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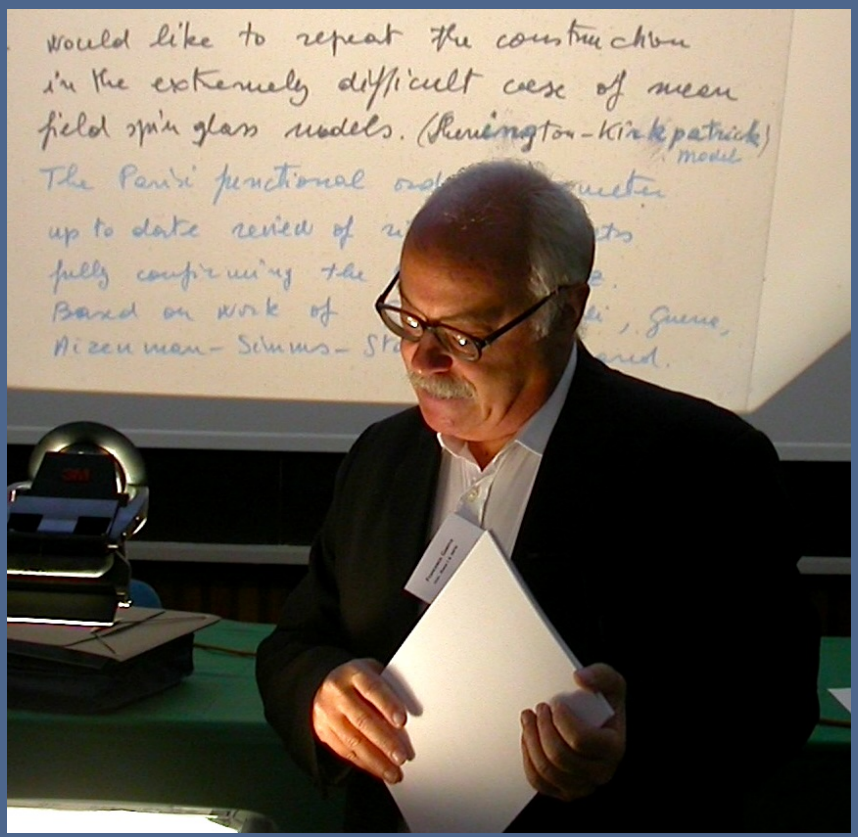

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Cover picture: Francesco Guerra (1942-2025)

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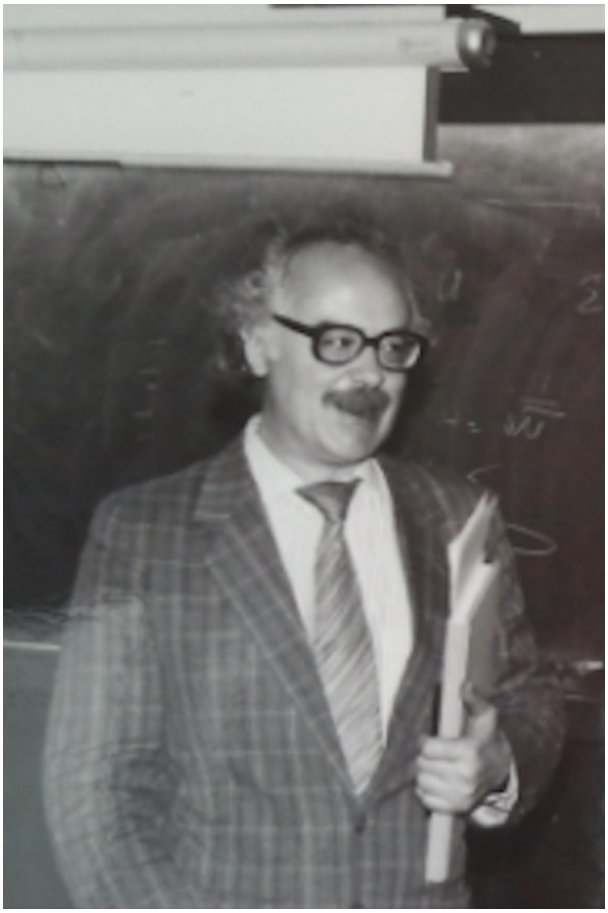
In memory of Francesco Guerra (1942-2025)



Francesco Guerra was a prominent mathematical physicist, who gave fundamental contributions in many fields, ranging from quantum field theory to spin glasses. He was a brilliant, original thinker and a man of kindness and moral stature and he will be greatly missed as a colleague, mentor and friend.

