DOI: 10.6093/978-88-6887-312-7

C. Bonfanti's Book Collection

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Abstract. In this paper we shed light on some aspects of the Corrado Bonfanti's book collection held at "I.T.S. Alessandro Volta" in Trieste. We will focus on four books. Two concern quantum mechanics, one relativity and one television. All these texts date back to the first three decades of the twentieth century. The two books on quantum mechanics (written by Antonio Carrelli and Enrico Persico in 1932 and 1936, respectively) show the great advances made in understanding the structure of the atomic nucleus after the discovery of the neutron by James Chadwick in 1932. The book about general relativity is the second Italian edition (from 1922) of a translation of the 1920 text *Das Weltbild der Relativitätstheorie. Allgemeinverständliche Einführung in die Einsteinsche Lehre von Raum und Zeit*. The book provides a fairly complete introduction to the subject and remains accessible to a wide audience. It is one of the first informative works on relativity. The last book is *Televisione, le basi fisiche del radiovedere* by Gaetano Castelfranchi, published by Hoepli in Milan in 1931. This book offers an introduction to the history and the development of the scientific discoveries that made possible the creation of the first apparatus for the transmission of moving images by means of electromagnetic waves. These texts provide a deep insight into the history of physics and its teaching since they were written when the fields they cover were not yet fully developed.

Keywords. History of Mathematics, Mathematical tools, I.T.S. Volta, Corrado Bonfanti.

1. Introduction

Since 2012 I.T.S. A. Volta of Trieste has hosted the PSIC (Percorsi Storici dell'Informatica e del Calcolo) exhibition, created by Corrado Bonfanti and sponsored by AICA. After the death of professor Bonfanti in 2019, the school inherited his entire calculating devices collection and his book collection. The latter is important as it contains several antique books printed before to 1830, some of which date back to the period from the 16th to the 18th century, as for example Federico Commandino's translation of Euclid's *Elements* and a copy of the treatise *Analyse des infiniment petits pour l'intelligence des lignes courbes* by the Marquis de l'Hôpital.

The book collection can be divided into several macro-sections. The first one deals with the history and the development of the calculating devices. It is linked to the PSIC exhibition and, more generally, to professor Bonfanti's devices collection. The second part, partially overlapping with the first is dedicated to the history of mathematics. The third section focuses on the history of the most important Italian and international IT companies, such as IBM, HP and Olivetti. Two other sections complete the collection: a large number of programming languages manuals and Hoepli manuals covering a wide range of subjects from mathematics to physics and engineering. Each section is composed of both theoretical and popular works.

I will focus on four books, two on quantum mechanics, one on relativity and one on television, each dating back to the twenties and the thirties of the 20th century. For these books give a clear picture of some of the key discoveries in the history of physics.

2. History of the I.T.S. Volta

The origins of the Alessandro Volta Technical School can be traced back to the "Staatsgewerbeschule" of Trieste, in turn heir to the "Scuola triestina di disegno". The latter was founded in 1850 on the initiative of Pasquale Revoltella and Francesco Gossleth with the aim of training a class of skilled workers to be employed in the industries of the region. From the preserved yearbooks we can deduce which courses were activated at the end of the 19th century. They were:

1) "Scuola superiore di costruzione navale" in 1896/97.
2) "Scuola industriale superiore edilizia e meccanica".
3) "Scuola per capi d'arte" divided into sections for painting, sculpture and woodwork.
4) "Scuola di ricamo e lavori in merletto".
5) "Scuola domenicale e serale per apprendisti".

The First World War partially disrupted school activities that were reactivated during 1918-1919 despite the Spanish flu pandemic. Until 1922 the region remained under military administration and then under extraordinary civil administration. During the twenties, the school became part of the Italian Industrial Schools. Therefore the Italian school system was applied. At the end of the decade the school changed its name in "Scuola quadriennale di tirocinio". Later on, denomination became "Regio Istituto Industriale" and in 1932, "Regio Istituto Tecnico Industriale". In 1934-35 the structure of courses was reformed with the creation of a two-year general course and a two-year specialisation course with three fields of study namely construction, mechanics and electronics. In the same year the school was dedicated to Alessandro Volta. During the Second World War, the school's activity was again interrupted, especially during the German occupation.

