The Milanese period of Albert Einstein

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Abstract: This presentation, dedicated to the young Einstein's environment in Milan, focused on two new points: (I) the library where he would work during his family trips from 1896 to 1901, identified as the library of the Lombardo Institute, academy of science and letters; (II) the new direction given to his doctoral work in mid-April 1901 – that can be linked to an article written by M. Reinganum, published in the *Festschrift* for Lorentz, a publication that could be found in this library from January 31st 1901. The end of the presentation raised a question about light quanta: could Einstein have had a first idea about this as soon as the 1901 spring in Milan? The research about Einstein's scientific environment in Lombardy has then known several developments: the question of light quanta, Michele Besso's family (Einstein's friend) and their connection with the electrotechnical environment, Michele's thesis, and finally, Einstein's scientific environment in Pavia. It seems desirable to give an insight of these recent developments as well.

Keywords: Einstein, Besso, Cantoni, Istituto Lombardo, molecular forces, light quanta.

1. Introduction

It should be reminded that Einstein has visited Milan between 1896 and 1901 during semester breaks of the Zürich polytechnic (September/October - March/April) at his parents', at 21 via Bigli, a stone's throw from the Scala theatre, in a famous palace then belonging to Prince Luigi Alberico Trivulzio. This palace had accommodated Countess' Clara Maffei salon until 1886. Albert's relatives (his father Hermann and his uncle Jacob) had settled in Milan and Pavia to actively participate into the development of the electrification of North Italy when they moved their electrotechnical company from Munich to Pavia in 1894. Since 1887 they had handled the electrification of several cities in Piedmont and Lombardy. It is in this context that the initial training in 1895 in Pavia of the young Einstein – then aged 16 and trained at his uncle's engineers office, preparing the ETH entrance examination – should be studied. Nowadays the documents allowing to follow the evolution of his scientific ideas that led to the publication of his famous 1905 papers about light quanta, Brownian motion, and relativity, are scarce. The main pieces of information are to be found in the letters addressed to his future wife Mileva Marić. (Stachel 1987), (Renn, Schulman 1992) Therefore it is important to clarify the context in which these letters were written in Milan, as well as, more generally speaking, the environment in which Einstein was evolving.

2. Einstein in Milan

2.1. The Istituto Lombardo library

It can be established, from the scientific content of his letters to Mileva, the topics and authors mentioned, that Einstein had read *Annalen der Physik und Chemie*, then *Annalen der Physik* (that replaced them from 1900), and probably also *Beiblätter zu den Annalen der Physik*, through his references between 1899 and 1901 to W. Wien, P. Drude and M. Planck, respectively. Einstein also specified in his letters that he had read Drude's paper 'at the library'. Yet, the only library that at the time owned these journals is the Lombardo Institute, academy of science and letters. It should be noted that the Politecnico in Milan did not own them, which can be explained by the fact that the school, then situated at the Piazza Cavour, was very close to the Lombardo Institute; that most of his teachers were members of the Institute; and that the Institute was at the origin of the Politecnico in 1863. The factual elements allowing the identification of this library were published in 2014 in the *Rendiconti di Scienze.* (Bracco 2015a) It is very likely that Giuseppe Colombo himself allowed Einstein's access to this library. He had been several times President and Vice-President of the Institute between 1890 and 1900, and the Einsteins were probably in touch with him. (Biscossa 2005, Bracco 2015a) His access to the library could otherwise have been granted by Giuseppe Jung, Michele Besso's uncle through marriage with Michele's aunt, Bice Cantoni. Jung was mentioned by Albert Einstein in his letters to Mileva as one of the people ensuring his "protection" in Milan. He was professor of mathematics in the Politecnico, where he taught static graphics, and he was also a member of the Lombardo Institute. A confirmation of Einstein's passage at the Brera Palace, where the Lombardo Institute was then, is to be found is in this quote from Rudolph Kayser:

> Milan was a paradise of freedom and beauty. He [Einstein] read much now, with that complete passion and devotion with which young men read. But he also enjoyed the landscape of Northern Italy, and the sun and warmth, which he loved about all things. For the first time in his life, he studied the plastic and graphic arts: the last supper of Leonardo da Vinci at Santa Maria delle Grazie, the collections at Brera – a world of classical beauty! (Kayser (alias Reiser, A) 1931)

2.2. Scientific consequences

2.2.1. The new direction given to Einstein's doctoral work in April 1901

A knowledge of the library where Einstein used to work in Milan allows us to draw connections between the content of his letters to Mileva or his friends and the resources then available at the library. One of them is particularly meaningful: the *Festschrift* for Lorentz, which gathers contributions from seventy well-known physicists (such as Boltzmann, Planck, Poincaré, Righi, Wien, Wiechert, Zeemann, etc.), and was given to Lorentz on December 11th 1900 to celebrate the 25th anniversary of his doctorate. It was published in a specific volume of the *Archives néerlandaises des sciences exactes et*

