CURRICULUM VITAE ET STUDIORUM OF GINO TAROZZI

Gino Tarozzi professor of Logic and philosophy of science at the University Urbino Carlo Bo since 1988, has investigated both the foundations of quantum physics, suggesting probabilistic generalizations of Bell's theorem and discussing some experimental tests of a proposed new realistic interpretation of the wave function, and the relationships between physics and epistemology, showing the opportunity of a reformulation of the main metaphysical theses in the history of scientific and philosophical thought, like realism, causality, holism, nothing, and the mind-body problem, in terms of empirical meaningful philosophical concepts and principles, that can be usefully compared with the descriptions of the world provided by our main physical theories.

He carried out his academic studies at the Bologna *Alma Mater Studiorum* University with Alberto Pasquinelli, philosopher of science, pupil of Rudolf Carnap, founding father of logical positivism, and Antonio Pignedoli, eminent mathematical physicist, who was very critical of the standard subjectivist interpretation of quantum mechanics. Tarozzi was thus influenced both by the neopositivistic anti metaphysical approach of the former and by the latter's yearning for a realistic and causal interpretation of quantum mechanics: Accordingly, he studied the foundations of physics, focusing on the open problems of quantum mechanics on the one hand, and general questions in the theory of knowledge in the light of the foundations of physics, on the other. He received his degree in philosophy in 1977, upon discussing a dissertion on the epistemological foundations of quantum theory. Part of this dissertation, comparing the logical non distributive with the realistic interpretation of the wave particle duality, appeared few months later on the review *Il Nuovo Cimento*, was considered "tres interessant" by Louis de Broglie (1), Nobel prize in Physics 1929 for his discovery of the wave nature of matter.

At that time he had already begun to work together with one of the most distinguished scholars of foundations of quantum mechanics, the theoretical physicist Franco Selleri, with whom he developed a research program on some crucial connections between quantum physics and philosophy. He became then acquainted with the philosopher Evandro Agazzi, and was deeply influenced by his idea that philosophy of science cannot be restricted to the formal and linguistic problems of theories, but should tackle problems of content and of natural philosophy as well. The philosophy of physics should study both the conceptual foundations of theories and their epistemological implications. On the other hand, and this is his new proposal, those philosophical questions may be analyzed in a non-metaphysical way by applying the neopositivistic criteria of meaning: for, although they failed as a demarcation of scientific propositions, they allow the reformulation of some metaphysical propositions as philosophical principles endowed with empirical meaning.

After graduation, he started a ten years long cooperation with the Institute for Cultural Heritage of the Region Emilia-Romagna, for which he took charge of the knowledge and preservation of historical materials of science, and in particular of scientific instruments, which are present in academies, universities, museums, and scientific laboratories. This investigation proved with perspicuous concreteness the continuity of our scientific tradition with respect to the Galilean one together with its fruitful experimental instances. From such research the methodological legacy of Galileo appeared implemented by scientists and technologists of the following centuries in Emilia and Romagna, to the point that their contribution to the history of science could not be separated from their role in the design and in the construction of new instruments and apparatuses of investigation, as in the case of Campani's lenses, Ramazzini's barometer, Nobili's astatic galvanometer, Melloni's bench, Amici's telescopes, Righi's oscillator and Marconi's radio.

These results can be easily extended from this specific case to the history of science in general in the sense that the history of (empirical) science is not only the history of scientific theories, but also the history of scientific instruments of measurement and observation.

His interest in the history of science, which has never waned after having characterized his early research, had a significant resumption following his appointment as president from June 2020 of the Foundation established by Rossana and Carlo Pedretti, one of the most important scholars of Leonardo's work. With this new role he has promoted and organized several research activities, conferences, exhibitions, and seminars on the origins of modern science, deepening the study of its roots in Italian Renaissance, characterized by a close relationship between arts and science.

