physical research. This was because of rather peculiar circumstances which made the Physical Institutes of the Universities of Rome and Florence the centre of advanced research and of formation of research leaders. Both groups originated through the dedication and the vision of enlightened men, Orso Mario Corbino in Rome and Antonio Garbasso in Florence, both good physicists open to the extraordinary discoveries of the years before and after the first World War, both sincere patriots willing to give their country a sound and up-to-date scientific culture.

The making and performance of the Group of Rome received wide attention and recognition in years due to the personality of Enrico Fermi in spite of the death of Corbino in 1937. The Group of Florence did not receive the same recognition, presumably because of the early death of Garbasso in 1933 and the quick dispersal of its members thereafter. Both groups were heavily hit by the racist campaign sparked off by fascism and culminated in the shameful racial laws of 1938.

In fact, the two groups were not formed in a desert. The tradition of scientific research in Italy gave remarkable results in time after Galileo, with such names as Torricelli, Spallanzani, Volta, Lagrange, Avogadro. But the Restoration after the French Revolution and the Napoleonic adventure, not only reinstated, in the first half of 19th century, the previous situation of political fragmentation in several small traditionalist principalities, among which the State of the Holy Seat, but also revived a

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L. Gariboldi et al. (eds.), *The Scientific Legacy of Beppo Occhialini*,
https://doi.org/10.1007/978-3-031-37034-2_6

reactionary attitude towards the heritage of Enlightenment. Fragmentation and conformity did not affect the development of mathematical research, mainly because it did not need financial investments, but were detrimental to the development of "natural" sciences of dimension and openness comparable with contemporary European, i.e. English, French and German, research and capable of becoming an active part of it. Restricting the interest to Physics, the Galilean tradition was maintained almost only in the sense of a careful experimentalism with good measurements often based on original instruments, more devoted to the discovery and description of peculiar "effects" than to the assessment of theoretical developments. Achievements recognized at the European level were those attained by Leopoldo Nobili (the thermocouple), Macedonio Melloni (the infrared radiation), Ottaviano F. Mossotti (the structure of dielectrics), Giovanbattista Amici (the immersion objective), Father Angelo Secchi (stellar spectroscopy and the dawn of Astrophysics). No less important the contributions to "applied" Physics, such as the telephone of Antonio Meucci, the dynamo of Antonio Pacinotti, the rotary magnetic field of Galileo Ferraris. It is a sign of the weakness of scientific and technical consciousness, as well as of economic structure, that neither the inventors nor the dawning Italian industry took a direct advantage of such results. On the other hand, by now we are well into the second half of the 19th century, after the independence wars and the political unification (1849–1870); now it is the stage of the greatest efforts for the integration and modernisation of the country and for the recognition of Italy at an international level. Many scientists, in particular mathematicians and physicists, were very active politically, taking part also in military actions and getting involved in governmental duties. It is worthwhile mentioning Carlo Matteucci (1811–1868), active in Pisa, interested in Florence, a good physicist founder with chemist Raffaele Piria of the journal *Il Nuovo Cimento*. He was Minister of Public Education in 1862–63, just after the proclamation of the almost unified Italian Kingdom, and made a first attempt for a structural reform and modernisation of the system of Italian Universities, too many and generally too weak as a consequence of the already pointed out localism. The Physical Institutes in particular were generally understaffed and poorly equipped also because of the prevailing petty humanistic culture of the ruling class, to the detriment of a more open attitude in consonance with the rest of European culture.

Physical Research in Italy From the End of the 19th Century to the Outbreak of First World War

It was a time of exceptional flourishing of Physics all over Europe, and also in the United States, from electromagnetism, spectroscopy and statistical mechanics to radioactivity, relativity and atomic structure. At the same time mathematical research was going on along the path initiated in the 18th and 19th century, contributing heavily to the building of what was to become the modern Theoretical Physics. The Italian mathematicians were well on the front line of this path, with Enrico Betti and

Luigi Bianchi in Pisa, Giuseppe Peano in Turin, Gregorio Ricci Curbastro in Padua, Tullio Levi Civita e Vito Volterra in Rome. Not equally impressive the contributions of the contemporary Italian physicists, still bound to the experimentalist attitude inherited from their predecessors of the 19th century. While important results were obtained, among others, in electromagnetism and later in spectroscopy, some of them refused stubbornly Einsteinian relativity in spite of the position of their mathematical colleagues, and only a few caught the importance of the Rutherford-Bohr atomic model. The development of research and teaching in Physics from the end of the 19th century to the outbreak of the first world war, can be outlined through the story of four Universities, Bologna, Rome, Pisa and Florence.

Bologna

Bologna was dominated by the personality of Augusto Righi (1850–1920), perhaps the most prominent Italian physicist before the 1st World War. He is better known for his elegant experiments in the wake of H. R. Hertz, proving the identity of electromagnetic oscillations of any frequency and light, but his ingenuity and thoroughness were present in all the subjects he treated, including the methodological approach to physical research [1]. This gave him recognition at the European level and power in improving the facilities of his Physical Institute. However he remained in doubt about relativity, characteristically lamenting the lack of a sound "laboratory" experimental basis.[1] Perhaps only his death in 1920 prevented Righi from elaborating the successes of the new theoretical (and experimental!) Physics. His equally doubtful successor Quirino Majorana (1871–1957), a good experimentalist in the old tradition, to the end of his life made use of the good equipment of the laboratory to carry out carefully designed experiments aimed at falsifying the results of Michelson and Morley. Of course, those experiments kept confirming the constancy of the velocity of light irrespective of the frame of reference.

As a matter of fact, the Physical Institute of Bologna did not contribute to the formation of the schools of Rome and Florence (with the exception of Bruno Rossi, but this occurred through the initiative of Rita Brunetti, of Pisan and Florentine origin).

Rome

Modern Physics in Rome begins with Pietro Blaserna (1836–1918). Born in Friuli under Austro-Hungarian administration, he completed his education in Physics at the

[1] Even after the Eddington's expedition, in 1920, he wrote to the French physicist Violle: "Apres la brillante confirmation que l'éclypse de Mai a donné à la théorie d'Einstein, il est juste que des epreuves sûres en faveur soient fournies même par les expériences de laboratoire" [1].

University of Wien and then in Paris with H.-V. Regnault. Called by Carlo Matteucci in 1862 (just one year after the first step of the unification of Italy) as teacher at the Museo di Fisica e Scienza Naturale of Florence, he became in 1863 Chair Professor of Physics at the University of Palermo. In 1872 he was called by the newly established University of Rome to join E. Keller in the establishment of a "Scuola Pratica di Fisica" in recognition of his contributions to electromagnetic induction and to the dynamic theory of gases. Interested in Terrestrial Physics, he was president from 1879 to 1907 of the Consiglio di Meteorologia e Geodinamica. In 1881 he founded the Physical Institute of the University in via Panisperna and there he called (1908) Orso Mario Corbino (1876–1937), who was then Chair Professor in Messina after spending several years in Palermo with remarkable achievements in various fields (magneto-optics and the Macaluso-Corbino effect). In Rome Corbino continued his successful scientific career (photoelasticity and the effect of Volterra distortions; specific heat in high-temperature metals; improvements in X-ray generators), also with the collaboration of young Giulio Cesare Trabacchi (1884–1959) who was to become director of the Physics Laboratory at the Istituto Superiore di Sanità in 1922 (Trabacchi had an important part in the development of Nuclear Physics in Rome).

Like several other prominent colleagues, Corbino was deeply involved in the First World War. The war caused a violent stirring of emotions, being perceived by most Italians as the way to the completion of national unification; also, it stimulated initiatives to overcome the weakness of the economic and industrial structure of the country, disclosed by the war needs. The very first outcome was the 1915 Committee, made mainly of industrials and scientists. A further initiative (see later) was the creation of an Office for Research and Inventions, attached to the Under-Secretariat for Weapons and Ammunitions (Ufficio Invenzioni e Ricerca, UIR): this government support made the difference, because, while the first Committee gave scarce results, the Office, directed by mathematician and physicist Vito Volterra, was the first step toward the foundation (1923) of the National Research Council (CNR). Corbino with other colleagues had an important part in it, as well as in other bodies created with the aim of developing the interaction of the scientific and industrial world also beyond the needs of the war [2]. Corbino initiated an intense public life in which he displayed both at the governmental and at industrial level his technical preparation, his leadership and his broadmindedness. He became senator shortly after the war and briefly Minister of Education, the first scientist after Matteucci. He was Minister of Economy for a few months at the beginning of the fascist government in a particularly troubled political period. He was able to keep his authoritative stand in the industrial and scientific world without becoming a member of the fascist party. The public life did not prevent him from continuing his scientific activity and above all from building what was to become the Group and School of Physics of via Panisperna.

Pisa

Pisa is peculiar because of the existence of the Scuola Normale Superiore next to a University of old tradition (13th century). Founded by Napoleon in 1810 as the core of his "Italian program" of reform of knowledge, the Scuola Normale followed the model of its twin Ecole Normale Superieure in Paris, with the same scope of formation of high-level secondary-school teachers; in fact, since its origin it became a school intended for the preparation of a selected cultural elite. Teachers at the SNS were specially appointed lecturers, often from the University of Pisa. This was the case in the first thirty years of the 20th century, when directors were the mathematicians Ulisse Dini and Luigi Bianchi, while Physics teachers were Angelo Battelli and Vito Volterra.[2] Several personalities who appear in the following were "normalisti".

As for the University, Angelo Battelli (1862–1916) succeeded in 1893 to Riccardo Felici (1819–1902, renovator after Carlo Matteucci of the Studio di Pisa and well known for his contribution to the interpretation of electromagnetic induction). Battelli, originating from le Marche, "laureato"[3] in Turin, 1884, was briefly Chair Professor in Cagliari and Padua, showing from the beginning his taste and ability in rigorous experimentalism (thermal properties of vapours, Peltier effect, thermoelectricity). In Pisa, he founded the Italian Physical Society, revived successfully the journal *Il Nuovo Cimento* and rebuilt and re-equipped the Physical Institute, receiving and stimulating a number of researchers and pupils, whom he would involve directly in the design and running of experiments. He was against specialisation, perhaps to the detriment of coherence in his projects, but he was ready to open his mind and his activity to the more recent results (gas discharge, cathode rays, X-rays, radioactivity), which were leading to the experimental and theoretical approach to the structure of matter beyond the limits of the chemical atom. This interest of Battelli, and also the method, is well presented in the treaty on Radioactivity (1909), written with his pupils and co-workers R. A. Occhialini (see below) and S. Chella and translated (1910) in German and French.[4]

Battelli had little time left for elaborating the next results of Rutherford (1911) and Bohr (1913) on the planetary atom: a fatal illness in the last years of his life brought him to a premature death in January 1916, only 54. Furthermore, in those years (as in

[2] With the reform of Giovanni Gentile, 1928, the Scuola added explicitly the further mission of promoting the scientific and literary national culture, with special postgraduate courses open to graduated from all over Italy and since 2002 from all over the world [3].

