History of RSB Interview: Miguel Virasoro

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PC: Thank you, Miguel, for agreeing to discuss with us. As we told you ahead of this interview, the main purpose of our exchange is to discuss the period from 1975 to 1995. But before we dive into this we'd like to ask a few questions on background. In particular, we read your 1997 interview in *Ciencia Hoy*[1], which describes fairly well your first years as a researcher, but it provides few details about what led you to physics in the first place. Can you tell us a few things about your youth, and especially what led you to be interested in physics, and then to pursue a PhD in theoretical physics?

MV: [2021-02-08, 8h17] My father was into philosophy [and] was a professor at the University of Buenos Aires[2]. So I was inclined to abstract thought. Then I realized that my mastering of language was rather poor. In high school we had a course on logics, and from there to symbolic logic and mathematics. At the beginning [of university] I followed math and physics, and within the third year I decided to follow physics.

PC: Was pursuing a PhD an obvious choice after that?

MV: [2021-02-08, 8h25] Yes. And theoretical physics, in particular elementary particle physics, was the most fashionable subject. It is naive but true. I had a salary as assistant. I was financially sustained since the first course.

PC: Was it a comfortable compensation? Could you live independently on it?

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[1] Marco Saraceno, Hernan Bonadeo and Martin Krucxenski, "Entrevista: Virasoro," *Ciencia Hoy* **6**(36) (1997). https://www.cienciahoy.org.ar/ch/hoy36/virasoro.htm (Last consulted February 9, 2021)
[2] Miguel Ángel Virasoro, sr.: https://en.wikipedia.org/wiki/Miguel_%C3%81ngel_Virasoro_(philosopher)

MV: [2021-02-08, 8h36] The first two years no. My family was traditional. No independence. But from the third year I could help my family (my father was fired as a professor because he was considered to be *peronista*). Frankly my help was modest.

PC: Jumping forward a bit. We'd like to hear a bit more about the period 1975 (when you left Argentina on a IAS sabbatical) to 1982 (when you obtained a professorship at La Sapienza). First, why did you decide to move to Italy, of all possible options?

MV: [2021-02-08, 8h43] I chose Europe. During the year at the IAS I met Francesco Guerra. He impressed me with his immense culture and Tullio Regge[3], who confessed to me that he was tired of the USA, so Italy was attractive. But Paris was another option.

PC: So you then moved to Torino or to Pisa? I'm a bit confused on this matter.

MV: [2021-02-08, 8h45] I spent a year in Paris, and when I heard that Tullio was coming back I moved to Torino. I then won a professorship in a large *concorso* (there were almost 20 positions in all Italy). They called me first [for Università degli Studi di] Lecce, where I spent one year, and then there was an opening in Rome [La Sapienza]. I accepted enthusiastically.

PC: Did you already have contacts with La Sapienza prior to your arrival, and if yes with whom?

MV: [2021-02-09, 8h04] Prior to the invitation with [Luciano] Maiani[4]. Post invitation, Giorgio [Parisi] took me to make a tour of the wonders of Rome. I did not know Giorgio's work, only by hearsay. Our friendship started with that tour of Rome.

PC: Who introduced you to the spin glass subject during this period? Can you please give us the context?

MV: [2021-02-09, 8h12] At the beginning of my stay in Rome I kept studying oceanography and magnetic monopoles. Giorgio gave a seminar about his RSB scheme and explained ultrametricity to me. But [it's during] a visit to ENS in Paris [that] I witnessed the excitement about Giorgio's interpretation in terms of many states with different overlaps. [Nicolas] Sourlas,

[3] Tullio Regge : https://en.wikipedia.org/wiki/Tullio_Regge
[4] Luciano Maiani: https://en.wikipedia.org/wiki/Luciano_Maiani

[Gérard] Toulouse[5] & Marc [Mézard] convinced me that I had to work on that.

PC: What were you all doing at the LPT-ENS at that time? Was it a sabbatical?

MV: [2021-02-09, 8h21] No sabbatical. It was more like a month[-long] visit. I do not remember the character of the visit.

PC: In what way was your earlier experience in theoretical physics instrumental for working on this topic?

MV: [2021-02-09, 8h24] It was [a] symmetry breaking scheme. It looked superficially similar.

PC: What was the immediate reception to the five-author works that came out of that visit[6]?

MV: [2021-02-09, 8h27] [They were] immediately well received.

PC: Is that what then led to the genesis of the 1986 Rev. Mod. Phys. on ultrametricity with Gérard Toulouse and Rammal Rammal[7]?

MV: [2021-02-09, 8h29] Yes. Maybe. Toulouse was the main protagonist of this review. I did not know Rammal[8] at that moment. I had long discussions with Gérard about the significance of ultrametricity (a concept that seduced me into [working] with Marc). I did not interact with Rammal after the review [either].

