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THE COMPARATIVE RECEPTION OF RELATIVITY

Edited by

THOMAS F. GLICK

Department of History, Boston University

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TABLE OF CONTENTS

MICHEL BIEZUNSKI

EINSTEIN'S RECEPTION IN PARIS IN 1922

INTRODUCTION

Ever since their formulation, Einstein's special and general theories of Relativity have given rise to passionate confrontations. France was no exception.

The characteristics of the French reception of the theories of Relativity can be summarized as follows: They were received with a significant delay[1] (the controversy within the scientific community began in the early twenties); the physicists were not, among the scientists, the most interested; mathematicians were more motivated to study and develop Einstein's theory (for the challenge of tensorial calculus in the general theory of relativity), as well as engineers (because they were conscious of the importance of Maxwell's equations). The delay in the physicists' reception can be explained by the fact that theoretical physics did not exist as a separate discipline. But there existed instead a discipline called "mathematical physics".[2] Thus, the theory of relativity was considered, during a long period, on the border of physics. One has to wait until nuclear physics develops – i.e. in the late 30's but mostly after the Second World War – to see a change in that perspective. Elie Cartan, Emile Borel, Jacques Hadamard, Jean Becquerel were among the scientists who played a role in the reception and development of the theories of Relativity. One figure, however, is prominent, Paul Langevin, who popularized Einstein's theory of special relativity as early as 1906. His seminar was attended by only a handful of students, of very high quality: apart of the names quoted earlier, Louis de Broglie and Alfred Kastler, for example, had their first contact with Einstein's theories through Paul Langevin.

Also philosophers showed interest in Einstein's theory of relativity. Henri Bergson tried to establish links between his concept of time and Einstein's.[3] Emile Meyerson developed an important epistemological reflection[4] based on the implications of Einstein's achievements. Gaston Bachelard criticized him[5] and developed an inductivist point of view. André Metz[6] contributed to the discussion with epistemological developments of Einstein's theories. Thus, one might think that France

Thomas F. Glick (ed.), The Comparative Reception of Relativity, 169–188.

would have afforded a particularly favorable reception of the theory of relativity. But it didn't happen that way. In the first place, though among the greatest of their time, the scientists concerned with Einstein's theories made up a very small minority. One way of determining how a new theory is actually received is to examine how it is taught. From this point of view, the situation appears quite different: Langevin gave his lessons at the *Collège de France*, which is not part of the regular academic system.[7] Apart from isolated initiatives (Lémeray in 1915 in Marseille, Eugène Bloch in the late 1920s, and, occasionally, Louis de Broglie in the early thirties) it is impossible to find any traces of courses of relativity in the University before the Second World War. And it is only in the mid-1960s that the special theory of relativity was introduced in the first years of the physics curriculum.

The theory of relativity has been part of physics training at the *Ecole polytechnique* from 1920 until 1925. Then, its teaching was stopped until 1936, because it was considered not crucial enough to be kept inside very dense physics courses.

The controversial issue created by the new theory is a rare case where one can see the effects produced by a scientific revolution.

The debate was not strictly scientific, limited to learned circles, but involved a portion of the general public as well. The reactions culminated in 1922, when Einstein came to Paris to explain and discuss both the special and general theories of relativity. The analysis of this visit and of the reactions to it will be the focus of this paper.

When I started to work on this topic,[8] I thought the major point of interest was the scientific debate within the community of mathematicians and physicists. But I discovered that the controversy was alive within the lay public also and that the wealth of popular journalism devoted to his ideas during Einstein's visit helped me understand more deeply the stakes of the controversy.

Drawing somewhat on a distinction made by Yehuda Elkana,[9] the first part of my essay will analyze this controversy in terms of (i) the current state of science (from the point of view of its development), (ii) the images of science, the main epistemological trends which support contradictory conceptions of what science should be, (iii) the ideologies which play a role in science. The related issues in the present case are scientism and anti-German feelings.[10] I will thus argue that the reluctance to accept Einstein's ideas originates, not from the current state of knowledge, but from images and ideologies shared by the scientific community.

Einstein was a special case: his renown extended beyond the limited circle of scientists and educated public. He was already almost as popular in the early twenties as he is now.

In the newspapers, scientists freely exposed their ideas, prejudices and opinions on scientific and extra-scientific matters. They are particularly interesting for the window they provide on the personal reactions of scientists confronted with a major rupture in their accepted scheme of knowledge. Journalists' opinions also show the dimension of the controversy. The questions discussed were not only centered on physics; they encompassed the role of science in society, the role of scientists in international relationships, the hope for a broader access to scientific knowledge. One usually doesn't find such elements in scientific articles.

I will try to show that there is a convergence between the terms of the debate as it emerged within the scientific community and the public debate as it appeared in the popular press.

I. A SCIENTIFIC CONTROVERSY?

1. The State of Science

If one considers the question of the acceptability of Einstein's theories in the context of the current state of knowledge, the response should have been entirely positive. I will try to illustrate this assertion by an example. I don't want to refer to the scientific writings of an enthusiastic supporter of Einstein's theory, such as Paul Langevin who argued in many books, articles or lectures[11] that Einstein's developments in the special, and later, general theory of relativity were of great relevance to the central, unanswered questions in contemporary physics.

