Contribution ID: **16** Type: **not specified**

Estimation of entanglement monotones in permutationally invariant spin systems

Thursday, August 29, 2024 3:30 PM (30 minutes)

We are interested in finding optimal entanglement witnesses and thereby bound entanglement monotones for interacting many-body systems that can be connected to experimentally relevant collective observables. For spin observables corresponding to two-body correlators, generalized spin squeezing inequalities [1, 2] are generally considered optimal witnesses. To begin with, we study thermal states of fully connected spin systems in the mean-field approximation which are permutationally invariant. We illustrate how this connection can be used to estimate entanglement monotones of such states, how this connects to the spin squeezing inequalities, and how this approach compares to numerical studies. More specifically, we present general strategies to find both lower and upper bounds to entanglement monotones and show specific calculations and results for some interesting models. These examples also illustrate how we can leverage additional symmetries to more efficiently calculate these bounds for many particles. In addition, we elaborate on extensions of our work to non-Hermitian collective spin observables, and on how our findings connect to entanglement measures other than those we have already considered. [1] G. Tóth, C. Knapp, O. Gühne, H.J. Briegel, Journal, Physical Review A, 79.4 (2009) 042334 [2] G. Vitagliano, I. Apellaniz, I. Egusquiza, G. Tóth, Physical Review A, 89(3), 032307

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