Title:	Dimensional Gain in Sensing Through Higher Dimensional Spin Chain
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Abstract:	Advancements in simulations of quantum systems pave the way for the utilization of higher dimensional quantum systems. State-of-the-art technology enables us to study and simulate higher dimensional quantum systems. Many studies on quantum technolo- gies have reported that higher dimensional systems outperform their qubit counterparts in terms of capability and versatility for example quantum computation and quantum batteries [Agrawal 23, Ghosh 22]. Recently there has been an interest in employing spin−1 parti- cles for quantum estimation problems[Dooley 21, Dooley 23]. We study the dimensional advantage in quantum sensing and how the limits of estimation protocol modify with in- creasing the dimensions of the Hilbert space. We generalize the bounds on minimum error achievable in quantum estimation protocol to d−dimensional systems, for both classical and quantum limits. We present a framework for accurately predicting the weak external magnetic fields using a higher-dimensional many-body quantum probe. We observe the distinct performance of the sensors for spin chains with half-integer and integer spins. Fur- thermore, we highlight that the time duration for the quantum-enhanced sensing increases with the increase in the dimension. Additionally, we observe that incorporating interactions to the next nearest neighbor increases the sensing precision, particularly with spin chains with integer spins
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