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Augusto Righi and the intuition of the experiment: a scientific portrait of the major Italian physicist across the end of the 19th and the beginning of the 20th Century

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Abstract
Ingenious experimental physicist, talented professor and science communicator, committed Senator, Augusto Righi has been the major Italian physicist across two epochs of physics history, the end of the 19th and the beginning of the 20th Century. By means of a close look into Righi's most significant experiments, apparatuses and documents, the paper provides on overview on Righi's major contributions to classical electromagnetism and structure of matter and sheds light on his peculiar "experimental intuition".

1. Introduction

Soon after the death of Augusto Righi, occurred on the 8th of June 1920, authoritative voices among scientists and intellectuals rose up to pay their respect to the illustrious physicist and, by doing so, provided several perspectives on him.

The brilliant physicist, future politician and mentor of Enrico Fermi – Orso Mario Corbino – during the commemoration held at the *Accademia dei Lincei* wanted to observe Righi in an historical perspective by describing him as "the most eminent physicist that Italy had since the epoch of Alessandro Volta" [1]. Shortly afterwards, the President of the Royal Society and physics Noble Prized Joseph John Thomson wanted to focus on Righi's major subjects of investigation and the role he had played in his country:

"Prof. Righi had made important contributions to our knowledge of electrical waves and the passage of electricity through gases. He was one of the leading spirits in the great renascence of scientific research in Italy, which has been so conspicuous a feature in its recent history" [2]

A more intimate portrait stems from the words of Righi's friend and colleague Giacomo Ciamician who, while taking the floor at the commemoration held at the Senate, wanted to emphasize Righi's research methodology:

"But I can tell you something more intimate about the way Righi worked, and how he conceived. He had what can be called the intuition of the experiment, in the sense that he thought by experimenting. As Senator Volterra has masterfully pointed out, the development of physics in the last fifty years is reflected in his works; every new fact, every new theory found an echo in his mind, and even more in his experimental intuition. When Righi was interested in some experience performed by others, he said: I want to repeat it; but to repeat it meant to transform it; day by day new facts were added to the facts and at the end of a month, or a year a masterful work arose. Thus was born the optics of electric oscillations, which had the following known to all. So I was able to

follow him in his scientific career from 1888 onwards, and I saw him rise from appreciation to celebrity" [3]

Retracing Righi's path from "appreciation" to "celebrity" and providing insights on his "experimental intuition" is the goal of the present paper. By following Righi's personal scientific career, an epoch of shifting paradigms in the history of physics unfolds: this epoch sees the major international physicists of the time engaged in the experimental completion of a well-grounded theory (the Maxwell electromagnetic theory) and the experimental exploration of the atomic domain for which a coherent theory was still to come.

Section 2 provides an overview on Righi's experimental activities until 1888, the year in which he gained an international reputation with his experimental studies on the photoelectric effect. Section 3 focuses on Righi's path from appreciation to celebrity: in particular, his thorough study of the optical behaviour of electromagnetic waves and his "experimental intuition" on how perfecting Hertz's apparatuses in order to do so will be carefully analysed. Section 4 draws from Righi's celebrity period – which includes 15 consecutive years of nominations to the Noble Prize, the nomination as Senator of the Kingdom of Italy and a successful career as popular science writer. Among the several studies carried out on this period, Righi researches on the Zeeman effect and magnetic rays will be addressed.

2. The built of a scientific career: Righi's activities until 1888

Born in Bologna on the 27th of August 1850, Righi attended the Royal Technical Institute of the city where he had the privilege of having a great figure of physicist and politician - Antonio Pacinotti - as teacher and mentor. Thereafter, during his studies in mathematics at the University of Bologna, Righi met Eugenio Beltrami, also a scientific reference for Righi's future career [4]. Righi's decision of completing his University training with a diploma for exercising the profession of Civil Engineer and Architect should not confuse about a keen interest for the physics of the time, at it is attested by his publication record.

In fact, object of Righi's dissertation was a small type of electrostatic generator, useful to measure small differences of potential and which he called "electrometer" [5] (Fig. 1): the apparatus had the peculiarity that the belt carrying the charges went through a cave sphere and it will be quoted as such by Robert Van de Graff when introducing his homonymous generator [6]. After succeeding to Antonio Pacinotti as physics teacher at the technical institute in 1873, Righi became assistant to the Cabinet of Physics at the University and associate at the Academy of the Sciences in Bologna. Along these years, Righi studies deal with electrostatic (controversial points, Volta principles, electrical discharges), light behaviour in magnetized materials and a series of experiences with the new Crookes radiometer.