naturelles, which was received at the library of the Lombardo Institute on January 31st 1901 as it is indicated in an inscription on its cover. Because he had then been a PhD student since the autumn of 1900, it is likely that through his bibliographical research Einstein had read this volume in the spring of 1901 in Milan. The letters successively addressed to his friend Marcel Grossmann and to Mileva, in mid-April, demonstrate the extent of the topic of his doctoral work about molecular forces to weakly compressed gases. His goal was then to determine the laws of attraction between molecules, considered as force centers, through an analogy with gravitation (with, however, a different power law), the molecule size playing no role. This work follows a first article about capillarity, written in December 1900 and published in March 1901 in the *Annalen der Physik*. My colleague, Jean-Pierre Provost pointed out to me that Einstein's point of view in the letters to Mileva could be related to Reinganum's in his *Festschrift* article *On molecular forces in weakly compressed gases*. In this article, for instance, a comparison can be found between molecular forces and "planetary forces" with a dependence in r^{-4} and the fact that the molecule size does not play any role, molecules being considered as force centers.

2.2.2. A first idea of light quanta in April 1901 in Milan?

A more speculative point concerns the hypothesis of light quanta. Einstein dated his reflections in 1900-1901, as he did through the two following quotes, the first one taken from discussions with R. Shankland:[1]

> I asked Professor Einstein about the three famous 1905 papers and how they all appeared to come at once […]. He quickly added that the photoelectric effect paper was also the result of five years pondering and attempts to explain Planck's quantum in more specific terms. (Shankland 1963)

and the second from a letter to Michele Besso in 1951:[2]

> All these fifty years of conscious brooding have brought me no nearer to the answer to the question, 'What are light quanta'? (Speziali 1979)

Einstein learned about the $\varepsilon = h\nu$ quanta hypothesis from Planck in April 1901 in Milan, as he indicated to Mileva. The aforementioned quotes both clearly attest of a reflection on the nature of light alongside his bibliographical work at the Lombardo Institute. The hypothesis of a first idea of light quanta as soon as 1901, based on his letters to Mileva, his memories and his atomistic vision was introduced by Jürgen Renn. (Renn 1993) Let us emphasize that such an idea could have been comforted by his reading of Poincaré's article in the *Festschrift* "*Lorentz theory and principle of reaction*" as discussed in Bracco (2015b). Indeed, an important result that is to be found

[1] Conversation of October 24th 1952.
[2] Letter from Einstein to Besso in December 1951, letter *EB* 177.

in Poincaré's calculations is, using the Lorentz transformations of 1895 at first-order in V/c and the interpretation of the *local time*, that the energy and frequency of a light pulse (a portion of a plane wave) transform in the same way. (Provost *et al.* 2013) This behavior demonstrates the compatibility of Planck's relation with an important property of the radiation itself and the coherence of a naïve model of quanta with a portion of plane wave $h\nu$. Bracco 2015c), a model to which Einstein will refer later. The proportionality of energy to frequency in Planck's relation could also have been comforted by the fact that it can be considered as a consequence of Wien and Stefan laws of the black body radiation in relation to the above model. (Bracco 2015b) Einstein's ideas about light quanta could thus be related to considerations about relativity and black body radiation as soon as 1901.

3. Michele Besso's thesis and his family

Einstein's scientific remarks to Mileva should be considered in the context of his collaboration with Michele Besso, that he met near 1896 in Switzerland, who graduated from the ETH in 1895 and who worked in Milan between 1899 and 1901. A series of letters between Einstein and Besso have been published by Pierre Speziali (Speziali 1979), with unfortunately only one letter from Besso before 1909, in February 1903. This unique letter proves a methodic bibliographical work led by Besso for Einstein about molecular dissociation, a topic that they were already studying in 1901. Einstein told Mileva in 1901 that he used to discuss 'at night' with Michele and they would allude various topics: molecular forces, dissociation, the nature of radiation, the relative motion of ether and matter, etc. It *de facto* appears that the Milanese period prefigured their famous collaboration in Bern from January 1904, when Besso worked at the Patent Office, at Einstein's request. A letter from 1913, found at the Marco Besso foundation in Rome,[3] addressed by Michele to his aunt Ernestina – Marco Besso's wife – in June 1913, contemporary to Einstein's work on general relativity, expressed in subtle terms the way in which he envisioned his collaboration with Einstein that he qualified as a 'gigante' as he designated himself as a 'pigmeo', but a '*pigmeo veggente*'. (Bracco 2015a)

3.1. Michele Besso's thesis

Einstein wrote to Mileva in October 1900 to encourage her to become a '*dozent*' i.e. to start a thesis. At the same time, he said he was working for Michele on a topic that can be associated with wireless telegraphy. (Bracco 2015a, Bracco 2015b) Elements confirming the hypothesis of a thesis about wireless telegraphy can be found in the inventory of the donation 'o Giuseppe Jung's (Michele's uncle) personal library as it is described in the mathematics library registers at the Politecnico in 1926 and at the

[3] Marco Besso Foundation, Largo Torre Argentina, 11, 00186 Rome.