Francesco Guerra was born in Naples on November 10, 1942. In 1960, he completed his secondary education at Liceo Classico Jacopo Sannazzaro, earning the Italian Diploma di Maturità. He graduated in Physics (*Laurea summa cum laude*) in 1964, at the University of Naples under the supervision of Eduardo Caianello. Immediately after he undertook research positions at the University of Naples until 1970. Between 1970 and 1976 he was Research Associate at the Department of Physics at Princeton University, visiting Professor of Mathematical Physics at the University of Aix-Marseille at Luminy and Member of the Institute for Advanced Study, Princeton. He was appointed full Professor of Theoretical Physics at the University of Salerno in 1976, where he was also Director of the Institute of Physics. In 1979 he was appointed to a

professorship in the Department of Mathematics at the University of Rome La Sapienza, and then, in 1985, in the Department of Physics of the same institution, where he stayed until his retirement. In his last years, besides being Emeritus at the University of Rome La Sapienza, he was also affiliated to the Centro Fermi - Museo Storico della Fisica e Centro Studi e Ricerche Enrico Fermi.

He held several administrative positions, such as Vice-Rector of the University of Salerno (1978-1979) (where he played a crucial role in the planning stage of the current campus in Fisciano), Director of the Department of Mathematics at the University of Roma La Sapienza (1983-1984) and Director of the Department of Physics at the University of Roma La Sapienza (1995-2001).

His scientific activity has been the expression of a versatile mind. He moved his first steps studying renormalisation in quantum field theory within the Caianello group in Naples, then he continued with the spectacular results in constructive quantum field theory, mostly in collaboration with Lon Rosen and Barry Simon. Successively he investigated gauge fields on the lattice and later stochastic processes on curved manifolds and stochastic variational principles in the context of the Nelson stochastic mechanics. His latest scientific breakthroughs were in the statistical mechanics of spin glasses and complex systems. For younger generations of mathematicians and theoretical physicists his name is associated with the Sherrington-Kirkpatrick model of spin glasses, where his work was fundamental to the Talagrand proof of the Parisi formula for the free energy and to the Panchenko proof of the ultrametricity conjecture. He has been plenary lecturer at the European Congress of Mathematics in 2004 and plenary lecturer at the International Congress of Mathematical Physics in 2006. Lately, he devoted himself to the study of the history of nuclear physics, with a special focus on the scientific and academic activity of Ettore Majorana, mainly in collaboration with Nadia Robotti. For these studies he received the Prize for the History of Physics of the Società Italiana di Fisica in 2008.

Besides this florid scientific activity and the many institutional roles, Francesco Guerra was a careful and dedicated teacher and mentor. While Fabio Toninelli was his sole PhD student, he has supervised numerous students at the University of Naples, Salerno and Rome as part of their Italian *Laurea* degree (the author of these lines was one of them). Dealing with a man of such a pure intelligence and elevated sensibility was a unique experience and he has left an indelible, lively memory, ever different, in each of us.

In the remaining part of this article we collect contributions and memories from scholars who shared with Francesco Guerra part of the journey, namely Sergio Albeverio (University of Bonn), Pieluigi Contucci (University of Bologna), Giovanni Gallavotti (University of Rome La Sapienza), Giorgio Parisi (University of Rome La Sapienza), Barry Simon (Caltech).

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Photo: courtesy of Pierluigi Contucci

I. Francesco Guerra: on his work and some personal reminiscences. It is with immense grief that I mourn the departure of Francesco Guerra. He was a great scientist and thinker, and a close friend.

I first met him in Princeton in 1970. He had just arrived from Naples, with his wife Anna and a new born baby. Gianfausto Dell'Antonio had given him the advise to contact me and Solvejg (my wife), and we arranged to meet at Nassau street. He was wearing a dark suit, first looked almost shy to me, asked a few practical questions on how to find his way in the new town, almost apologizing to steel our time. After taking notes about our answers in a black note book, he suddenly opened up his face in a large, friendly jovial smile. He told us that he had never stayed before in a western country outside Italy, but that he had a research stay in Kiev. After that the conversation ran, as always on our further meetings, over all kind of topics. Already in this first conversation he struck me by the intelligent witty questions he was posing and a genuine interest in finding out about all things in a rational enlighted way. We understood each other very well and this was the beginning of a steady life long strong friendship. In our conversations, that would easily change from physics and mathematics to history, culture, society, politics, I always appreciated the originality and depth of his reflections. In fact I completely agree with Ed Nelson who wrote *He is focused on science [...] enriched by a profound appreciation of history and culture. One cannot fail to learn unexpected things in a conversation with Francesco Guerra*[1].