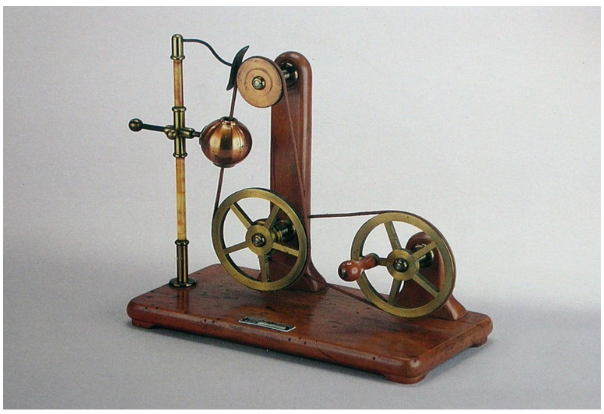

Fig 1. Righi's induction electrometer (Department of Physics and Astronomy, University of Bologna – DIFA)

Righi soon reveals also a special attention for the technological frontiers of the time - the electrical communications – a sector in which he will provide a long-life contribution. In 1878, few months after the introduction of Bell's telephone in Italy, Righi introduces his "own telephone" (Fig. 2), a device in which the communication between two people was extended to two groups of people. To the purpose, Righi transformed the Bell's receiver in loudspeaker and introduces the first conductive powders microphone [7].

Fig 3. Righi's telephone (Museo Crescenzi-Pacinotti)

Righi begins his University careers in 1880 as professor of experimental physics at the University of Palermo and quickly positions himself at the frontline of physics research. He publishes for example a short memory which contains the first observation of the hysteresis of steel [8], a discovery usually recognized to Emil Warburg and to his longer paper published the year after [9]. Along these firsts years, Righi's methodology recalled by Ciamician - consisting in repeating and modifying experiments performed by others in order to extract new knowledge – quickly reveals: after William Crookes had showed that "shadow phenomena" were created by cathode rays in evacuated tubes subjected to a different of potential, Righi shows that electric shadows could form also in open air and that "electrified particles" able to move along the line of an electric field existed also in atmosphere. In 1881, Righi refer to these particles as "ions of the gas, according to the new terminology" anticipating the German physicist Walther Giese who, in 1882, assumed gaseous ions to explain the electric conductivity of flames [10; 11]. Following the same method, after carrying out a detailed study on the variation of intensity of polarized light when it is reflected by magnetized materials – known as the "Kerr effect" [12] – Righi finds out the existence of a thermal analogue to the Hall effect, today still called "Righi-Leduc effect"[13].

However, Righi's encounters with the "great physics" of the time takes place in Padua, when he will be professor from 1885 to 1888 and become one of the physicists involved in the first experimental investigation of the photoelectric effect. An effect whose name was coined by Righi himself and for which Albert Einstein would introduce the hypothesis of the photon.

In 1886, after discovering the existence of the electromagnetic waves predicted by Maxwell's electromagnetic theory and while performing experiments to study their behavior, the German physicist Heinrich Rudolph Hertz noticed that when the waves emitted by the oscillator were filtered with a quartz-plate, the intensity of the discharge in the resonator became higher. Hertz realized that the ultra-violet component was responsible of lowering the discharging potential between the electrodes and, by doing so, identified the "core" of the photoelectric effect [14].

Following Hertz's steps, in the first months of 1888, his collaborator Wilhelm Hallwachs advanced the hypothesis that the phenomena could consist in a dispersion of negative charge from the negative electrode [15;16]. Righi's contribution to the matter dates to the April of 1888 and consists in a more complete experimental account of the phenomena: he showed that conducting or insulating materials, when irradiated with ultraviolet light became positively charged according to the proximity of the source and the extension of the metallic surface [17]. Two years later the German colleagues, in the person of Hallwachs himself, will recognize Righi's merits by saying that:

[. . .] If I therefore have to deny the priority of discovery, I would not like to omit to mention that the laws of the phenomenon, which we have gained up to now, are mainly due to him" [18].