[3] At that time the Italian "laurea" was based traditionally on a (minimum) 4-year curriculum (this is the case for Physics and Mathematics) and on a written thesis preferably on an original subject. In the period discussed here the theses in Physics were typically experimental. The Italian words "laurea" and "laureato" will be used in the following.

[4] See Gamba [4]. Together with a meticulous review of the experimental results updated to 1909, none of them original, but many of which carefully replicated in the laboratory, the book contains a critical presentation of the current dubious models of atomic structure in the light of an electric theory of matter—a remarkable behaviour for a researcher strictly devoted to the empirical basis of Physics. Notably, no reference is made to the work of Einstein, presumably because of a supposed absence of an experimental basis.

previous years) he was deeply engaged in public life, becoming repeatedly a Member of Parliament with particular interest in the school system. Like so many Italian fellow-scientists in the 19th century, Battelli was an active patriot: a few days after the engagement of Italy in the first World War, he wrote to a leading newspaper an open letter, July 11, 1915, urging the Government to take immediate steps for the formation of a body, a "Scientists Section", where scientists would put their expertise in the selection and production of ideas and inventions useful for the war effort (similar bodies were already active in Germany, France and Great Britain) [5]. A "National Committee of Inventions" was promptly formed with the active participation of pain stricken Battelli and others. Alongside with other similar initiatives, this led to the creation in 1917 of the Ufficio Invenzioni e Ricerca, mentioned in the above.

Luigi Puccianti (1875–1952), born in Pisa, succeeded Battelli in the direction of the Institute in 1917. An enthusiastic pupil of his, "laureato" in 1898 with a thesis on the absorption of near-infrared light in a large sample of organic liquids: this was actually a first observation of vibrational spectra of molecules. From 1900 to 1915 Puccianti was in Florence, first in the position of assistant and "aiuto" (aide) to Antonio Ròiti at the Istituto di Studi Superiori (see later), then keeping his activities in that Institute while acting, with a better salary, as professor of Physics at the Istituto Superiore di Magistero Femminile. Chair Professor in 1915, first briefly in Genoa and Turin, after two years he was back in Pisa to the end of his life. His scientific contributions are in electromagnetism and, more importantly, in spectroscopy, where he shares with Antonio Garbasso the merit of the rebirth of spectroscopy in Italian Physics (see later). He was a good and dedicated teacher and had the chance of being the director of a well organised institute with a good mathematical school nearby.[5] Differently from Battelli, Corbino and Garbasso, Puccianti did not engage in political and administrative life.

Florence

For centuries, Florence did not have a University, although there was intermittently a Studio opened since the 14th century [8]. This was conceived as a place for "natural" (according to the meaning of the time) investigations and was housed from the end of the 16th century in the Uffizi as "Gabinetto delle Matematiche". During the House of Lorraine grand duchy, this became in 1775 the Museo di Fisica e Storia Naturale, well equipped with instruments and collections and housed nearby Palazzo Pitti. In spite of the label Museum, it was intended to be also a laboratory for Physics experiments. A few years later, a small astronomical observatory (later known as la Specola) and a room for meteorological measurements were added. It is worth to stress that

[5] Perhaps Puccianti was not active enough to fill the gap between the traditional experimentalist culture and the culture of the "new" Physics which was stimulating the interest of eager young people. He was however generous and broadminded, to the point of asking the still student Enrico Fermi "to teach him something" of the new Physics "which he might still learn": see [6, 7].

shortly after the death of its first director, Felice Fontana (1730–1805), a very early professorial chair in Astronomy was instituted, during the period of the Napoleonic domination of Florence. In 1859 the provisional government, installed in Tuscany after the expulsion of the Lorenese family, gave rise to the Istituto di Studi Superiori Pratici e di Perfezionamento according to the plans of Carlo Matteucci for a kind of super-university concentrating high-level competence and adequate financial means, with emphasis on observational and experimental activities. The Museo di Storia Naturale became a part and the basis of the "Sezione di Scienze Fisiche e Naturali" of the Istituto, strongly oriented towards experimental research and education. The local rivalries and the financial difficulties of the newly born Italian State frustrated the project, not so much in the chemical and naturalistic section as in the physical section, in spite of the support of Matteucci. The situation worsened after his death (1868). However, the meteorological and geophysical observatory kept on working [9] under the Direction of, among others, Antonio Ròiti, Antonino Lo Surdo and then Antonio Garbasso (see later). In 1876 the Istituto was made "equivalent" to Italian universities, with the possibility of offering "laurea" theses of experimental kind but without the structure of a regular faculty (and classed B, i.e. mainly supported by local financial contributions, a condition whose consequences were felt in years, discouraging teachers at Chair Professor level to remain for long). In spite of that, in 1880 Antonio Ròiti accepted the offer of a chair professorship.[6] Since he was a respected scientist, he obtained quickly an "aiuto" and an assistant, and increased and updated the equipment of the Physical Institute, still named Sezione di Fisica. In spite of the absence of a regular "corso di laurea" and of the obsolescence of the seat, Ròiti was able to attract in Florence several eager young elements in the position of "aiuti" and assistants: among them Luigi Pasqualini, Luigi Puccianti, Antonino Lo Surdo, naming only the ones who are directly involved in the story of Florence Physics. When Ròiti retired in 1913, keeping for himself only the position of co-director of *Il Nuovo Cimento*, his place was taken by Antonio Garbasso.

Garbasso (1871–1933) was a remarkable mix of a naturalist scientist and a humanist: born in Piedmont, he changed into an enthusiastic Florentine, extending his patriotism towards united Italy into a kind of worship for the adopted Tuscan homeland. To a large extent, this was due to that deeply appreciated "natural and positive" approach to reality as distinctive of the "flower of the Latin culture, namely the Tuscan thought" [10]. "Laureato" in Turin, 1892, with a good physicist and teacher, Andrea Naccari, he completed his scientific preparation in Bonn with Hertz and in Berlin with Helmholtz and initiated his interesting scientific activities working on the optical properties of electromagnetic waves. After teaching appointments in Turin,

[6] With an honourable record as companion of Garibaldi in the 1866 war against the Austrian Empire, Antonio Ròiti (1843–1921), native of Ferrara, got the laurea in Pisa (1868) with Felici and was also a "normalista". He taught at secondary school level (at the time a non-diminutive position for many young scientists!) in Leghorn and Florence and, 1878, was Chair Professor in Palermo with a good recognition as a careful experimenter, gaining him an authoritative membership in the International Commission for Electric Standards. In Florence he took a particular commitment in teaching, producing a successful text, *Elementi di Fisica*, comparable with recognised texts at the European level.

in Pisa with Battelli (working with him on X-rays) and again in Turin, in 1902 won two competitions, one for Mathematical Physics in Pisa, the other for Experimental Physics in Genoa. This latter was his choice and there he remained for 10 years, continuing his research in electrodynamics and spectroscopy (in full development at the time in Europe, and about which he published a treatise in German). His research and teaching method was based characteristically on the association of the mathematical treatment of problems and the accurate experimental verification of results[7] but he did not refrain from proposing "analogic" models, as in the case of his "electromagnetic model" of atomic structure intended to explain line spectra.[8] Apart the limits of his model, Garbasso was ready to appreciate the new field of quantum spectroscopy, at the time when he was appointed professor of Experimental Physics at the Istituto Superiore of Florence in 1913. The staff he inherited from Ròiti comprised Puccianti, already active in Florence part-time since 1905, and the "aiuto" Antonino Lo Surdo.[9] Garbasso quickly set Lo Surdo to investigate spectroscopically the Doppler effect in the light emitted by the positive "retrograde rays" discovered, 1886, by Goldstein near the cathode of a discharge tube.[10] With an original design of the discharge tube Lo Surdo, in summer 1913, rediscovered in more efficient conditions the effect found in the same months by Stark. While a not interesting dispute followed about the priority, in which also Corbino was involved, Garbasso was able within 1913 to propose a first theory of the effect based on the Bohr model which had appeared a few months before. While his calculations contained an error pointed out to him by Bohr himself, Garbasso can be correctly considered the initiator in Italy of the use of the Bohr model along the first steps of quantum mechanics.[11]

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[7] See Manlio Mandò, [8] page 599 and following. An amusing statement to the benefit of his students was: "Mathematics is very important for a physicist, almost as much as mercury".

[8] Garbasso expressed his conception of models with the following words: "Any theory in its essence is a model, better, is a description of a model … the only connection between nature and model, in the most favourable case, is that the laws which describe the variations of corresponding quantities are the same in both systems … so, a theory can be true without containing anything of the real". An interesting treatment of the impact of Garbasso and Puccianti in the development of spectroscopy in Italy is found in [11] and references therein.

[9] Antonino Lo Surdo (1880–1949), born in Siracusa, a good experimentalist with interests in terrestrial physics and spectroscopy. He became "aiuto" of Antonio Ròiti in 1908 and was also appointed director of the Meteorological Observatory at la Specola two years later. Lo Surdo moved to Rome in 1918 and became "aiuto" of Corbino, obtaining in 1919 the chair of Fisica Superiore. In 1937 Lo Surdo became director of the Physical Institute after the death of Corbino. He founded and directed to the end of his life the Istituto Nazionale di Geofisica of CNR.

[10] See [12] and references therein. This article gives a vivid picture of the results obtained in a few weeks confirming and completing the first observations, also Puccianti taking part in them.

[11] A touching presentation of the scientific and human figure of Garbasso is due to Rita Brunetti [13]. A comment showing the interest and the limitations of the scientific attitude of Garbasso is found in [14]. See also note ([8]).

The Hill of Science

The Sciences of Light: Astronomy

To provide a complete picture of the scientific environment in Arcetri, two institutions must be mentioned: the Arcetri Astronomical Observatory and the Laboratory that, in successive steps, became the National Institute of Optics. Besides the possibility of new overlapping fields of research, the benefits for the growing Florentine Physics were the international collaboration scenario (Astronomy) and a special care for applied Physics (Optics). The two institutions are close to the Physical Institute, although built before and after it, in a period just longer than half a century. The first was the Observatory.