PC: What led to the decision to write the major work, *Spin Glass Theory and Beyond*[9]? What can you tell us about the genesis of this book?

MV: [2021-02-09, 8h44] It was Giorgio's idea, a wonderful idea. The MPV [Mézard-Parisi-Virasoro collaboration] was already formed, when Marc came to Rome and one day G[iorgio] came with the idea.

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[5] Gérard Toulouse : https://en.wikipedia.org/wiki/G%C3%A9rard_Toulouse

[6] M. Mézard, G. Parisi, N. Sourlas, G. Toulouse and M. Virasoro, "Nature of the Spin-Glass Phase," *Phys. Rev. Lett.* **52**, 1156 (1984). https://doi.org/10.1103/PhysRevLett.52.1156; "Replica symmetry breaking and the nature of the spin glass phase," *J. Phys. France* **45**, 843-854 (1984). https://doi.org/10.1051/jphys:01984004505084300

[7] R. Rammal, G. Toulouse and M. A. Virasoro, "Ultrametricity for physicists," *Rev. Mod. Phys.* **58**, 765 (1986). https://doi.org/10.1103/RevModPhys.58.765

[8] Rammal Rammal: https://en.wikipedia.org/wiki/Rammal_Rammal

[9] Marc Mézard, Giorgio Parisi, Miguel Ángel Virasoro, *Spin Glass Theory and Beyond* (Singapore : World Scientific, 1987).

PC: When and how did you get interested in neural networks and the perceptron model, in particular?

MV: [2021-02-11, 8h07] I am not a faithful person to a subject. I get tired and need to find any other subject. Now, I have to admit Giorgio and Marc passed to optimization problems, and so I was imitating them. Anyway, Amit-Gutfreund-Sompolinsky [AGS] had some influence.

PC: How important were the ITP meeting in Santa Barbara[10] and the IAS meeting in Jerusalem[11] in this context?

MV: [2021-02-11, 8h11 & 2021-02-12 8h51] The ITP visit to Santa Barbara was hidden behind a visit to Santa Fe institute, where I met Phil Anderson and many other interesting people. That visit was the origin of my interests in other subjects. It was the same trip to USA. With respect to the IAS in Jerusalem it was very important. I had the chance to interact with the 3, AGS. It was there that my basic idea that the brain could not be hard wired (and as a consequence it has to be disordered) that matured and it was through conversations with them.

PC: At about that time, I think, you recruited Silvio Franz as your student. Was he your first PhD student? How did you convince him to work on disordered systems?

MV: [2021-02-11, 8h19] He was not my first PhD student, [and recruiting him required] no effort on my part. The group on disordered systems was the most desired group to belong to (thanks to Giorgio). Giorgio was in Roma 3 [Tor Vergata]. But he was doing research in Roma 1 [La Sapienza]. Federico Ricci-Tersenghi graduated the same year as Silvio Franz, both from La Sapienza. I had noticed them and shared with Giorgio the feeling that they were exceptional. Federico went to work with Giorgio, and Silvio Franz with me.

PC: In 1993, you were the first recipient of the Rammal Medal[12]. Can you provide some context for this award?

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[10] John Hopfield and Peter Young, "Spin Glasses, Computation, and Neural Networks" September to December 1986 Institute for Theoretical Physics, University of California at Santa Barbara. See, *e.g.*, Dana H. Ballard. "Modular learning in neural networks" In: *Proceedings of the sixth National conference on Artificial intelligence – Vol. 1* (AAAI'87). AAAI Press, 279–284 (1987).

[11] Year-long meeting in 1987, organized by Hanoch Gutfreund *et al*. at the Israel Institute of Advanced Studies: https://en.wikipedia.org/wiki/Israel_Institute_for_Advanced_Studies

[12] The Rammal Medal: https://www.euroscience.org/tag/rammal/ (Last consulted February 12, 2021)

MV: [2021-02-11, 8h34] Gérard [Toulouse] wanted a medal that represented the Mediterranean spirit and I had wonderful discussions with him about the conflicts in the Middle East. So Gérard proposed me as an example of the spirit of the *mediterraneo*. [For instance,] in the IAS meeting we went with Gerard to visit the Academy of Sciences in Palestinian land.

PC: The 1998 medal intended to Daniel Amit was later held back by French diplomats[13]. Did that create tensions in the community?

MV: [2021-02-11, 8h45] Yes. It was a deep disappointment and frustration. Did you know that the Shiite community was in favor (Rammal was Shiite), and there were other groups that opposed? An interesting point: Amit justified the opposition because of deep reasons. I was against [it].