Rather I want to consider the case of scientists, well acquainted with modern physics, who were able to understand and could have accepted the special theory of relativity but did not do so. The most enigmatic example of this kind is that of Henri Poincaré. His work on the electrodynamics of the electron and on the principle of relativity would seem to place him in a particularly favorable position to accept Einstein's theory of special relativity. But he remained silent, except in a lecture given in 1909 in which he does not mention Einstein's name.[12] His silence is analyzed in previous studies.[13] Stanley Goldberg showed that Poincaré's project was so different in content than Einstein's that it was impossible for him to accept Einstein's point of view.[14] Henri

Poincaré died too early (1912) to be part of the controversy I am studying here. That is the reason why I will focus on Emile Picard, whose attitude was rather close to that of Poincaré.

One of France's most prominent scientists, he was born in 1856. He became professor of physical and Experimental Mechanics at the Sorbonne in 1881. He was elected to the Academy of Sciences in 1889 and was its permanent Secretary from 1917 until his death in 1941. In addition to his scientific work as a mathematician and mathematical physicist, he wrote a number of books and articles on the state of science aimed at a lay audience. One of them, *Modern Science, its present state*,[15] was published precisely in 1905, the year of publication of the four famous articles by Einstein,[16] including the one on special relativity. Of course, at the time he wrote his book, he could not have heard of Einstein's work, because Einstein was not yet an ordinary physicist. However, the questions that preoccupied him were not so far from Einstein's preoccupations. In this book, Picard lists a set of open questions in modern physics:

How was the seemingly arbitrary alliance of mathematical demonstration and experimental principles in classical mechanics to be made comprehensible? How could the conceptions of absolute space and time be made less abstract? Must physics be based on a deductive method? In what way were the problems associated with the hypothetical electromagnetic ether to be resolved? And how can the Michelson experiment be explained?

One sees, afterwards, that the special theory of relativity gives an answer to these questions, directly related to the "body of physics". It establishes furthermore a link between those items. In 1922, Picard knew quite well the content of Einstein's theories. In January 1922, two months before Einstein's visit to Paris and even before it was planned, a debate on the theory of relativity was held at the Académie des Sciences. A rather controversial debate must have taken place, since the headline of that day's *Echo de Paris*[17] was: "Coming back to Newton's Mechanics". The major event in that debate was a communication by Emile Picard.

In discussing the contributions made to contemporary science by Einstein's theories of special and general relativity, Picard expressed mixed feelings on the conceptions of space and time on which they are based. He qualified the "new" ideas on space and time as "concerning metaphysics rather than physics".[18] And he didn't take a clear position

for or against the theories claiming that the time hadn't come for reaching a verdict. This absence of position suggests that Picard, though disturbed by its epistemological consequences, could not find any scientific argument to refute to theory or relativity.

A number of attempts were made to refute Einstein's theories. Daniel Berthelot, presenting Carvalho's works to the *Académie des Sciences*, reported that his main conclusion was that the Michelson experiment can be explained by means of the Newtonian theory.[19] This example is a case of indirect refutation: not a straightforward attack, but an effort to avoid a change of theory. It is, in the strict sense, a conservative position.

A third example of refutation is the analysis of the results of an experiment concerning the gravitational redshift of spectral rays of solar metals conducted by Pérot in *Observatoire de Meudon*. The *compte rendu* at the *Académie* took place during Einstein's visit to Paris, on April 3, 1922.[20] The results of this experiment giving the value of the redshift were of the same order of magnitude as the experimental error. For some scientists, including Deslandres, director of the Meudon Observatory, this was an opportunity to reaffirm that prudence counseled waiting for further results before adopting the theory – while he was reported to say that the bases of the theory of relativity were disputable and fragile.[21] Very different comments were made on the same experiment by others: Léon Brillouin affirmed that the measured value "fits, taking into account the errors resulting from experiment, with the value announced by Einstein",[22] while Paul Langevin stated that "the redshift predicted by the new theory conforms exactly to the results of the experiment".[23]

The points of disagreement didn't yield a scientific alternative resulting in a coherent frame that could lead to a consensus and could definitely answer whether the theory should be accepted or rejected. This doesn't mean that the theory would be unfalsifiable in the Popperian sense, which might constitute a reason for denying it scientific status. An attempt at such a falsification was presented to Einstein by Jacques Hadamard during the scientific colloquium organized at the *Collège de France*.[24] He imagined what might happen to the gravitation equation in a case where the mass became infinite. In that case, the equation would cease to be valid. Einstein responded the next day by showing Hadamard a calculation (of which, unfortunately, no trace remains) showing that this situation is physically impossible.[25] However, "Hadamard's catastrophe", as Einstein liked to call it, was a prefiguration of the hypothesis of the black holes.

This attempt at a "falsification" is very different from the other critics of the theory of relativity. Hadamard was not an opponent to the theory of relativity. On the contrary, he wanted to know to what extent the theory could be used. His attempt at a refutation was located inside the theory. In all other cases, attacks on the theory of relativity didn't reach its theoretical core, but only its epistemological implications. Thus, the debate was not limited to purely technical issues, in order to compare theories which were placed on the same level, but raised the question of the frontier of physics: most physicists thought they had a clear idea of what physics was and what it should be. The theory of relativity was not to be included in that frame.

Given the state of science in France, scientists were in a position to accept Einstein's theory of relativity. This theory could have helped them to answer Picard's open questions and to further the development of modern physics. The sources of the reluctance to accept new ideas must therefore lie somewhere else.

2. *The Prevailing Images of Knowledge*

When scientists express their feelings about the way science should be developed, they refer – implicitly or explicitly – to existing traditions.

