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First echoes of relativity in Argentine astronomy

Alejandro Gangui[1,2], Eduardo L. Ortiz[3]

(1) IAFE – Instituto de Astronomía y Física del Espacio – CONICET, Ciudad Universitaria, Buenos Aires, Argentina
(2) CEFIEC – Facultad de Ciencias Exactas y Naturales – UBA, Ciudad Universitaria, Buenos Aires, Argentina
(3) Imperial College London, South Kensington Campus, London SW7 2AZ, England

Abstract.

In this note we consider the attitude of astronomers in Argentina in connection with the new problems posed by relativity theory, before and after General Relativity was presented in its final form. We begin considering, very briefly, the sequence of "technical" publications related to relativity that appeared in Argentina and use it to attempt to identify who were the relativity leaders and authors in the Argentina scientific community of the 1910-1920s. Among them there are natives of Argentina, permanent resident scientists, and occasional foreign visitors. They are either academic scientists, or high school teachers; we leave aside the *philosophers* and the *aficionados*. For the main characters we discuss, very briefly again, the scientific facts and publications they handled, the modernity of their information and the "language" they use to transmit their ideas to their readers.

Finally, we consider astronomers proper; first Charles Dillon Perrine, an astronomer interested in astrophysics, contracted by the government of Argentina in the USA as director of its main observatory. He became interested in testing the possible deflection of light rays by the Sun towards 1912; his Argentine expedition was the first to attempt that test. Perhaps Perrine was not so much interested in Einstein's formulation of relativity theory, which then was perceived as very far away from his own field of research, as in testing the particular astronomical effects it predicted. In any case, he attempted to do so with the acquiescence and financial support of the Argentine state, and as a leading member of its official scientific elite. We briefly contrast his very specific and strictly scientific efforts with those of our second astronomer, José Ubach, SJ, a secondary school teacher of science at a leading Buenos Aires Catholic school who reported in response to Eddington's expedition. Finally, our third astronomer is Félix Aguilar, a leading scientist with a more definite interest in astrometry, who made an effort to contribute to the public understanding of Einstein's theories in Argentina in 1924, when Einstein's visit to Argentina had become a certainty.

1. First publications

Even some years after 1905, it was only a few authors that discussed advanced dynamics, electron theory and radiation in Argentina. In their works they did not necessarily refer to the 1905 work of Einstein. We follow (Ortiz 1995) to present a list of "technical" papers connected with relativity. The main responses are those of Lepiney (1906-8), who makes reference to work of Max Abraham on electron dynamics, and again (Lepiney 1907), now with a general discussion of dynamics with a velocity-dependent mass. Also Broggi (1909) discussed Lorentz's electrodynamics and included a mathematical analysis of the works of Minkowski. Following the early experiments of J. J. Thomson, physicists knew that the motion of an electron was modified in the presence of an electromagnetic field, which could be interpreted as an increment of its mass. Lorentz's aether theory and descriptions of the behaviour of the electron, compatible with Maxwell's equations, were also discussed at the time. All these ideas, as well as Abraham's description of the electron as a perfect sphere with surface charge, were descriptions that agreed with ordinary 'common sense'.

In 1910 Vito Volterra delivered a lecture at the Sociedad Científica Argentina (the Argentine Scientific Society; SCA herein) in Buenos Aires; in (Volterra 1910) he discussed the now well-known paper which started the relativity revolution and, with it, Einstein's *annus mirabilis* (see Gangui 2007). In the decade of 1910 Jakob Johann Laub, a physicist of Polish origin, trained in Germany and hired by the Physics Institute at La Plata, offered lectures and gave courses connected with the theory of relativity. Pyenson (1985), who has studied Laub's personality in detail, has indicated that he was the first physicist to co-author a paper with Einstein, and also suggested that a set of lectures on relativity theory given by him at La Plata may have been the first course on that subject given in the Americas. Once in Argentina Laub translated into Spanish some results obtained in Europe. In (Laub 1912) he discussed briefly optical effects in moving bodies in a paper published in the *Anales* of the SCA. The French physicist Camilo Meyer, a former secondary school companion of Henri Poincaré in France, delivered a series of optional courses on mathematical physics at the University of Buenos Aires in 1910-15; even if he did not specialize in relativity, his courses mentioned recent research in physics, including Kaufmann's experiments on the velocity dependence of the electron mass; he also made reference to Einstein's work without entering into details. Again, between 1916 and 1919, Laub (1916; 1919) considered physical and philosophical questions connected with relativity theory from the point of view of a physicist. In the same years there were also translations or adaptations of general articles that reflected an interest on relativity theory; mostly, they were taken from the foreign press or from popular science journals.