PC: Between finalizing the MPV book and the early 90s (when people such as Jorge Kurchan, Leticia Cugliandolo and Rémi Monasson were in Rome, together with Silvio Franz and Federico Ricci-Tersenghi), was there a main topic of interest for the Rome group? Or was everyone working rather separately?

MV: [2021-02-12, 8h11] [Kurchan] first collaborated with me and [Giorgio] in a paper that I considered important about the saddle points in RSB[14]. Leticia [Cugliandolo] worked with [Daniel] Amit (he too was in Rome). Then Kurchan & Cugliandolo did their work totally independently[15]. They came to me with the result, so my advice was only "publish". [Giorgio] was again the center but Remi was telling me [about] his results. [Silvio Franz] was working with me, and [Federico Ricci-Tersenghi] was working with [Giorgio]. I was interacting a lot with Amit.

PC: Can you tell us a bit about how Jorge and Leticia arrived in Rome? What was your (prior) relationship with them? Did you play a role in their arrival?

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[13] See, *e.g.*, Michael Balter, "Physics Prize Falls Foul of Middle East Politics," *Science* **283**(5407) 1422-1423 (1999). https://doi.org/10.1126/science.283.5407.1422;

[14] J. Kurchan, G.Parisi and M. A. Virasoro, "Barriers and metastable states as saddle points in the replica approach," *J. Phys. I France* **3**, 1819-1838 (1993). https://doi.org/10.1051/jp1:1993217

[15] *E.g.*, Leticia F. Cugliandolo and Jorge Kurchan, "Analytical solution of the off-equilibrium dynamics of a long-range spin-glass model," *Phys. Rev. Lett.* **71**, 173 (1993). https://doi.org/10.1103/PhysRevLett.71.173

MV: [2021-02-12, 8h18] Jorge was the PhD student of Daniel Bès[16], a respected professor, who strongly recommended him. Leticia was the student of [Fidel] Schaposnik[17], who also strongly recommended her. Obvious they wrote to me but it was easy to find INFN[18] positions for them.

PC: In 1995, you moved to ICTP as director[19]. Did you ever use your administrative leverage to support the study of disordered systems or RSB-related themes?

MV: [2021-02-12, 8h25] Yes, definitely yes. I brought [Silvio Franz], Riccardo Zecchina, [Matteo] Marsilli, and I had the intention that Rémi and Simona Cocco came to ICTP but there was opposition because they are a couple. With [Daniele] Amati[20] in SISSA, we wanted to develop interdisciplinary subjects and biophysics was one of them.

PC: During your time at La Sapienza, at ICTP, or elsewhere, did you ever get to teach about spin glasses, RSB and related themes? If yes, can you detail?

MV: [2021-02-12, 8h30] No. I did not. I had the chair of *Istituzioni di Fisica Teorica*, a 3rd year course. And when I went back [to La Sapienza] they asked me a course on mathematical models in economics. In that course I taught a model that used the RSB trick.

PC: We're approaching the end of the interview. Is there anything else you would like to share with us about this era?

MV: [2021-02-12, 8h45] It was very exciting [work]. Prior to the book, Marc and I were working with Giorgio. [Giorgio] was a source of new ideas every day. We were assimilating the previous day's ideas, and he would come up with new ideas. Claude Itzykson, [who also worked with Giorgio,] told in a seminar that he barely followed his ideas. And, believe me, the ideas had to be worked out because they were in draft [form]. But most of them (I would dare say all of them) were correct and resulted in beautiful results. Giorgio thinks in a different way than me. He aims at a result and checks whether it is not in patent contradiction with several constraints. Then he proposes

[16] Daniel R. Bès: https://de.wikipedia.org/wiki/Daniel_R._B%C3%A8s
[17] Fidel A. Schaposnik : https://sites.google.com/site/schaposnik/ (Last consulted February 12, 2021)
[18] Istituto Nazionale di Fisica Nucleare: https://en.wikipedia.org/wiki/Istituto_Nazionale_di_Fisica_Nucleare
[19] International Centre for Theoretical Physics: https://en.wikipedia.org/wiki/International_Centre_for_Theoretical_Physics
[20] Daniele Amati was then, and until 2001, the director of the Scuola Internazionale Superiore di Studi Avanzati (SISSA): https://en.wikipedia.org/wiki/Daniele_Amati

it to the collaborators (in my case, Marc and I), and we have to figure the line of reasoning that brings his result.

PC: Finally, do you still have notes/papers/correspondence from that epoch? If yes, do you have a plan to deposit them in an academic archive?

MV: [2021-02-12, 8h51] No. I was moving a lot and lost all my correspondence.

PC: Thanks for everything.