In France of the 1920s, the images of knowledge, which, as Elkana argues, are socially determined, culture-dependent and time-dependent, consisted essentially of a mixture of Cartesian mechanism and Comte's positivism. They had constituted the "mental set" of generations of French scientists, imparting to French science a distinctive style. The development of Celestial Mechanics was considered the acme of scientific achievement. As we shall see, the mechanistic tradition was advanced both in behalf of and against the reception of Einstein's theories of relativity, while the positivist tradition was urged mostly against the reception of the new ideas.

The importance of Cartesian philosophy in France is well-known. It gave rise to the mechanistic point of view in science: every phenomenon can be reduced to a description in terms of elementary movements, and this is true not only for physics, but for chemistry and biology as well. The supremacy of what was called in France "rational mechanics" – as a reference to Descartes' philosophy – had been made explicit by Auguste Comte in his classification of the sciences. In Comte's scheme mechanics was considered totally different from and superior to physics. It was a "*science rationnelle*" in the sense that it established a connection between an imperfect reality and an ideal, mathematical, model. Mechanics is also notably flexible: new experimental results can be integrated by means of *ad hoc* rectifications of the mathematical model. This flexibility of classical mechanics accounts for much of its appeal.

For this reason, many scientists remained attached to this tradition. Paul Painlevé, for example, tried to present Einstein's special relativity in the frame of the freedoms allowed by classical mechanics in his lessons at the *Ecole polytechnique*: "To define a means of measurement of durations and of lengths, Einstein has to adopt a new principle, and he chooses, from experiments, the principle of conservation of the speed of light".[26] Thus, he denies the theoretical change. Einstein's first motivation was to solve the problem of the non-invariance of Maxwell's equations with the principle of relativity, which is a quite different point of view that the one expounded by Painlevé.

Paul Langevin, who was a defender of the theory of relativity was also trained in the mechanistic tradition. But, for him, the most important issue included in that tradition was to try to unify various physical theories. Einstein was for him in this continuity because, after Maxwell's achievements on the unification of electricity and magnetism, the unificationist trend shifted from a pure mechanistic origin to an electromagnetic and mechanical base.

Secondly, there is the positivist tradition. In his book *De l'Explication dans les sciences*,[27] Emile Meyerson characterized the positivist stance as motivated by the intention to exclude metaphysics from science. According to positivism, physics is based on "facts", the relationships between facts being the physical laws. Now, if facts are "given" – i.e. exist independently of us – they only have to be observed and there is no room for physical concepts. Meyerson, of course, rejected this view and argued that, as a matter of fact, science does not conform to such precepts. Meyerson's influence, however, was limited to philosophical circles and the positivist conception of science prevailed among the major part of the French scientific community.[28]

Now, what one considers as an appropriate legitimation of scientific knowledge depends upon the view of science one holds. Thus, if science is limited to establishing relationships between facts, there is no need to be in possession of a unique theory for a given domain. The choice of a theory can be made, for example, on the grounds of utility. This empirical position is a liberal one. It recognizes the possibility that several different theories can describe the same physical phenomena. On utilitarian grounds, then, the introduction of special relativity into physics can be regarded as not well motivated; because one had to overthrow the well-established concepts of space and time. Speed of light didn't appear as a significant scale for experiments to most physicists, except the few ones working on radioactivity, and later, on nuclear physics. Furthermore, if one regards physics as a phenomenological construction derived only from experimental results, it is obvious that a theory such as relativity can be regarded as a metaphysical dream, without any connection to what was considered to be physics at the time: it dealt only with very high velocities, which were beyond experimental reach until the mid 1930s.

Henri Bouasse wrote, in a pamphlet entitled "*La question préalable contre la théorie d'Einstein*":[29] "Finally, it is us, laboratory physicists, who will have the last word: we accept theories which are commonplace to us; we refuse those which we can't understand and are, for that reason, useless to us (. . .). We, i.e. all physicists, since physics has existed."

Some holders of this "utilitarian" point of view referred to the heritage of Henri Poincaré, defining their point of view as the conventionalist one. In fact, Poincaré was much more subtle. He did not pretend to possess the uniquely valid point of view on science. As Langevin said, he was "eclectic". Poincaré's position can be described as a lack of confidence in theories in general. He abandoned the opinion that one theory could be considered as "true", definitely, and then admitted that several theories could follow, to explain the same phenomenon.

Among his epigones was Edouard Guillaume who openly fought against Einstein's theory. In correspondence with Paul Langevin in 1917,[30] he advanced the idea of a modification of the ether due to the movement of a body, which could explain the Lorentz contraction. In his theory, the speed of light becomes relative but time remains absolute. He invokes Poincaré's authority to justify his position, saying that this idea had been expressed by Poincaré at the St. Louis Exhibition in 1904, and secondly that Poincaré would certainly have accepted the process of replacing an idea by another.

But Poincaré's position was not as clear as Guillaume says: Poincaré admitted that the "old mechanics" could be replaced by a "new one", which could itself be replaced by another one, and so on. Then, he accepted the possibility of a temporal succession of theories, which implies that one could replace another one. It seems to me that this is a nuance to introduce to a narrow interpretation of Poincaré's conventionalism. Nevertheless, Poincaré never quoted Einstein's theory, even if in that lecture he was speaking of it. The argument of generalized equivalence between all theories in physics is thus used only to show that Einstein's theory is likely to be replaced by any "simpler" theory, i.e. one closer to familiar concepts.

These images of science appear to be much more relevant to the attitudes towards the new theory than the different ways of putting the questions unsolved by contemporary physics. They concern the way scientists think science should be.

