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Observation of quantum synchronization and blockade in spin-1 atom PRATIK ADHIKARY, ARIF WARSI LASKAR, SUPRODIP MONDAL, PARAG KATIYAR, IIT Kanpur, SAI VINJANAMPATHY, IIT Bombay, SAIKAT GHOSH, IIT Kanpur — synchronization between different physical systems has gained lots of attention in research. While in classical system, numerous research articles report the signature of synchronization, synchronization in the quantum regime has not been observed yet. We report the first observation of quantum synchronization in an ensemble of cold spin-1 ^{87}Rb atoms. In particular, when we store and destructively interfere two dark state polaritons, we observe an otherwise delocalized limit-cycle spin-1 state gets localized and entrained to classically controlled phases, only in presence of artificially engineered, anisotropic decay channels, These observations are in accordance with the recent predictions of Roulet and Bruder of quantum phase synchronization in the smallest quantum systems, spin-1 atoms, due to anisotropic internal decay channels. We numerically reconstruct the underlying quantum state and when viewed in phase space, in presence of artificially engineered asymmetric decay channels, we observe the state getting entrained even when the dark states interfere destructively. The corresponding relative phase difference of the dark state polaritons locks to a classical, controlled phase difference. Furthermore, we observe a blockade of synchronization due to quantum interference, a genuine quantum signature, which gets lifted due to increasing asymmetry in decays. When the system is driven harder, we observe emergence of Arnold tongue-like typical signatures of all synchronization.

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