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Quantum multiphase estimation in an integrated photonic circuit

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Quantum Metrology is one of the most important quantum technologies where quantum resources are exploited to enhance the estimation of unknown parameters [1]. In this context, since realistic scenarios generally involve more than one parameter, quantum multiparameter estimation is a central and very active research area. Nevertheless, in such relatively new field, several open questions are still present and experimental platforms able to perform multiparameter estimation protocols have to be developed. We realized a reconfigurable photonic integrated circuit, built through the femtosecond lase writing technique, able to perform simultaneous multiphase estimation with photonic quantum states. The circuit realizes a three arm interferometer and is highly tunable, so that the two independent phase shifts between the interfetometer's arms can be tuned. Firstly, we demonstrate quantum enhanced two-phases estimation by using two-photon probes [2]. Then we provide a demonstration of a Bayesian adaptive protocol able to saturate, in the limited data regime, the sensitivity bound (Cramer-Rao bound) on the estimation of the two phases when single photon probes are employed [3].

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[3] M. Valeri, E. Polino, D. Poderini, I. Gianani, G. Corrielli, A. Crespi, R. Osellame, N. Spagnolo, and F. Sciarrino, arXiv preprint arXiv:2002.01232 (2020).

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