3. From appreciation to celebrity: "The optics of electrical oscillations"

Righi's interest on the electromagnetic, or "Hertzian" waves develops around 1892, during his professorship at the University of Bologna, which began in 1889. With four consecutive papers, Righi introduces some "new experimental settings to demonstrate and study the electrical oscillations of Hertz" [19]. The innovations consisted in a new type of oscillators for the emission of the waves, a new type of resonator to detect them and the replication of some the Hertz's experiences with the new equipments. Righi states very clearly how further researches on the electromagnetic waves were hanging upon the resolution of a technical problem:

"It is known how uncomfortable and difficult it is to repeat the beautiful experiences of Hertz, which show the complete analogy between the propagation of the rays of electric force and that of light rays. Even when the wavelength is only 66 cm, as in the classic experience of Hertz, mirrors, lenses and prisms of colossal dimensions are needed, in order to show the reflection or refraction of electrical radiation, so that it would be not even thinkable to attempt the performance of many other optical experiences. I therefore believed that it would be worthwhile to try to experiment with much shorter wavelengths, and I have come to build rectilinear resonators with such a short vibratory period, as to respond clearly to electrical vibrations whose wavelength is few centimeters as well as the relative oscillators, capable of exciting them effectively "[20].

Since the beginning then, Righi's program is twofold:

a) introducing suitable devices to reduce the wavelength of the electrical oscillations so that Hertz's experiences could be repeated in a laboratory environment, without being tied up to the use of "colossal mirrors, lenses and prisms". On this account, since his very first paper, Righi repeats Hertz's experiences on reflection, refraction, interference and diffraction with a wavelength of 7.5 cm (reflected by metallic mirrors of the size of 1 dm^2), a wavelength that he was going to reduce to few millimeters in the years to come;

b) extending Hertz's experiments to the "ordinary optical experiences". In order to demonstrate that the new, Hertzian waves (radio waves, in modern terms) were the same thing of visible light (today, different region of electromagnetic spectrum), the totality of the optical phenomena such as double-refraction, total reflection and diffraction had to be verified in the new regime.

The completion of this scientific program is reported by Righi in the volume *The optics of electrical oscillations*, published in 1897 [21].

a) Experimental intuition: the new apparatuses

In Hertz's apparatus, the wave was generated by the oscillating tension of an induction coil applied to a secondary circuit allowing big quantities of charge to accumulate on the external spheres and discharge between the internal ones (Figs. 3,4).

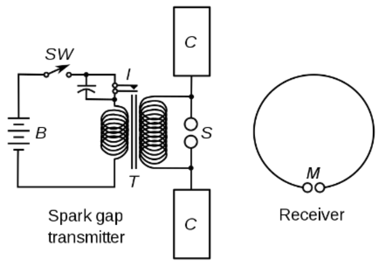

Fig. 3 Electrical circuit and Hertz's apparatus for electromagnetic waves

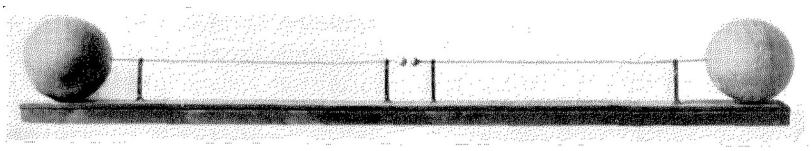

Fig. 4 Detail of Hertz's oscillator for the emission of electromagnetic waves

The critical point of Hertz's setting was the total capacity of the system: the big quantity of charge which was at stake produced low frequency oscillations with a high wavelength. On the other hand, reducing the size of the spheres would decrease the intensity of the signal, making it undetectable. Righi's intuition consisted in finding out the way to reduce the total capacity and preserving the detectability of the signal. The three sparks, or "Righi oscillator", was made of six spheres of small diameter in order to reduce the total capacity, the inductance of the circuit and its period of oscillation (Fig. 5).

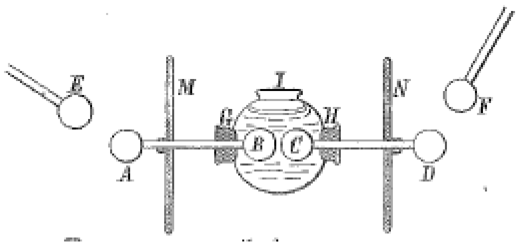

Fig. 5 Righi's three spark oscillator

The spark generating the wave struck between the two central spheres, charged by induction by two couples of external ones. The immersion in a dielectric liquid - "vaseline oil" – increased the quantity of charge necessary for the spark, so to compensate the loss of intensity implied by the small size of the spheres. Righi gives an empirical correspondence between the diameter of the spheres arranged in this way and the wavelength of the emitted oscillation: 0.8 cm diameter corresponded to a wavelength of 2.6 cm, 3.75 cm to 10.6 cm and 8 cm to 20 cm of wavelength. Righi's oscillator and the empirical knowledge embedded in it for mastering the wavelength was quickly noticed by Guglielmo Marconi and absorbed in his first patent for wireless telegraphy [22].

