

Miguel Angel Virasoro (1940-2021)



On July 23, a great Argentinian-Italian theoretical physicist, Miguel Angel Virasoro, one of the founders of string theory, and one of the initiators of complexity studies, passed away. His scientific contributions were outstanding and stimulated an impressive number of subsequent developments. He was an extraordinarily intelligent, profound, visionary person with a great sense of humor. We were very close friends: he had a great influence not only on my studies, but also on a personal level.

Virasoro had an eventful life, just as his studies in physics were varied. Born in Buenos Aires in 1940, with an Italian grandmother, he bore the same name as his father, a noted Argentinian philosopher and founder of dialectical existentialism. After high school Virasoro enrolled in physics, graduated and studied for his doctorate. But in 1966 General Juan Carlos Onganía successfully led a *coup d'état* in Argentina, overthrowing the democratic government and establishing a dictatorship that would last until 1973. The universities and in particular the Faculty of Science in Buenos Aires became a center of opposition: the police broke into the university massacring the occupants during what will be called "the night of the big sticks". In the following months various university structures were dismantled, 300 professors emigrated abroad: Virasoro finished writing his doctoral thesis working from home; as soon as he got his doctorate he moved to Israel, to the Weizmann, one of the best universities in the world.

At the Weizmann there was a strong group of physicists led by a brilliant Argentinian physicist, Hector Rubinstein: under his guidance Virasoro, together with Gabriele Veneziano and other physicists (Marco Ademollo, Adam Schwimmer), began a long series of studies of particle physics from which the string theory was born. In fact, although the fundamental step towards string theory will be made by Veneziano with the first open string model in 1968, these preliminary studies were fundamental to form the conceptual

framework in which Veneziano's model could be conceived. Stimulated by Veneziano's work, a few months later, Virasoro extended the theory by introducing the closed string model.

In the following years, first at Madison (Wisconsin) and later at Berkeley, Virasoro worked with great success on the string theory, and introduced a fundamental tool, the Virasoro algebra, which will be the subject of tens of thousands of studies by physicists and mathematicians.

In 1973 democracy was restored in Argentina; Miguel Virasoro returned to his own country and was elected very young dean of the Faculty of Science in Buenos Aires, a very politically exposed position, which committed him full time. In 1975 he accepted an invitation for a year at Princeton, where he resumed his interrupted studies; but during his stay in the United States, in 1976 Videla's *coup d'état* brought the dictatorship back to Argentina, in a more cruel form than the previous one, establishing the regime that has become sadly famous for its *desaparecidos*: many professors and students were slaughtered at the university. Virasoro was not only fired from the university, but he was told that if he returned to Argentina, he would be arrested or worse.

So he decided to move to Europe, and after a year in Paris, he arrived in Italy, first in Turin and then from 1981 at La Sapienza in Rome, where he remained for thirty years as full professor, taking Italian citizenship. As soon as he came back in Europe he started to study a new problem, the relationship between the emerging theory of quarks and gluons and the string theory that he himself had contributed so much to grow a decade before.

In 1983, however, there was a sudden change in his interests: we began to work together on statistical mechanics of complex systems, first with other Parisian physicists (Marc Mézard, Nicolas Sourlas and Gerard Toulouse) and then with Mézard alone, who had moved to Rome for two years. Together we obtained important results on which rest the bases of the physical theory of complexity and we also wrote a book on these results, framing them in their scientific

context: I remember this period as one of the happiest of my career.

Starting in 1988 Virasoro became passionate about studying how, starting from neural networks, we can understand the functioning of the brain and some of its high-level abilities, such as the ability to classify objects into categories.

From 1994 to 1999 he was called to direct the ICTP physics center of UNESCO in Trieste. It is an extremely important institution dedicated to the training in physics of third world scientists, with more than 5000 young researchers passing through it every year. Under his direction the center developed further, broadening its scope and acquiring greater stability.

Back in Rome, in the last years before his Italian retirement (in 2011), he worked on applications of physical theories to finance, an activity that he continued in Argentina, where he returned, at the Universidad Nacional de General Sarmiento.

In 2009 he received the Enrico Fermi Prize from the Italian Physical Society (SIF) and in 2020 he was awarded the Dirac medal (one of the most important awards in theoretical physics) for his work on string theory and in particular for the invention of the Virasoro algebra.

His deep curiosity drove him to change the subject of his studies, which ranged from particle physics and statistical mechanics of complexity to brain function and economics. Virasoro cherished this ability to use knowledge learned in one field in a different field, opening up new vistas. He once told me that after giving a seminar on prosopagnosia (a cognitive disorder of face recognition) he was asked if he was the son of the inventor of Virasoro's algebra (one of his major discoveries 20 years earlier). He was both amused and proud of this episode, from the lively person with a sense of humor that he was.

Giorgio Parisi
Accademia dei Lincei
Università di Roma La Sapienza