2. Perrine's involvement in the first attempts to verify observationally Einstein's ideas

In the meantime, Einstein laboriously worked to complete his theory and, eventually, incorporate gravitation to his new relativistic framework. In (Einstein 1907) he made his first statement of what later became known as the equivalence

principle. In it he assumes "the complete physical equivalence of a gravitational field and a corresponding acceleration of the reference system." Einstein then combined this principle with key assumptions of Special Relativity and was able to predict that clocks would run at slightly different rates if located in different places within an inhomogeneous gravitational field (smaller rates for strongest fields). Another conclusion he derived, which turned out to be a most important one for the acceptance of the theory, was that light-rays would bend in a gravitational field. Einstein developed his thoughts in an article published in 1911, in which he was looking for a new framework that would allow him not to postulate, but to derive the equivalence principle, and led to a more general relativity principle as compared to his 1905 proposal. It is in this work that Einstein combined his equivalence principle with Newton's gravitational theory and computed, wrongly, the deviation suffered by a light-ray of a far-away background star, as it travelled close to the Sun's limb, towards an observer on Earth. He gave the value of 0.87" for the bending of light in the gravitational field of the Sun, which he would later revise. For both, the gravitational red-shift and the bending of light-rays, Einstein found a useful collaborator in Erwin Freundlich, a young astronomer who became interested in putting these new ideas to test by astronomical means.

Perrine, of Lick Observatory, California, was a world class astronomer with a solid reputation for his achievements in his field (see Hodge 1977); in 1909 he accepted the position of director of the Argentine National Observatory, Córdoba (see Landi Dessy 1970; Bernaola 2001). In (Perrine 1923; 1931) he has described with concision, but accurate details, his early involvement with the testing of relativity. Let us recount the main points. In a brief visit of Perrine to Berlin, in 1911, young Freundlich asked him for advice on Einstein's deflection problem; the matter involved an eclipse observation, which was an area in which Perrine was a world leader. The topic was also close to Perrine's past interests and, as a consequence of Freundlich requests, he made early efforts to test relativity in several eclipse expeditions he conducted from Argentina. Perrine's attempts began with the Brazil total solar eclipse of 1912, which he observed as head of the Argentine mission; sadly, as it often happens with eclipses, adverse meteorological conditions prevented him from making good observations and producing the required results. Laub also travelled to Brazil for the observation of the eclipse, but his interests were not directly connected with relativity, but with atmospheric electricity. The same happened to Perrine on a second Argentine expedition organized a couple of years later, this time to Russia. Perrine's old friend and colleague at Lick, William Wallace Campbell, who had also became interested in the testing, was also in Russia, as well as Freundlich. The latter, a German, was prevented from making observations on account of the First World War. Bad weather again, made it impossible for anyone to produce accurate results. As it is well known, in 1919 it was Arthur S. Eddington who resolved the matter.

3. "Post-eclipse" publications

After the November 1919 announcement of Eddington's eclipse results, notes on Einstein's ideas attracted considerable public interest and articles appeared in journals of different levels all over the world. This was also the case in Argentina,

where a number of lectures and articles, neither fully technical nor entirely at popular level, appeared. Some of them clearly stated that they were not expositions for the expert, or scientific innovations, but contributions to satisfy the interests of the general reader, as for example the astronomer Aguilar (1924) made quite clear.

In addition to the ones cited above from a much larger list, the main authors involved in disseminating the new ideas of relativity in the Argentine community included visitors such as Blas Cabrera, Richard Gans (director of La Plata's Institute of Physics), or Georg Friedrich Nicolai (visiting professor of physiology in the University of Córdoba); stable members of Argentina's academic or education circles such as Aguilar, engineers Enrique Butty and Jorge Duclout, physicists José Collo and Teófilo Isnardi, writer and poet Leopoldo Lugones, mathematician Julio Rey Pastor and the astronomer and Jesuit priest and teacher José Ubach. A number of philosophical and pseudo-philosophical interpretations of relativity found also a fertile soil in the Argentina of the 1920's (see Asúa & Hurtado de Mendoza 2006). More details can be found in (Ortiz 1995; Gangui & Ortiz 2005; and Ortiz & Rubinstein 2008).

In Argentina relativistic ideas were propagated through journals associated with scientific societies, university, professional associations or student union's, as well as by literary journals. Among others: *Anales de la Sociedad Científica Argentina*, *Anales de la Universidad de Buenos Aires*, *Revista Humanidades (University of La Plata)*, *Revista Técnica*, *Boletín del Centro Naval*, *Revista Politécnica* (later *Revista del Centro de Estudiantes de Ingeniería*, or *CEI*), *Verbum* (journal of the Buenos Aires Humanities Student's Union, the Centro de Estudiantes de Filosofía y Letras), *Revista de Filosofía* and *Nosotros*.

However, an interesting and rather unusual channel for the diffusion on *Einsteiniana* in Argentina was *La Vida Literaria*, a fringe literary journal of limited circulation, produced by left-wing writers and poets, which was responsible for the publication of what has been called Einstein's *inédito*: the philosophically oriented text of the lecture Einstein intended to use to open his courses at the University of Buenos Aires, but which somebody persuaded him to leave aside "to keep everybody happy" (see Gangui & Ortiz 2008).