It is well known that Galileo Galilei spent the last years of his life confined in the Villa del Gioiello, a country house at the Pian de' Giullari on the hill of Arcetri, a few kilometres from the centre of Florence. There he carried out his last heavenly observations and wrote fundamental Physics works. Accordingly, that hill seemed to be the most suitable place, when, in the second half of the 19th century, a new site for the Astronomical Observatory was sought. Still positioned downtown, it was by then incompatible with some aspects of the post-unification developing city, first of all with the street lighting. The decision was for Arcetri, at walking distance from Galileo's historical house. The new Observatory was inaugurated in October 1872.

Unfortunately the Astronomy research suffered from the same restrictions affecting Physics: first of all inadequate teams, in the present case two or three people, usually a director and an assistant. As for the scientific activity, the main fields beyond eclipses were "terrestrial" phenomena, like, e.g., northern lights or meteoric showers, and of course the hunt for comets. The name of Giovan Battista Donati (1828–1873) is associated to many celestial bodies, but he died only a few months after the inauguration of the Observatory.[12] His "aiuto" became the new director, but he too died some six months later: then it was pretty hard to find a replacement. Eventually Giovanni Virginio Schiaparelli (1835–1910), director of the Observatory of Brera (Milan) and world famous discoverer of the so-called Martian canals, had his German assistant, Wilhelm Tempel (1821–1889), appointed by Florence. The fame of Tempel too is based on the observation of comets and quite a few were named after him, but he was not a real astronomer. From our modern point of view, he was slightly more than an amateur, and actually he was only an assistant never in charge of the direction. However he had a very valuable ability: in those days when the photographic emulsions were not fast enough he was a gifted drawer, really skilled and accurate. His hand-painted plates were a good tool for the sky studies, and moreover nice to look at. Those plates yielded him the Royal Award of the Accademia dei Lincei in 1879. But a lithographer does not open research lines and for a while, after his death in 1889, the Observatory was neglected: twenty years elapsed since the opening and almost never there was a director.

[12] A short history of the Arcetri Astrophysical Observatory can be found in [15].

Only in 1893 the professor of Astronomy Antonio Abetti (1846–1928) came from Padua. He had to make a great effort in the restoration and maintenance of instruments. Thanks to him the already existing "Officina Galileo", specialized in Fine Mechanics and Optics, underwent a strong development. Abetti was known as a bright scientist: his scientific career already comprised work done at the Astronomy Institute in Berlin and an expedition in India, in 1874, to observe the transit of Venus before the Sun. His figure was recognised at the international level and even the great American astronomer George Ellery Hale visited him and his Observatory. Hale was looking for a European support for a new scientific journal, *The Astrophysical Journal*. His visit initiated a long-lasting collaboration on Solar Physics with a significant role in Arcetri's astronomical research. Abetti was mainly an observational astronomer but he understood soon the need of a deeper integration between Astronomy and Physics, the so-called "New Astronomy" or Astrophysics. Donati himself, after Father Angelo Secchi, carried out investigations on the spectral classification of stars. Aware of this evolution, Abetti favoured the plans of Antonio Garbasso to transfer the Physical Institute from the decaying seat in the centre of Florence to a new building on the same hill of Arcetri, close to the Observatory (see later). The emphasis on the international quality of research and the need of evolution from Astronomy to Astrophysics were the remarkable features of the scientific policy of Antonio Abetti. Following his steps, the son Giorgio Abetti (1882–1982) carried out studies and collaborations abroad, mainly in German universities. Back to Italy, he obtained a position at the Collegio Romano in Rome and in 1913–1914 he took part to an engaging multi-scientific expedition in the Himalayas. In 1917 he went to the USA as a member of a military mission organized by the just founded Italian UIR, the already mentioned Research and Development Board of the Department of War. In 1921 he was again at the Arcetri Observatory to become, shortly after, its director. Since the beginning, his scientific production was noticeable and most of it concerned astronomical spectroscopy. In the same year he succeeded in changing the Observatory's denomination to Astrophysical Observatory, as recommended by Garbasso [10]. The Faculty of Science introduced the teaching of Astrophysics, beside Astronomy, already after the end of the World War. The time was ripe for this new approach to heavenly phenomena. In fact the first Italian Astrophysical Observatory was established in Catania, as early as the end of the 19th century, along with the first Chair of Astrophysics [16]. This was a model for Arcetri, but while Catania was unable to develop an Astrophysics school, this succeeded in Florence. Indeed a few years later, in 1925, a Solar Tower was built on the hill to study high-resolution solar spectra. It has to be stressed that it was the first Solar Tower in Europe and the third in the world, after the ones already built by G. E. Hale. Actually, both Hale's scientific and financial help were instrumental for the design and the realization of the Arcetri Tower [17]. The contemporaneous establishment of the "corso di laurea" in Physics (see later) stimulated the formation of a school of Astronomy which produced several of the directors of Italian observatories after having been students or junior astronomers in Arcetri (see Table 4 later on).

This was the favourable scientific environment found by the bright students and teachers gathered around Garbasso. In those very years Giorgio Abetti devised the

Seminar on Astronomy, Physics, and Mathematics according to the model of the seminars in Anglo-Saxon universities. Both Italian and foreign physicist and astronomers were happy to present their ideas and results: lectures were held among others by Hall, Bethe, Persico, Fermi, but also by younger physicists as Rossi and Bernardini. More important, students were encouraged to attend and contribute to the lectures.

The Sciences of Light: Optics

With the expansion of the "Istituto di Studi Superiori", new research buildings were supposed to be built in the proximity of the Observatory. In addition to the new seat of the Institute of Physics, almost completed during the war, there was also a minor building, halfway between the Physical Institute and the Astronomical Observatory. This building was supposed to house the Chair of Terrestrial Physics which should inherit the activity of la Specola, and was meant also for meteorological measurements through balloon-borne instruments. So, in the words of Garbasso, one would join in the same area "Physics of Earth and Physics of Heaven, the most Tuscan ones among the Tuscan Sciences" [10]. Instead, the scope of the new building changed very soon. The director should have been Antonino Lo Surdo, director since 1910 of the old Meteorological Observatory. The idea was to keep Lo Surdo in Florence. But in 1918 Lo Surdo joined the Physical Institute in Rome and the building remained deserted. Nine years later, it became the seat of the National Optics Institute (INO).[13] That was the last step of a project stemming from the needs of the "Great War": in fact, as soon as the conflict began, scientific and industrial Italy had to face with a complete dependence on foreign countries for products based on Optics. Pointing systems, periscopes, binoculars, all these were imported mainly from Germany, but then Germany had become the enemy and among other restrictions a block on import was applied. All of a sudden, Italy realized that optical goods were not only for peace times. Not by chance, "Industrial Mobilization" was the specific aim of the UIR (see Sects. 6.2 and 6.3.1): it was decided to support the birth in Florence of a Laboratory of Applied Optics and Fine Mechanics,[14] following an original idea of Garbasso. Behind this undertaking, there was, of course, a strong military concern together with the will of some Italian enterprises, interested also in civil production. In fact, the real proponent of the whole project was the physicist Luigi Pasqualini (1888–1999), a former assistant of Ròiti, inventor, skilled technician first and then director of a workshop specialised in precision mechanics, the "Officina Galileo". Moreover, he could rely on the great experience gained in the Italian Navy as "electric" technician, in charge of the Torpedoes Laboratory, close to La Spezia. He was well aware of the Italian deficiency in Optics, which extended to the technique of

[13] For an analysis of the complex phases of such evolution and its links with the Florentine political and industrial environment see [18].

[14] As for the governmental side of science in that period see [19], in particular the Appendix with the report of Lo Surdo on a meeting held in Palazzo Vecchio to establish the Laboratory.

optical glass, and was strongly motivated in the development of a national industrial production of high-quality instrumentation; furthermore he was convinced that this required the formation of specialised technicians with scientific background. The Laboratory had to be the first step.

To carry out his plan, Pasqualini was able to involve other industries, local politicians and of course Garbasso (details on the role of Garbasso and the evolution of the project at the end of the war are found in the next section). But as soon as the Florentine project was officially approved, in September 1918, and even before the inauguration of the Laboratory, the war was over. As a consequence, the Optical emergency was over and the industrial interest decreased. At variance with the original intentions, Garbasso chose as director a university lecturer, his "aiuto", Raffaele Augusto Occhialini,[15] former "aiuto" of Battelli in Pisa. Occhialini started working in rather unfavourable conditions also because of the transfer of the whole Physical Institute and of the attached Laboratory to the new seat in Arcetri. He succeeded in publishing the first few issues of the journal *Rivista di Ottica e Meccanica di Precisione*, one of the statutory obligations of the laboratory, containing among other things his study on "moiré" interference fringes and their use in optical and mechanical applications. Unfortunately he was not aware that a rather complete study of the subject had been carried out by Augusto Righi about 30 years before (and had fallen in oblivion!). Frustrated Occhialini abandoned the subject. On the other hand he was on the verge of leaving Florence after winning a competition for a professorship.

The work on "moiré" interference fringes was picked up by the young Vasco Ronchi,[16] who had been appointed by Garbasso (1920) assistant to the (empty) chair of Fisica Terrestre under recommendation of Occhialini. Ronchi was for years the only scientist engaged in the activity of the Laboratory, mostly to determine the technical features of lenses on behalf of the Astronomical Observatory (the Amici's objectives!) and the Officine Galileo. Very soon he obtained (just by chance, as he was proud to say) an important result, that is a new method, based on moiré fringes, to verify smoothness and quality of an optical surface. This easy yet powerful tool is still

[15] Raffaele Augusto Occhialini (1878–1951): "marchigiano" like Battelli, born in Fossombrone, educated in Pesaro (see [20]), student of Battelli and also "normalista" in Pisa 1898, "laureato" in 1903, was his assistant and "aiuto" till the death of Battelli. Briefly in the same positions with Puccianti, 1916–1917. After the war (see text) "aiuto" of Garbasso in Florence, Chair Professor in 1921 in Sassari, in 1924 in Siena and from 1929 in Genoa. With good connections in Germany and the United States, he was an excellent teacher, and notable for his works on radioactivity, gas-discharge, spectroscopy, electrotechnics. He produced also a booklet on relativity of popular character.

