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Chance in Physics

Foundations and Perspectives



Springer

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Preface

The conference *Chance in Physics: Foundations and Perspectives* was held from 29th November to 3rd December 1999 in Ischia, Italy. It was sponsored by the *Istituto Italiano Per Gli Studi Filosofici* in Naples, by the *Deutsche Forschungsgemeinschaft* (DFG), and by the *Società Italiana Di Fondamenti Della Fisica*. Sponsoring by the *International School for Advanced Studies* (ISAS) of Trieste, Italy, made the compilation of this volume possible; the funding by the *Istituto Italiano Per Gli Studi Filosofici* was crucial for the conference and is very gratefully acknowledged. The Istituto managed to provide a unique atmosphere for an interdisciplinary meeting, and these proceedings reflect indeed the very friendly but nevertheless intense and neverending discussions on one of the most debated issues of science: probability, and in particular probability in physics. We gratefully acknowledge the organisational work as well as the editorial work done by our secretary of the meeting PhD student Roderich Tumulka.

The meeting was intended to stimulate renewed reflection on the fundamental and practical aspects of probability in physics, in particular the foundations of statistical mechanics, the probability in the foundations of quantum mechanics, the algebraic view of probability and the philosophy of probability in its interrelation with physics.

Questions like what probability is, or what it is about, or how probability enters physics are of a subtle kind. They are difficult in various ways, often mixed up with the enormous complexity and the inescapable lack of mathematical rigor in the physical application, or with the foundational problems of quantum mechanics, where the probabilistic ignorance concerning the values of certain physical quantities has even been elevated to a matter of principle. At present, the understanding of probability in physics is almost as personal as the understanding of quantum theory.

The aim of the conference was thus to focus on ideas about probability in physics, its meaning and its philosophical implications, by reviewing the different facets of probability in physics in its modern settings and by taking into account modern quantum theories without observers, where the origin of probability is not mystified by dogmatism.

The reviews were given in one-hour talks, and the discussions were held in the form of roundtables, where shorter contributions were also given.

The speakers were asked not to dilute the main themes of the conference with technicalities and to focus sharply on the issue of probability. This was

taken to heart by all speakers and the meeting thus proved very successful. The contributions in this volume consequently focus on conceptual issues, and they make worthwhile reading for specialists in the field of foundations as well as for nonspecialists, because extensive technical prior knowledge is not required. The contributions have been left in the order they were discussed in the meeting, which proved to be a very natural one:

1. *Classical Statistical Mechanics*, where Boltzmann's understanding of statistical mechanics as arising from kinetic gas theory is reviewed and put into modern perspectives, with an outlook on relativistic statistical mechanics. The relative lack of emphasis on the effect of chaotic behaviour on the foundations of probability is noteworthy.
2. *Quantum Mechanics*, where we review those *ontological* quantum theories, that have been most seriously discussed in the recent years. Among these are a deterministic theory (Bohmian mechanics) and both the intrinsically random theories of wavepacket reduction and the operator-based consistent (decoherent) histories. It starts with the "orthodox" view, again with emphasis on the probabilistic aspects of these theories.
3. *Chaotic systems*, where the dynamical aspects for the foundations of probability in physics are addressed.
4. *Philosophy of Probability*, where the issues of the earlier sections are further scrutinized on philosophical grounds. These contributions have no abstracts.

The book starts with an introductory paper, in which almost all the topics which are discussed by the later contributions are critically presented.

München,
January 2001

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