Righi's improvements of Hertz's apparatus concerned also the receiving system, or resonator, which in Hertz case consisted in an open, metallic ring terminating with two spheres. According to the orientation of the spheres, the passage of an electromagnetic wave would induce a current through the ring, an accumulation of charge in the spheres and their discharge through a spark. Starting from the observation that the sparks became more visible when propagating on the surface of a conductor, Righi replaced Hertz's resonator with his "silver glass resonator", a small rectangular glass to which he applied a millimetric cut all along its length. The wave emitted by the oscillator was then detected by the resonator and visualized as a series of sparks connecting the two disconnected sections of the resonator, perpendicularly to the cut. An increase or loss of intensity would correspond to a higher/lower number of horizontal sparks sequencing each other. Oscillator and resonator were mounted by Righi in a unique bench for the study of electromagnetic waves (Fig. 6). The two arms of the bench could rotate around a central pin and two parables hosted the oscillator (on the left) and the resonator (on the right). Sparks in the resonator were observed from the back of the parable through a small telescope. The orientation of both oscillator and the resonator could be varied for polarizing the emitted/received wave. Devices such as metallic mirrors, thin sulphur layers, prisms of sulphur and selenite were positioned on the central platform (Fig. 7).

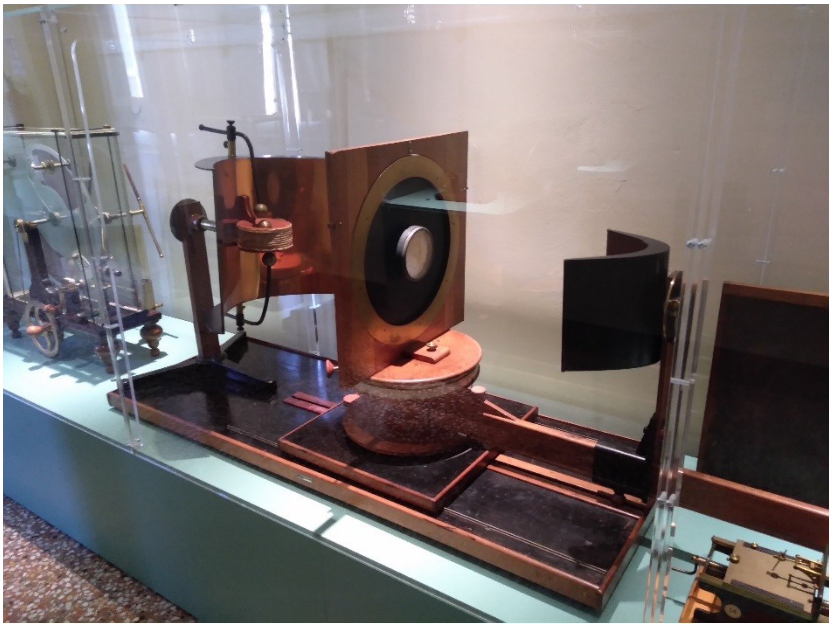

Fig. 6 Righi's electromagnetic bench (DIFA)

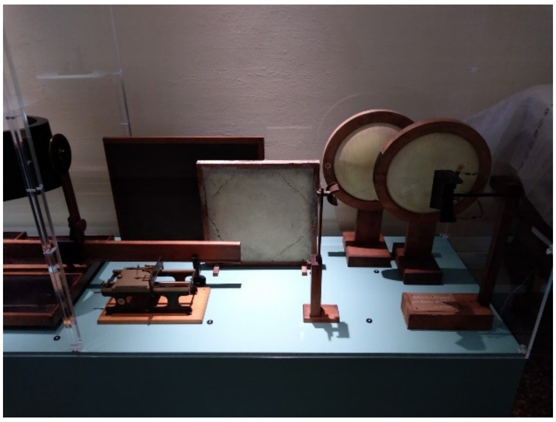

Fig. 7 Metallic mirrors, thin sulphur layers and lenses (DIFA)

b) Extending Hertz's experiences: the completion of a scientific program

Among the optical experiments allowed by the new apparatus, Righi tests the famous Fresnel's relations (Fig.8).