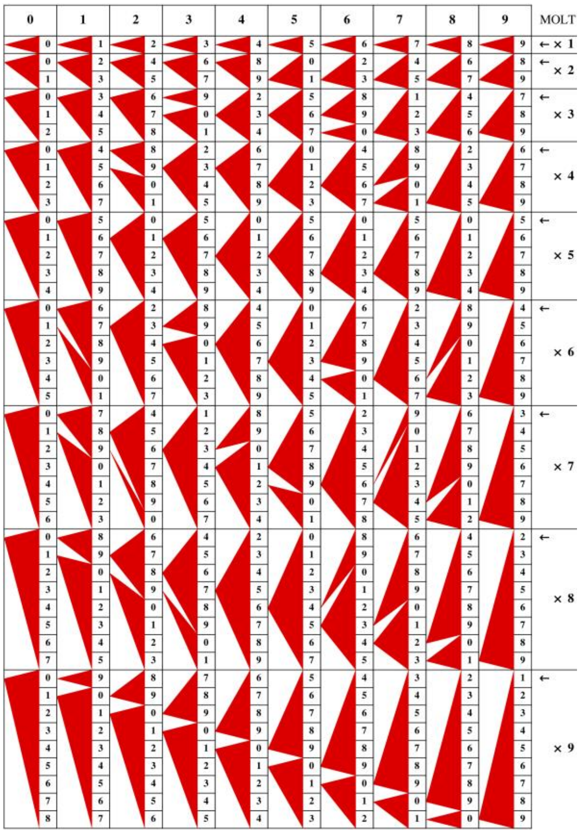
In 1948 new five-year courses were started, and ten years later a branch of the school was opened in Gorizia. During the sixties, new courses were activated, together with an evening school for surveyors. In 1972 the school moved to its present location in Monte Grappa Street. (AA.VV. 1987; Iona 1996; Caroli 1999)

3. Corrado Bonfanti: his life and legacy

Corrado Bonfanti was born in Tripoli (then part of the Italian colony of Libya) in 1940. He graduated in Physics at University of Rome (La Sapienza) and worked for many Italian IT companies such as IBM Italia, Finsiel Group; with Italsiel in Rome, with Insiel in Trieste (where he lived for more than 30 years), and abroad in Bucharest as a General Director of Finsiel-România. During his career he wrote more than 20 articles on the history of calculating tools and of computer science and was invited as a speaker in several seminars on this subject in Italy. He held numerous teaching positions at the Universities of Rome, Milan, Bari, Trieste and Udine.

He was an honorary member of AICA (Associazione Italiana per l'Informatica ed il Calcolo Automatico, namely Italian Association for Computer science and Automatic calculation) since the '80s and directed the "Gruppo di Lavoro di Storia dell'Informatica" in AICA and the AICA-History of mathematics project. He was a member of the scientific committee of the "Mondo Digitale" (a journal published by AICA) since its foundation. His role in the series of AICA courses on the history of mathematics, which involved twelve universities over three years starting from the academic year 2005-2006, was remarkable. Along his career, he collected more than 300 calculating tools and antiquities related to the history of mathematical instruments. The PSIC exhibition, host at I.T.S. A. Volta, collects only a small part of his collection. The permanent exhibition is divided into several sections, each dedicated to a specific period and/or a particular family of calculating devices.

Fig. 1, left. An integraph.
Fig. 1, right. A planimeter.