3. The Scientistic Ideology

The scientistic ideology still represented a strong influence at the time of the debate on Einstein's theories. It was inherited from the 19th century. Scientism developed as an anti-religious tool, and constituted a basis of agreement for the majority of scientists who strongly believed that progress of mankind was inseparable from the progress of science. Science was considered the best means for man to dominate nature. The so-called "experimental method" was defended as the only way of considering science.[31]

The change in the conception of physics brought by Einstein's theory of relativity was incompatible with the scientistic point of view because it entailed a reconsideration of the most fundamental concepts in physics – space and time. Therefore it appeared as an attack against the religious ones, and science was not allowed, in the scientistic point of view, to generate any doubt, especially in the non-scientists' minds. I use the word "ideology" to characterize scientism because this philosophical point of view was a weapon employed against other influences, particularly religious ones, not only on science, but on society as well.

The form it took during Einstein's visit in Paris is indicated in a speech given at the time by Henri Le Châtelier, a distinguished chemist, whose remark is quoted in *Le Journal* of March 22:[32]

> I never had the ambition of overturning any existing law. On the contrary, any defect, even only partial, in a law, gives me the same feeling as a stain on a new garment. I have directed all my research toward confirming and enlarging my predecessors' work. I have

done so from inclination and without any selfish motives; through practice, I have discovered that this approach is infinitely preferable. It is insane to think that everyone of us can create new sciences by overturning the structure painfully built by generations of scientists. Any progress needs the involvement of a great number of researchers; science is, as Berthelot said, a collective work.[33]

His remark is followed by a comment of the journalist using these arguments against Einstein's theories.

There are other reasons that have played a role in forming opinions towards Einstein's achievements. These are related to the historical and political context of France in the first decades of this century.

4. *The Historical and Political Context of Einstein's Visit to Paris*

Paul Langevin, who had been teaching the special theory of relativity in his seminar at the *Collège de France* since 1906, first invited Einstein to come to Paris as early as 1914. At that time, there were strong relationships between scientists throughout Europe, epitomized in the First Solvay Physics Congress which met in Brussels in 1911. Einstein's visit, however, had to be cancelled when the First World war broke out. During the war, international scientific relations declined: 93 major German scientists signed the famous "Manifesto to the Civilized World" in defense of Germany; similarly, French scientists were writing texts opposing "French genius" to the "German spirit" in science. Pierre Duhem,[34] for example, argued that the extreme rigor of the so-called "geometrical spirit" of German science made it a slave to the deductive method. According to Duhem, because they were not based on facts, German theories amounted to little more than metaphysical speculation. French science, on the contrary, was characterized by its "esprit de finesse", which leads to a clarification of the relationship between observed facts and theories.

The postwar period was still a period of international tension. France had suffered 1 300 000 casualties during the war, the greatest disaster in its history. And there was the vexing issue of reparations: as long as they remained unpaid, Germany had to be banned from the community of nations. Even after the "victory", anti-German feelings were widespread in France. Very influential since the war against Germany in 1870, they were further exacerbated after the First World war. The scientific community was not untouched by this current of opinion. Furthermore, French scientists were among the most virulent proponents of a boycott of German scientists, which ended only in June 1926[35], to start again – on new grounds – during the Nazi period (from 1933 on).

It was in this context that Einstein was invited again by Paul Langevin in 1922. The main argument Langevin used to convince the reluctant opinions was that science had to play a role in the progress of mankind and peace. For the sake of safety, however, Langevin wanted the visit to be strictly "private", reserved to a few members of the scientific élite. But Einstein was no longer an ordinary physicist. After the 1919 Royal Society Session and his trip to the United States in 1921, he had become a legend. And the press made of his visit an event.

When Einstein's visit was announced publicly, several newspapers presented him as a "Swiss scientist" living in Germany.[36] The camouflage provoked a controversy. Other newspapers replied by arguing that France should not be ashamed of receiving the greatest German scientist, because science was universal and profitable to mankind as a whole.[37] The argument reveals the esteem in which science was held even after the criticism it had sustained as a result of having been involved in the war.[38] With the exception of the extreme right wing and the most virulent anti-Semitic press, the major newspapers were well disposed toward Einstein from the moment of his arrival. Everybody was "surprised" to see that he didn't fit their preconceptions of a German university professor. Only one incident marred his visit. Einstein was supposed to be received at the *Académie des Sciences* on April 3rd, 1922, where 30 members were planning to leave as soon as he entered. When Einstein learned what awaited him, he decided not to go. The session, nevertheless, took place, and the physicists present discussed the results of the experiments conducted in Paris by Pérot on the gravitational redshift of solar metals. The analysis of the *compte rendu* of the session is very revealing: the discussion among those present including Deslandres shows that they felt General Relativity still had to be "demonstrated" and that the demonstration had to be "conclusive". Indeed, their image of science implied that, in order to be accepted, the theory of General Relativity had to conform to the scheme of the experimental method as it had been expressed by Claude Bernard. Perot's experiments were deemed inconclusive; the same verdict had been passed on the results of the British solar eclipse expedition of 1919.

There was consensus on a necessary carefulness before adopting Einstein's theories. One must remember the conditions in which this session was held to maintain that, all members of the Academy who were, for political reasons, opposed to Einstein, were not among his supporters from a scientific point of view. This point illustrates a characteristic division of political opinions in French academic society which begins with the French Revolution and which plays a crucial role in the intellectual debates.