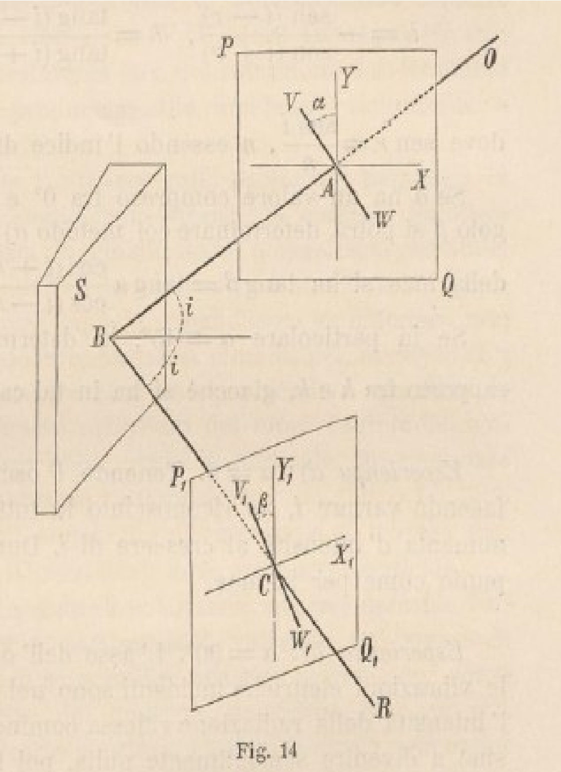

Fig. 8 Test of Fresnel's relations: schema of the experiment (Righi, Optics of electrical oscillations)

The wave was emitted in O, polarized according the angle α and received in R with the angle β. Righi verified that when the polarization plane of the emitted wave is perpendicular to the incidence plane, the reflected wave is also vertically polarized and its intensity increases according to the angle of incidence as predicted by the Fresnel. Besides, Righi verified that, when the polarization angle is different from zero and the incidence angle is minor to the polarization angle, polarization changes its sign.

Righi's experiences did not only consist in repeating optical experiences but also in perfecting electrical experiences carried out by his contemporaries, as it was for the measurement of the wave-length. Righi remarks how the original experience, suggested by Boltzmann to his collaborators Ignaz Klemenčič e Paul Czermak, contained a critical point. In the original setting, two metal mirrors AB and BC were used (Fig. 9). When these mirrors are combined to form a unique mirror, the resonator placed in R detect a maximum of intensity. When BC is then moved in the position B_1C_1 in a way that the difference between the optical paths of the two beams is a multiple of $\lambda/2$, the resonator should detect a minimum of intensity and should stop signaling.

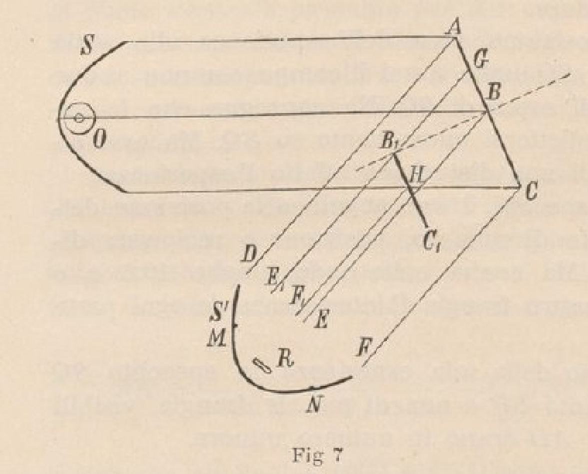

Fig. 9 Measurement of the wavelength: Boltzmann, Klemenčič and Czermak experiment (Righi, Optics)

Righi remarks that, even though this was theoretically correct, the performance of the experiment proceeded in a different manner. In fact, in order to reduce diffraction effects, the metal plates would be sensibly longer than the ones reported in the figure 9. This wouldn't cause any problem when the mirrors are in the first position; however, when the second mirror BC would be moved forward, the resonator would receive more radiation from the second mirror than from the first. The result is that the complete extinction of the signal couldn't be observed, the position of the minimum wouldn't be precisely determined and so it was for the wavelength of the radiation.

Righi's revision of the experiment foresaw the combined use of metal mirrors with a thin sulphur layer (Fig. 10).

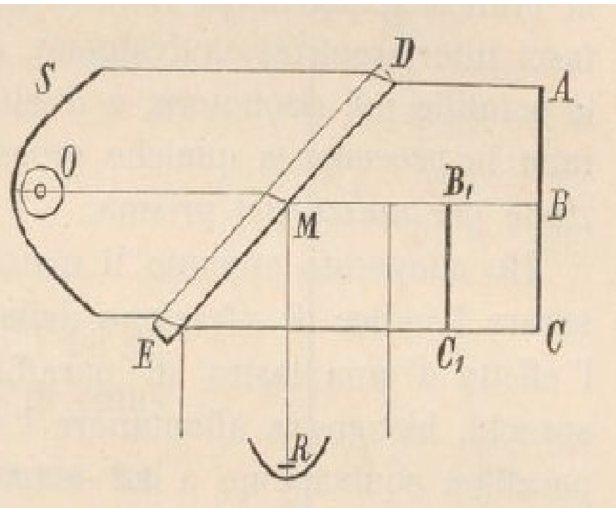

Fig. 10 Measurement of the wavelength: Righi's revision of the experiment (Righi, Optics)

