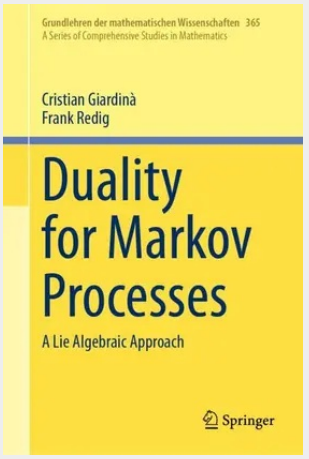
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# Duality for Markov Processes

A Lie Algebraic Approach




This monograph studies duality in interacting particle systems, a topic combining probability theory, statistical physics, Lie algebras, and orthogonal polynomials. It offers the first comprehensive account of duality theory in the context of interacting particle systems.

Using a Lie algebraic framework, the book demonstrates how dualities arise in families of systems linked to algebraic representations. The exposition centers on three key processes: independent random walks, the inclusion process, and the exclusion process —associated with the Heisenberg, su(1,1), and su(2) algebras, respectively. From these three basic cases, several new processes and their duality relations are derived. Additional models, such as the Brownian energy process, the KMP model and the Kac model, are also discussed, along with topics like the hydrodynamic limit and non-equilibrium behavior. Further, integrable systems associated to the su(1,1) algebra are studied and their non-equilibrium steady states are computed.

Intentionally accessible and self-contained, this book is aimed at graduate-level researchers and also serves as a comprehensive introduction to the duality of Markov processes and beyond.

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