Concerning physics and mathematics, our conversations in Princeton at that time were mainly concentrated on the theory of quantum fields. Francesco had a much deeper insight in physical aspects of the theory, and I learned a lot from him. I told Francesco that I was attending a very interesting course that Ed Nelson was giving at Fine Hall on Kurt Symanzik's Euclidean approach to quantum fields and that I had taken some notes of it. Francesco was very interested into looking into the notes, he already knew the physical aspects of the theory (through work by Schwinger and Nakano). Soon after reading my notes he came up with an astonishing understanding of the whole matter, and in fact he had found the way to the celebrated control of the infinite volume limit of quantum fields models. He sent a note to Physical Review Letters (published in 1972)[2]. This paper and successive fundamental work with Barry Simon and Lon Rosen constituted the beginning of many new rapid developments in the realm of constructive quantum field theory. Barry Simon himself wrote several times about the shock caused to the community by Francesco's work in this area[3].

Before leaving my souvenirs about that time in Princeton with Francesco and his family I cannot refrain from mentioning another aspect of Francesco, namely his generosity as a human person. Before leaving Princeton in the beginning of 1972 to join Raphael Höegh-Krohn in Oslo, I was invited by Francesco and Anna to have a dinner at their apartment and I men-

[1] E.Nelson, Preface to Special Issue on "Perspectives in quantum field theoy,statistical mechanics and Stochastics,Festschrift dedicated to F. Guerra on the occasion of the 60th birthday, Held in Pontignano (Siena) 2002, eds. S. De Siena, M. Loffredo and P. Ruggiero, Int. J. Modern Physics B, Vol. 18, No 04n05, 2004

[2] F. Guerra, Uniqueness of the Vacuum Energy Density and van Hove Phenomenon in the Infinite-Volume Limit for Two-Dimensional Self-Coupled Bose Fields, Phys. Rev. Lett. 28, 1213 (1972)

[3] see Simon's contribution to this article, or also B. Simon, in Twelve Tales in Mathematical Physics: An expanded Heinemann Prize Lecture, J. Math. Phys. 63.2, 2022

tioned in passing that I had troubles in selling the two old cars I had, one having a hole just below the driver's seat, the other one requiring special care, since it would overheat quite frequently... Francesco patiently listened with a sort of amused expression on the face and then said , in his calm but quite determined way that he did not see any problem in selling them and he proposed to take care of that. Just after I arrived in Oslo we received a post card from Francesco saying that the problem had been successfully handled. To me this was just another sign of Francesco's basic attitude to all problems, that he would approach in a realistic, pragmatic way. I thought this was because he had his roots in a very rich cultural and historical background, and this was later confirmed by what I experienced when I came to know a bit better the culture of Naples, its history and its intellectual life, that had strongly influenced Francesco. When he came back to Italy (first to Naples and Salerno, then after 1979 Rome) he became first especially interested in Nelson's approach to quantum theory from stochastic mechanics. He gave decisive contributions to the development of the theory, establishing it as a general approach to the study of relations between classical and stochastic processes, including in particular quantum mechanical features. Let me quote e.g. his work with Laura Morato on variational methods for stochastic mechanics, with Patrizia Ruggiero on Euclidean Markov fields and relativistic quantum fields and with Daniela Dohrn on stochastic parallel translation for stochastic mechanics on manifolds. I spent the year 1973 in Naples, following an invitation by Gianfausto Dell'Antonio and Francesco. Francesco was living there and teaching in Salerno. We had much contact, both scientific and human, in particular he helped us to get a housing in Naples. Our scientific contact was intensive, both on quantum fields and stochastic mechanics. I hope to be able to come back to this in some other publication. About some of my work in the latter area Francesco wrote himself generously[4].

Francesco's influence on me has been present in many successive activities and publications. When Sarah Nelson Jones, the widow of Edward Nelson, wrote to us to invite us to contribute an article for a planned volume on the Collected Works of Edward Nelson we were very honoured and happy to join forces in this project. Besides corresponding on this and meeting a few times, we planned to concentrate particularly on Ed's influence on our own work, particularly on stochastic mechanics. The whole project of the publication kept being delayed for reasons not clear to us, and at one point we heard that the editors would like rather a post face rather than a specific article, so we were waiting before doing more. In fact my last exchange with Francesco on this goes back to 2024. It is my enormous regret that we did not manage to proceed more on this joint work, but I have the hope that one day, if the whole project will finally materialize, I would still be able to contribute, hoping to be able to represent as far as possible also Francesco's point of view on the matter.

Let me also mention some other components of Francesco's beautiful and deep scientific production. One concerns further aspects of the theory of quantum fields in their interaction with statistical mechanics, including his important work on gauge fields and Fermi fields, also in connection with operator algebras; this is also of special relevance for present days intensive

[4]see F. Guerra, The Albeverio-Höegh-Krohn paradox in Nelson Stochastic Mechanics, In: Hilbert, A., Mastrogiacomo, E., Mazzucchi, S., Rüdiger, B., Ugolini, S. (eds) Quantum and Stochastic Mathematical Physics. Springer Proceedings in Mathematics & Statistics, vol 377. (2023), a publication where also many references to Francesco's own work are presented

developments in the study of stochastic quantization equations.

