The Positive P-Representation and the Stochastic Simulation of Spin Systems in Quantum Optics

Sean Muleady[1], Saeed Khan[2], Gerry Angelatos[2], and Hakan E. Türeci[2]
[1] Department of Physics, Princeton University, Princeton, NJ, 08544, USA
[2] Department of Electrical Engineering, Princeton University, Princeton, NJ, 08544, USA
email: smuleady@princeton.edu

Modeling the dynamics of large quantum optical systems has proved to be a computational challenge. Among the many methods of simulating such systems is the positive P-representation, a generalization of the Glauber-Sudarshan P-representation that allows a well-defined mapping to a Fokker-Planck equation [1]. This equation may be mapped to a set of stochastic differential equations, which are then more amenable to computation than standard master equation techniques for large systems. However, stochastic algorithms tend to rapidly destabilize, limiting the utility of this method [2]. Furthermore, modeling the dynamics of spin systems poses the additional challenge of finding a suitable representation for spin states [3]. The subject of our research is the open Dicke model, a generalization of the Jaynes-Cummings model to higher spin systems [4]. We aim to investigate the effectiveness of different spin representations on our models, as well as to explore methods of achieving numerical stability, with the ultimate goal of performing laser linewidth calculations for the pumped Dicke model.

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