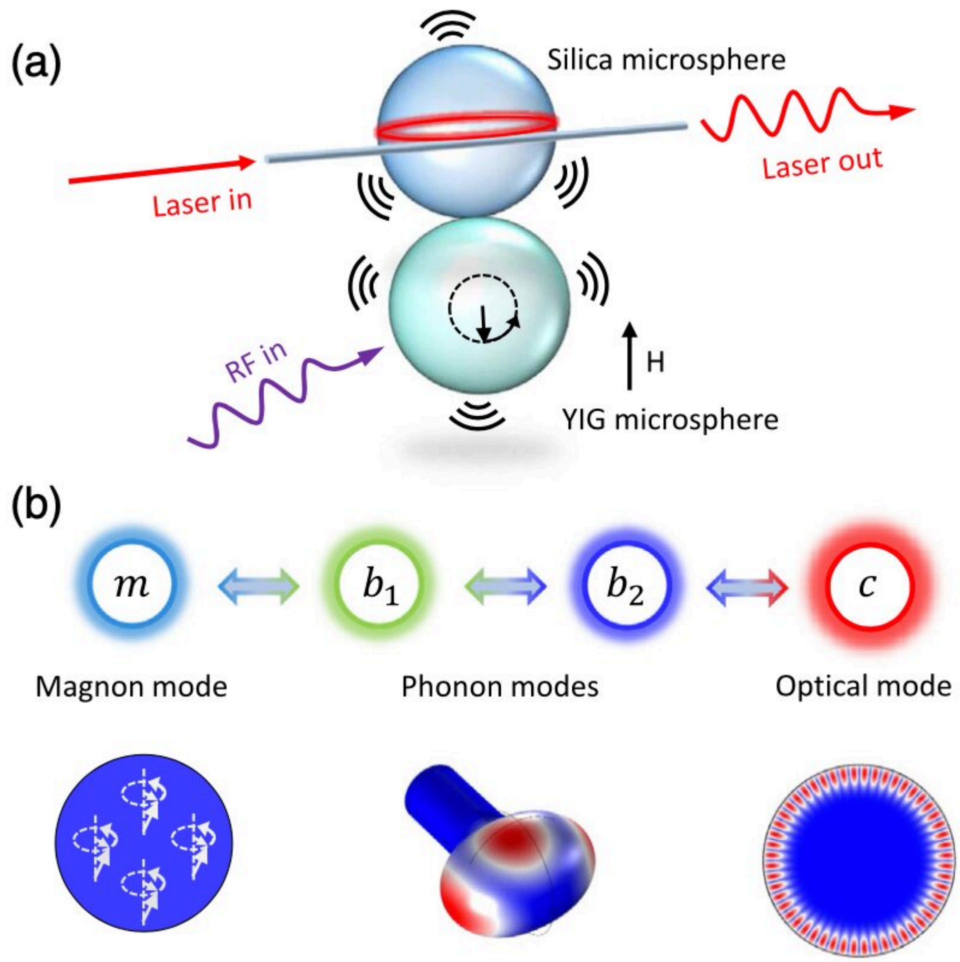
Scientists create magno-optomechanical hybrid system with wide tuning range

January 12 2023



Schematic of the hybrid system that combines controlled phonons, magnons, and photons. Credit: Shen Zhen et al

A research team headed by Academician Guo Guangcan and Prof. Dong Chunhua from the University of Science and Technology of China (USTC) of the Chinese Academy of Sciences (CAS) has made progress in designing a magno-optomechanical hybrid system.

The team developed a hybrid system supporting the coherent coupling between an optomechanical cavity and a magnomechanical cavity though straightway physical contact, achieving a microwave-to-optical conversion. The results were published in *Physical Review Letters*.

Different quantum systems, including rare-earth-ion-doped crystals, superconducting circuits, and spins in yttrium iron garnet (YIG) or diamond, have their unique type of quantum operation.

In previous research, the team realized a tunable frequency conversion between microwave and photons utilizing the dynamical Faraday effect in a YIG microsphere.

However, both the implementation of cavity optomagnonics and most optomechanical systems have issues, with the former having limited magneto-optical interaction strength and the latter demonstrating limited practical applications due to a lack of tunability.

In this research, the team developed a system consisting of an optomechanical cavity with a silica microsphere and a magnomechanical cavity with a YIG microsphere. Photons could be electrically manipulated through magnetostriction effect or optically manipulated through optical radiation pressure. Furthermore, photons in different microcavities could be coherently coupled through direct physical contact.

Based on the high quality optical measurement of the mechanical state of the system, researchers achieved a microwave-to-optical conversion with an ultrawide tuning range, far exceeding that of the previous magneto-optical single system.

In addition, the team observed a mechanical motion interference, in which the optically induced motion of the mechanical resonator is canceled by microwave-driven coherent motion.

In the future, this hybrid system that combines controlled phonons, magnons, and photons is expected to be applied in signal transduction and sensing.

More information: Zhen Shen et al, Coherent Coupling between Phonons, Magnons, and Photons, *Physical Review Letters* (2022). DOI: 10.1103/PhysRevLett.129.243601

Provided by University of Science and Technology of China