Boycott of German scientists was a reality. Einstein's visit to Paris was a symbol for a future reconciliation. Not everyone in France, nor in Germany for that matter was convinced that this was the right thing to do. The very fact that Einstein could be received at all in Paris was most surprising. Indeed, the situation was worsening. Walther Rathenau, who convinced Einstein to go to Paris, was killed in June 1922. Less than one year after Einstein's visit to Paris, the French army occupied the German industrial area in the Ruhr valley. The anti-German feelings were not reserved to marginal nostalgics; it was a strong and influential current.

In short, one sees that the obstacles to the reception of Einstein's theory of relativity came both from prevailing images of science – mechanism and positivism – and from contemporary ideologies – anti-German feelings and the scientistic ideology.

The content of the articles published in the French press reveals somewhat different aspects. Einstein's visit constituted, for the week he was in Paris, the principal topic in the 40-odd Paris daily newspapers. One of the most controversial issues discussed concerned the understanding of the theory of relativity, and furthermore, of science. Through the study of the impact of a scientific revolution among the lay public, it is possible to establish a link between the scientific debate and the public reception.

II. THE POSSIBILITY OF POPULARIZATION

The theory of relativity had the reputation for being understood by an only handful of people – estimates ranging from one to twenty. This belief was an important element in the Einstein legend as early as 1921 when he went for the first time to the United States and may already have existed in Germany.

1. The Irrelevance of the Usual Popularization Pattern

Einstein's visit created a new realization: certain kinds of science could not be popularized. Several articles argue that theory of relativity defied

all efforts to be made evident to laymen. Two reasons were usually advanced: it was argued that the mathematics of both the special and general theories of Relativity are indissociable from the theoretical content so that no merely verbal presentation of the ideas is possible; and the so-called "paradoxes" were believed to conflict too violently with common sense. The point I want to make here is that there is something more behind this reputation. Commonly, popularization is thought to be a process of translation from the language of science into the vernacular. This model works as long as science itself is an established, completed product; but it breaks down during "scientific revolutions" and during lesser controversies within science due to the fact that there is no agreement over what scientific language should be. Such was the case for the theory of relativity.

Thus, the famous "misunderstandings" – everything is relative, etc. – were not due to a bad popularization. I will show that they are simply not efforts at popularization at all, but something directly related to images of science and ideologies which, as I mentioned before, had influenced reception within the scientific community itself. I want to show that the "distortions" as they appear in the press resulted from the specificity of the context of the early twenties. Three factors are especially noteworthy.

The first factor is the revolutionary side of Einstein's theory. It was perceived as an obstacle to popularizing because its "destructive character" was anathema to the traditional scientistic conception of popularization, which seeks to show the achievements of triumphant science.

The second factor is the "novelty" of the theories. In 1922 they were still new theories for the average physicist. Physicists' resulting and frequent admissions that they didn't understand the theory contributed to the difficulty that popularizers felt themselves to be operating under.

The third factor has to do with the fundamental character of the theories. It had far-reaching implications for concepts which were taken for granted, such as space, time, observer-dependence, simultaneity. The corresponding classical concepts were part of ordinary language, while the new, revolutionary ones could not easily be expressed in this way. The fact that Einstein rejected the usual concepts of classical science forced him to express himself. Scientists, and especially physicists, are used to specific forms of communications including a high level of formalism. Everybody is supposed to agree on the basic concepts and there is no need to speak about them. This is the field of the philosophers. Indeed, Einstein was accused of having rejected the use of the traditional language of science. In *L'Oeuvre* of April 2nd, a journalist quotes a scientist saying that Einstein, who "should have spoken in the international scientific language, i.e. formulas written on a blackboard, preferred to express himself in a language which is not his; he wanted to speak to the 'gens du monde' (educated public)" and therefore could not be understood by his peers". Another example is the following: in the April 4 issue of *L'Oeuvre*, there is a long report of Einstein's lecture. It includes this quotation: "You see this man? He is falling! Well, for him, gravitation doesn't exist any more, because he is falling. Isn't it funny?" The journalist adds this comment: "but we understand at once that it is sufficient that the body brings with it its axes of coordinates to suppress gravitation." This reflection shows that clarity was of lesser importance than the display of technical jargon, egregiously employed in this case. What Einstein actually said was perfectly clear, but the form he used to express it didn't fit the scientific norm and was not understood for that reason.

In order to confirm the hypothesis that one can speak of context-dependent images of science, I will present the form taken by these three characteristics I have emphasized – revolutionary, novel and fundamental aspects – outside the scientific community.

2. *Effects Produced by the Scientific Controversy Outside Science*

1. The revolutionary aspect of Einstein's theory was used by those who considered themselves as political revolutionaries. One can read, for example, in *l'Humanité*, one of the Communist daily newspapers[39] that Einstein had given a mathematical form to the philosophy of "absolute relativism", a cornerstone of Marx's dialectical materialism and a major weapon in his refutation of absolutes. The author writes that he will leave it to others to give a detailed analysis of Einstein's ideas. His text, then, should not be understood as a popularization one but rather as a free use of Einstein's concepts, interpreted for his own revolutionary purposes. He uses a semantic trick, consisting in a literal interpretation of the words. The freedom of interpretation of the scientific concepts is perhaps due to the fact that they were not yet accepted within the scientific community. Many scientists claimed they didn't know what relativity was about, and didn't want to know. Journalists could feel free to present openly his way of understanding the theory. The absence of consensus within the scientific community authorized the use of "semantic slidings".

