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Spin squeezing and entanglement quantification in spin-j atomic gases

Tuesday, 29 June 2021 12:00 (30 minutes)

I will present some recent results on entanglement detection and quantification with collective spin measurements in many-body ensembles. After a brief review of the idea of "Spin Squeezing"and its relation with multipartite entanglement and quantum metrology, I will show how the original spin squeezing approach can be generalized in several respects and how it allows to quantify multipartite entanglement by means of the so-called depth of entanglement. Especially, I will present particular examples of criteria that has been recently applied to detect the depth of entanglement in (i) unpolarized Dicke states, produced dynamically in a Rb BEC [1,2]; (ii) Planar Quantum Squeezed states, produced with Quantum-Non-Demolition measurements in a Rb atomic cloud [3]. Similarly, I will present EPR-like criteria tailored to detect bipartite entanglement in generalized spin squeezed states split in two spatially separated modes [4,5], analogous to other well known criteria [6], but applicable to a wider set of states. In the final part, I will focus on the quantification of entanglement by means of entanglement monotones with similar methods [7]. I will consider broad families of entanglement criteria that are based on variances of arbitrary operators and analytically derive the lower bounds these criteria provide for two relevant entanglement measures: the best separable approximation (BSA) and the generalized robustness (GR). As a concrete application, I will show the results of applying this method with experimental data of a spin-squeezed Bose-Einstein condensates of 500 atoms.

[1] B. Lücke, J. Peise, G. Vitagliano, J. Arlt, L. Santos, G. Tóth, and C. Klempt. Detecting multiparticle entanglement of dicke states. Phys. Rev. Lett., 112:155304, 2014.

[2] G.Vitagliano, I.Apellaniz, M.Kleinmann, B.Lücke, C.Klempt, and G.Toth. Entanglement and extreme spin squeezing of unpolarized states. New J. Phys., 19, 2017.

[3] G. Vitagliano, G. Colangelo, F. Martin Ciurana, M. W. Mitchell, R. J. Sewell and G. Tóth, Entanglement and extreme planar spin squeezing, Phys. Rev. A 97 020301(R) (2018)

[4] K. Lange, J. Peise, B. Lücke, I. Kruse, G. Vitagliano, I. Apellaniz, M. Kleinmann, G. Toth, C. Klempt, Entanglement between two spatially separated atomic modes, Science 360 416–418 (2018)

[5] G. Vitagliano, M. Fadel, I. Apellaniz, M. Kleinmann, B. Lücke, C. Klempt, G.Tóth, Detecting Einstein-Podolsky-Rosen steering and bipartite entanglement in split Dicke states, arXiv:2104.05663

[6] V. Giovannetti, S. Mancini, D. Vitali, P. Tombesi, Characterizing the entanglement of bipartite quantum systems, Phys. Rev. A 67, 022320 (2003)

[7] M. Fadel, A. Usui, M. Huber, N. Friis, G. Vitagliano, Entanglement quantification in atomic ensembles, arXiv:2103.15730

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