Probably other aspects of the important work by Francesco in statistical mechanics and its applications will be mentioned in other contributions. One however I would like to stress. As Francesco already demonstrated by his work on the infinite volume limit for quantum fields, he was a master in solving difficult physical and mathematical problems, because of his deep insights into both areas, joint with his exceptional technical skills. Let me tell an episode: in 2000 I met Michel Talagrand in Saint Flour, who was lecturing on spin glasses. In his opinion the complete mathematical justification of Parisi's approach seemed to be still far away. Once more it was Francesco's insights that soon after opened the way for much further decisive progress in this area[5].

Let me add that Francesco was also very active in extending and promoting the range of applications of the advanced theory of stochastic processes to various interdisciplinary areas; I remember vividly how his presence at various interdisciplinary meetings (e.g.research centers in Bielefeld, Luminy and Locarno/ Ascona) gave a strong momentum to further studies. His beautiful public lectures on topics like stochastic processes applied to biology or music and linguistic were masterpieces of clarity.

Francesco was also a passionate physicist and had a very genuine interest in the history of this science. He wrote alone and in collaboration, in particular with Nadia Robotti, very interesting and well documented research articles and beautiful essays and books, with a special interest in the development of last century's physics, particularly to the research carried out by physicists like Fermi, Majorana and Pontecorvo associated with the famous Via Panisperna Institute.

Besides being a top physicist and mathematician, Francesco was also an excellent and generous teacher, as testified by his many students and coworkers. He was an intellectual inspired by a great historical tradition in philosophy of nature and society; and he had a strong "engagement" towards cultural, social and political issues. He was constantly in my mind whenever I thought about some new topics and I often asked him about his opinion, knowing for sure that his answers were always very original and inspiring.

I am missing him very much and his departure is a great loss for the whole community.

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[5]here I can only refer to Contucci's and Parisi's contributions to this article or to the masterly written surveys by Francesco himself.

II. Francesco Guerra as Scientist and Mentor. It is deeply sad to lose Francesco, and difficult to organize my thoughts at this moment. Yet what stands clearly before me is the extraordinary contribution he made to science.

Francesco had a rare gift: the ability to solve extremely difficult problems using remarkably simple mathematical arguments grounded in deep physical insight. Problems widely thought to require heavy technical machinery, Francesco would solve with conceptual clarity and essential elegance.

Two cases stand out as emblematic.

The first dates back to his postdoctoral years at Princeton, when he proved the existence of the infinite volume limit for polynomially coupled Bose fields in two dimensions. The significance of this achievement is best captured by Barry Simon in his review Twelve Tales in Mathematical Physics: An Expanded Heineman Prize Lecture. Simon recalls:

Indeed, I have a vivid memory of how I first learned of these results. Guerra had been visiting Princeton at that point for about 18 months. He was very quiet. I'd probably exchanged only a few words with him and he'd given no talks. Wightman told me that Guerra had asked him to set up a meeting with Lon Rosen and me. We met in Wightman's office in early January 1972. Guerra began by writing three facts that he was going to prove. Lon and I later compared notes and we had the same thought: 'yeah, sure, you're going to do that.' These went so far beyond what was known that it was literally unbelievable. Ten minutes later, he'd proven the three facts. We were shell shocked.

and again

The above mentioned work of Guerra and GRS[6] *got the attention of experts in CQFT and virtually all papers in the subject after early 1972 used the EQFT framework. I recall that a few weeks after GRS started working together, Glimm came to Princeton to talk about the bounds he obtained and spent the hour seminar sketching their subtle proof. Afterwards, Francesco, Lon and I waylaid him and explained in 10 minutes the short proof we had found using an extended version of Nelson's symmetry. It was Glimm's chance to be shell shocked.*

Beginning in the early 1990s, Francesco made a series of groundbreaking contributions to the mathematical foundations of Parisi's mean-field theory of spin glasses. In 1998, he identified structural properties of the spin glass phase, now known as the Ghirlanda Guerra identities, by deriving them from bounds on the fluctuations of the internal energy.

He also proved, in a result that remains one of the most admired milestones in the field, that the Parisi solution provides a rigorous lower bound (the BRS bound) for the model. His interpolation method, introduced in a previous paper, has since become a standard tool in the field.

I remember a moment in January 2002, in Les Houches. During a joint conversation with Francesco and myself, Michel Talagrand remarked, "It will take a lifetime to prove the existence of the thermodynamic limit for the SK model." Francesco's result came just a few months later and changed the field permanently, rekindling the same sense of wonder that Barry Simon

[6] Guerra, Francesco, Lon Rosen, and Barry Simon. *The $P(\phi)_2$ Euclidean quantum field theory as classical statistical mechanics.* Annals of Mathematics 101.1 (1975): 111-189.

evokes in his writings.

