Poincaré on the Revolution in Physics

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In the autumn of 1904, Henri Poincaré took part in the International Congress of Art and Science held in Saint-Louis, USA, where at this time the World's Industrial Exhibition took place. On the 24th of September Poincaré presented the talk *"The Present and Future Status of the Mathematical Physics"** that could be considered as a guideline. As is known, there was a large audience when he was reading his talk though many Americans were not at all interested in the exact science problems and came just out of mere curiosity: to listen to a prominent French scientist.

However, many experts got the opportunity to closely see into his deep and far-going prophecies due to the French publication of Poincaré's talk the same year and the English version** in the beginning of the next year. The work made a certain impression on further development of the most decisive lines of research in theoretical physics of the first quarter of the XX century.

Below are listed the problems that Poincaré was going to try to cover and that could be found in the beginning of his talk. "What is the present status of the mathematical physics and what are the problems that are to be solved? What is its future and what changes, if any, can be expected in its development? Will the former purposes and methods of its development be the same ten years later or shall we witness its drastic transformation?

But asking these milestone questions on the future development of physics, Poincaré suddenly told the audience that *"no prophecies"* ought to be expected from him, he disliked "*predictions"*, while, on the other hand, he could not help but *"afford to make some diagnosis".*

In the meantime, we can easily see that Poincaré's talk was merely saturated by both the forecastings for the nearest future and quite astonishing prophecies for the far future that came true in twenty years yet. Counter to his promise to make no forecasts, while analysing the difficulties that had arisen in physics of that time, Poincaré pointed unmistakably the so called hot periods of growth of the future physics, where principally new laws were expected to come. Further we will see those hot periods of growth of the future unusual physics in all completeness and trueness as Poincaré showed them.

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* The term "mathematical physics" in the title of the talk corresponds to the nowday meaning of "theoretical physics" as we understand it.

** At first the talk by Poincaré was published in the journal "Bulletin des Sciences Mathématiques" (December 1904, v.28, p.302) then the English version made by Halsted was included in the journal "Monist" (January 1905, v.15, n.1). Three chapters (7,8 and 9) of his book *"La valeur de la science"* (Paris, Flammarion), 1905, comprise the text of the talk with some slight changes. In Russian this book was published in Moscow in 1906. For the first time in the shape of the Saint-Louis talk, translated into Russian by T.D. Blokhintseva, it was published in the collection "The Relativity Principle" composed by the author of this talk (Atomizdat. 1973, p.27) and in the 3d volume of "Selected works" by H. Poincaré (The Publishers "Nauka". M.: 1974, p.559) and also in the journal UFN (1974, v.113, No.4, p.663) translated by I.Yu. Kobzaryov.

It won't be an exaggeration to say that the Poincaré's analysis of the basic difficulties of the classical physics was not the first one, neither it was the only one made during the next years to come. Tracing the situation prior to Poincaré, some awareness of concern for the physics can be observed when attempts had been made to settle the arising problems, but there was nothing that could be considered as a total estimation of the situation in physics as crisis. It was Poincaré's talk in Saint-Louis Congress that summarised the general situation in physics and affirmed that "There are all evidences of a bad crisis". This turned other scientists, both physicists and philosophers, to face the crisis in physics and speak about it. Meanwhile some time ago the great Lord Kelvin compared physics in his lecture with a ship safely sailed across the underwater rocky shelves and entered the calm harbour. According to the scientist, there were just two little shadows in the scientific heaven. Those two shadows in the Poincaré's talk have grown to the basic milestones of the further development of nowadays physics.

Now, here are examples of the nearest predictions taken from the Poincaré's talk.

"...Michelson showed that the physical processes failed to reveal an absolute motion. I'm sure the same is with the astronomic processes irrespectively of the accuracy degree that can be reached".

"On the base of all these results, if confirmed, a quite new mechanics would emerge to be mainly asserted that no velocity could be above the velocity of light (since the body inertia could be infinite at reaching the velocity of light) which is very much similar to the temperature that cannot drop below the absolute zero".

"We probably must invent an absolutely new mechanics that is still rather dim in our understanding, a mechanics with the inertia to grow along with the velocity while the velocity of light would be an obstacle impossible to overcome. The traditional mechanics, a simpler one, would serve as the first approach that is true for not very high velocities and thus the new dynamics would comprise the former dynamics".

The last author's phrase embodies the most important idea on the correlation of the new physics theory and the former one experimentally supported by the vast observations. Later this distinctly formulated Poincaré's idea will be called the correspondence principle theory.

Now, here is an example of a wonderful longterm prophecy made by Poincaré that fully came true in a bit more than twenty years.

"Why the spectral lines have been distributed according to a regular law? ... These laws are rather simple but they are of quite alien nature... Nobody could still fully realize this but I think that this is where one of the most crucial mysteries of Nature hides... Thus, we are going to get a thorough insight into what is hidden in the matter".