[16] Vasco Ronchi, (1897–1988): student in Pisa and "normalista" from 1915, recalled for military service in 1917, back to Pisa in 1919, succeeded in completing the exams and graduating in that very year with the encouragement of Puccianti. Introduced to Garbasso by Occhialini, he was appointed assistant in the Institute of Physics in Florence from 1920 and, when Occhialini left for his chair in Sassari, he took responsibility of the Laboratorio di Ottica e Meccanica di Precisione. In the following years he succeeded in transforming that initiative, which had badly suffered in the aftermath of the war, in the Istituto Nazionale di Ottica with a notable stand in the Florentine and national scientific and technical panorama. He was instrumental also for the foundation of the Associazione Nazionale di Ottica. In his initiatives Ronchi had the support of Garbasso until the latter's death.

nowadays called the "Ronchi test". Thanks to it, Optical techniques gained an official recognition. From then on Ronchi spent all his efforts to revive the original project of the Laboratory. He kept the contacts with Pasqualini on the one hand and with the military ambient on the other, in particular with the "Istituto Geografico Militare", which had its seat in Florence and was obviously interested in optical devices. The person instrumental in the development of the Laboratory along the lines hoped by the still young Ronchi, was Gen. Nicola Vacchelli, responsible of IGM. On the other hand, with the advent of the fascist government, the policy towards military expenditures and towards the support of the related optical and mechanical industry changed. Pasqualini and Vacchelli joined Ronchi in promoting the renovation of the Laboratory with an extended program which included explicitly formation courses intended for civil and military (not only Italian) high-level technicians. A first step was the transfer of the instrumentation of the Laboratory from the inadequate rooms in the Physical Institute to the still empty pavilion which should have housed Fisica Terrestre. The second step was the acquisition of Gino Giotti, an optical expert working at the Merate Astronomical Observatory, who became an excellent co-worker of Ronchi and was also involved in the administrative management. The third step was the foundation of the Associazione Ottica Italiana, in view of promoting the coordination of the interests of the industries involved. The aim was to favour the diffusion of optical culture according to the original idea of forming skilled shop foremen.

At this point it was possible to transform the Laboratory in the Istituto Nazionale di Ottica under the direction of Vasco Ronchi. The inauguration took place in 1928 and the small pavilion was recycled in the seat of a kind of advanced vocational school, with room and some equipment for applied research. In time, the increasing activity led to the expansion of the primitive construction into the present building. Thanks to a strong governmental support and to the determined character of his director the INO underwent a fast growth and reached significant objectives [21] favouring the practice rather than the theory, with a feeling for the evolving civil and cultural needs. Although the part of the program aiming at the formation of skilled technicians was not completely fulfilled, what was left is an efficient school for optometrists. The scientific side followed the personal taste of Ronchi, more and more oriented towards physiological optics in the last part of his life.

Remarkably, never the activity of INO crossed that of the Physical Institute in the period between the two world wars. A more productive relationship was maintained with the Observatory and the Italian astronomers. After the death of Ronchi in 1988, the INO underwent, under the direction of Tito Fortunato Arecchi, a considerable reorganization, with an extension of its scientific and applied landscape (dynamics of complex systems, lighting techniques; restoration and preservation of the cultural heritage).

Garbasso and Florence

Arcetri from the Beginning to the End of the 1st World War

As soon as Garbasso settled in Florence, in summer 1913, he backed a convention between the Administration (and banks) of the town and the Superintendent and Directorate of the Istituto di Studi Superiori, obtaining new positions for the Sezione di Scienze Fisiche e Naturali, and financial support for the renovation of the laboratories, in primis for the building of a new Physical Institute. The actual construction started quickly on the site Garbasso himself had chosen romantically on the hill of Arcetri, not by chance at walking distance from the site of the Astronomical Observatory, which was again in operating conditions after years of abandonment (see Sect. 6.3.1).

The following year 1914 marked the outbreak of the first World War. After one year of negotiation and fierce debate, Italy joined the Triple Entente and engaged in the war against the Austro-Hungarian Empire, in May 1915 (see Sect. 6.2.2). Garbasso, at the age of 54, joined immediately the front-line as a volunteer lieutenant in the Engineer Corps, setting up a system of phonotelemetry against the Austrian artillery units. But he remained in close contact with his institute and his plans for the development of an advanced scientific and technical Florentine centre. His interest in the technical side was stimulated by his war experience and by his acquaintance with Pasqualini. They had much to share, both physicists, innovators and involved in political life (at the time Pasqualini was also town councillor). Pasqualini visited Garbasso on the front-line sometimes in 1916. Then, on leave for the beginning of academic year 1916–1917, Garbasso sized the opportunity of the "opening address" to recall the convention of 1913 and to thank the administration (and the banks) for the generosity with which the Istituto di Studi Superiori had been endowed with new staff positions and with the almost completed new Physical Institute, with its arcade and cloister in "Tuscan" style, on the hill of Arcetri ([10], pp. 16–17).

But Garbasso had a wish which coincided with the wish of Abetti, namely the concentration of more Institutes in a common area. So, apart the abundant patriotic rhetoric of the speech, Garbasso presented in full his plan for the Physical Section of the Istituto di Studi Superiori, to be concentrated in Arcetri. In his mind, the hill was to become a kind of City of Science, as can be seen in the decoration of the hall of the Physics building. The ceiling shows, in Art Nouveau style, the Galilean discoveries: the Sunspots, Jupiter's four satellites, the phases of Venus, the ring of Saturn, the features of Moon surface. On the walls, two large frescos display allegories of Research and of Learning. Moreover, the bas-reliefs of the members of the Accademia del Cimento (1657–1667) are aligned around the central cloister and in the surrounding garden there was a bust (now lost) of Minerva, the goddess of knowledge. Besides the building for the Physical Institute, large enough for housing a number of researchers and technicians, the "pavilion" intended for Terrestrial Physics was already completed (see Sect. 6.3.2).

Furthermore, Garbasso urged also the creation of another Laboratory, better, a Research Institute, where (in his words) "people with scientific formation and aware of the needs of practical work would be prepared to help and advise shop foremen … in view of the gigantic economic upheaval announced by the gigantic war". These were the premises of the Laboratorio di Ottica applicata and Meccanica di Precisione discussed in the previous section. Garbasso expressed also the hope to have in Arcetri the "Museo degli Strumenti Antichi" of Lorenese origin (partly dispersed by the Lorena themselves when they left Florence), to become a centre for the study of the History of Science. This part of the project was not realised, but one more thing shows the broadmindedness of Garbasso in envisaging a site devoted to Physical Sciences: he hoped that "the old, glorious Observatory of Donati and Amici would turn at least part of its activity to the studies of Astrophysics, as in the intention of his excellent colleague, professor Abetti". Antonio Abetti, who supported fully Garbasso's plan, indeed changed the name from Astronomical to Astrophysical Observatory, the second in Italy, mindful of the work of Father Secchi. The Observatory would have later an important part in the cultural environment of the Group of Florence (see Sect. 6.3.1).

The project of the Laboratorio di Ottica Pratica e Meccanica di Precisione (accounted for in previous section), was officially approved September 1918 as a body attached to the Physical Institute.[17] One of the problems was the director, who should have been in principle a technician with a good scientific background, not necessarily a university professor. The choice in the end was Battelli's pupil, Augusto Occhialini, co-author of the treatise on Radioactivity, the second "normalista", after Ròiti, entering the story, on the move from Pisa after the death of Battelli, and already father of Giuseppe, Peppino, not yet GPS or Beppo (see note ([15]) and Sect. 6.3.2). Garbasso was in touch with Occhialini while this one served at the UIR: Garbasso encouraged him to move from Pisa to Florence, where the position of "aiuto" was vacant (Lo Surdo had left for Rome, 1918), and was instrumental for his appointment as a member of the Italian War Mission in USA with the task of studying the techniques of optical glass and of setting up agreements of technical cooperation. Occhialini stayed in USA from June 1918 to February 1919 and had the opportunity of meeting several American scientists, among whom R. W. Wood, A. A. Michelson and R. A. Millikan. In the meanwhile he became "aiuto" and, October 1918, was appointed director of the Laboratorio. The official inauguration took place on November 24, 1918, twenty days after the collapse of the Austro-Hungarian Empire. The speech of Garbasso began with the words: "The war ended: we must rebuild the world". The task proved to be much more difficult and even painful than expected.[18]

[17] Many details with some errors and questionable opinions are in [22].

[18] Garbasso left the army as a major of the Engineers Corps and resumed eagerly his place at the Istituto di Fisica with particular care for his duties as a lecturer, but his interest shifted more and more towards public life and political commitment, with the aim of benefiting at the same time his adopted city and his institution in times of economic difficulties and of social unrest. It is not strange that, after years of direct engagement in warfare, patriot Garbasso joined the nationalist party of chauvinist Luigi Federzoni, ending into the fascist party seen as the defender of the values of the Risorgimento and of the sacrifices sustained by so many on the front line during the war. This

From the Institution of the University to Academic Year 1925–26

In spite of the circumstances, the scientific and didactic activity of the institute did not stop during the war and this happened by merit of Rita Brunetti, "normalista" and "laureata" in Physics with Battelli with a well recognised work in spectroscopy. After one more year of specialisation in Pisa she took up the position of assistant of Garbasso in Florence and started working on the Stark effect with Lo Surdo until he left for Rome. With Garbasso at war, Brunetti managed to keep going the Physical Institute, still in the old seat downtown, both in teaching and in research, working successfully in X-ray and visible spectroscopy.[19] Back from the States in spring 1919, Occhialini took up his appointments as "aiuto" and as director of the Laboratory during an exhausting time, when the Physical Institute and the attached Laboratory were replaced in the new buildings in Arcetri. He and Brunetti were helped in that job by Vasco Ronchi (see Sect. 6.3.2). In 1921 Occhialini went to his chair in Sassari. Brunetti became "aiuto" and Garbasso promptly filled the vacant position of assistant with a brilliant student of Puccianti, Franco Rasetti, "laureato" by the end of 1922 with a remarkable thesis in spectroscopy. In Arcetri Rasetti found, in his words, *"a very pleasant place … with a pretty good equipment … especially for spectroscopy … and not much teaching … because Garbasso gave the Physics course"*.[20]

attitude was common among ex-combatants, even among upright refined intellectuals like Garbasso. So he was elected mayor of Florence in 1920 and kept the position under the fascist government with the title of Podestà until 1928. At the same time, like Corbino, he filled important positions in the organisation and direction of scientific research, in particular in the CNR (see Sect. 6.2.2), supporting actively the financing of well equipped laboratories and promoting the cultural updating and qualification of students and young researchers with the institution of scholarships for stays in foreign advanced institutions.