Once located the sulphur layers on the central platform to form an angle of 45°, the radiation emitted by O would cross the layer and reach the two metal mirrors AB and BC. Then, the radiation reflected by the mirrors would be reflected also by the sulphur layer to be detected by a resonator placed in R. By moving one of the two mirrors (BC in B_1C_1**)**, the optical path of the two beams would vary so as that in R maxima and minima of intensity would be clearly observed. From the measurement of the distance BB_1 and the optical relations (destructive interference when BB_1 is a multiple of $\lambda/4$) Righi could obtain a precise determination of the wavelength. It is worth noticing how the set up for this experience draws from the Michelson and Morley interferometer, an element which confirms Ciamician's perspective on Righi's peculiarity of adapting others' experiences to new environments.

Conclusion to the section

As remarked by the historian of physics Mario Gliozzi, "The optics of electrical oscillation" is a title which means, and we should add closes, an epoch in the history of physics. After Righi's work of systematization and replication, visible light and Hertzian oscillations could be considered "oscillation of electromagnetic ether" and the electromagnetic nature of light could be finally decreed. On that year 1897, J. J. Thomson's experiments clarified the nature of electrical currents, by identifying the "atoms of electricity" – already hypothesized by Helmholtz and Maxwell - in the fundamental particle universally known as "the electron". In the meanwhile, the discovery of radioactivity by Becquerel, the studies of Marie and Pierre Curie, together with the observation of astonishing new effects such as the so-called "Zeeman effect" pushed the community toward the understanding of the internal architectures of matter and the incoming atomic models. Righi, despite the achieved celebrity, will not step back from this new chapter of history.

3. Righi's celebrity and full maturity: the studies on the structure of matter and the "magnetic rays"

Righi's growing visibility and achievement of celebrity can be detected at different levels. At University level, he will become the Principal of the Faculty of Mathematical, Physical and Natural Sciences of the University of Bologna (1896-1902; 1912-1915). At National level, besides becoming member of prestigious societies such as the Accademia dei Lincei and Accademia dei XL, he will be founder member and President of the Italian Physical Society (1897), alternating this presidency with the one of the Accademia delle Scienze dell'Istituto di Bologna.

At international level a series of honorary memberships include the Philosophical Society of London, the Royal Institution of Great Britain, the Royal Societies of London and Edinburgh, Uppsala and San Petersburg, the Academy of Sciences in Paris. In 1903, after the success of Marconi's intercontinental experiments and the publication of Righi's volume on the history of wireless telegraphy [23], the prestigious journal Nature wanted to underline that "Prof. Righi has considerable claims to be regarded as the father of practical wireless telegraphy" [24].

On those years, Righi's scientific recognition is enriched by an important institutional one: on the 4th of March 1905, Righi will be nominated Senator of the Kingdom of Italy and in such capacity, he will engage in school and University reforms, water treatment plants for energetical purposes and organize the first service of air-mail in Italy (and Europe) [25].

A sign of celebrity must be identified also in the authoritativeness recognized to him in the the popularization of his own discipline. Starting from 1904, the editor Cesare Zanichelli transforms Righi's conferences into books addressed to large audiences. In this way, a conference on radioactivity where Righi illustrates the principal discoveries of Becquerel, Marie e Pierre Curie using apparatuses introduced by himself – such as a special electrometer able to detect the activity of 15mg of radio at 4 meters distance – is published as "The Radio" [26]. Along this line, Righi writes his successful philosophical-oriented book "The modern theory of physical phenomena" [27]. In this essay, drawing from Lorentz's theory of electron, Righi explains how the electromagnetic theory of Maxwell and electron's discovery, finally allowed to articulate the comprehension of the physical reality in terms of ponderable matter, electrons and ether. Righi will discuss these ideas also in the lesson-demonstration entitled "On the electrical constitution of matter", given on the foundation of the Institute of Physics of the University of Bologna, the 12th of April 1907. Righi's ideas were noticed and appreciated by important philosophers of the time such as Vladimir Lenin [28] and Benedetto Croce [29]. Righi's popular works include an analysis of the cometary phenomena (such as the "comet tail") from the point of view of physics (such as the radiation pressure in gases or observations carried out in vacuum tubes). Presented in the form of a conference given at the Academy of the Sciences in Bologna on the 22th of June 1910 for the passage of the Halley Comet, Righi's speech became the book "Comets and electrons" [30].