University of Milan in 1935, as we shall see. Firstly, let us remark that this donation contains the totality of Einstein's scientific articles written before 1907 (twelve articles), in the list of the nearly 2.500 preprints of mathematics articles owned by Jung. This not only means that Einstein had actually given (with Michele's help) his first article about capillarity to Jung, but also that he had continued to do so, at least until he obtained his first position at the Bern University in 1907. Among 500 mathematics books, a few physics books about electricity and wireless telegraphy, most of them edited between 1897 and 1901, can be found in the donation. Three of them are marked as 'donation from the editor', which proves that they are original copies. A plausible explanation would be that Jung brought these books from the Politecnico or the Lombardo Institute for his nephew Michele who was then studying these topics. Michele Besso, for his part, confirms that he had started working on a thesis that never was completed. The reason for this could be the death of his father in October 1901 and his departure to Trieste. On the basis of these remarks, we may wonder which group Michele could have envisioned his thesis with. Some very indirect elements suggest Pietro Blaserna's group (Bracco 2015d) at the Physics institute via Panisperna in Rome – which was working on wireless telegraphy, and several of its members, starting with Blaserna himself, who knew Michele Besso and his family. It should be reminded that Michele had been Blaserna's brilliant student during his first year at the Science University in Rome between 1890 and 1891, when Blaserna was Dean and his uncle Marco was a friend of his.

3.2. The Einstein and Besso families and the electrotechnic environment

Our study may now be widened to the general context of engineers and leaders in which Einstein and Besso evolved. Jakob Einstein, engineer from the 'Stuttgart polytechnic school', author of many patents in the electrotechnic field, played an important role in the training of the young Einstein, who worked in 1895 in Pavia at his uncle's office. There he could study the main European journals in the electricity field, which offered, beside the technical descriptions, presentations of engineer courses, as it is the case in the French publication l'*Éclairage électrique.* (Bracco 2015b) About Michele's family, if precious data were published by Speziali, other details could have been noted about not only the paternal branch of the family, but also the maternal branch of the Cantoni which was not discussed by Speziali. Michele's mother, Erminia Cantoni's siblings are, apart from Bice, Jung's wife that we already mentioned, Emma, Maria, Vittorio and Tullo. (Bracco 2015a) It should be noted that Vittorio, engineer of the polytechnic in Zürich and then of the Politecnico in Milan, was the engineer in chief of the electric line that carried alternative power between Tivoli and Rome, and was inaugurated in 1892, placed under the supervision of Guglielmo Mengarini. Vittorio had already implanted a Gaulard-Gibbs transformer in Tivoli in 1886, probably in direct connection with Galileo Ferraris. On the Bessos' side, it should be noted that Marco Besso, director then president of the Assicurazioni Generali also played an important role in the fundraising for the development of electricity in Italy. He was a member of the board of

directors, then president of the "Società per lo Sviluppo delle imprese elettriche in Italia" that employed his nephew Michele in 1900-1901.

4. Einstein's scientific environment in Pavia

Several articles and books dealing with the professional and social context of the Einstein family in Pavia have been published in Italy (Bevilacqua *et al.* 2005), (Biscossa 2005), (Fregonese 2005), E. Sanesi whose publications are indicated in Fregonese (2005), and also F. Bernini. (Bernini 1994) The linking of the pieces of information contained in these studies and recent verifications allow us to establish a direct connection between the Einsteins and the Pavia University (Bracco 2015d): Angelo Cerri, one of the associates of the "Einstein, Garrone and C.", the Einsteins' company in Pavia, had been professor Gobbi-Belcredi's assistant since 1885, at the chair of theoretical geodesics, where he would in particular teach spherical geometry, geodesy and geometrical optics. He also taught mathematics and French at the Bordoni Insitute. It should also be underlined that Giulio Vivanti, a mathematician and professor at the Scuola normale, taught analysis and algebra to freshmen at the science university of Pavia. He was a university classmate of the Einsteins' main associate, Lorenzo Garrone, who graduated in civil engineering in 1881 at the Politecnico in Turin. Then, Albert Einstein, who asked in August 1895 for a '*piccola racommandazione privata*' to attend H.F. Weber's classes at the ETH of Zurich (Silvestri 2005), could, without any major difficulty, informally attend the mathematics classes at the University of Pavia, if this could help him in the preparation to the ETH competitive exam. It also appears that Ernestina Marangoni – Albert's friend – had her uncle, Carlo Marangoni (Bracco 2015d), who was a physicist, specialist of capillarity (quoted by H. Minkowski) and known for the Gibbs-Marangoni effect in physics. He had conducted his doctoral work in Pavia with Giovanni Cantoni. It should finally be noted that the Einsteins, who had relations with Ferraris and Colombo, probably also had connections in Pavia with Cantoni himself, their counterpart in the committee who had planned the participation of Italy to the first international electrical exhibition in Paris in 1881. Cantoni was also quoted in 1913 in the first issue of the *Isis* publication by I. Guareschi, for his work on Brownian motion. In 1895, the physics laboratory of the university was directed by Adolfo Bartoli, who is known for his studies on radiation pressure. Albert Einstein *de facto* benefited from a first rate scientific environment in Pavia, in the fields of electrotechnics, mathematics, and physics – and his early training could have benefitted from this environment.

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