Thanks to the RSB bound[7], Talagrand was later able to show that the difference between the Parisi free energy and the SK free energy vanishes in the thermodynamic limit. This marked a turning point, as recounted in Talagrand's History of RSB Interview[8]. Following this, Dmitry Panchenko proved that any spin glass measure satisfying the Ghirlanda Guerra identities must also be ultrametric, thus advancing the rigorous foundation of the Parisi theory.

Alongside his work in mathematical physics, Francesco also gave remarkable contributions to the history of physics. In particular, his long collaboration with Nadia Robotti produced a series of meticulous and illuminating studies on the life and scientific legacy of Ettore Majorana and Enrico Fermi. With his usual intellectual integrity, Francesco combined historical depth, technical expertise, and narrative clarity. He brought to life not only the ideas, but also the human and institutional contexts of twentieth century physics, with special attention to the Italian school and its ethical tensions during the fascist period.

Francesco Guerra's work has shaped the landscape of modern statistical physics and enriched our understanding of physics as a human enterprise. His marks were intellectual elegance, scientific depth, and cultural responsibility.

I received many beautiful and moving comments in his memory. Among those that touched me most are the words Elliott Lieb wrote to me: *Francesco was one of the small but happy band that made modern mathematical physics what it is. It is not often given to a scientist to have such a far ranging influence on a scientific field, and many of us stood on his shoulders and are very much in his debt.*

Francesco has been my mentor, and certainly one of the maestri I learned the most from. He has always been an example to me and will always be. He was a free, liberating, and light spirited teacher, in the deepest and most beautiful sense of the word.

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[7] Guerra, Francesco. *Broken replica symmetry bounds in the mean field spin glass model.* Communications in Mathematical Physics 233 (2003): 1-12.

[8] P. Charbonneau and F. Zamponi, *The History of Replica Symmetry Breaking in Physics* https://caphes.ens.fr/history-of-replica-symmetry-breaking-in-physics/ (2022).

III. Francesco Guerra: in memoriam. With sadness I write this short note on Francesco Guerra: it is short because recalling it evokes for me a most intense memory, among the many linking me to him. I met him, by chance, in the early 1970's at the Princeton Physics Department on the way back from a workshop. There I found several colleagues deeply intent to pursue the innovative idea used by Francesco to solve the infinite volume limit problem in quantum field theory : $P(\phi)$:$_2$, linking it to properties recently developed in the theory of the Ising model. I remember to have asked a description and explanation of his idea: and that I was dazzled by the originality of the approach and by the clarity of his exposition, essential and concise. I was deeply impressed and determined to follow the successive developments. Shortly later I had the honor of being his colleague at the University of Roma "La Sapienza", and to follow continuously his very original work on the theory of spin glasses and his deep interests about the Physics leaders of last century; however the afternoon spent to listen and learn his point of view on constructive QFT deeply affected my work and I remain grateful to him.

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IV. Francesco Guerra and the theory of spin glasses. I met Francesco Guerra for the first time at the beginning of the seventies. I was impressed by his great culture, and we immediately became very good friends. We started to see each other quite regularly when he came from Naples to Rome (about 1980). We were discussing subjects of all possible kinds. He had very clear ideas about politics, which he considered the art of compromise among different positions. I remember that when I was a candidate for the administrative council of the city of Rome in the list of the Communist Party, he came to me to discuss the situation and give suggestions. He told me that he was a candidate of the Communist Party for a Senator position a few years before. Neither of us was elected, maybe also because neither of us was not member of the Party.

Francesco had a strong ability in high-level administrative work. He was first the Vice-Rector of Salerno, and when he moved to Rome, Director of the Department of Mathematics in Rome. Later, he was for two terms Director of the Department of Physics in Rome. Certainly, these administrative duties interfered with the scientific production. His wonderful paper on replica bounds in spin glasses[9] came out only after he stepped down from the direction of the Physics Department in Rome.

In recent years, together with Nadia Robotti, started to work on the history of physics:

[9]Guerra, Francesco. *Broken replica symmetry bounds in the mean field spin glass model.* Communications in mathematical physics 233 (2003): 1-12.

they studied many Italian scientists (e.g Maiorana[10] and Fermi[11]); we had long discussions not only on what he discovered, but also on his conjectures and on the strategy to prove them in a definiteve way.

I remember that already at the beginning of the eighties, Francesco Guerra was deeply interested in spin glasses. He was saying that the spin glasses will be a cornerstone of future statistical mechanics. He was following the developments with extreme attention: we had frequent discussions that were very useful to me. His first paper on spin glasses was written in 1995. From that moment on, he wrote many fascinating seminal papers on spin glass, introducing many new tools.

