Squeezing microwave fields by magnetostrictive interaction

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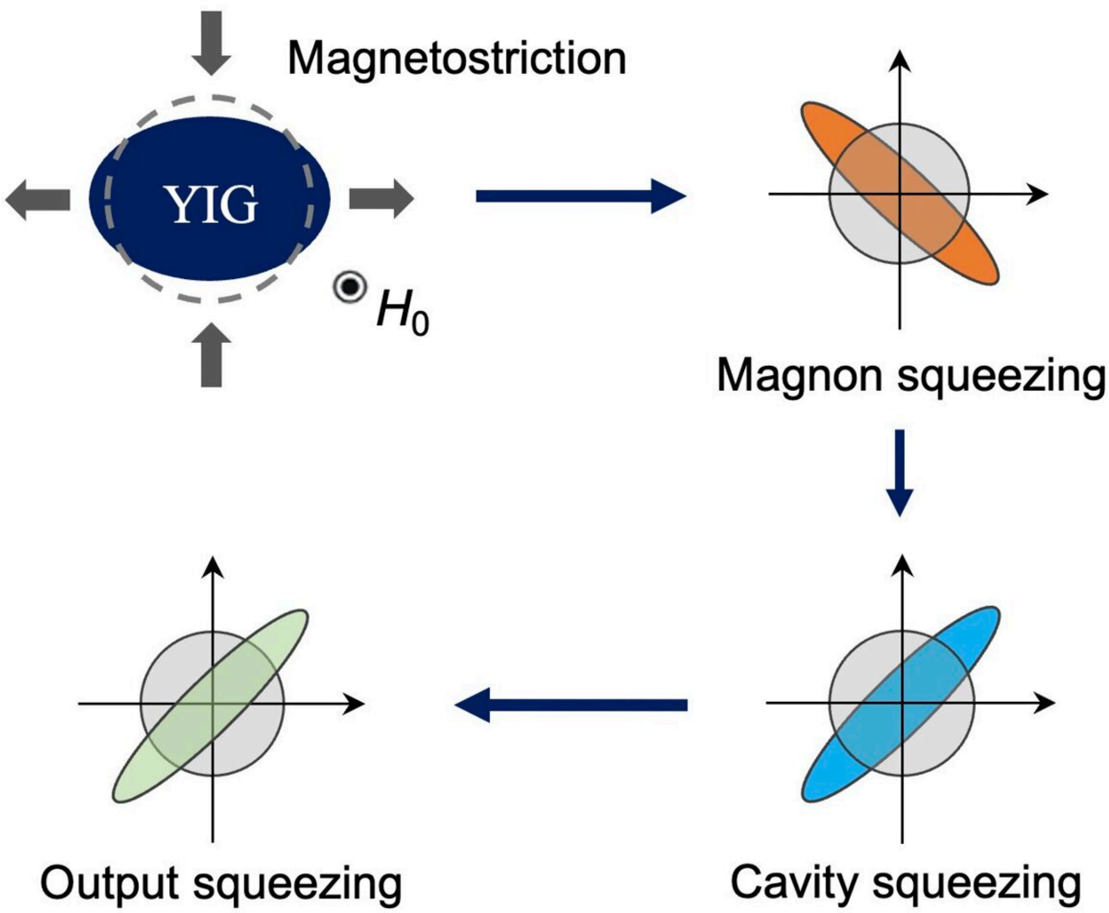

The magnetostrictive interaction of an yttrium-iron-garnet (YIG) sphere in a cavity magnomechanical system prepares the magnon mode in a squeezed vacuum state. The squeezing is transferred to the coherently coupled microwave cavity field, thereby yielding a squeezed microwave cavity output field. Credit: Science China Press

Squeezed states of the electromagnetic field find many important applications in quantum information science and quantum metrology. Dr. Jie Li et al. at Zhejiang University put forward a new mechanism for preparing microwave squeezed vacuum states using a cavity magnomechanical system.

Specifically, the spin wave (magnon mode) formed by a large number of spins in a ferrimagnet couples to the phonon mode of the deformation vibration of the ferrimagnet via the magnetostrictive force. The magnetostrictive interaction is a nonlinear effect, which can establish a unique correlation between the amplitude and phase of the magnon mode. This correlation can reduce the quantum noise of the magnon mode, yielding squeezed vacuum of the magnon mode.

Due to the state-swap interaction between magnons and cavity microwave photons, the cavity mode also gets squeezed, leading to squeezed vacuum of the microwave cavity output field. The work shows that the cavity magnomechanical system exhibits some advantages over the most-widely-used method using Josephson parametric amplifiers (JPA) in preparing microwave squeezed states. The working temperature of JPA is typically at 10–20 millikelvin.

This work shows that at temperature of 200 millikelvin, the cavity magnomechanical system can produce microwave squeezed states with the same degree of squeezing as that produced by JPA. This greatly reduces the stringent requirement for ambient temperature. In addition, the operation of JPA requires a large auxiliary circuit, while the cavity magnomechanical system is much simpler, which greatly reduces the cost of the experiment.

The work provides a new mechanism and approach for preparing microwave squeezed vacuum states, which will find many important applications in microwave quantum information processing and quantum metrology.

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