

Editorial

Quantum field theory is the language of modern physics. Our understanding of nature from the initial stages of the early universe, via fundamental forces and elementary constituents of matter, to macroscopic complex condensed-matter and many-body systems depends crucially on quantum field theory. Quantum field theory has been with us for many decades now. But astonishingly, quantum field theory for non-equilibrium systems is just in the making.

It cannot be overemphasized that non-equilibrium quantum field theory is one of the great challenges of contemporary physics. It is urgently needed to understand pressing topical phenomena ranging from early-universe cosmology, the evolution of stars, the collisions of heavy nuclei, via the transport properties of mesoscopic systems to the time evolution of complex quantum systems. Because of this, out-of-equilibrium dynamics is an area that has seen a substantial increase of theoretical activities in recent years.

In the present issue, four substantial tutorial reviews have been gathered that address selected aspects of this emerging field: Wolfgang Cassing deepens the insight into the formalism of non-equilibrium many-body physics. Ultracold atom gases and their non-equilibrium properties are thoroughly surveyed by Thomas Gasenzer. Herbert Schoeller develops and applies new renormalization group methods to non-equilibrium problems of mesoscopic systems. Last but not least, Massimo Pietroni gives a comprehensive introduction to the fascinating topic of non-equilibrium cosmological processes in the quantum field theoretical context. We believe that this volume will help triggering future research in the specific branches of physics concerned, as well as promoting cross-fertilization of the different areas. Both new ideas within a field as well as the transfer of knowledge across field boundaries will be necessary to address the challenges posed by present-day and future experiments and observations.

With this issue we continue the successful series of Schladming lectures (cf. Springer lecture notes and this journal, volumes 140 und 152), where the lecturers are invited to write up previously unpublished material in review like format for the benefit of both young and experienced researchers alike. Notes on the excellent lectures by Peter Arnold on the thermalization of the Quark-Gluon Plasma, by Hans-Thomas Janka on supernovae and by Joachim Stroth on the Compressed Baryonic Matter experiment have not been included in this volume, since they are already published elsewhere.

We take the opportunity to thank everyone involved in helping to make the “46. Internationale Universitätswochen für Theoretische Physik” in Schladming a successful event, as well as our sponsors, in particular the Austrian Ministry for Science and Research, the Government of Styria, the Karl-Franzens University Graz and the City of Schladming. Furthermore, we received additional support from the companies Computer Majer and Konica Minolta, Graz.

As organizers, we cordially thank all lecturers also on behalf of all participants, and as volume editors we would like to thank in particular the contributing colleagues for their effort in providing extensive original material that will bridge a gap in the relevant literature.

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Graz,
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