Laudatio for Michael Aizenman, by Hugo Duminil-Copin

It is a pleasure and an honor to deliver the laudatio for Michael Aizenman. Michael obtained his B.Sc at The Hebrew University in 1969. He then was enrolled at Yeshiva University where he successfully received a PhD with a thesis supervised by Joel Lebowitz. Michael held successive positions at Princeton, and at the Courant Institute before finally settling in Princeton in 1990, having a joint position in Mathematics and Physics.

Michael is a perfect example of what a modern mathematical physicists can be : his intuition and taste are deeply influenced by physics, yet are not bound to it. His research is driven by the search for elegant rigorous proofs often using probability theory as a main mathematical input.

Maybe the most striking example of the influence of Michael on Mathematical Physics is embodied in his celebrated proof, in 1982, of the triviality of the phi4 theory in dimension d>4. This fundamental contribution gathers everything that characterizes Michael's research.

First, it brings an answer to an important question for mathematical physics. Trying to construct a non-trivial four dimensional quantum field theory that was one of the main goals of constructive quantum field theory. It was natural to expect that the scaling limit of strongly coupled phi4d lattice models was a good candidate. What Michael proved is that this is a dead end in dimension d>4 : any field constructed via this procedure is trivial (meaning Gaussian). Alan Sokal wittily referred to Michael's contribution to constructive field theory as *destructive* field theory.

A second important feature of this paper is that the strategy of the proof is physically enlightening. It was already observed that the Gaussianity of the model was related to the properties of non-intersection of certain weighted lattice walks. But Michael pushed the reasoning further. He argued that the relevant point of comparison, to guess whether those lattice walks intersect or not, was to consider the simplest probabilistic model of a random path, namely Brownian motion. It is well known that two Brownian paths avoid each other in dimension d larger or equal to 4, hence, it suffices to turn this intuition into a mathematical proof.

The third important feature, to borrow one of Michael's favorite terminology, is that the argument has legs. For people who are not versed in Michael's language, understand that it can be used to do many other things. In order to prove his result, Michael developed a geometric analysis of random currents based on percolation intuition. In a nutshell, Michael's genius idea was to combine both random walks and percolation. The argument did better than borrowing from random-walk and percolation, it actually shed a new light on both models. The geometric analysis of random currents, as well as for instance the use of non-linear partial differential inequalities, have been central to the development of probability theory in the last thirty years.

To cite but a few results (with coauthors) which were influenced by Michael 1982 paper, Michael proved the exponential relaxation away from criticality, both for the Ising and percolation, the continuity of the phase transition of the Ising model. He derived critical exponents above dimension 4. He unraveled, together with Newman, the importance of the triangular diagram for percolation. He developed graphical representations enabling to use the techniques I mentioned, in the case of quantum spin chains. All of this led to a beautiful unified understanding of Ising, percolation and quantum spin chains.

In the field of disordered systems, Michael Aizenman's name is attached to two major results that share the same features as the previous one. First, a rigorous proof, with Wehr, of the Imry-Ma phenomenon which concerns the rounding of phase transitions due to quenched disorder. As is widely appreciated, the argument goes well beyond merely filling the details in the physics conjecture and was recently shown to extend to quantum systems, again. Second, in order to develop a deeper understanding of Anderson localization and in particular the dynamical implications of it, Michael successfully borrowed intuition from probability and developed the fractional moment (now called the Aizenman-Molchanov) method.

I could also mention Michael's work on metastability for bootstrap percolation and the Thouless effect explaining the discontinuity of the phase transition for some long range one dimensional Ising models. But Michael's research cannot be simply summarized to a (long) list of solutions of important problems. Michael also influenced the mathematical community in a more subtle way. The physical intuition entering into his proofs has a direct consequence : those proofs are not only tools, they also trigger new questions which can lead to new areas of research. Let me discuss two examples in more details.

1) The observation that the intersection probabilities of random currents could be understood by intuitively thinking of Brownian motion led Michael to the following question. What is the probability that two planar Brownian motions starting at distance 1 do not intersect before reaching distance R ? While the answer in dimension d>4 was at the heart of the proof of Gaussianity (it does not decay to 0), the answer in dimension 2 is trickier. It is expected that the probability decays like an inverse power driven by a critical exponent. At the time, this critical exponent was not known to Michael. He presented this problem at the University Paris 6, which was at the time the hunting ground of Marc Yor, who was a world expert in Brownian motion. Adopting the French culture, Michael promised a nice bottle of wine Château Margot 1982 to the people who would solve this problem. What came next is history : Duplantier and Kwon conjectured that the exponent is 5/8, a fact which was proved 20 years later by Lawler, Schramm and Werner, using SLE.

2) After seeing the beautiful numerics done by Langland, Pouliot and Saint-Aubin Michael, Michael suggested that crossing probabilities in percolation should be conformally invariant. This corresponded to the embryos of the rigorous approach to conformal invariance that emerged in the next decade.

Let me conclude. I hope that the few words above illustrate how much Michael contributed to bringing probability and mathematical physics together, a union that is very successful today. To many people in the community, Michael is an example and a fatherly figure. It is a pleasure to see that, by joining the list of recipients of the Henry Poincaré prize, Michael is finally welcomed in the pantheon of mathematical physicists.