ISSN 1330–0008
CODEN FIZAE4

THE ROLE OF PREJUDICE IN SCIENCE

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Talk at the Symposium

I am very glad and honoured to be back here in the Ruđer Bošković Institute where I have been many times and especially on this occasion to honour Professor Ivan Supek whom I admire very much. I hope he will alow me to say we are old friends.

My talk was inspired by his ideas and by his life, despite the fact that the title is rather technical. Then, I want to say that my talk will be in two parts. The first part is on the subject The role of prejudice in science, while in the second part I want to talk a little about the collaboration between Trieste and Zagreb institutes and to see how this collaboration could be enhanced.

So, I start then with the word prejudice, what does it mean? If we look in the Oxford dictionary, it says: a preconceived opinion. In an Italian dictionary called Petrochi the word prejudice means judgement admitted without examination. Then, let us consider the axioms, or principles, or postulates on which a certain branch of science is based. So far, as these are accepted for true for their immediate evidence, they might fall in the frame of the definition of prejudices. That is their statements are accepted as true without further examination, i.e. they are preconceived opinions of truth. So these prejudices or axioms, now I am concentrating on the axioms of science, they have some common ground with what Kant called a priori sintetic judgement. However, at difference with Kant's philosophy, axioms of science have to be constantly subjected to criticism and they may be changed. The axioms, or postulates of science may be changed generally for two main reasons. One, because of internal self-consistency and second because some consequences drawn from them are contradicted by experimental observations. By this I mean that some of the postulates may originate internal antinomies or are experimentally falsified. When this happens, the postulate is abandoned, then you have a drastic change in that branch of science, in general. Sometimes such developments are called revolutions in science.

We have a well known example of the first case of the abandoning of a principle, which is the birth of a new of geometry, the geometry of Lobachevski, which was derived from the Euclidean geometry when the fifth postulate was abandoned, was left out. So a new geometry was born.

The other way of abandoning an axiom, which is more interesting for us, physicists, is when the consequences derived from this axiom are in contradiction with experiments. This was the case of one of the two main revolutions in science in this century, the theory of relativity. Relativity came out by considering as not anymore true one of the main axioms of Galilean and Newtonian mechanics. Which axiom? The axiom which said that mechanical laws refer to phenomena which happen in space and time. The space is three dimensional while the time is absolute. What does it mean absolute? It means that it doesn't depend on the observer. It is the same for every observer, at rest or in motion. Now, this postulate was abandoned as false in relativity. How did it happen? Allow me to trace the path, because I want to arrive at how Professor Ivan Supek is connected with this. One of the consequences of Galilean and Newtonian mechanics, as everybody knows, are the laws of kinematics, called Galilean kinematics. It says that velocities may be added as vectors. Now, this is a law which is very intuitive and people accept it based on common sence. Here is an example. If you are on the bridge of a ship which is navigating, the wind you feel in your face is the sum of the velocity of the wind with respect to the sea plus the velocity of the ship with respect to the sea. This is very intuitive, and everybody will accept it as true.

Now, it happened that this law was contradicted by experiment. Which experiment? A similar experiment to that of the ship. The ship was replaced by the Earth, and the wind by light. As everybody knows, this experiment was done by Michelson and Morley. They measured the velocity of light coming from a star, while the Earth was moving in the direction toward the star. And they found a certain value of the velocity. Then they measured the velocity six months later, when the Earth, having turned around the Sun, was moving in the opposite direction, away from the star. And the velocity of light was always the same, contradicting the intuitive law of Galilean kinematics. There was no change as the velocity of the Earth changed. This is a simbolization of the Michelson-Morley experiment, it was not made exactly that way, but essentially it was like that. This was a paradoxical fact, a paradox, because it was against common sense. The general conclusion is that the velocity of light is constant, it is actually the maximum possible velocity for natural phenomena, and no velocities could be added to exceed that value. So, it doesn't obey the Galilean kinematics, which was a consequence of the axioms which I mentioned above.

Now, after many difficult attempts, in the end it was Poincaré and Einstein who discovered that in order to understand this paradoxical phenomenon, the only possibility was to abandon the axiom of absolute time as a wrong, as a false axiom. Instead, every observer has his own time, together with space coordinates.