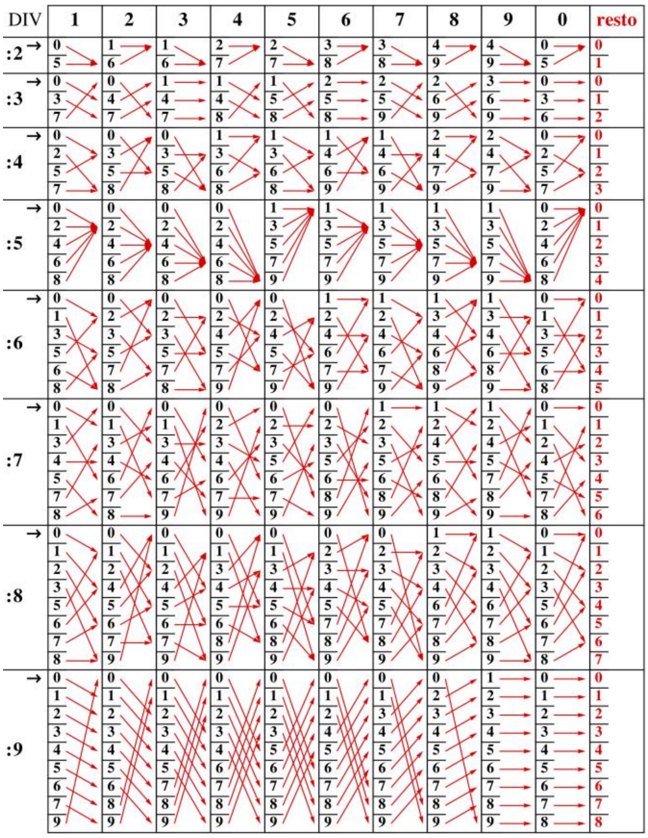


Fig. 2, left. Genaille's rods for multiplication (reproduction).
Fig. 2, right. Genaille's rods for division (reproduction).

Fig. 3, left. Specimens of table abacus tokens, minted by wealthy bankers and merchants of various northern European cities.
Fig. 3, right. A Russian abacus (schoty).

Following an almost chronological order, the exhibition traces the evolution of calculating devices from the 17th century to the end of the 20th century, starting with the abaci and other elementary tools for numerical calculations then moving on to slide rules and other tools for analogical computations. Another part of the collection is devoted to mechanical calculators and electromechanical calculators. Mechanographic systems and punched cards, together with the origins of the desktop PC, form another important part of the exhibition. Attention is focused on newer technologies such as pocket calculators, magnetic core memories, thermionic valves, floppy and hard disks.

It should be noted that the collection also includes some very peculiar calculating devices. For example there is a modern reproduction of the Genaille-Lucas rulers (also known as Genaille's rods) for multiplication and division, and a reproduction of Napier's bones are on display. Other remarkable devices are an integraph, namely a mechanical tool used to trace the integral curve of a given function, and a planimeter, namely a tool used to measure the area of a plane figure with an irregular boundary (See e.g. Fig.1). Parts of his collection of mathematical tools have been displayed in two temporary exhibitions:

1) "Numeri e macchine: breve storia degli strumenti di calcolo", held in two successive editions at the University of Udine from 7 to 26 February 2000 and from 6 to 16 March 2001. The exhibition was conceived and designed by Paolo Giangrandi who also edited the catalogue.
2) "Per fili e per segni. Ingegno italiano e società dell'informazione". First national exhibition held in Genoa from 10 November to 30 December 2004, promoted by AICA and FIDA Inform (Federazione Nazionale delle Associazioni Professionali di Information Management) devoted to the past and the future of Information and Communication Technology.

4. *La teoria dei quanti*

The first book we will describe is *La teoria dei quanti* by Antonio Carrelli (1900-1980), published in Rome in 1932 by Paolo Cremonese. Antonio Carrelli was an Italian physicist whose main interest was matter physics. The book is part of "Collezione Omnia", a large series of books on subjects ranging from literature to history and physics.

