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Tematica vincolata Politiche della ricerca scientifica. Come valutare la fecondità di un porgramma di ricerca in fisica teorica

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TITOLO DEL PROGETTO: Quantum Gravity and the scientific community: a methodological analysis

RICERCA PROPOSTA

Finding a theory of quantum gravity is the most important goal of theoretical physics to date. Many efforts have been made in the last fifty years, but no definitive results have been obtained.

String theory is the main research programme in this field, but it has many problems that have led to strong debates, mainly regarding its incompleteness, the impossibility of (Popperian) falsification, the anthropic principle, and its monopolisation of human and financial resources.

It is interesting that such debates are mainly philosophical, specifically methodological. Up to the last century philosophy of physics was considered useless by physicists, but string theory has changed this scenario, so that both its opponents and its supporters use philosophical arguments to argue in favour or against the theory. Recently, philosophical research in quantum gravity has increased. One of the main reasons regards the above mentioned complex epistemological status of string theory.

An example is the paper "String theory and general methodology: A mutual evaluation" by Lars-Goran Johansson and Keizo Matsubara, where the authors try to give an evaluation of string theory from the perspective 1 of different methodologies. Another reason concerns the impossibility of testing string theory, and in general to collect data at the Planck scale to guide theory building in quantum gravity, that has led to the question of how to evaluate a research programme in absence of experiments. This one is becoming a more and more important line of research. The most significant work in the last years about this topic is the book "String theory and the scientific method" by Richard Dawid, where he attempts to provide a methodology for a non-empirical theory assessment. This book has become quite popular among string theorists, being used to defend their research programme.

My Master's thesis follows the same line of research. I used Lakatos methodology to analyse string theory's history in order to provide a general evaluation of this research programme. Furthermore, I analysed the internal debates within the scientific community, its organisation and the difficulties it is experiencing. Through this work, I was able to identify the main problems in current research and get some clues on how to solve them.

I believe that these problems have a significant impact on research. Rivalries and futile arguments contribute invisibly to slowing down the scientific process, and the same can be said about the organization of the scientific community. Academic regulations and policies, funding

and other administrative and social dynamics can have a strong influence.

Finally, a correct and objective methodological analysis of research programmes is necessary both in order to organise the scientific process and to provide a useful external tool for scientists to achieve greater awareness of their own research programmes and those of others, also helping to make debates between them more constructive. In fact, in order to decide which research programmes to allocate resources to, the scientific community always evaluates them. Doing so without reliable criteria might lead to wrong choices severely affecting the scientific development. Furthermore, not only the different specific programmes have to be evaluated, but also the field of research in which they are located: the quantum gravity project as a whole is considered immature by many physicists, so we should understand whether it deserves all the resources it is given, and organise the scientific community accordingly.

The domination and sterility of string theory have raised questions about the rationality and degree of awareness with which the scientific community organises itself. This fact highlights a malfunctioning in the scientific process, and I believe that a philosophically-based organization can play a crucial role in restoring it. In fact, the stagnation that theoretical physics is experiencing suggests the necessity of some strategy to continue to achieve scientific success; philosophy of physics, studying how science achieves success, might be able to provide such a strategy.

These are all the reasons I put forward in support of the project I propose. This project aims to contribute to the resolution of the above mentioned problematic issues. First of all, a methodology must be chosen to appraise research programmes in quantum gravity. Lakatos methodology seems to be the most appropriate one, but it might need to be empowered or extended with novel tools and concepts in order to be adapted to contemporary research. Being 2 graduated in theoretical physics, I am confident I have the necessary skills to go deep in this topics; in addition, my thesis work allowed me to deepen my knowledge of the philosophy of physics needed for this purpose.

Then, such a methodology should be applied to the main research programmes. In my Master's thesis I already applied Lakatos methodology to the most important case, that is string theory, but such an important issue demands to be further investigated.

Another important research programme which deserves to be investigated is Loop Quantum Gravity (LQG). This theory is not a unifying one like string theory, but it is the most developed theory of quantum gravity we have after string theory. Researchers in this field are often strong opponents of string theory, complaining its domination. Analyzing LQG from a methodological perspective is important both on its own and because of its relation with string theory. In fact, even if LQG is not technically in contrast with string theory, the two communities are 'rivals', so it would be useful to analyse both of them separately and then the relation between the theories and the respective communities.

In addition to the evaluations resulting from these analysis - that would constitute a major achievement on their own -, a further investigation of the settlement of the scientific community and of the scientific process should be sufficient to identify precisely the causes behind the crisis in contemporary theoretical physics, that is where the actual strategy - if there is a strategy - applied by the scientific community deviates from the one leading to scientific success. Briefly speaking, the analysis of the two main research programmes in quantum gravity, of their communities and of the organization of the scientific community, should help to apply in the best way that methodology which, being able to explain how science achieves its success, is able to suggest how to make it continue to be successful.

To conclude, the final results of this project would be: the study of scientific methodology, looking for the best one; the methodological analysis of string theory and LQG, of their communities and their relations; the critical analysis of the organisation of the scientific community to understand the causes of the actual 'crisis' in theoretical physics, suggesting a philosophically-based strategy and reorganisation of the community in order to make research going on. More generally, looking beyond these specific objectives, this project also aims to bring the scientific and philosophical communities closer together, to foster a collaboration that can guide the scientific process in a rational and conscious manner. Finally, I believe that for this purpose it is crucial to have a mixed academic background, that is to possess knowledge in both fields that one wants to bring together, in order to be a professionally credible 'mediator' able to dialogue with both sides. For this reason, I believe I am capable of completing the objectives of this project.

ABSTRACT

The main purpose of this project regards the appraisal of research programmes in quantum gravity, focusing on string theory. To this aim, a suitable methodology would be adopted, providing tools to evaluate research programmes also in absence of empirical data.

This work would be correlated by other analysis. String theory is the centre of many philosophical debates inside the scientific community; a methodological perspective might help to resolve them, or at least to make them constructive. The study of scientific methodology would also help to understand why theoretical physics has been experiencing a stagnation in the last decades, suggesting to the scientific community new strategies to continue to achieve success.

Finally, this project could stimulate a fruitful collaboration between the scientific and philosophical communities.

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