Despite the new activities, Righi's attention to frontier physics does not slow down. Since 1895, he had worked on the propagation of electricity in gas through the Röntgen rays and the comparison between Röntgen rays and ultra-violet light, showing that the new radiation creates dispersion of charges of both signs, differently from the UV in the photoelectric effect [31]. Starting from 1898, Righi focused on the Zeeman providing contributions which include an experimental settings to observe the phenomenon without the use a spectroscope, the test of Lorentz's prevision according to which, when the gas is immersed in a magnetic field, each spectral line splits in two or three and the light is circularly polarized in case of a doublet and linearly polarized in the other case. Besides, picking up Lorentz's suggestion, Righi was among firsts studying the inverse Zeeman effect, occurring when a circularly polarized ray passes through a highly absorbing gas and magnetizes it [32].

After 1907, Righi's interests come to focus on one, single topic to which he devotes the last segment of his scientific activity, i.e. the intriguing subject of "magnetic rays". Righi's renewed attention to an "old topic" – physicists had known the magneto-cathodic rays since the half of the 19^{th} Century – studied by means of an "old technique" - the passage of electricity through gases - is however accompanied by a "new attitude" concerning the way of making research and the role of experimentalists in physics.

In the addresses to the Italian Society for the Progress of Science during the conference of 1911, Righi remarks that in the last three or four decades, *"slight importance was accorded to scientific hypothesis […] and the main activities of the most eminent physicists was principally devoted to rigorous and patient measurements, to the verification of numerical values and constants to a higher level of precision, to the search and understanding of very specific phenomena, or, in the best occasion, to the invention of experimental methods which would allow the choice between antagonists hypothesis. Today, on the contrary, a different trend, though less severe, tends to be preferred by many of us. Explicative hypotheses are not recoiled with horror, and intuition and scientific imagination are widely used as well" [33].*

Between the lines, one can read the reference to Einstein's heuristic hypothesis for the interpretation of the photoelectric effect in 1905 and guess that Righi must have been impressed, also due to his longstanding involvement. However, Righi will never really get into the realm of the new quantum hypothesis concerning the interaction between radiation and matter or the atomic models; perhaps, he will stay on a more macroscopic level, proposing a semi-classical model for gas behavior when they are crossed by electricity in vacuum tubes. Before Righi, physicists such as Edouard Sarasin and Auguste de la Rive had tried to understand the beautifully colored and appealing phenomena which can be observed when the electric glow in a cathode tube is immersed in a magnetic field. At the beginning of the Century, after the discovery of electron, eminent physicists like Paul Villard (discoverer of gamma rays) had risen the subject that the green fluorescence typical of the cathodic rays didn't suffice to explain the variety of these colored phenomena, called "magneto-cathodic" effects.

Righi's first contribution to the subject firstly consisted in the design and construction of an apparatus which was able to provide an almost complete separation between the well-known cathodic rays and the "other rays", needing further explanations. The horizontal tube in Figs. 11, 12 was commissioned by Righi to the famous instrument-maker Richard Müller-Uri in Braunschweig. It could be crossed horizontally by a magnetic field produced by electromagnet R and, differently from any other apparatuses of this type, it has the anode (A) and cathode (C) in a vertical position. When the tube was evacuated and a tension applied, a green fluorescence – cathodic rays, or electrons - were observed in the vertical column between C and A. However, when the electromagnet was switched on, a blue column formed horizontally and by increasing the intensity of the field, the blue column increased its length until a maximal extension E. At this value of the field, a second column of a reddish color appeared between E and D [34].