4. Astronomy: the Collo-Isnardi-Aguilar paper and the testing of relativity

Some of the references mentioned above touched upon certain topics of astronomy, but did not consider them in any detail. The first thorough description of the astronomical testing of Einstein's ideas in Argentina, as (Ortiz 1995) has shown, is a neglected contribution of Father José Ubach. A science teacher at Colegio del Salvador, Buenos Aires, Ubach had received training in Cataluña. He reviewed the results of Eddington's expedition in (Ubach 1920) immediately after the former published his results. His views were critical and circumspect, but on the whole balanced. His main point being that the results of the 1919 observations were important but, on account of the complexity of the observations, not yet definitive. Within the Argentine scientific community, Ubach's views reflected a more open attitude of the Catholic Church in Europe vis-à-vis

contemporary scientific research, and a further manifestation of the movement who supported becoming more directly involved in it.

Some four years later, in 1924, in preparation for Einstein's arrival in Argentina, Félix Aguilar published a note on the results of the same expedition in *Boletín del Centro Naval*, the journal of the navy officers club (Centro Naval). His review is the third in a set of three articles on relativity theory; the first two were written by José Collo and by Teófilo Isnardi, respectively. These three authors were among the young most promising Argentine researchers of the time. As we pointed out before, the articles were neither technical nor popular, addressed to "those who, without being experts, possess enough knowledge to become interested in some of the details of the development of the theory" (Collo, Isnardi & Aguilar, 1923-24). Their reviews, they said, were motivated by cultural considerations; that is, strictly, they were not "scientific" papers.

We will only highlight some of the main ingredients of the first two of these three papers, and then concentrate a bit more on the third one, the astronomical review by Aguilar. Collo was in charge of the first part, dealing with "preliminaries" on the special theory, from Galilean mechanics up to Einstein's conceptions of time, simultaneity, the postulates of Special Relativity, and ending with Lorentz transformations and Minkowski geometric representations (Collo 1923). In the second paper Isnardi focused on General Relativity and gave a discussion up to the theory's predictions regarding the deflection of light in a homogeneous gravitational field and also the resulting gravitational red-shift of light propagating in an inhomogeneous field as that of the Sun. In the second half of his contribution, he computed geodesics in Schwarzschild spacetime getting the classical value of 43" per century for the anomalous perihelion advance of the planet Mercury and the 1.74" deflection of light-rays of background stars passing close to the Sun (Isnardi 1923).

The third paper (Aguilar 1924) began with a historical review of the question of the anomalous perihelion advance of Mercury (to which Perrine, with his observations and search of a possible intra-mercurial planet and celestial photography, had contributed substantially), and Einstein's interpretation of this phenomenon. Aguilar then discussed the observations related to the verification of the second classical test of General Relativity: the deflection suffered by background starlight passing close to the limb of the Sun. In this part, he reviewed briefly the 1914 eclipse, but did not mention Perrine's work or the Argentine expeditions of 1912 and 1914. He gave a detailed account of the famous British eclipse expeditions of 1919 to Sobral, in Northern Brazil, and to the island of Príncipe, near Africa, which confirmed Einstein's predictions. For these, as well as for the following Lick Observatory eclipse expedition in Australia of September 21st, 1922, he included tables and diagrams of the shifts in the position of many background stars, quoted even with error bounds, and photographs of the eclipsed Sun and of the experimental setting. Aguilar's article finished with three pages in which he explained the extraordinary difficulties involved in trying to test the third classical prediction of General Relativity, namely, the tiny red-shift of the Sun light spectrum due to the gravitational field of our star. He quoted the analysis Freundlich and others performed on Sun plates obtained for previous studies of the Sun; however, he failed to remark that these plates had come to Freundlich's hands through the generous intervention of Perrine, the astronomer

from local Córdoba. Aguilar carefully emphasised the difficult problem of differentiating the Doppler shifts, kinematical in origin, from the gravitational shifts. As Ubach before him, Aguilar concluded that the situation was not clear, neither in favour nor against General Relativity predictions, and that Einstein's theory was pushing experimental observations to their technical limit.

5. Final remarks

New developments in mathematics and in theoretical physics attracted attention in Argentina from at least the last third of the nineteenth century; from the early part of the twentieth century there was an interest in the new theory of "quanta", and later in Einstein's relativity theory. Argentina's economical prosperity made it possible to attract to its universities and advanced institutions scientists with a remarkable record. One of them, Charles Dillon Perrine, director of the Córdoba National Observatory, played an interesting role in the earlier efforts to verify Einstein's theory, personally and through his advice to others, Freundlich, among them. The importance of these attempts, understandably, may not have been as clear then as they were after 1919. However, even as late as 1926, after Einstein's visit to Argentina in 1925 and after the publication of (Perrine 1923), such perception is still absent in both (Aguilar 1924) and in the official SCA's history of astronomy in Argentina for the period 1872-1922 (Chaudet 1926). In his review, Chaudet makes reference to the 1912 and 1914 eclipse expeditions of the Córdoba Observatory, of which he was an employee, but without any reference to Perrine's attempts in connection with relativity theory (Chaudet 1926, p. 72). In any case, Perrine attempted to prove or disprove relativity with the acquiescence and financial support of the Argentine state, and as a leading member of its official scientific elite. Ubach's interesting paper had also gone into oblivion. Clearly, there was some lack of communication at the highest scientific levels of the astronomical community in the Argentina of the mid 1920s.

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