[19] This was the beginning of a noteworthy career, which led Rita Brunetti (1890–1942) to become "aiuto" of Garbasso from 1921 to 1926, and then Chair Professor for two years in Ferrara, for eight years in Cagliari and from 1936 in Pavia. Her work covered spectroscopy from visible to X-rays, magnetic properties of matter, nuclear physics and its bio-medical applications, history of science, good popular works, two treatises at the didactical level. In an academic environment dominated by males Brunetti was the only Italian woman attaining the directorship of a Physical Institute. She died prematurely, probably because of a professional disease, but in the very last years she attempted to use photographic plates for the detection of cosmic rays.

[20] Rasetti gives an interesting account of his experience with Garbasso: *"he had been a good physicist, at the time he was only interested in politics"*, but *"he gave his course in elementary Physics and was quite intelligent at it. And later Fermi explained to him what we were doing and he understood..he followed what we were doing and he was a very pleasant person … as for being fascist he was very moderate, in fact (Rasetti is sure that) had he lived longer, he would have become disgusted with Fascism. But in the first few years … Fascism didn't seem very bad … after 1924 … people lost hope (that Fascism would become a reasonable dictatorship). Still, even in the States there was a lot of admiration for Mussolini."*, excerpt from [7].

Table 1 Teaching staff of the "corso di laurea" in Physics, academic year 1924–25

Courses	Teachers
Analisi Matematica (I e II)	F. Tricomi
Analisi Superiore	F. Tricomi
Geometria Analitica e Proiettiva	E. Ciani
Geometria Descrittiva	E. Ciani
Fisica Sperimentale (I e II)	A. Garbasso
Fisica Superiore	A. Garbasso
Esercizi di Fisica	A. Garbasso
Chimica Generale e Inorganica (I e II)	L. Rolla
Chimica Fisica	L. Rolla
Meccanica Razionale	E. Fermi
Fisica Matematica (Electromagnetism, Spectroscopy)[a]	E. Fermi
Astrofisica	G. Abetti
Disegno	R. Brizzi
Mineralogia (optional)	P. Aloisi
Chimica Organica (optional)	A. Angeli

([a]) The following year, the course was named Fisica Teorica and Fermi changed the program in topics of Fisica Statistica (Statistical Physics)

Actually Garbasso was succeeding in transforming the Istituto di Studi Superiori in a regular University, be it still of class B,[21] and to establish the regular "corso di laurea" in Physics (and Mathematics), with the pattern of teaching subjects provided by the national regulations originally set by Matteucci: it became possible to have students from the beginning of their curriculum. The first regular academic year began November 1924. The teaching staff of the "corso di laurea" in Physics was as per Table 1: notice the position of Enrico Fermi.

Indeed a turning point was the professorship "in charge" (Professore Incaricato) offered him by Garbasso for the teaching of Mathematical Physics and Theoretical Mechanics (Meccanica Razionale).

Apart the famous work of Fermi on Statistics (written in those years in Arcetri), he and Rasetti, old friends from the times of Pisa, initiated a very fruitful collaboration both on experimental (spectroscopy!) and theoretical subjects, the two being endowed with a vivid physical sense, the first adding his profound understanding of the new atomic Physics (and relativity), the latter his ability in devising and handling experiments. Both made friends with spectroscopist Rita Brunetti, exchanging ideas and experience. Later Fermi would quote Brunetti's results of those years.

A second turning point is 1926. Rita Brunetti won a competition for Experimental Physics and left Florence for Ferrara, destitute of a laboratory: she was hosted for

[21] In the opening address Garbasso underlined that the inauguration of the revived "Studio Generale" was greeted by the representatives of the same Communes already existing in the State of Florence in 1321, when the "Studio" came to existence for the first time.

Table 2 The parallel lives of Persico, Fermi and Rasetti as young men

Name	Born	Liceo	Laurea	1st Appointments
Persico	July 9, 1900 Rome	July 1917, Rome	Nov. 1921	'21–'24 Rome assistant
				(Corbino)
				'24–'26 Rome professor
				"in charge" (Corbino)
Fermi	August 10, 1901 Rome	July 1918, Pisa	July 1922[a]	'22–'24 Rome professor
				"in charge" (Corbino)
				'24–'26 Florence professor
				"in charge" (Garbasso)
Rasetti	July 10, 1901 Rome	July 1918, Pisa	Dec. 1922	'22–'26 Florence
				assistant (Garbasso)

([a]) "Normalista"

her experimental work by Quirino Maiorana in Bologna. At the same time Fermi and Enrico Persico won the first competition for Theoretical Physics,[22] a new entry in the set of physical teachings, strongly supported by both Corbino and Garbasso. Fermi was called by Corbino in Rome, Persico by Garbasso in Florence. It is worthwhile noting here the position of Pisa in the years following the end of the war, a point of excellence with the high-level teaching of Puccianti in Experimental Physics in the wake of Battelli and with the school of Mathematics conducted by Luigi Bianchi after Ulisse Dini. This favourable situation was rewarded by the presence of a number of very good students, of whom three were to play a key role in the development of the Italian school of Physics and in particular of the groups of Florence and Rome: Enrico Fermi, Franco Rasetti and later Gilberto Bernardini. The fourth personality in this context was Enrico Persico, "laureato" and assistant of Corbino in Rome, familiar with such mathematicians as Tullio Levi Civita and Guido Castelnuovo, and a theoretician with a sense for experiments.

Table 2 highlights the parallel lives of Persico, Fermi and Rasetti as young men.

The friendship between Persico and Fermi begins during the Liceo (secondary school) in Rome, that between Fermi and Rasetti during the University in Pisa. The

[22] The third winner was Aldo Pontremoli, called by the University of Milan, where he founded the Physical Institute, and disappeared in the Arctic in the disaster of the *Italia* dirigible in 1928. Pontremoli, born in 1896, was an assistant of Corbino around 1920 and signed a paper on the mass of radiation in an empty space with Fermi [23].

relationship among the three, practically self-taught in the fields of new Physics, is well described by the set of their scientific articles covering the years (1921–1926).

When in 1926 Fermi goes back to Rome (and Persico goes from Rome to Florence), Rasetti follows Fermi, as assistant and "aiuto" to Corbino, and in two years will become professor of Spectroscopy (with an important programme on Raman effect). Corbino will attract around the personality of Fermi more promising students: Emilio Segré (1905–1989), Ettore Majorana (1906–1938), Edoardo Amaldi (1908–1983), the group of Rome is formed.

The story of Florence is less simple, but also here Garbasso was able to attract outstanding young people and build a successful group. One must underline once again the action of the two men who were instrumental in those achievements. Both Corbino in Rome and Garbasso in Florence opened their institutes to the best young physicists emerging from Italian universities in those years, several of them from Pisa. This is a recognisable policy: both use their scientific stature and their position in public administration in order to build "schools of Physics" based on the work of young individuals of precocious capacity and qualification, with a keen interest and a fresh understanding of the "new" Physics, which placed them above the average culture of the contemporaneous academic establishment. In the fifteen years or so after the end of the war the two groups were unusually close, with an effective exchange of persons and of knowledge, setting up connections and friendships which would last in time.

The Group of Arcetri and the Dawn of Cosmic Ray Physics in Italy (and not only that)

A Good Teaching Staff and a Good Set of Students

4 December 1987 was the 80th birthday of Giuseppe Occhialini. On that occasion the Physics Department of the University of Florence organized a round table, with Paolo Blasi as moderator, with the presence of (in order of age) Bruno Rossi, Gilberto Bernardini, Giuseppe Occhialini and Daria Bocciarelli, the four surviving personalities of the "Group of Florence". Edoardo Amaldi took part in the round table and Manlio Mandò, a student in Florence from 1931 and a witness to the last part of the life of the group, opened the session illustrating the following Tables 3 and 4.[23]

All the contributions showed how deeply felt, after so long, was the recollection of that short stretch of years, short but so full of ambitions, hopes, strength, joy of being a part of a significant common effort towards "scientific truth" and overall friendship. Mandò and the external witness Amaldi defined that feeling "the spirit

[23] From the contribution of M. Mandò to the Round Table 1987, unpublished. The original Tables are integrated and slightly modified with added notes for the purpose of the present work.

Table 3 Teaching staff of the Physical Institute of Florence 1913–1937, with A. Garbasso director from 1913 to March 1933, L. Tieri from Fall 1933

Academic Years	"Aiuto"	Assistant	2nd Assistant	Other Teachers
1913–17	A. Lo Surdo[a]	Rita Brunetti	–	A. Abetti
1917–18	–	Rita Brunetti	–	A. Abetti
1918–20	A. Occhialini	Rita Brunetti	–	A. Abetti
1920–21	A. Occhialini[a]	Rita Brunetti	V. Ronchi	A. Abetti
1921–22	–	Rita Brunetti	–	G. Abetti
		V. Ronchi		
1922–24	Rita Brunetti	V. Ronchi	F. Rasetti	G. Abetti
1924–26	Rita Brunetti[a]	V. Ronchi	F. Rasetti	G. Abetti
				E. Fermi[b]
1926–27	–	V. Ronchi	–	G. Abetti,
				E. Persico[c]
1927–28	V. Ronchi	F. Olivieri	B. Rossi[d]	G. Abetti
				E. Persico
1928–30	V. Ronchi[a]	F. Olivieri	B. Rossi	G. Abetti
				E. Persico
				G. Bernardini[d]
1930–31	B. Rossi[e]	G. Bernardini	G. Occhialini	G. Abetti
1931–32	B. Rossi[e]	G. Bernardini[f]	G. Occhialini	G. Abetti
1932–33	G. Bernardini	G. Occhialini	L. Emo Capodilista	G. Racah[g]
			Daria Bocciarelli[h]	
1933–35	G. Bernardini	G. Occhialini	L. Emo Capodilista[i]	G. Racah
			Daria Bocciarelli	
1935–37	G. Bernardini[j]	G. Occhialini[k]	Daria Bocciarelli[l]	G. Racah[m]

