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Φ_3^4 Theory from many-body quantum Gibbs states

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We derive the Φ_3^4 measure on the torus as a rigorous limit of the quantum Gibbs state of an interacting Bose gas, where the limiting classical measure describes the critical behavior of the Bose gas just above the Bose–Einstein phase transition. Since the quantum problem is typically formulated using a nonlocal interaction potential, a key challenge is to approximate the local Φ_3^4 theory by a Hartree measure with a nonlocal interaction. This requires uniform estimates on the Hartree measure, which are achieved using techniques from recent development on stochastic quantization and paracontrolled calculus from [?]. The connection to the quantum problem is then established by applying the variational approach in [?], where using a recent correlation inequality from [?] we refine the analysis and derive a quantitative convergence of the quantum correlation functions to those of the Hartree classical field.

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