2. The novelty of Einstein's theories was particularly noted by those interested in new ideas. The post-war period was a time of cultural renewal, the surging forth of modernity: dadaism, psychoanalysis, expressionism, and Nietzschean philosophy were being introduced to France simultaneously. The theory of relativity was compared[40] to the recently issued movie, the *Cabinet of Dr. Caligari*. Both are noticed for being up to date and for having been "produced" in Germany! In the literary chronicles of the time, translations and expositions of Einstein's work as well as Freud's, crowd the review columns. At the same time, the people declaring their interest in Einstein's theories are qualified as "snobbish" both by the "regular" scientists and also by the journalists for whom this way of thinking is well outside their mental set.[41]

3. The belief in the impossibility of expressing in a simpler way the basic concepts of the theory led to widespread plays with words. For example, in almost every newspaper, one finds this sentence: "Time doesn't exist, Einstein says", usually associated with cartoons. In one of them, published in *L'Intransigeant*,[42] an old lady applying make-up in front of her mirror quips: "How smart Einstein is, he said that time doesn't exist". Another turns on the fact that the French language uses the same word (*temps*) for time and for weather:[43] A man holding an umbrella waits until the rains stops then says: "Einstein is right: time doesn't exist". Here again, these statements evidently are not attempts at scientific popularization, for Einstein is not quoted as saying: Absolute time doesn't exist. The omission of the word "absolute" can be explained by a confrontation of the debate among the scientific community. For most physicists, there was no difficulty with the concept of time. A frequent variable in their equations and used daily in their discussions, it had acquired an entrenched and unquestioned character. To raise the issue of its validity seemed unnecessary and capricious. The numerous newspaper references to the sentence "Time doesn't exist, Einstein says", don't pretend to explain anything about Einstein's theories. Their ironical form is not oriented toward Einstein, but rather indicates symptomatically what terms were at stake in the representations of science, both for scientists and for the lay public. There was no place to discuss the concept of time, accounting to the organization of the physical sciences: physicists had forgotten that physics once dealt with time. Identifying absolute time with experienced time means that the Newtonian concept has been incorporated into common sense. These "jokes" about time do not indicate that people did not under-

stand relativity but rather that Einstein's preoccupation with time remained a puzzle. This question could not have been raised by a true physicist!

3. Outside and Inside Science

These three points – revolution, novelty, and fundamental character – relate to the influence of prevailing images of science and of ideologies as obstacles to the reception of Einstein's ideas within the scientific community.

Scientific revolution was not appealing to those who believed, in the positivist manner, that science was nearly completed. Classical mechanics, the paradigm of perfected knowledge, seemed an undamaged structure and one without need or room for the theory of relativity.

Furthermore, the theory had its origin in Germany. This fact enlivened prevailing anti-German feelings. Arguments in defense of tradition had a distinct isolationist flavor nourishing the insularity that had contributed so much to France's general scientific decline from the mid-19th century.

Finally, the absence of theoretical physics in France proved crucial. Mathematical physics thrived, but theoretical physics could not be fit into the positivist hierarchy, where physics came below mechanics. This hierarchy was institutionalized in France's university system, which had chairs in General Mathematics, Rational Mechanics, Mathematical Physics, and, at the top, Mathematical Astronomy and Celestial Mechanics. This structure served as an obstacle to Einstein's theories, which forced a new perspective on the internal organization of the different branches of physics.

4. On March 31, 1922, Einstein Was Understandable

There is a curious twist connected to Einstein's visit. The press releases of his public lecture of March 31 at the *Collège de France* were almost unanimous:[44] Einstein was understandable! Almost everybody admired the way he developed his ideas, his clear mind, the slow but good French he spoke, etc.; and almost everybody had the feeling of having understood something of his scientific conceptions. The interest he aroused transformed, for a while, the usual conceptions of the popularizers. Coupled with the fact that a German scientist was being honored in Paris less than four years after the end of The First World war, the future of the theory seemed promising in France. Unfortunately, the potential was not actualized, neither in science nor in politics. It remained an extraordinary event.

NOTES

[1] Stanley Goldberg: *The Early Response to Einstein's Special Relativity 1905–1911. A Case Study in National Differences (Germany, United Kingdom, France, USA)*. Ph.D Dissertation, Harvard University, 1969 (HU 90.9562 Widener Library, Harvard University).

[2] Lewis Pyenson shows that this fact acted as a brake in the reception of the theory of relativity in 'La réception de la relativité généralisée: disciplinarité et institutionalisation en physique', *Revue d'histoire des sciences*, 1975, **XXVIII/I**, 61–73, p. 70.

[3] Henri Bergson: *Durée et Simultanéité*, Félix Alcan, Paris, 1922. See also P.A.Y. Gunther (ed.): *Bergson and the Evolution of Physics*, The University of Tennessee Press, Knoxville, Tennessee, 1969.

[4] Emile Meyerson: *La déduction relativiste*, Payot, Paris, 1925.

[5] Gaston Bachelard: *La Valeur inductive de la Théorie de la Relativité*, Vrin, Paris, 1928.

[6] André Metz: *Les nouvelles théories scientifiques et leurs adversaires. La Relativité*, preface J. Becquerel, E. Chiron, Paris 1926.

[7] The *Collège de France* was created precisely in the 16th century by the king François ler to make possible the introduction of new ideas that couldn't find a place in the university system: it was still the case with Einstein's theories.

[8] Michel Biezunski, Ph.D. dissertation: *La diffusion de la théorie de la Relativité en France*, Université Paris 7, 1981.

