# Feynman diagrams, Luttinger-Ward formalism, and Gibbs measure

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**Abstract**: Many-body perturbation theory (MBPT) is widely used in quantum physics, chemistry, and materials science. At the heart of MBPT is the Feynman diagrammatic expansion. However, for quantum many-body problems, many developments of MBPT are only formally valid. These shortcoming raise both theoretical and practical questions. By exploring the correspondence between the Feynman diagrammatic expansion and a certain class of Gibbs measures, we provide a relatively concise and self-contained introduction to MBPT, which requires no more a-priori knowledge than multivariable calculus.

We demonstrate that the resulting models yield diagrammatic expansion that can provide useful insights toward a rigorous understanding of certain topics in MBPT, such as the existence of the Luttinger-Ward functional and the validity of the bold diagrammatic expansion. We also demonstrate that the numerical implementation of MBPT for such Gibbs model, compared to that of the quantum many-body problem, requires significantly reduced effort.

(Joint work with Michael Lindsey).