Now, the point I want to make is that, actually, one could have arrived to this result of the inconsistency of Newton's axiom of absolute time even before the Michelson and Morley experiment. In fact, I must say that two great personalities, Galilei and Newton were aware of this difficulty. How I learned of it? The first time that I discovered this for my own interest was from Professor Ivan Supek. About fifteen years ago Professor Ivan Supek was studying the manuscripts of Galilei while he was in Padova. And he told me that he discovered with great surprise that during that time there was a dispute between Galilei on one side, and Marco de Dominis on other side. At that time Marco de Dominis was also teaching physics in Padova. And the dispute was about the origin of the sea tides. According to de Dominis the origin of sea tides was the moon. According to Galilei it was not possible that the moon could exercise the effect of the sea tides. We know now that de Dominis was right. However, we can also recognise that the argument of Galilei was very deep indeed. He was a deep personality. De Dominis lived in Venice, I think. The Venicians were measuring the sea tides with the great accuracy, because of their ships entering the lagunes, and de Dominis saw clearly the correlation between the phases of the moon and the sea tides. Well, it was a simple connection of the cause and effect. However, the argument of Galilei was the following. The moon is far away. In being far away it can not exercise the effect of the tides. Why? Because in Galilean kinematics, as I said just a moment earlier, you can add the velocities, and if you add velocities like segments, there is no limit, you can reach very easily the infinite velocity. So, in his mechanics there was place for infinite velocity. Therefore, in his argument, if there was action at distance then there was no reason to exclude that this action could be instantaneous. But if the action is transmitted with infinite velocity, you have the difficulty with the principle of causality, which tells that the effect has to be after the cause in time. That principle, that Galilei considered fundamental, became ambiguous. And I think that this is a real reason why he refused to consider action at distance as real. Because he wanted to respect the principle of causality. It is interesting to know that in the Principia of Newton, at the end of this wonderfull book in which he founded the theory of gravitation, he said that his theory was all right. However there was a fundamental difficulty, that of the action at distance, the instantaneous action at distance. He stated that he put it in his theory and unfortunately had no way to overcome it. So, in a way, this difficulty, which was afterwards solved by the relativity of Poincaré and Einstein, was present already in the minds of Galilei and Newton. And now we know that it can be traced back to the postulate of absolute time which is not true. Well, this is an example how even a postulate which at a certain time is the most firm basis in our science may sometimes impede the recognition of the truth. In this case, it impeded Galilei to recognize a law which is true, that the moon is at the origin of the sea tides. It was so much of a problem, as Ivan Supek probably knows, that Galilei was wery much preocupied with the fact that he could not understand the cause of the sea tides. Galilei was hoping that the sea tides have to do with the rotation of the Earth. In fact, the first title of his most famous work was On the Flux and Reflux of the Sea, later changed to On Maximal Systems.

So, I wanted to start my talk with the subject of prejudices. Even the prejudices which are inside science, the priciples have to be constantly critically considered by scientists because they might be wrong, they may have to be abandoned.

But, there are other sources of prejudices which impede the progress of science. They come either from the science itself or from the outside. Let us see first those which come from the science, but apart from the axioms. They may come in the form of fashions. Great personalities, great scientists, naturally, very often create schools. In schools there are many students which create an environment which is ideal for the flourishing of science. We have good examples of this. Let me name a few, the school of Bohr in Copenhagen, of Sommerfeld in Munich, and of Fermi in Rome. However, this kind of influence of great personalities in science is not always only positive. Especially nowadays as there are many great physicists working in the field of theoretical physics. Not only that, but there is also a great number of other scientists working in theoretical physics. You probably know that there are more scientists working now, than is the number of scientists which had lived since the ancient Greek times. We have an enormous number of scientists. So a common phenomenon is that of fashions. Whenever there is a great man, take the example of Gell-Mann, who says something, and you have hundreds or thousands of young people following that idea. And they do so not only because the man is a great master, or he did wonderfull things, but also because they know that if they do so, they can make good carriers. And there are many other reasons which are not so obvious. These fashions change, they have a maximum and then they die down. And then we have a new fashion. We had many fashions, like Regge poles, Chew poles, more recently strings, superstrings, supersymmetries and so on. The superstrings are the last one and they are going down. Soon there will be a new one, I'm sure. This is one way of progress in science. However, I think that young people should be encouraged to think as much as they can with their own mind, and to try not to follow a fashion just because there is a fashion. This is something of which many people are aware. Those who have the responsibility of directing the institutes should encourage people, especially young people, to follow a fashion only to a certain limit.

Now I want to tell you a story, a personal experience, which was very impressing for me, and I think it is emblematic, and also I am telling it because it has to do with Heisenberg, with whom also Professor Supek was in great friendship.

In 1949 I was working on cosmic rays, and I got a fellowship to go from Trieste to Göttingen, to Max Planck Institute für Physik which was directed by Professor Heisenberg. For me it was a very big event and very important for my life. I arrived to Göttingen with my bag, I went to the Institute and as soon as I arrived someone said: "Oh yes, we know you were arriving. Tell us where were you born?", I said "Lussin Grande, well Veli Lošinj" and then he asked when was I born, I said the date, then "At what time, at what hour", I said "I don't know that, you better ask my mother". Then I said, I could not resist, I was very divided, "Excuse me, you are German, I am Italian, we are very approximate people, but please, why do you want to know also the hour of my birth? "Oh", he said, "because we want to make you a horoscope". So I said "Ah, then probably I am in a wrong place" and I took my bag ready to leave. But he said, "No, you are here, here is Professor Heisenberg, yes, yes, yes. If you don't want a horoscope, it is not obligatory, we will not do it". And then I said, "No, no, please, go ahead".