([a]) The events concerning Lo Surdo, Brunetti, A. Occhialini, Ronchi, Rasetti, Fermi till Academic year 1925–26 have been accounted for in Sects. 6.4.1 and 6.4.2 (see Sect. 6.3.2 for Ronchi)
([b]) Professor "in charge" of Meccanica Razionale and Fisica Matematica (see Table 1)
([c]) Chair Professor of Fisica Teorica and "in charge" of Meccanica Razionale. From 1930–31 in Turin. From 1950 in Rome
([d]) See Table 5
([e]) Also professor "in charge" of Fisica Teorica in the place of Persico. From 1932–33 Chair Professor of Experimental Physics in Padua and director of the Institute of Physics. From 1938 in Copenhagen, guest of Niels Bohr, then in Manchester with P. M. S. Blackett and then in the United States
([f]) Professor "in charge" of Meccanica Razionale
([g]) Professor "in charge" of Fisica Teorica in place of Rossi
([h]) "Extra" assistant of Garbasso
([i]) From 1935 to 1946 in the United States with a scholarship at Berkeley. Back to Italy he leaves research
([j]) From 1937–38 Chair Professor of Experimental Physics in Camerino. From 1938 in Bologna, also director of the Institute. From 1947 in Rome
([k]) From 1937 in Brazil. From 1944 in Bristol and, 1948, in Brussels. From 1949 Chair Professor in Genoa and from 1951 in Milano
([l]) From 1937 at the Physical Laboratory of the Istituto Superiore di Sanità in Rome with G. C. Trabacchi
([m]) From 1937–38 Chair Professor of Fisica Teorica in Pisa. From the end of 1938 at the Weizman Institute in Israel

Table 4 "Laureati" in Physics from academic year 1928–29 to 1937–38, "Corso di Laurea" established in academic year 1924–25

Academic year	Names
1928–29	Londei Luisa, Marconi Rita, Panerai Tullia, Zini Rodolfo
1929–30	Colacevich Attilio[b], Occhialini Giuseppe[a], Romani Abigaille, Francesco Scandone[c]
	in Mathematics: Calamai Giulio[b]
	in Chemistry: Franchetti Simone[a]
1930–31	Genoviè Gino, Racah Giulio[a], Righini Guglielmo[b]
1931–32	Baroni Ermanno, Bocciarelli Daria[a], Caponi Pier Giovanni, Mari Giovanni Antonio
	in Mathematics: Foà Alberto
1932–33	Castellani Giuseppe, Cipriani Edvige, Crinò Beatrice[d],
	Emo Capodilista Lorenzo[a]
	in Mathematics: Sestini Giorgio
1933–34	De Benedetti Sergio[a], Francese Clara
1934–35	Mandò Manlio[a]
1935–36	Castelli Iris, Fracastoro Mario[b], Persano Aldo, Ricci Elena,
	Serafini Francesco
1936–37	De Seras Luigi
1937–38	Barsotti Nedda, Landini Oliviero[d], Orzatesi Giuseppe, Pagani Lina

([a]) Physical Institute (see Tables 3, 5 and text)
([b]) Astrophysical Observatory (see Sect. 6.3.1)
([c]) "Istituto Nazionale di Ottica" and then industry (see Sect. 6.3.2 and Table 5)
([d]) Industry

of Arcetri". What follows is an attempt to present the "administrative" scenario and the meaning of the word "school" as applied to the group.

Table 3 shows the evolution of the staff of the Physical Institute under the direction of Antonio Garbasso from 1913 to 1933, and of Laureto Tieri[24] to 1938, when the racist campaign sparked off by Mussolini led to the 1938 laws, which expelled Jews from one day to another from the Italian scientific community. The notes give details about the fate of Arcetri's actors when she or he left the group. Table 4 lists the "laureati" in Physics (plus some in Mathematics) after the coming into operation of the "corso di laurea" in 1924. The table shows also that the "corso di laurea" provided with fresh young personalities both the Physical Institute and the Astrophysical Observatory, this being one of the successful results of the policy of Garbasso and Abetti.

[24] L. Tieri (1879–1952) "laureato" in Rome 1903 and assistant of Blaserna and then of Corbino. Known for his experiments on the Hall effect in Bismuth, is co-author of the first paper (experimental!) of Persico [24]. From 1924 Chair Professor of Experimental Physics in Messina. From 1933 in Florence in the place of Garbasso. Ritired in 1949.

It is interesting to examine in Tables 3 and 4 the four academic years from 1926 to 1930, the years of Persico. For one year Ronchi is the only assistant of Garbasso, becoming later "aiuto", but he is engaged in his effort to revive the Laboratorio di Ottica e Meccanica (see Sect. 6.3.2) and is not in the least interested in the "new" Physics introduced by Persico. On the other hand the first students are already in their second year of the regular corso di laurea, among them Giuseppe Occhialini and Francesco Scandone, who will be joined year after year by Giulio Racah, Daria Bocciarelli, Beatrice Crinò, Lorenzo Emo Capodilista. Then the turning point of the arrival of Bruno Rossi, Fall 1927, and of Gilberto Bernardini, Fall 1928: the Group of Florence comes to existence.[25]

One after the other the best students get the "laurea" and find a position in the institute through the interest of Garbasso and of Persico. The theses of "laurea" are all on experimental subjects related to the researches initiated by Rossi and Bernardini (except Racah, see Table 5). But experimentalist Rossi and student Racah collect the first notes from the lectures of Persico, first published in Florence 1929.[26] As a result Rossi will be professor "in charge" of Fisica Teorica when Persico leaves for Turin, and Racah will inherit that position when Rossi wins the professorship and goes to Padua.

Table 5 summarises the initial steps of the "young Arcetrini": the names are those which appear in all the papers published from 1928 to 1937, when, after the death of Garbasso, the winning of professorships and the political situation led eventually to the dispersal of the group.

A facet of the behaviour of these young people is their quick integration in the group since students. This is not only because of the enthusiasm of the leaders, Rossi and Bernardini, who would share their work with the students. They took profit also of two important assets which are frequently referred to in their recollections: the weekly reading of the leading international journals promoted by Persico and sustained by Bernardini with his characteristic zeal, and the Astrophysical, Physical and Mathematical Seminar promoted by Giorgio Abetti. In this way all of them were made aware of the more recent developments in the ongoing physical research;

[25] Bruno Rossi (Venice 1905; Cambridge Mass. 1993). Among the rich set of biographic material one may choose the autobiography [25, 26]. From Venice to ill-equipped Padua and Bologna: the happy encounter with Rita Brunetti, *"the only person who taught him some Physics"* and supervisor of his "laurea". Brunetti recommends Rossi to Garbasso, who promptly accepts him as assistant.

Gilberto Bernardini (Fiesole 1906, La Romola (Florence) 1995). A good biography does not exist as yet, in particular for the first period of his scientific activity. See Mandò, [8] p. 613, the biographic sketch of the Accademia dei Lincei and Giorgio Salvini [27]. "laureato" *cum laude* in Pisa with Puccianti, 1928, "normalista", working at first in a small optical industry in Florence, unhappy researcher in the first year of the Istituto Nazionale di Ottica. Attracted by the lectures of Persico, gets a position as "extra" assistant to his course of Meccanica Razionale. In 1930 Ronchi quits the Physical Institute and Bernardini becomes assistant of Garbasso (Rossi becoming "aiuto").

[26] These notes will become the first draft of the well known treatise by Persico, *Fondamenti di Meccanica Atomica* (Zanichelli, Bologna) 1936.

Table 5 The initial steps of the "young Arcetrini"

Name	Born	Laurea	First appointment
Rossi	1905, Venezia	1927 Bologna	Fall 1927, 2nd assistant of Garbasso
Bernardini	1906, Fiesole	1928 Pisa	Fall 1928, "extra" assistant of Persico (see note ([25]))
Occhialini	1907, Fossombrone	1929 Firenze	From 1930 2nd assistant of Garbasso
Scandone[a]	1909, Firenze	1929 Firenze	INO, and then Officine Galileo
Racah[b]	1909, Firenze	1931 Firenze	Fall 1932, professor "in charge" of Fisica Teorica
Bocciarelli[c]	1909, Firenze	1931 Firenze	From 1932 "extra" assistant of Garbasso
Crinò[d]	1913, Firenze	1933 Firenze	Laurea in Chemistry and Officine Galileo
Emo Capodilista[e]	1909, Firenze	1933 Firenze	From 1933 2nd assistant of Garbasso
De Benedetti[f]	1912, Firenze	1933 Firenze	in Padua with Rossi
Mandò[g]	1912, Terni	1935 Firenze	in Palermo with Segré

The following list points out the papers which were the result or the premise of the thesis of "laurea" made under the supervision of members of the staff

([a]) Persico E. and Scandone F., "L'effetto Hall con elettrodi estesi", *Rend. Accad. Lincei*, **10** (1929). This paper was splitted into three parts: nota prima 238–249; nota seconda 361–368; nota terza (Scandone only author) 437–440. A very precocious student, after the thesis Scandone finds a position at the Istituto Nazionale di Ottica and then in Industry, becoming soon the director of the Officine Galileo

([b]) Rossi B., Racah G., "A proposito di un'osservazione di Stark sulla realtà del moto assoluto", *Il Nuovo Cimento*, **6** (1929) 317

([c]) Bocciarelli D., "A hard component of the beta-radiation of Potassium", *Nature*, **128** (1931) 347

([d]) Rossi B., Crinò B., "Le anomalie di assorbimento della radiazione penetrante", *Rend. Accad. Lincei*, **15** (1932) 741. A very precocius girl student, Beatrice Crinò shifted her interests to Applied Physics

([e]) Bernardini G., Emo Capolista L.,"Sulla radiazione gamma del Po+Be", *La Ricerca Scientifica*, **2** (1935) 17

([f]) Bernardini G., De Benedetti S., "Misure di assorbimento della radiazione penetrante secondo diverse inclinazioni zenitali", *La Ricerca Scientifica*, **2** (1933) 73

([g]) Bernardini G., Mandò M.,"Sulla disintegrazione del Berillio per azione dei raggi gamma", *La Ricerca Scientifica*, **2** (1935) 38

also they became acquainted with leading scientists who were happy to visit Arcetri through the international connections established by Abetti.[27]

A third important asset was the position of Garbasso in the Italian scientific environment, which gave him the possibility of providing scholarships for stays in leading foreign (mainly European) laboratories. It is likely that these circumstances largely compensated for the scarcity of financial means: those ambitious young men were striving after "fundamental" problems in the investigation of the physical reality ("… of the secrets of nature", as Bruno Rossi puts it humorously in his autobiography), but they were also enough well-informed, perceptive enough, and wise enough, to identify subjects which would not involve large expenses in costly instrumentation.[28]

Another facet of the behaviour of the "Arcetrini", to a certain point different from the behaviour of the group of Rome, is pointed out by Guido Tagliaferri who reports [28] a precise remark of Occhialini: *"The presence in Arcetri of Enrico Persico and the arrival of the newly "laureati" Bernardini from Pisa and Rossi from Bologna as assistants made possible the formation of a group of enthusiastic young physicists. The [scientific] interest of the Laboratory shifted from spectroscopy to nuclear physics and cosmic rays. So, 1927–1928, the School of Arcetri was born."* [29]. Tagliaferri writes: *"With the word "school" used by G. O. one should not understand a group of followers of a "maestro", but rather an informal community of scholars in the same discipline, who share the scope of its advancement, and to that scope they address the investigations of each one of them, using freely the results"*. That this was the case is shown by considering the whole of the papers published by the members of the group from 1930 to 1937: most bear only one signature, but all represent the results of a shared knowledge. G. Occhialini provides an interesting addition to Tagliaferri's commentary. In his words: *"the absence of scientific guide by Garbasso was important to train the muscles of Rossi and Bernardini"*.[29] Politician Garbasso was not only a passionate man of science, but also wise and generous enough as to let the intelligence and fantasy of his young researchers free, giving them his constant support in practical problems and encouraging them to publish quickly their results, which he was happy to present in the *Rendiconti dell'Accademia dei Lincei* and in the journal of the CNR, *La Ricerca Scientifica* (see note ([29])).