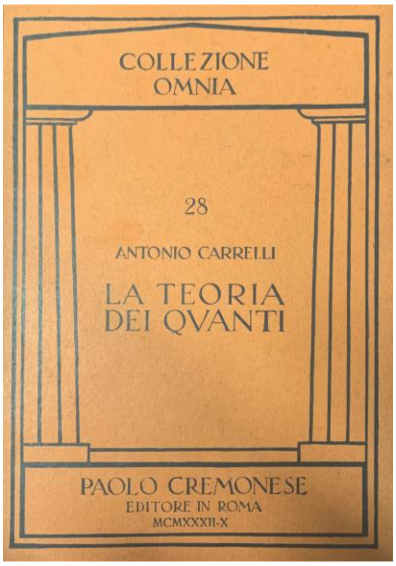
After a brief introduction to matter structure down to the atomic level the author summarises the kinetic theory of gases and the wave theory of light with some references to interference phenomena. Carrelli supports the so-called nuclear electron hypothesis.

He then moves on to the description of the electromagnetic spectrum and in particular to Wien's law and Stefan-Boltzmann's law which underlie the contrasts that arise from the application of the equipartition theorem of classical statistical mechanics to the study of the blackbody emission. Planck's and Bohr's theories are thus presented together with the notion of energy quantum. The orbit quantization postulate, although rather arbitrary, correctly explains the stability of the hydrogen atom. The theory presented here is sometimes called "Old quantum theory". It includes several extensions of the Bohr model, the most famous being the Bohr-Sommerfeld theory, now part of the so-called semi-classical approximation. The first part of the book is concluded by an account on Stern-Gerlach experiment, the photoelectric effect, Compton effect and the Frank–Hertz experiment. The next two chapters present respectively the main criticism and the most recent interpretations of quantum theory. The author recalls the arbitrariness of quantum postulates, emphasizing that the development of the theory relies heavily on an application of classical mechanics in a quantum framework and that the results agree with observations only for the hydrogen atom. Afterwards he presents De Broglie theory (the wave-particle dualism) and the Schrödinger theory, introducing the wave function which explains that the quantized orbits are the only possible solutions to the Schrödinger equation for negative energies. In particular he expounds Born's interpretation of Schrödinger's ψ function. Finally, Carrelli analyses the consequences of the quantum theory and underlines that, when dealing with quantum mechanics, the motion of a particle cannot be predicated without any uncertainty. The classical example of the observation process for the motion of an electron along a straight line is thus presented. The last part of the book describes the most recent experiments in support of quantum mechanics (the Davisson-Germer and George Paget Thomson experiments), together with some physical and chemical phenomena that can only be explained by quantum mechanics, and ends with some open problems. This text is very technical, especially in the last parts. A good knowledge of quantum mechanics, at least at an introductory level, is required to fully understand it.

5. *Fondamenti della meccanica atomica*

The second book here presented is the first edition of the treatise on atomic physics by Enrico Persico (1900-1969), published by CNR in 1936. This text expounds the most recent developments in atomic and nuclear physics. The book is the first Italian handbook in this field and was used in Italian universities for decades. It is divided into three parts.

In the first part (consisting of four chapters), the author gives an introduction to matter structure describing the most important experiments (from Rutherford's experiment to Chadwick's discovery of the neutron) and then moves on to the theory of light quanta giving a detailed account of the experiments that demonstrate the impossibility of a purely undulatory or purely corpuscular theory of light. Therefore, the photoelectric effect, the Compton effect and the experiments of Taylor, Dempster and Batho are explained. The exposition continues with a complete discussion of atomic spectra and their interpretation in the light of the Bohr's quantization principle. A complete account of the experiment supporting the theory is given, going into detail of the anomalous Zeeman effect and the Ramsauer effect, both of which require a quantum explanation. The first part ends with an introduction to the Heisenberg matrix method, where the notion of "observable" is central. Here, the De Broglie theory (wave – particle dualism) is presented and the main experiments on diffraction patterns for electrons are described. Persico concludes this part underlining that in quantum mechanics, physical concepts need to be defined in an operational way.