It was Professor von Weizsäcker, a brilliant scientist who was making systematically horoscopes, in the German way. He consulted all the middle age books on how to do it, and he did it, and he made statistics. I am sure, Heisenberg didn't believe in horoscopes. It was wonderfull that Heisenberg knew that it was done, and he allowed it. For me this was a sign that he was a really great man, you really will agree with me that Heisenberg was a great man. As I said, not only in science, this everybody knows, but also as a man. And he was wonderfull to me, also for teaching me that, you have not to have prejudices. Even scientific prejudices have to be abolished. I mean, science has to be absolutely free. Provided you trust the man, naturally. Well, if a magician came to my Institute and wanted to do a magic thing then I would say No, please, go out. But for von Weizsäcker it was all right to give him the possibility to do it, and to show it. At that time he actually had difficulties at the University. He had a sort of a trial. But this is another story.

Now I want to raise the point that research has to be absolutely free, it has to be free from all forms of prejudices and pressures coming from any side. Namely, there are even more dangerous prejudices, those coming from the outside of scientific work. These are sometimes very dangerous. There are well known stories about attempts to influence the scientific research by outside pressures, either social or political, and they all have been in fact only detrimental. These have to be fought absolutely in every possible way. There is the famous case of Lysienko in the Soviet Union that everybody knows. There are other examples, I think also the example of kibernetics which was forbidden in certain countries because of Jewish origin. These are the things which have been fought.

In line with the teaching of Professor Supek, I think that freedom is very important, an essential ingredient of research. Not only in research but also in life, I mean in general. In fact, one of the duties of science, regarding this necessity of freedom in the human cultural activity, is that it should be transmitted also to the rest of the world, to other cultures of world.

Well, in this short talk I wanted to show that science has to be always very critical with itself, with its own prejudices. And so, it is important that the critical attitude of science, its action on itself, should be a very important basis of teaching, should be the major content of learning of the scientific method. And this should be transmitted to people in general, because we have a tendency instead to impose believes, to impose dogmas.

This is one of the reasons which convinced us that we should dedicate part of our effort to this problem of science communication, by which I mean to communicate the cultural content of science, of which the fighting of prejudice is one of the main values.

Now, in parallel to Professor Supek's actions to try to establish bridges between science and humanistic culture, we have created in Trieste a new laboratory which is called Interdisciplinary laboratory. One of the subjects of studies in this laboratory will be exactly to try to put together scientists and men of culture, philosophers, historians, linguists, and to try to study this problem of communication of science and of the communication of the cultural value of science to philosophers and to the rest of the world. We will have good people there, one of the collaborators will be Professor Claudio Magris. Probably some of you know him. And I hope that also Professor Supek will come and join us, because I know that his interests are very close to this kind of activity.

Now, since I am talking of collaboration, I want to say that I have been here already many times and that many of you, of people who are here and people who are not here, have been to Trieste, to the International Centre for Theoretical Physics. For 25 years of existence of the Institute we have kept ties with you here in Zagreb, with scientists in Prague, in Budapest and in Warsaw. It is the moment to enhance this connection between Italy and eastern countries, in particular with Zagreb. And I should say that with Zagreb we had the most intensive and fruitful collaboration. Especially with Gaja Alaga and also Vladimir Glaser who was actually born in Trieste, and then many, many more other physicists from here, "the nephews" and "grandchildren" of your school, Professor Supek. Many of them I saw in Trieste. Now, I think that we should make plans to enhance this collaboration, to broaden it and to make it more intensive, because there will be possibilities, as I said, to make proposals to our government, specific proposals for research that we could do together and to propose to do that and this and I am sure there is a good probability that it would be approved. In particular in the field of science communication which at this time in Italy, but also in Europe, attracts great attention by the governments. In Europe a great attention is payed to the efforts to try to make people aware of what is science, what science is doing and what are the cultural values of science. There is a new society named ECSITE which was recently formed, it was actually born in England, but now it is becoming European. Its president is Richard Gregory from Bristol. He has inaugurated a new way of teaching science with "hands on museums", which has been extremelly successful and very interesting. We are members of this society, we are the only representatives from Italy. In Trieste we have a laboratory which has prepared a show on science. So I think there are good reasons to think that this occasion of honouring Professor Supek may also be an occasion to start a new, a more intensive era of collaboration between Trieste and Zagreb, and the Ruđer Bošković Institute in particular.