The Science and the Scientists

A proper account of the scientific results is beyond the scope of this paper. What follows is intended rather to shed some light on the attitude towards research and on the efficiency of the "modus operandi" of the "informal community" of Arcetri.

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[27] G. Occhialini, private communication to A. B. and contribution to the Round Table 1987. Also Bruno Rossi, ibid. and [25, 26].

[28] G. Occhialini, private communication to A. B. and contribution to the Round Table 1987.

[29] G. Occhialini private communication to A. B., 1987.

Giuseppe Occhialini states that with the advent of Rossi and Bernardini the interests of the Laboratory shifted from spectroscopy to nuclear physics and cosmic rays (see [29] and note ([29])). The very fact of this reorientation is an indication of the quality (of the curiosity) and of the ambition of Bernardini and Rossi, in their attempt to attack research along "new" lines, new at least in the Italian environment, these lines being typically of an experimental kind, associated with the development of "new" instruments.[30]

The first attempts are daring but not successful: an experimental verification of the corpuscle-wave nature of electrons [30] and a spectroscopic determination of the chemical composition of the cometary tail, a subject which reveals an incipient astrophysical interest.[31] And then in 1929, the cosmic rays. The story has been told mainly in the recollections of Bruno Rossi and Giuseppe Occhialini,[32] but some details perhaps are still missing. It has not been possible up-to-now to find the original thesis for the laurea of Occhialini, not even the title (a research is in progress at the Archives of the University of Florence). But a testimony of Livio Scarsi, from the very words of Occhialini sometime in the late eighties [32], is that Augusto Occhialini suggested the subject of cosmic rays to his son Beppino. Augusto was familiar with several American as well as German physicists, in particular Millikan, busy in propounding his theory of gamma-rays emitted in primitive nucleosynthesis, and Kohlhörster, who was working with Bothe in experiments for cosmic ray detection with Geiger-Müller (GM) counters (and with a coincidence method). The point is that the thesis work of Beppino contained a "tesina" (extra contribution) presenting the results of Bothe and Kohlhörster, just appeared in *Zeitschrift für Physik* [33]. Rossi was not moved by Millikan's theory, but the paper of Bothe and Kohlhörster awoke Rossi's understanding of new, different, features of cosmic rays and of the possibility of performing new, critical, measurements on them. Rossi obtained quickly a scholarship from the CNR and spent the summer months of 1930 in Berlin at Bothe's Laboratory. Back to Arcetri with the good recipes, he "put himself immediately at work" with his mates in Arcetri, first of all on the production of GM counters,[33] Rossi understood that these were the right detectors apt to open a new field of research, a new chapter of Physics. Furthermore, they were not very costly, which fulfilled one of the requirements of an enthusiastic but poorly financed Laboratory. But Rossi did more

[30] This is not surprising in the case of Rossi, a grateful pupil of Rita Brunetti, who maintained that the history of instruments coincides with the history of Physics (see note ([19])). But also Bernardini was born in the experimentalist environment of the Pisa of Battelli and Puccianti.

[31] Minor contributions of Rossi in 1929 refer to the Raman effect, a spectroscopic subject well in the reach of the Laboratory in Arcetri: in that very year Rasetti would publish his important results on Raman effect taking up the field.

[32] A general information with extended references is found in Leonardo Gariboldi [31], who suggests that Giuseppe Occhialini was influenced in his intellectual formation by Battelli through the influence of his father. The suggestion appears to be correct, if only because of the strong feeling for the motherland, which is characteristic of the "marchigiani". G. O., native of Fossombrone like his father, was educated in Florence and was one of the first students in the "corso di laurea" just started up by Garbasso.

[33] A lively description is in [25, 26].

than that: with astounding efficiency he invented and realised within the year his coincidence method based on the use of thermionic valves, the "circuito alla Rossi" [34].[34] From then on the results follow one another, giving Rossi the possibility of defending publicly against Millikan the notion of the corpuscular nature of cosmic rays in the "International Conference on Nuclear Physics" held in Rome, October 1931.

In a few years Rossi, Bernardini and the younger co-workers, in primis Daria Bocciarelli, produce about thirty short notes and papers on the absorption of cosmic rays (the Rossi curve and the multiple production [35]), their behaviour in the Earth magnetic field (zenithal effect,[35] the first attempts to E-W effect) and related technical problems. The last paper of Rossi before leaving Arcetri for Padua is with Fermi: "Azione del campo magnetico terrestre sulla radiazione penetrante" [37]. This was also the first work of Fermi on cosmic rays: it also witnesses the connections of the Group of Florence with the Group of Rome.

The measurements on cosmic rays implied the use of ionisation chambers not only for the detection of the "primary" radiation but also for the measurement of environmental low-level ionising radiation. The GM counters offered a new efficient way for this kind of measurements: indeed they were already an important tool in the study of Radioactivity (see note ([34])). The quick learning of the technique of GM counters is at the basis of the shifting of the interest of the laboratory from spectroscopy to cosmic rays and nuclear physics. So while Rossi proceeded with tireless energy in cosmic-rays investigation, he encouraged just "laureato" Beppino Occhialini to study weakly radioactive substances making use of counters.[36] The result was the first paper of Occhialini, on the activity of rubidium with a magnetic spectrometer designed and built by him. The detector was a small counter with very thin (less than ten microns) Al wall [40]. The same apparatus was used by Daria Bocciarelli for her thesis and for her first paper on the radioactivity of potassium (see Table 5). In successive three papers Bocciarelli extends the measurements making use of a method of coincidences. The success of these measurements gives an idea of the skill in producing "refined" counters, in designing instruments and in conducting measurements.

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[34] *"The first counting of the penetrating rays was in 1916 by Hess and Lawson, but Bothe and Kohlhörster used for the first time the wire corpuscle-counter, already in use in researches on radioactivity and extraordinarily useful. This device sends in a circuit a short electric signal whenever it is traversed by a fast charged particle. The signals can be amplified and the amplified current can reach a counting device. The method of the corpuscle-counter has been adopted in the researches carried out in the Physical Institute of our University and allows, by suitably connecting two or more devices, investigations on absorption, direction, nature of the cosmic rays, which may be very difficult or impossible to perform with electroscopes."*. This is how Persico announced the state of the art in Arcetri in the first days of November 1930, in his last opening address to the academic year before leaving for Turin. He quoted also by name "doctor Rossi of our Physical Institute" who was able to show "the formation of secondary electronic rays through a lead shield traversed by the primary radiation".

[35] The first work on this effect was by G. Bernardini [36].

[36] See [38]. Bernardini has a contribution on the technique of magnetic spectrometers for slow electrons [39].

In 1931 Bernardini was prevented by military duties to go to Cambridge, so Occhialini took his place and with a three-months scholarship of the CNR joined P. M. S. Blackett at the Cavendish Laboratory. His mission was to learn the technique of the Wilson cloud chamber mastered by Blackett. Occhialini added the technique of counters and of fast coincidences learnt from Rossi in Arcetri. The three weeks became three years and the results are contained in the four papers signed between 1932 and 1934 by Blackett, Occhialini[37] and later also by Chadwick [43]. Those in Arcetri joined in the enthusiasm for the success when reading Occhialini's letters describing his work (see note ([23])).

In the meanwhile the neutron had been discovered opening a new window in the study of the atomic nucleus. The testimony of Rasetti is interesting [7]. He spent one and half year at Lise Meitner's Laboratory in Dahlem between 1931–32. Back to Rome he found that during his absence there were *"only vague talks"* about leading the Laboratory towards nuclear physics (the experimental work in progress was essentially in spectroscopy). He found however that Fermi was ready to shift from spectroscopy to a more exciting field: the actual work started when Rasetti built the first apparatus on the basis of his experience in Dahlem.

The Group of Florence had already abandoned spectroscopy since 1930. Perhaps also because of the departure of Rossi in the Fall of 1932, the investigation in nuclear physics was accelerated, the subject chosen being the production of neutrons from berillium. After some preparatory work (cfr. M. Mandò [8]), Bernardini spent a few months in 1934 at Lise Meitner's Laboratory with a scholarship of the Academy of Lincei (also Emo Capodilista was there in the same year). The result was a study of the reaction ($Be + He \rightarrow C + n$) with several papers, mostly in collaboration with Daria Bocciarelli (also with Emo and Mandò, see Table 5). A result of Bernardini and Bocciarelli was also the study of proportional counters.[38]

But the balance of the Physical Institute was changing. A few months after the departure of Rossi for his professorship in Padua, badly ill Garbasso died, in March 1933. Rossi (already busy with the rebuilding of the institute and the preparation of the E-W experiment in Asmara) expressed later his deep gratitude to a man who had done so much for him and, to the last moments of his life, gave support to Bruno's project recommending its financing [25, 26]. After the death of Garbasso, Abetti became the provisional director of the institute with full satisfaction of the junior members of the staff, but the Faculty, suspicious of their independent attitude, after some hesitation called Laureto Tieri instead of waiting for Emilio Segré, the probable winner of the next competition (as suggested by Fermi). The direction of Tieri was not necessarily antagonistic towards the group [8].