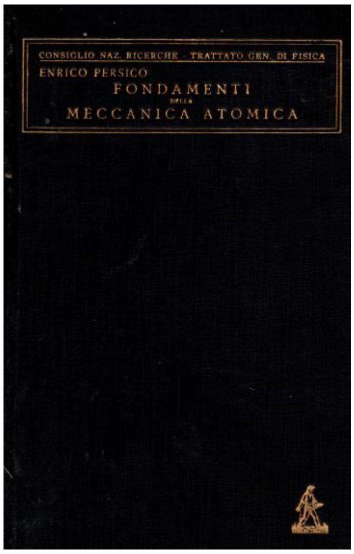


Fig. 4, left. Antonio Carrelli's book *La teoria dei quanti*.
Fig. 4, right. Enrico Persico's book *Fondamenti della meccanica atomica*.

The second part describes the wave mechanics of a particle. Persico starts with the theory of linear second order differential equations and Fourier series. The attention of the author then shifts to the probabilistic approach for problems at atomic scale. From this point of view the superposition principle and the uncertainty principle for both photons and massive particles are derived together with the Schrödinger equation. The results developed in the first chapters of the second part are then applied to the study of the one-dimensional problems for the particle motion derived from the application of Schrödinger equation (free particle, step potential and confined particle problems). The last chapters of the second part are focused on a discussion of the Bohr-Sommerfeld model and of various methods to find approximate solutions to the Schrödinger equation.

The third part of the book begins with the mathematical tools to study quantum mechanics, such as Hilbert spaces, the algebra of linear operators and their matrix representation, and an introduction to the Dirac delta function. The discussion then shifts to the notion of "observable" and to the compatibility criterion. Matrix methods and their application to perturbation theory are also discussed. Electron spin, fine structure for spectral lines, and the nature of antimatter complete the exposition.

The book presents the state of the art of the subject at the time and describes all the most important experiments that marked the development of quantum mechanics from its origins until to the mid-1930s. The book is complete and modern in its exposition, although the main interest lies in the complete account of the main experiments that mark the development of quantum mechanics.

6. *La prima conoscenza della Relatività dell'Einstein alla portata di tutti*

This book by Harry Schmidt (1894-1951) was published in Italy in 1922 by Hoepli. It is the second Italian edition of an Italian translation of the 1920 text *Das Weltbild der Relativitätstheorie. Allgemeinverständliche Einführung in die Einsteinsche Lehre von Raum und Zeit* also translated into English in 1921 under the title *Relativity and the universe. A popular introduction to Einstein's theory of space and time*, published by Methuen in London.

After a brief introduction to the life of Albert Einstein, the first four chapters present an introduction to the history of physics from its origins to the beginning of the 20th century. The author recalls some of the most important experiments in the history of physics such as the Cavendish experiment and the Foucault pendulum experiment. With regard of to the atomic structure the author presents a description consistent with the nuclear electron hypotheses. This part of the book is concluded by a discussion of the Galilean relativity principle.

The next part of the book deals with the propagation of light in vacuum. Starting from the fact that a mechanical wave needs a medium to propagate, the author analyses the origin of the ether hypothesis and the problems that arise from its existence. The exposition continues with a detailed account of the Michelson–Morely experiment of 1879 and its interpretation by Lorentz who postulates a contraction of any object in the direction of motion. The author then introduces the postulates of relativity namely the constancy of light speed and the invariance of physical laws under uniform rectilinear motion. The following chapters analyse the notion of simultaneity and the operativity of the measurement process, as well as the structure of space. To explain the deformation of space-time, the author introduces non-Euclidean geometries presenting a model of hyperbolic geometry taken from *La science et l'hypothèse* by Poincaré: the classical conformal disk model.