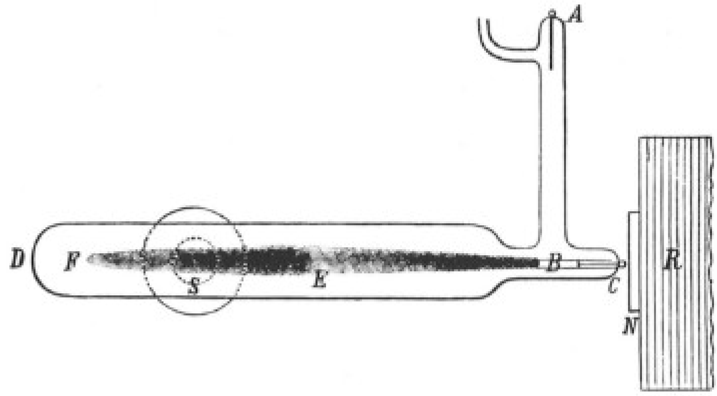

Fig. 11 Righi's apparatus for magnetic rays

Fig. 12 Righi's apparatus for magnetic rays

Righi's theoretical proposal to interpret these horizontal rays ("magnetic rays") consisted in the hypothesis of the "planetary doublets": electrons and ions in a gas crossed by electrical currents do not only exist in stable, bounded state (molecule) or in a ionized one; according to Righi, they can exist on a third, weakly-bounded state in which they elliptically rotate around a common center of mass during their propagation, analogously to the double-stars in the Universe (or comets around the sun). The hypothesis was supported from the fact that, according to Maxwell theory, the magnetic field could confer temporary stability to these electrical systems, as the gravitational force does for the masses: when sufficiently strong, the magnetic field could position the doublets in a stable orientation via the Lorentz force, prevented that the sense of rotation of the electron should be the same of the current generating the field. However, because of the current produced by the revolving electrons, the doublets would act as elementary magnetic dipoles, and move toward regions of decreasing field strengths, where they would dissolve either forming a molecule or an electron and an ion. Righi's proposal was to interpret the blue fluorescence between B and E as evidence for the formation of the magnetic rays and the red one between E and F as evidence for their dissolution. In fact, few electrons emitted from the cathode would escape the way to the anode and combine with the ions of the gas to form the doublet which would form continuously. The existence of soil value in the magnetic field and the presence of a second column would be evidence that, below a certain value, the magnetic field would not be able anymore to support the formation. The fact that the left part of the tube contained ions and electrons in a separate state was reinforced by the observation that, when a magnetic pole S was place near the tube, an electric current moving from D to E was observed: the ions of the broken doublets, because of their inertia, would remain close to the breaking-point (and so between E and S), while the fast electron would reach the bottom of the tube and recalled back by the magnet.

Righi's hypothesis was meaningful of the belief that the understanding of the intimate structure of matter – the microcosmos – should reflected the understanding the whole – the macrocosm. In the same years, Ernst Rutherford suggested his planetary model for the structure of the atom and what an intriguing and inspirational coincidence the passage of the Halley Comet in 1910 must have been.

Scholars have noticed that Righi's hypothesis, even though was the object of a lively controversy, was never really rejected through solid experimental refutation; perhaps, it was more "neglected" as time went by. The weakest point of it was probably Righi's decision of not entering the mechanism of how doublets released light by rearticulating the hypothesis within Bohr's theory of light emission [35].

Along the years of the controversy and magnetic rays studies, Righi's international reputation continued its course. The most evident sign are surely the 15 consecutive years during which he is nominated for the Nobel Prize by 40 of his colleagues. He is supported by many Italian scientists such as Orso Mario Corbino, Giacomo Ciamician and Vito Volterra and European ones such as Henri Poincaré, Henri Becquerel, Oliver Lodge and Pieter Zeeman. In 1918, Righi became member of the Solvay Institute and sat on its scientific committee for the 1921 meeting – dedicated to "atoms and electrons" – along with H.A. Lorentz, Madame Curie, William Bragg and Ernst Rutherford. However, he couldn't participate to this meeting since he died on the 8th of June, 1920.

Righi's last paper, published with an unfinished final note focused the other fundamental framework of 20th Century physics, i.e. the theory of special relativity [36]. As many other experimental physicists will do until the 1930s, Righi was re-analyzing the Michelson and Morley experiment, asking the "supreme question" on whether the uniform motion does or does not affect the optical phenomena observed in it, planning new experiences to come, not easily prone to banish away the nineteenth-century ether from the theoretical imaginary of physics.

Conclusions

The paper provided a scientific portrait of Augusto Righi through a close look into Righi's major contributions to the history of physics, i.e. the experimental researches on Maxwell electromagnetic theory and the studies on the structure of matter.

The analysis showed that Righi's "experimental intuition" brought him to solve sophisticated technical problems as the reduction of the wavelength of the electrical oscillations, which influenced the development of wireless telegraphy. However, the paper also shows that Righi's contributions must be understood beyond the wireless telegraphy in so far they concerned the pure development of physics: Righi had the merit of bringing to completion a scientific program began by Hertz and devoted to show that visible light and electric oscillations were both electromagnetic waves. The celebrity that Righi gained from this enterprise didn't prevent him from engaging in the new physics which opened in the last years of the 19th and flourished at the beginning of the 20th Century. Righi looked at the new epoch with the eyes of a Maxwellian, stretching at best the insights of the classical electromagnetic theory and becoming one of the most representative figures of that era of physics.

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Short bio

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