

# Preface

While *nonequilibrium Green's Functions* (NEGFs) are a mature theory with a history of some 50 years, it is only recently that they have turned into a practical tool for quantitative analysis in many-body physics [1–4]. Despite the attractive features of NEGFs—generality and selfconsistency, conservation laws, diagram technique and applicability to ultrafast processes—the relatively large computational effort in treating the dynamics of functions that depend on two times has prevented a broad use of this technique.

Yet, the dramatic progress in available computational resources has made NEGF calculations practical, as was demonstrated by many applications to spatially homogeneous systems in nuclear matter, plasmas and condensed matter systems over the last 15 years. Recently, attempts have been made to extend the use of NEGFs to *spatially inhomogeneous systems* which requires a substantially increased numerical effort. However, new strategies such as the finite element-discrete variable representation, the generalized Kadanoff-Baym ansatz (GKBA), and clever program parallelization make such applications well feasible. This monograph discusses these techniques in detail and should pave the way for a broad application of NEGFs to inhomogeneous systems that are of great importance in atomic, condensed matter and high energy physics.

**Acknowledgments** We thank Sebastian Bauch for close collaboration over the last years and Sebastian Hermanns for providing numerical results based on the GKBA, cf. Sect. 5.2.1. This monograph has greatly benefited from discussions with students and postdocs at the chair of MB in Kiel, in particular, Alexei Filinov and David Hochstuhl, as well as many colleagues from the Nonequilibrium Green's functions community, first of all Pawel Danielewicz, Robert van Leeuwen, Vaclav Špička, Arnau Rios Huguet and Matthias Garny.

The authors are grateful to the Deutsche Forschungsgemeinschaft and the Bundesministerium für Bildung und Forschung for financial support of this work. Furthermore, the North-German Supercomputing Alliance (HLRN) is acknowledged for providing computing time.

Kiel, Germany

Karsten Balzer

Michael Bonitz

Nonequilibrium Green's Functions Approach to  
Inhomogeneous Systems

Balzer, K.; Bonitz, M.

2013, XII, 130 p. 31 illus., Softcover

ISBN: 978-3-642-35081-8