The last part of the book begins with an introduction of the general relativity principle and its comparison with the special relativity principle, in particular as regards to the influence of gravitational fields. Indeed, massive objects induce a deformation of spacetime that must be taken into account when calculating the motion of both particles and photons. The main phenomena in support of relativity theory were recalled (the perihelion precession of Mercury, light deflection by gravity and gravitational redshift of light). A summary of relativity theory and a small notice on the figure of Johann von Soldner who was the first to hypothesise deflection of light by massive objects such as the Sun, completes the book.

This work is accessible although the total absence of formulae makes the reading complicated.

7. *Televisione: Le basi fisiche del "radiovedere"*

Televisione, le basi fisiche del "radiovedere" by Gaetano Castelfranchi (1892-1965), was published by Hoepli in Milan in 1931. The author wrote many books about physics and engineering. This text offers a complete introduction to the history and the development of the technology necessary for the transmission of moving images by means of electromagnetic waves. The title of the book itself can be translated into English as *Television: physical basis of "radio-seeing"*.

The first two chapters describe the state of the art on the television transmitting techniques (in 1931) with particular attention to the most advanced country (the United States), and a complete account on the pioneering studies by Marconi, Fessenden, Vanni and many others. Generation and propagation of electromagnetic waves is discussed, focusing in particular on the properties of each part of the electromagnetic spectrum. The functioning of transmitting and receiving parts (namely antennas and microphones) is explored in details.

The next two chapters describe selenium and photoelectric cells respectively. Here the author provides a complete history of the studies on the use of selenium cells to transmit images. He also explains how the development of photoelectric cell studies is linked to several important experiments in the history of physics (such as the mass-charge ratio for the electron and, of course the photoelectric effect). The internal structure of several specific cells is also examined in detail.

Chapter five address various methods of transmitting static images, namely the phototelegraphy. Several devices are described, from the older ones to the most recent. Each description is accompanied by the corresponding electric diagram. The next two chapters deal with the Nipkow's disk and with the history of pioneers of the "true television". The author uses this expression to indicate an instrument that is able to produce moving images. The works of Szczepanik, Rosing (who invented the cathode ray tube), Mihaly and many others are described.

In the following chapters, the author describes the most common techniques used for image exploration and signal modulation, with a careful analysis of the maximum resolution achievable with the various techniques. A major problem is highlighted: the maximum resolution also depends on the bandwidth available on each transmitting channel. To improve signal propagation TV stations operate (with rare exceptions in the LW or lower SW bands) mainly in the medium wave band and therefore are subject to the same limitations of radio stations (namely the 9 kHz bandwidth). This section is concluded by a description of the main devices used to convert electrical signals into light.

The last part of the book begins with a portrait of the inventor of television, John Baird, and then shifts to the description of the most recent developments in the transmission of moving pictures. The problem of synchronisation between transmitting and receiving stations is analysed, together with amplification techniques. The book then ends with a brief description of the most recent developments, namely colour television and even stereoscopic television.

The book is particularly interesting because it gives a complete account of the development of television at the very beginning of the 1930s. Although it is rather technical, it provides a complete series of illustrations, which are very helpful for comprehension.

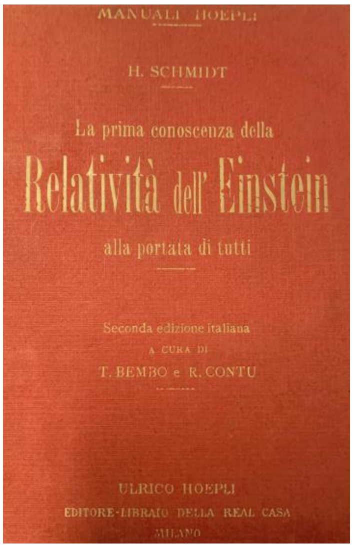


Fig. 5, left. Harry Schmidt's book *La prima conoscenza della Relatività dell'Einstein alla portata di tutti*.
Fig. 5, right. Gaetano Castelfranchi's book *Televisione, le basi fisiche del "radiovedere"*.

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