"We can't foresee the trend of the development. There are many good reasons to expect the kinetic theory to be the top developing theory and a model for other theories. ... the physics law will acquire then a very new aspect, this won't only be a differential equation, it will acquire a character of the statistical law". Thus, H. Poincaré not only predicted absolutely non-classic mechanisms to be obvious when the laws of electron motion in atom were discovered but he foresaw the statistical character of the new laws.

While proposing the way out of the emerging crisis in the non-classic nature of physics laws, Poincaré still formulated five basic principles of the classic physics that, as he was firmly sure, should counteract the coming storm of drastic transformation of the conven-

tional physics basis. This the most concervative part of his talk, as they thought it, was a matter of puzzle even for nowdays physicists not less than his prophetic words of genius, for he provided new insights into the very heart of theoretical process of understanding the world of the other kind phenomena.

He distinguished five principles of classical physics that could stand the forthcoming drastic changes. First of all, that was the law of energy concervation* . The next was the principle of the energy breakdown/degradation, the principle of equality of action and reaction and the relativity principle. He also added the principle of the least action. Those were the principles that served as a ground for the classical physics and, according to the author, doubts were thrown upon them that time.

It is worth dwelling at this part of the talk because in the article by I.Yu. Kobzaryov that followed directly the H.Poincaré's talk, published in UFN, an obvious attempt can be seen aimed at distorting the French scientist's position in this question. On page 682 of his article I.Yu. Kobzaryov elucidated as such: "Perhaps, it is an intention to keep the physics grounds constant that was one of the reasons making Poincaré assert that principles were actually conventions that could not be rejected by an experiment, though he did not always adhere to this point of view".

In the meantime, to meet the opposition, Poincaré once mentioned in the talk under consideration, that earlier it was a usual practice for him to regard the physical principles that summarized a large experimental material as conventions. In his short reply to the opposition he recognized indeed his former inconsistence. Using the difficulty with energy release by radium in the Curie calorimetry experiment that had been explained by some arbitrary admission he revealed absolute inefficiency of the principle based on the admission as this.

It seems that the purpose to I.Yu.Kobzarev's elucidation on this topic was just to quote in the note to this phrase that "H.Poincaré's opinion on gnostic problems had been critisized by V.I.Lenin... ". Since the problem has been concerned, let's deal with it in more details and show that H.Poincaré for the first time had brought us in touch with inmost sides of theoretical awareness so delicate that theorists themselves found them difficult to comprehend while for dialectic philosophers thought they appeared to lie beyond their competence.

As a matter of fact, Poincaré not at all confused the physical principles that were to have been checked experimentally in every new application field and the adopted or agreed conventions that physicists used implicitly. Even discussions of experiments to check the conventions of this kind Poincaré thought just a misunderstanding. Among typical conventions of that kind was a concept of simultaneousness for the events of different places and kinematic description that necessarily used this conventions** .

* The doubt was thrown on the universality of the law of the energy concervation due to radium discovery, because it seemed to emit the energy of constant and permanent intensity .

** According to Poincaré, the implicitly adopted agreed conventions comprised the definite geometry used to describe physics phenomena and later the metrical groups (Lorenz groups or Galilei groups) were used. He was ironic to the great non-Euclidean geometry inventors because they were concerned about getting some information on the possibility of making check of their geometries via astronomic experiments. Poincaré thought the reasons to perform these experiments fallacious because the experimental result could be interpreted in any geometry. In this Poincaré was a hundred years ahead of all his

The problem was first considered by Poincaré in 1898 in his work *"Measurement of time"* ("La mesure du temps." - Rev.metaphys. et morale, t.6, pp.1-13). The somewhat transformed text of this article was later published as the second chapter of his book *"La valeur de la Science".* In Russian this text of 1898 translated by I.S.Zarubina was published in the mentioned above collection "The Relativity Principle" in 1973, p.27) and in 1974 in the 3d volume of "Selected works" by H. Poincaré.

As to the talk in Saint-Louis H. Poincaré mostly spoke about physical principles, having serious experimental grounds. As far as it concerns five distinguished principles, he said that "those principles are abstracted from experiments and their generality shows that they are true to a large extent". He called up to continue to believe those principles and wrote in conclusion of his Saint-Louis report: "They are so useful that they must have their place for long. To exclude them at all would mean to be deprived of a valuable weapon. At the end I must emphasize that it has not yet happened and no proof exists that these principles will lose and won't stay intact".

It happens as if we are facing now that just these physical principles survived and kept their fundamental notion in the today's physics, though the related physical concepts have largely altered their shape. What we have to do is stay amazed at the H.Poincaré's insight into the ins and outs of the most abstract realm of the human knowledge of the world around us.

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contemporaries. I reasoned this assertion in detail in 1970 in the article "Conventional definitions and unprejudiced invariants" ("Voprosy filosofii", No 7, p.64) and in the talk "On the geometry of the physical world" published in conference proceedings in Uzhgorod (Proceed.of the Intern.Conf., in Uzhgor., August, 1997, p.40).