Here, I would like to concentrate my attention on three papers that completely changed the theoretical panorama: they were completely unexpected, and they are at the basis of the modern understanding of spin glasses and related problems. These fundamental results are:

- The proof of Ghirlanda Guerra identities[12] (1998);
- The proof of the existence of the free energy in the Sherrington Kirkpatrick model in the infinite volume limit[13] (2002);
- The proof that the replica formulae provide lower bounds to the free energy of the Sherrington-Kirkpatrick model[14] (2003).

Ghirlanda Guerra identities (1998). In the theory of spin glasses, a crucial role is played by the probability distribution of the probability distribution of the overlap, i.e., $P_J(q)$: the overlap distribution function $P_J(q)$ depends on the sample J, we are interested to compute the functional $\mathcal{P}[\mathcal{P}]$ that tells us which is the probability measure of finding a sample with a given $P_J(q)$. The average of the sample is denoted by $P(q) \equiv \overline{P_J(q)}$.

It is an incredible fact that the whole probability distribution over the sample of $P_J(q)$ is determined by its first moment. The starting point is the Ghirlanda and Guerra identities, which they were able to prove using a simple yet ingenious trick. The first Ghirlanda Guerra identity concerns the second moment of $P_J(q)$: it is $\overline{P_J(q_1)P_J(q_2)} = 2/3P(q_1)P(q_2) + 1/3P(q_1)\delta(q_1 - q_2)$. This identity was proved firstly by Guerra alone[15]. It was later generalized by the Aizemann and Contucci identities[16]; later Ghirlanda and Guerra [17] found more general identities. It is remark that these papers use two very different approaches.

The work is really remarkable: although the identities were derived in the non-rigorous replica approach 15 years before, no one even dreamed that these identities could be proved simply and compactly.

[10] F. Guerra, and N. Robotti, Physics in Perspective **15**, 160 (2013)

[11] F. Guerra, and N. Robotti, Physics in perspective **11**, 379 (2009); F. Guerra, and N. Robotti, *The lost notebook of Enrico Fermi*. Springer, (2018).

[12] S. Ghirlanda and F. Guerra, J. Phys. A **31**, 9149 (1998).

[13] F. Guerra, F., and F. L. Toninelli. Comm. Math. Phys., **230**, 71 (2002).

[14] F. Guerra. Communications in mathematical physics 233 (2003): 1-12.

[15] F. Guerra, Int. J. M. Phys. B **10**, 1675 (1996).

[16] M. Aizenman and P. Contucci, J. Stat. Phys. **92**, 765 (1998).

[17] S. Ghirlanda and F. Guerra, J. Phys. A **31**, 9149 (1998).

At face value, the Ghirlanda and Guerra identities are not enough to reconstruct all the moments. However, in a deep and rather complex paper[18], fifteen years later, Panchenko proved that the Ghirlanda Guerra identities are enough to reconstruct the whole probability distribution of the $P_J(q)$. The Ghirlanda Guerra identities are now at the basis of the modern approach to spin glasses and related problems.

Guerra Toninelli (2002). It looks very strange, but it is not a trivial task to prove the existence of the infinite volume limit of the free energy density of the prototypal spin glass model, i.e., the Sherrington Kirkpatrick model: it is a random model where the distribution of the coupling changes with the size of the system, and standard tools do not work.

In 40 years, the only known result was due to Aizenman, Lebowitz, and Ruelle in 1987: they were able to prove the existence of the limit in the high temperature region $\beta < 1$, where the free energy is simply given by $-1/2\beta$. Although it was trivial to prove that at all temperatures the free energy is greater than -1, at low temperatures ($\beta > 1$) it was not possible to exclude that the average free energy density oscillates with the number of spins N: in this situation, the limit would not exist.

Guerra and Toninelli proved that the free energy density is a monotonously decreasing function of N; no oscillation is possible. The crucial step was the proof of the sub-additivity of the total free energy. The quite short proof was based on a smart interpolation method that interpolates between the Hamiltonian of two systems, one with N_1 spins and the other with N_2 spins, and the Hamiltonian of a system with $N \equiv N_1 + N_2$ spins. After having written the definitions, integration by parts was the most sophisticated part of the argument.

This paper was the starting point of many methods of interpolation that lead to many bounds and are at the cornerstone of so many rigorous results[19].

Guerra's replica symmetry bound (2003). The interpolation method was so strong, and Guerra had an incredible idea: to interpolate between the explicit formulae of the replica approach, written as a function of the weight of the states and the real Hamiltonian of spin glasses. Here, the formulae are really complex, and one needs a great ability to control all the details.

At the end of the day, he proved that the free energy density obtained with any choice of the order parameter within the replica is a lower bound to the exact result. Therefore, the maximum over all order parameters is a lower bound to the exact result.

Talagrand, six months later, proved[20] that the Guerra result was not only an inequality, but an equality, proving the final formula for the free density of the SK model. This paper is very important: it is one of the few results of Talagrand quoted in the motivations of the 2024 Abel prize to Talagrand.