But also the political situation was rapidly worsening. Differently from Rome, the members of the Arcetri Group were quite aware and felt politically involved, there were even harsh debates among them, that only the strong ascendancy of Garbasso had been capable of quenching. In the words of Occhialini: *"Garbasso was that*

[37] The first paper [41] was followed by [42]. From then on the signature of Occhialini as author becomes GPS.

[38] Contribution to the Round Table 1987 and Ref. [44].

not-existent animal, the intelligent, honest, good fascist … with a smiling tolerance for the divergent opinions of the junior persons".[39] In a climate made uneasy by the death of Garbasso, Occhialini, back from Cambridge and the Cavendish, made a big but unsuccessful effort to obtain an adequate financing for the construction of a Wilson Chamber.[40] He would react more sharply than the majority of his friends to the cultural ambience which was leading Italy into wars and racism. So he decided to leave Italy for some time and joined Gleb Wataghin in Brasil, to lay the foundation of a modern school of Physics in São Paulo. He was back in Italy eight years later after his detours in Bristol and Brussels.

In fact 1937 was the year of the dispersal of the group. Bernardini became Chair Professor and, after one year in Camerino, settled in Bologna, where he was director of that Physical Institute till 1947. With his characteristic energy he succeeded in continuing his work in particular on cosmic rays. One of the last papers while still in Florence is with Simone Franchetti, a chemist (see Table 4) who was appointed assistant in 1937 by Tieri, and was forced to abandon by the racist persecution. He was back at the end of the war.

Racah had built a very successful career in Theoretical Physics also through an intense relation with the theoreticians of the Group of Rome. He became Chair Professor in Pisa just in time to be forced to leave his position in 1938 and to emigrate to Israel at the Weizman Institute. Once filo-fascist, Racah perhaps remembered the hot discussions with Occhialini.

Daria Bocciarelli found a position at the Istituto Superiore di Sanità with Trabacchi and contributed to the success of that Physics Laboratory during long years, first in nuclear physics (the million Volt accelerator for neutron production), and then in Electronic Spectroscopy.

Lorenzo Emo Capodilista went, in 1935, to the United States for a stay at the Stanford Laboratory in Berkeley. He came back after a couple of years as agent of a firm for scientific instrumentation, abandoning active research.

Mandò after his laurea joined Emilio Segré in Palermo. When Segré was forced to leave, in 1938, Mandò joined Bernardini in Bologna. Then there was the bracket of the war, including a period in a prisoners of war camp. Finally, he returned to Florence and contributed, with Simone Franchetti (successor of Tieri in 1949), to the development of the post-war institute. Arcetri was coming to life again, and this together with the rest of Florentine Physics, no longer concentrated on the hills through the activity of the CNR Microwaves Centre, a remarkably successful achievement of Nello Carrara (a "normalista" and student in Pisa with Fermi and Rasetti) and the outstanding scientific and didactical work of Giuliano Toraldo di Francia.

[39] G. Occhialini, private communication to A. B., 1987.

[40] G. Occhialini, unpublished document.

The "Spirit" of Arcetri

The time is now to leave the stage to the actors, picking up a few significant quotations from the notes (unpublished as yet) of the Round Table, December 4, 1987 (see Sect. 6.5.1). The quotations are from Bruno Rossi, Edoardo Amaldi and Giuseppe Occhialini.

Bruno Rossi: *"When I think back to my past life I feel as if the years in Arcetri were a dream, a magic experience, which left a permanent mark on all my life: I think that Daria, Gilberto and Beppo, here with us, can understand, can interpret what I am trying to say, and also those would understand that are not here any more, Racah, Emo, Scandone, Righini, Beatrice Crinò … We were a small group of young people, just "laureati", in part still students. We were very different from one another as for familiar tradition, attitude, tastes, character, but we were united by strong friendship ties and by a common commitment to science. Other factors contributed to the special atmosphere created by these human relations, to what Mandò defined "the spirit of Arcetri". First the almost paternal attitude of the director, professor Antonio Garbasso, who would do his best to facilitate our work, using his political authority. Second, the proximity of the Observatory and specially of Giorgio Abetti who … somehow … took us physicists under his protection. Last but not least, the fascination of Florentine hills which would reassure our spirit and would allow our mind to sweep over the contingent practical problems of our work. I arrived in Arcetri … full of enthusiasm for the new life which was to begin and with the ambitious intention of undertaking some kind of research which would contribute in a substantial way to the development of science. I found … Gilberto who had the same intention…"*

Edoardo Amaldi: *"Corbino in Rome and Garbasso in Florence played a truly important role. Corbino was a self-made man … of great intelligence and a clear vision of the scientific and organizational problems of the country. Garbasso was a man of remarkable culture … very different from Corbino … [But he had the same] very positive attitude towards the new Physics which was being born in Europe [in those years] …and had the same will and ability to help the young physicists who would enter in those fields and produce scientifically … Contacts and exchange of ideas between the groups of Rome and Florence were kept through relatively frequent visits of the Florentines in via Panisperna and of the Romans in Arcetri … The Florentines would invite us to present our results in the Seminar … established through the initiative … of Giorgio Abetti … I was particularly impressed [by him], an exceptional person endowed with an uncommon charm, who would ask appropriate and interesting questions on any subject with unsurpassable grace and politeness … I was coming from the Institute of via Panisperna, which was beyond doubt a very well functioning and attractive place. In Arcetri the atmosphere was very different: the interest for music and beauty arts would appear frequently during the work … or in intervals such as that for having tea, which was prepared by Daria for everybody. An almost imperceptible romantic climate would waft in Arcetri, while in via Panisperna extra-scientific interests were almost exclusively mountain trips and nature … and*

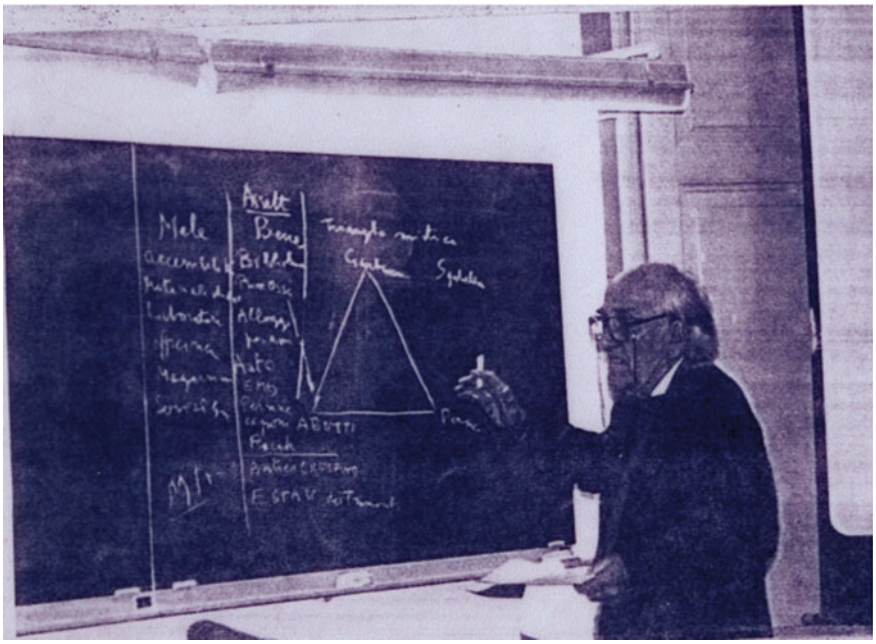

Fig. 1 Beppo describing "male" (Bad) and "bene" (Good) of Arcetri (December 4, 1987) and the *mystic triangle* made of Abetti, Garbasso and Persico. The writing on the black board is as follows. Bad: accessibility, didactic material, laboratories, workshop, storeroom, general services; Good: library, proximity of the Observatory, accomodation for assistants, motorcars (Persico, Racah, Caponi, Emo: these persons would collect colleagues and students from downtown) Antico Crespino (a "trattoria" at walking distance from the institute), ecstasy of sunsets

international contemporary literature, a field in which Rasetti surpassed everybody … Also the research subjects were rather different, but all these diversities between Rome and Florence were a reason of attraction between the members of the two groups" (Fig. 1).

G. Occhialini: *"Garbasso, Abetti and Persico … these persons had in common very important qualities: they [belonged to the category] of professors and scientists who were loved and respected, with no fear, no feeling of awe in front of them … [and furthermore] a common style, a common attitude towards what would be called Europe … those aristocratic sages probably had an influence on the members of the laboratory in a notable lack of aggressivity … [Abetti's] Seminar would bring the name of Florence where it was unknown … people came from everywhere, such as Hans Bethe, same age as Rossi, already involved in what was to become the Physics of fields … the Seminar was a high-level club … but it was not only for senior or junior researchers, but also for students who were striving to become researchers … So, together with the regular reading of journals promoted by Persico, junior people were put in the condition to have access with up-to-date scientific information to such exclusive Institutes as Rutherford's Cavendish."*

The contribution of Occhialini was made specially amusing and touching by his "Table list of Bad (Male) and Good (Bene) in Arcetri" that he draw on the blackboard in his characteristic humorous way: one misses Beppo's sharp to-the-point commentary.

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Acknowledgements The intention of the authors was to give an idea, however sketchy, of the cultural premises from which the group of Florence emerged with its peculiar characteristics. A parallel reference to the group of Rome appeared necessary to make clear similarities and differences, also because of the rich human and intellectual exchanges between the two groups in the few years of a surprisingly productive revival of Italian Physical Sciences, with results lasting in time.

Our thanks are due to many people and organizations. First of all to DARIA BOCCIARELLI (and SERGIO STEVE) for their moving effort in recuperating eight years of old memories and references. The same to MARIA SERENA SCANDONE, acting on behalf of her father. A special acknowledgement for the professional, and generous, work of ANNA CORINNA CITERNESI, editor of the Italian Bibliography of History of Science, who carried out the bibliographic researches and made the consultation of original documents possible.

LUISA BONOLIS provided most of the references of the early scientific production of Bernardini and Bocciarelli and contributed to the understanding of historical and interpretative problems about the origin of the groups of Rome and Florence.

MILLETTA SBRILLI, director of the Centro Archivistico della Scuola Normale Superiore, kindly provided useful information on the scientific staff of the School from the Archivio Storico, minutes of the board of directors, and a list of students from the end of 19th century to early 1930s.

We are indebted to ROBERTO VERGARA CAFFARELLI for a nice biography of Luigi Puccianti and to VALERIA DEL GAMBA, who kindly provided us with information about the life of Rasetti.

The Archivio Storico dell'Università degli Studi Firenze allowed full access to the set of Annuari from 1870 to 1937.

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