[9] Yehuda Elkana: 'A Programmatic Attempt at an Anthropology of Knowledge', in Y. Elkana and E. Mendelsohn (Eds): *Sciences and Cultures, Sociology of the Sciences*, vol. 5, Dordrecht, Reidel, 1981, pp. 1–76.

Yehuda Elkana analyzes science as a cultural system in distinguishing three factors (i) the body of knowledge, (ii) the socially determined images of knowledge and (iii) values and norms included in ideologies which do not directly depend on the images of knowledge. "At any given moment there is a state of knowledge with its methods, solutions open problems, nets of theories and, at its core, scientific metaphysics (. . .) The two or more different theoretical networks are engaged in a critical dialogue. Depending on the stage of the science, on the time, the place and the culture, there will probably be several dominant research programmes and there will be a consensus which are in a critical dialogue with other groups.

"Beliefs held about the task of science (understanding, prediction, etc.) about the nature of truth (certain, probable, attainable, etc.) about sources of knowledge (. . .) are all part of the time-dependent, culture-dependent images of science. It is the image of science which decides what problems to choose out of the infinity of open problems suggested by the body of knowledge (. . .) Ideologies, political considerations, social pressures, values and norms strongly influence the emergence of the dominant images of knowledge."

[10] Although of different origin, scientism and anti-German feelings were very influent in the early twenties. Scientism was on the decline, but still represented a major trend.

[11] The first article on the theory of relativity was published by Paul Langevin in 1911. It is

entitled: 'L'Evolution de l'Espace et du Temps'. *Scientia*, **X**, 1911, 31–54. Other texts include *Le Principe de Relativité* (lecture in 1919 at the Société française des électriciens), Chiron 1922. Paul Langevin gave a lecture during Einstein's visit in Paris at which Einstein was present: 'L'aspect général de la théorie de la relativité', *Bulletin scientifique des étudiants de Paris*, **2**, avril-mai 1922, 2–22.

[12] Henri Poincaré: *La Mécanique nouvelle. Conférence, mémoire et note sur la théorie de la relativité*, Intr. de Edouard Guillaume, Gauthier-Villars, Paris, 1924.

[13] Gerald Holton: 'On the Thematic Analysis of Science: The Case of Poincaré and Relativity', in *Mélanges Alexandre Koyré*, Hermann, 1964, II, 257–268.

[14] Stanley Goldberg: 'Henri Poincaré and Einstein's Theory of Relativity', *American Journal of Physics*, **35** (10), 934–944, Oct. 1967.

Stanley Goldberg 'Poincaré's silence and Einstein's Relativity', *The British Journal for the History of Science*, **5** (17), (1970).

[15] Emile Picard: *La Science moderne, son état actuel*, Paris, Flammarion, 1905.

[16] Albert Einstein: *Eine neue Bestimmung der Moleküldimensionen*, Bern: Wyss (inaugural dissertation, Zürich Universität.)

Albert Einstein 'Über einen die Erzeugung und Verwandlung des Lichtes betreffenden heuristischen Gesichtspunkt', *Annalen der Physik*, ser. 4, **XVII**, 132–148.

Albert Einstein 'Über die von der molekularkinetischen Theorie des Wärme geforderte Bewegung von in ruhenden Flüssigkeiten suspendierte Teilchen', *Annalen der Physik*, ser. 4, **XVII**, 549–560.

Albert Einstein 'Elektrodynamik bewegter Körper', *Annalen der Physik*, ser. 4, **XVII**, 891–921 (followed by the short article: 'Ist die Trägheit eines Körpers von seinem Energieeinhalt abhängig?', *Annalen der Physik*, ser. 4, **XVIII**, 639–641.)

[17] *L'Echo de Paris*, January 7, 1922. In the following days, *L'Echo de Paris* published two articles about Emile Picard's attitude towards the theory of Relativity: 'M. Emile Picard et la Relativité', January 14, 1922 and 'La théorie de la relativité – D'Einstein à Emile Picard', January 28, 1922.

[18] In *Le Matin*, January 10, 1922: "M. Emile Picard, Secrétaire Perpétuel de l'Académie des Sciences, donne son opinion sur les théories d'Einstein."

[19] *L'Echo de Paris*, January 7, 1922, *op. cit.*

[20] This session was held in a very particular atmosphere: Einstein, who had been invited after much hesitation, refused to go: a boycott had been planned by about 30 academicians because Einstein was a German scientist. Einstein's friends did not attend that session.

[21] 'L'effet Einstein n'a pas encore été vérifié', *Le Temps*, April 5, 1922.

[22] Léon Brillouin: 'Les théories d'Einstein et leur vérification expérimentale', *La Science et la Vie*, 63, **XXII**, June–July 1922, 19–29.

[23] Paul Langevin: 'L'aspect géneral de la théorie de la relativité', *op. cit.*

[24] One can read a detailed *compte-rendu* by Charles Nordman: 'Einstein expose et discute sa théorie', in *Revue des deux mondes*, **IX**, 1922, 129–166.

[25] Charles Nordmann, *ibid.*

[26] Paul Painlevé et Charles Plâtrier: *Cours de Mécanique*, Gauthier-Villars, 1929.

[27] Emile Meyerson: *De l'Explication dans les Sciences*, Paris, Payot, 1921.

[28] I want to emphasize that there is a difference between "positivism" in the French and in the logical positivist's sense. French positivism is Comte's: knowledge is restricted to relationships among observed facts and is arranged in a natural hierarchy beginning with mathematics and ending with sociology.