Talagrand's paper could not exist without Guerra's paper. In the long paper with the proof, dedicated to Francesco Guerra, he writes: *We learned the present formulation in Guerra's work, to which we refer for further discussion of its connections with Parisi's original formulation. In this truly remarkable paper, Guerra proves that the left-hand side of the previous equation is bounded by the right-hand side, using an interpolation scheme that is the backbone of the*

[18] D. Panchenko, Ann. Math. **177**, 383 (2013).

[19] see e.g. M. Aizenman, R. Sims, and S. L. Starr, Phys. Rev. B **68** 214403 (2003).

[20] M. Talagrand, C.R.A.S. **337**, 111 (2003); Ann. Math. **163**, 221 (2006).

present work. Guerra and Toninelli had previously established the existence of the limit.

In a very detailed and interesting interview[21], Talagrand returns to this point. *Because without Guerra's replica symmetry breaking bound, the paper could not exist. Guerra's replica symmetry breaking bound belongs to the category, as I was explaining, that I am not sorry I didn't do it because I could never have reached that level. (..) You see, this is sort of funny, because in my eyes, Guerra did the difficult part of that proof, which is to find that. The other part is really a schoolboy idea, but somehow that schoolboy idea was not so easy to find. Life is hard!*

In the same interview, Talagrand also mentions Ghirlanda Guerra: *That's another of the same category. You do something which just looks so simple. You take an equality of two things and you integrate... How can one invent such a thing? When I see this kind of result, I just feel so lucky that chance and fate took me to results I could prove when other people can prove this kind of stuff. I don't deserve to be a mathematician. That's why I mentioned that. I have infinite admiration for these two results of Guerra.*

Talagrand was right; it is unlikely that without Guerra these results could have been found; without them, a lot of modern theory of disordered systems would not exist. Guerra's ability to find a simple proof for a problem that had resisted for decades was unmatched.

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[21] P. Charbonneau and F. Zamponi, *The History of Replica Symmetry Breaking in Physics* https://caphes.ens.fr/history-of-replica-symmetry-breaking-in-physics/ (2022).

V. The work of Francesco Guerra et al. on Constructive Quantum Field Theory. In my second year as a graduate student in theoretical physics, my advisor, Arthur Wightman, gave me a potential thesis problem. An Italian physicist, Eduardo Caianiello, had used Hadamard's inequality on determinants to get some useful bounds on Feynman series for Fermion field theories and my task was to see how much of them extended after renormalization in some particular two space-time dimensional fermion theories (this is an aside, but I had publishable results, although too limited for Wightman and me to think they should be my thesis). The next academic year, 1968-69, I completed my thesis on a different topic, so I could begin as an Instructor in mathematics in Princeton in 1969-70. Wightman knew I'd be interested to know that Caianiello was sending his former graduate student, Francesco Guerra, with Italian postdoc money to Princeton for 1970-72. Caianiello had raved about how great Guerra was. I was looking forward to interacting with him. In the fall of 1970 when he arrived, he settled in but was very, very quiet. I tried to talk to him a few times but since I had lots of other balls in the air and people to talk to (e.g. Lon Rosen, Mike Reed and Sergio Albeverio), I didn't try very hard. In July of 1971, I was promoted to a joint tenure track assistant professorship in Mathematics and Physics. In January, 1972 roughly 18 months after Guerra's arrival, Arthur Wightman told me that Guerra wanted to talk to Lon Rosen and me. While I knew Francesco was still there, I'd had almost no contact with him. What followed was one of the most dramatic moments of my scientific career. We four met in Wightman's office. Guerra began by saying he wanted to tell us of some of his new results on the $P(\Phi)_2$ quantum field theory. This was the hot area where Lon and I were working together. It was being developed by putting a space cutoff on the Hamiltonian and looking at the resulting energy, ground state and ground state expectation value and trying to prove things uniform in the volume. One might then hope to pass to subsequences but proving infinite volume limits ever existed seemed way beyond anything that could be proven with the current function analytic methods. He began by writing 4 things on the blackboard that he was going to prove. Several involved the infinite volume limit and the others were as subtle. This was unbelievable. It was an order of magnitude beyond anything that I believed then current technology could get. I thought to myself: "yeah, sure." (and Lon later told me he thought the same). Francesco began by reminding us of an equality we now call Nelson's symmetry. Nelson had presented this in some talks he gave the year before (in Princeton and in Berkeley, the latter at a summer school in Berkeley attended by many experts on $P(\Phi)_2$; Guerra had been at neither but got someone's notes from the Princeton talk). Lon and I were not alone in not appreciating Ed's work in Euclidean QFT - it was just too new and too different and Ed didn't have any striking new results. Given his track record (he had discovered what I named hypercontractivity), this was very unwise of us. Ten minutes later Guerra had proven everything! Lon and I were in shock. Francesco agreed to continue looking at developments with the two of us. Within a week, we had had a ten minute proof of a very important technical result of Glimm-Jaffe (the GJ Φ bound). Also using Nelson's symmetry, we had extended a number of Guerra's results from the week before. Guerra's Physical Review

