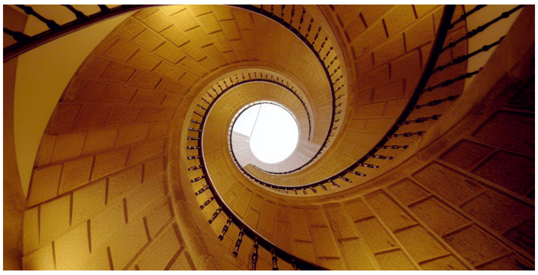

Contribution ID: **18** Type: **Talk**

Neural-network-assisted quantum magnetometers

Monday 29 May 2023 16:40 (20 minutes)

As important branches in quantum technologies, quantum sensing and quantum metrology have experienced significant progress, placing themselves at the forefront of the new generation of technologies harnessing quantum effects. In this presentation, different quantum magnetometers assisted by neural networks are introduced. Our results show that neural networks are valuable in distinct quantum systems for quantum sensing leading to adaptive protocols for quantum detection with broad working regime and high accuracy.

The benefits to integrate neural networks are illustrated to decipher the information contained in the sensor responses at the data processing stage of general quantum sensing tasks. We experimentally demonstrate that the combination of 171Yb+ atomic sensors with adequately trained neural networks enables to investigate target fields in the presence of large shot noise, including using the limit case of continuous data acquisition via single-shot measurements [1]. We significantly extend the working regime of atomic magnetometers into scenarios in which the RF driving induces responses beyond their standard harmonic behaviour [2].

The way for the practical use of quantum many-body systems as black-box sensors exploiting quantum resources to improve precision estimation is also demonstrated [3]. Entangled quantum many-body systems can be used as sensors that enable the estimation of parameters with a precision larger than that achievable with ensembles of individual quantum detectors. Neural networks faithfully reproduce the dynamics of quantum many-body sensors, thus allowing for an efficient Bayesian analysis. We exemplify with an XXZ model driven by magnetic fields and demonstrate that our method is capable to yield an estimation of field parameters beyond the standard quantum limit scaling.

References:
[1] Y. Chen, Y. Ban, R. He, et al., A neural network assisted 171Yb+ quantum magnetometer. npj Quantum Inf. 8, 152 (2022).
[2] Y. Ban, J. Echanobe, Y. Ding, et al. Neural-network-based parameter estimation for quantum detection, Quantum Sci. Technol. 6, 045012 (2021).
[3] Y. Ban, J. Casanova, R. Puebla, Neural networks for Bayesian quantum many-body magnetometry, arXiv: 2212.12058 (2022).

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