In 1985 he began his collaboration with the University of Urbino, organizing one of the main international congresses for the 50th anniversary of the Einstein, Podolski, Rosen (EPR) paradox, a subject he has always been particularly interested in, and "to the examination of which has made a substantial and original contribution" according to the judgement expressed in 1987 by the commission of the competition for associate professor of Foundations and History of Physics, from which he withdrew his candidature having been

approved in the meantime winner in another competition for professor of Philosophy of Science. With the result of this, the University of Urbino appointed him as associate professor in Philosophy of Science (1988-94), then full professor in Logic and Philosophy of Science in 1994. In earlier years he served as Chairman of the Corso di laurea (B.A. program) in philosophy (1995-98), Head of the Institute of Philosophy "Arturo Massolo" (1998-2004), Coordinator of the Dottorato di Ricerca (Ph.D. program) in Philosophical Anthropology and Foundations of the Sciences (2001-2009), Chairman of the Corso di studi specialistico (M.A. program) in Theories of Knowledge, Morals and Communication (2004-05), Dean of the Faculty of Literature and Philosophy (2005-09), Head of the Department of Philosophy (2009-10) and then of the Department of Pure and Applied Sciences (2015-18). Within the Urbino University he has gathered one of the prominent groups of research in the philosophy of science, and especially in the foundations of quantum physics, a group including Vincenzo Fano, appointed to a second chair of full professor of Logic and Philosophy of Science, with whom he is fruitfully cooperating for several years, Mario Alai, associate professor of Philosophy of Language, Pierluigi Graziani, assistant professor of Logic, Isabella Tassani, lecturer of History of Science, and moreover Rossella Lupacchini, associate professor of Logic and Philosophy of Science at the University of Naples Federico II, Alexander Afriat, maitre de conference in Philosophy at the University of Brest, Claudio Calosi, professor of Philosophy of Nature at the University of Geneva, Gennaro Auletta, associate professor of Philosophy of Science at the University of Camerino, Giulia Giannini, associate professor of History of Science in the University of Milan, Flavia Marcacci, full professor of History of Scientific Thought at the Pontifical Lateran University. As it was pointed out by Evandro Agazzi:

My contacts with Urbino were further consolidated after the arrival in this University of Gino Tarozzi, a philosopher of science who carried out important studies in the field of philosophy of physics and who shares with me a realist conception of science. (...) On these occasions I also had the opportunity to know and appreciate some of his valuable collaborators and disciples, which ensure to this University a solidity in the field of the studies of philosophy of science that, despite appearances, it is not easy to achieve in most Italian universities (2).

From 1995 to 2000, and again since 2005, he has been the Director of the Centre for Research in the Philosophy and Foundations of Physics of the Universities of Bologna, Insubria, Salento and Urbino.
Tarozzi is corresponding member of the Accademia delle Scienze dell'Istituto di Bologna (1994-), and of the New York Academy of Sciences (1997-), permanent member of the Accademia Nazionale di Scienze, Lettere e Arti di Modena (2017-), since 1989 corresponding member), and of the Académie Internationale de Philosophie des Sciences (2009-).
From 1996 to 1999, he was president of the Società Italiana di Logica e Filosofia delle Scienze, vice president of the Académie Internationale de Philosophie des Sciences (2015-21), of which he is presently assesseur.
His research aims to contribute to the critical analysis and conceptual clarification of some of the foundational open problems still unsolved in the standard interpretation of quantum theory. They cluster around three main questions: (a) the interpretation of the wave function, and the related problem of the dual behaviour of microphysical objects; (b) the theories of measurement and the postulate of reduction of the wave function, along with the problems concerning the formal description of measurement instruments in quantum formalism; (c) the incompatibility, displayed by the EPR argument and Bell's theorem, between the empirical prescriptions of the principle of local reality and the predictions of quantum theory.
Concerning the interpretation of the wave function, he rejected Born's probabilistic (and corpuscular) approach, developing some ideas originally due to de Broglie and Selleri and suggesting a new realistic interpretation based on "quantum waves", viewed as objects endowed with merely relational properties. He then conceived some experiments able to discriminate between such a realistic interpretation and the orthodox one, which has been realized by experimental physicists like Mandel and Hardy, confirming a smooth form of complementarity. More recently he has proposed with G. Auletta (who subsequently collaborated also with Giorgio Parisi, Nobel Prize for Physics 2021), a further experiment, where wave-like properties are associated to quantum states endowed with surprising formal analogies with entanglements, discriminating between the reality of quantum waves and the reality of the predictable properties.
As regards the Einstein-Bell contradiction, in papers written with Franco Selleri, they suggested an extension of the validity domain of Bell's theorem, showing that Bell's inequality is satisfied also by the best known non-local theories, like Newtonian dynamics and de Broglie's and Bohm's hidden variables theories; they found some proofs of the EPR paradox and Bell's theorem based only on the principle of local reality, with no need of hidden variables (the so called "Selleri and Tarozzi's proof of nonlocality of quantum mechanics"(3);

they criticized Clauser (Nobel prize in Physics 2022) and Horne's probabilistic proof of Bell's theorem. In further works, some of which still in cooperation with Franco Selleri, he has shown how a probabilistic proof of Bell's theorem may be given without recourse to the factorizability hypothesis, thus avoiding Clauser and Horne's unjustified identification, endorsed by many other authors, between statistical independence and the physical notion of separability. As it was stressed by Karl Popper in 1985:

F. Selleri and G. Tarozzi found a model that satisfies Bell's definition of locality but not the Clauser-Horne definition of locality (also known as the 'factorizability condition'); this seems to show again that Clauser and Horne have not established the Universality Claim (4)

In order to do so, he defined physical reality without using the notion of predictability with certainty, thus providing a probabilistic generalization of EPR's criterion. The value of these contribution was stated by Max Jammer, one of the greatest historians of science of last century, in his opening speech of the 1991 conference in memory of John Bell:

Other current developments concerning Bell's inequalities, which promise further to clarify their significance, contains certain elaboration of ideas which had been mentioned already in 1980 by A. Garuccio and F. Selleri and in 1981 by F. Selleri and G. Tarozzi in their attempts at systematically derivating all Bell-type inequalities, but only recently explored as to their experimental consequences (5)

Of the measurement problem he mainly discussed some epistemological aspects, with particular regard to the mind-body problem, negative result measurements, and the implications of macrorealistic theories, showing that even a satisfactory physico-mathematical account of the reduction process would still leave unsolved the more serious problem of the entangled superposition states. He also studied the epistemological and methodological aspects of measuring and experimental instruments in the history of classical mechanics and electromagnetism.
These foundational researches are based on his reformulation of the demarcation criterion, allowing for philosophical sentences that are meaningful, but non-falsifiable. Cases in point are
- the realistic hypothesis of Lewis "If all minds disappear from the universe, stars still go on on their courses", analyzed in "Testability and Meaning" by Carnap, who highlighted how this was a statement satisfying the most stringent requirements of factual significance since it is testable, albeit incompletely;
- the EPR principle of physical reality, indirectly veriafiable, according to the definition given by Alfred Ayer, who noted regarding this matter:

I agree you have shown the possibility to obtain non trivial empirical consequences from what you choose to call a realist philosophical hypothesis, but I am non persuaded that your result could be interpreted by an instrumentalist accordig to his own fashion (6)

-the probabilistic generalizations of the EPR principle.
In a similar way Tarozzi has shown that there are at least four formulations of the principle of causality endowed with empirical meaning and contradicting the orthodox interpretation of quantum theory: Laplace' determinism, causality as lawfulness according to Kant's second analogy of experience, Mill's principle of the uniformity of nature, and Hume's causality as ordered connection which excludes any reversal of the temporal order. Moreover, he analyzed the mind-body problem with respect to von Neumann's and Wigner's subjectivistic interpretation, pointing out the paradoxical consequences of orthodox quantum mechanics and the need of alternative theories.
Such a possibility of reformulations endowed with empirical meaning of metaphysical principles has been furtherly extended to holism, strongly supported by quantum mechanical description based on entangled states and even to the archimetaphysical concept of nothing, stressing how the reality of nothing, implied by a new quantum paradox, represents an argument against the idea that (only) macroscopical properties are real.

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ACADEMIC EXPERIENCE

President of Italian ASN for full and associate professor of Logic, History and Philosophy of Science
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Assesseur at Acadèmie Internationale de Philosophie des Sciences
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President of Nuova Fondazione Rossana and Carlo Pedretti
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Dean of the Department of Pure and Applied Sciences at Urbino University
November 2019 - present

Permanent member of the Accademia nazionale di scienze, lettere e arti di Modena
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Permanent member of the Acadèmie Internationale de Philosophie des Sciences
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Head of the Centre for Research in the Philosophy and Foundations of Physics
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Head of the Department of Philosophy
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Dean of Faculty of Literature and Philosophy
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Chairman of the Faculty Board (M.A. program) in Theories of Knowledge, Morals and Communication
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Coordinator of Dottorato di Ricerca (Ph.D. program) in Philosophical Anthropology and Foundations of Sciences
April 2001 - October 2005

Head of the Institute of Philosophy "Arturo Massolo"
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Vice-President of the Italian Society for Logic and Philosophy of Science (SILFS)
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