Letter[22] and our follow-up paper in CMP[23] cemented the revolution in constructive quantum field theory begun by Ed Nelson. Before this, Euclidean methods hardly appeared but after this work virtually every paper in constructive QFT was on Euclidean QFT. About a week after our dramatic meeting and after we'd found the new proof of the GJ Φ bound, Glimm gave a seminar in Princeton on these bounds. Their proof was involved and he could only sketch it in his hour talk. Afterwards the three of us waylaid Jim with the new ten-minute proof. It was Glimm's turn to be floored. Lon, Francesco and I worked together for several years, initially while he was at Princeton but then while he was in Naples. Before email even, it wasn't easy from Naples and once he left, it was mainly finishing up what we started when we were all together. No doubt our most important work was on statistical mechanical methods in EQFT which led to an Annals paper that was so long they made us split it in two. We had two fundamental discoveries each of which was among the most important of my career. One was the lattice approximation. While Wilson's rediscovery later than us was much broader including fermions and lattice gauge theory, our credit for this first step is largely ignored. The second was that correlation inequalities from Ising and D-vector model extended to Bose EQFT. This became a major tool for us and others working on CQFT.

Working with Francesco was a great pleasure. He was very original (in this and his later work on spin glasses).

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[22] F. Guerra, Uniqueness of the Vacuum Energy Density and van Hove Phenomenon in the Infinite-Volume Limit for Two-Dimensional Self-Coupled Bose Fields, Phys. Rev. Lett. 28, 1213 (1972)

[23] F. Guerra, L. Rosen, B Simon, Nelson's symmetry and the infinite volume behavior of the vacuum in $P(\phi)_2$. Communications in Mathematical Physics 27.1 (1972): 10-22.

Call for nominations for the Henri Poincare Prize

We call for nominations for the 2027 Henri Poincaré Prize.

The deadline is **September 30, 2026**. A nomination should include the following:

- Description of the scientific work of the nominee emphasizing their key contributions
- A recent CV of the nominee
- A proposed citation should the nominee be selected for an award

Nominations should be sent to the President (president@iamp.org) or to the Secretary (secretary@iamp.org) of the IAMP. Please also spread the word among your colleagues who are not IAMP members.

Note that members of the Executive Committee of the Association (see http://www.iamp.org/page.php?page=page_about) are not eligible for nomination for the prize.

For past winners see http://www.iamp.org/page.php?page=page_prize_poincare.

News from the IAMP Executive Committee

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IAMP welcomes the following new members

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5. Dr. Maxime Van de Moortel, Rutgers University, USA
6. Prof. Pundikala Veeresha, CHRIST Deemed to be University, Karnataka
7. Dr. Dario Benedetti, École Polytechnique, France
8. Anik Chakraborty, University of Delhi, India
9. Linda Khachatryan, National Academy of Science of the Republic of Armenia, Armenia
10. Dr. Matthew Lapa, USA
11. Matteo Ravot Licheri, TU Berlin, Germany
12. Felix Medwed, University of Potsdam, Germany
13. Dr. Albert Much, Leipzig University, Germany
14. Lorenzo Pettinari, University of Trento, Italy
15. Prof. Sumati Surya, Raman Research Institute, India
16. Dr. Ilya Vilkoviskiy, Princeton University, USA
17. Dr. Harman Preet Singh, Eberhard-Karls-Universität Tübingen, Germany
18. Dr. Rayan Fahs, Université de Rennes, France
19. Dr. Maxime Mahdi Zreik, Université Paris Saclay, France
20. Dr. Joscha Henheik, University of Geneva, Switzerland

Recent conference announcements

Mathematical aspects of the physics with non-self-adjoint operators

April 20-24, 2026; CIRM, Luminy (France).

Women in Mathematical Physics 3

April 27 - May 1, 2026; ICMS, Bayes Centre, Edinburgh (UK).

Effective Approximation and Dynamics of Many-Body Quantum Systems

June 29 - July 3, 2026; Bremen, Germany.

Stochastic and Analytic Methods in Mathematical Physics

September 7-12, 2026; Yerevan, Armenia.

Thematic program on Mathematics of Many-Body Entanglement

September 7-12, 2026; Isaac Newton Institute, Cambridge (UK).

More forthcoming meetings.

Open positions

For an updated list of academic job announcements in mathematical physics and related fields visit

http://www.iamp.org/page.php?page=page_positions

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