[29] Henri Bouasse: *La Question préalable contre la théorie d'Einstein*, A. Blanchard, 1923.

[30] The Langevin-Guillaume correspondence is part of the Langevin Archive, still in possession of his family. I thank Mrs. Luce Langevin for having authorized me to access this material.

[31] The *Introduction à la Médecine expérimentale*, by Claude Bernard, written in 1885, "defines the fundamental principles of any scientific research", referring to the Académie Française (Petit Larousse illustré, 1977).

[32] Le Châtelier's remark is quoted in *Le Journal*, 22 March 1922, in an article by Lucien Chassaigne, entitled '*Belle modestie d'un savant*': "Je n'ai jamais eu l'intention de renverser aucune loi existante. Au contraire, la mise en défaut, seulement partielle, d'une loi me fait l'effet d'une tache sur un vêtement neuf. J'ai dirigé toutes mes recherches dans le but de confirmer et d'étendre le travail de mes devanciers. Je l'ai fait par goût et sans aucun calcul, mais à l'usage j'ai reconnu que cette méthode était infiniment avantageuse. C'est folie de croire que chacun de nous peut renverser l'édifice péniblement établi par des générations de savants. Tout progrès nécessite la collaboration d'un grand nombre de chercheurs; la science, comme le disait Berthelot, est une oeuvre collective."

[33] Marcelin Berthelot (1827–1907) was a chemist and a politician. He is considered with the physiologist Claude Bernard (1813–1878) as the one of the initiators of the scientistic point of view in science.

[34] Pierre Duhem: 'Quelques réflexions sur la science allemande,' *Revue des deux mondes*, 25 février 1915.

[35] Brigitte Schroeder-Gudehus: *Les Scientifiques et la Paix*, Presses Universitaires de Montreal, 1978.

[36] This is the case of *Le Temps*, *L'Ere nouvellle*, and *La France*.

[37] *Le Populaire*, *L'Eclair*, *L'Internationale*, *Le Matin*, etc.

[38] *La Victoire*, *Le Journal du Peuple*.

[39] The quotation comes from the April 1, 1922 issue.

[40] *Le Journal*, March 28, 1922.

[41] The number of references is too big to be quoted exhaustively. The following articles are some of the ones refering to the question of snobism:

- Marcel Coulaud: 'La première d'Einstein au Collège de France', *Bonsoir*, April 3, 1922.
- Julien Benda: 'Einstein et les salons', *Le Gaulois*, October 28, 1921.
- 'N'entre pas qui veut aux conférences d'Einstein', *Le Journal du Peuple*, April 3, 1922.
- Emile Borel: 'Einstein et les gens du monde', *L'Oeuvre*, April 4, 1922.
- 'Einstein et le snobisme', *Paris-Midi*, April 2, 1922.
- 'Les chaussettes d'azur en joie', *Le Peuple*, April 6, 1922 ("Chaussettes d'azur" is an ironical turn for "bas bleus", itself an ironical way of qualifying the women involved in the Feminist movement.)
- Victor Snell: 'Mode et Relativité', *Le Populaire*, March 31, 1922.
- J.B.: 'Snobisme nouveau', *Le Temps*, April 7, 1922.

[42] *L'Intransigeant*, in the April 6 issue.

[43] In the April 5, 1922 issue of *L'Oeuvre*.

[44] The only notable exception is an article published in *L'Oeuvre* of April 1, 1922. But it is remarkable that on April 4, 1922, 4 articles (a whole page) are devoted to Einstein's theories, correcting this opinion.

BARBARA J. REEVES

EINSTEIN POLITICIZED: THE EARLY RECEPTION OF RELATIVITY IN ITALY

In Italy as elsewhere amid the turbulence following World War I, the reception of Einstein's theories of relativity took on distinctive political colorings in certain settings. This paper analyzes two such episodes. The first focuses on the language used in scientists' writings, for audiences wider than the community of practitioners, about what had earlier been termed a "revolutionary" theory in the context of the new climate of revolution in postwar society and politics. Stalking the metaphors they used, such as revolution and evolution, destruction and construction, facilitates understanding of the variety of impacts of relativity within the scientific community, especially on scientists' views of the relation of theory to experiment and the nature of scientific growth and change. Scientists' publicly expressed opinions of scientific development were transformed by the postwar political situation from an easy acceptance of revolutionary change in science to a rejection of it and an adherence to an evolutionary, progressive view. Furthermore, this new gradualist view stimulated the doing of science: the mathematical physicist Tullio Levi-Civita wrote what became an influential paper in all Latin countries, entitled, "How a conservative could reach the threshold of the new mechanics."

The second episode follows the association of Einstein, considered as a "relativizer" of traditional conceptual absolutes and claims of objectivity in science, with contemporary "relativizing" movements in philosophy, cultural analysis, literature, the arts, and politics. The interplay of the language and the categories of absolute and relative in nonscientific evaluations of Einstein and in cultural and political analyses reveals the writers' general philosophical, cultural, or political predilections as well as their individual momentary assessments of the rapidly changing political and cultural climate in Italy in the years immediately following the end of the war. The culture critic Adriano Tilgher linked Einstein's theory of relativity to the philosophical relativism of Hans Vaihinger and the cultural relativism of Oswald Spengler, and Mussolini was pleased to associate his actions as *Duce* of Fascism with these "great philosophies." This communality of language suggests a new way of

Thomas F. Glick (ed.), The Comparative Reception of Relativity, 189–229.