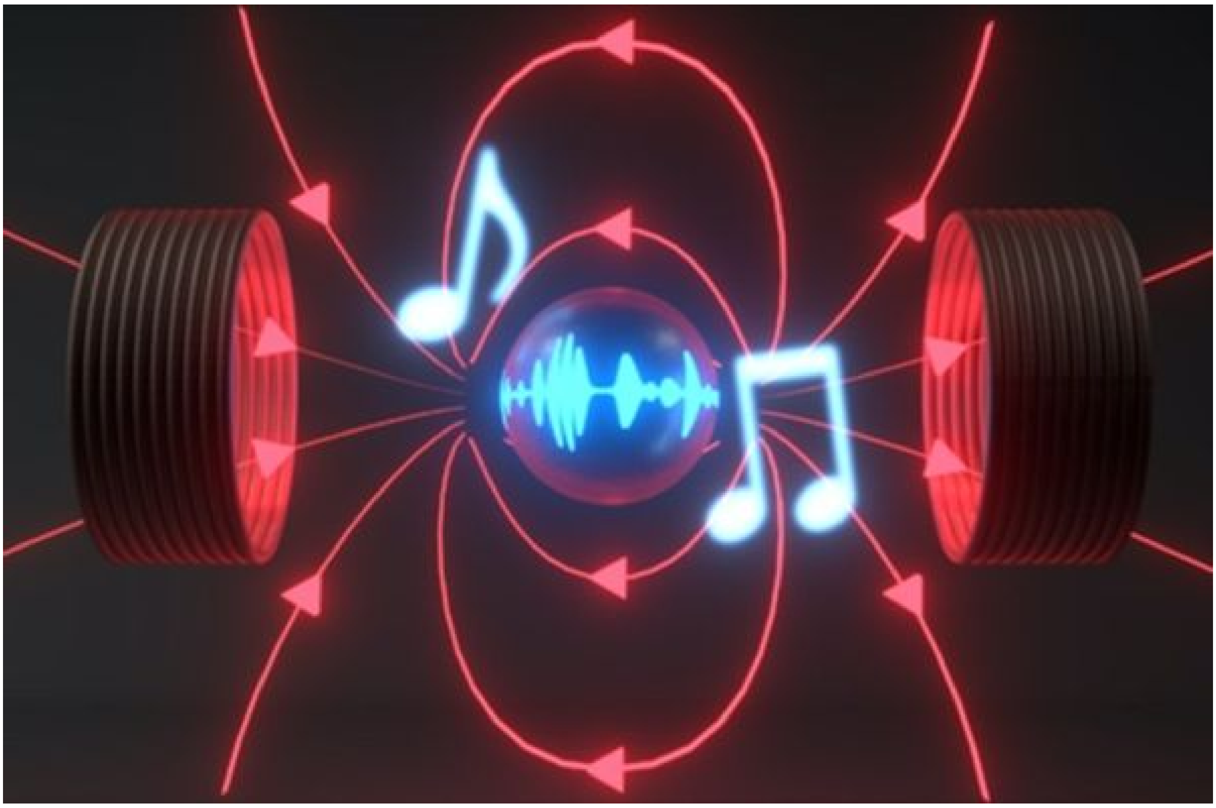

Cooling magnets with sound

A team of researchers from Innsbruck, IQOQI, and ICFO reports on the development of a novel technique to cool down nano-objects with sound instead of light.

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While quantum physics is usually concerned with the basic building blocks of light and matter, such as atoms, electrons and photons, for some time scientists have now been trying to investigate the quantum properties of larger objects, thereby probing the boundary between the quantum world and everyday life. For this purpose, particles are slowed down with the help of electromagnetic waves and the motional energy is drastically reduced. Therefore, one also speaks of "motional cooling".

So far, the way to cool down particles to the absolute zero in order to reveal these quantum properties could only be done with the use of photons in an electromagnetic resonator. However, in a recent theoretical study, the team of theoretical physicists led by Carlos Gonzalez-Ballestero and Oriol Romero-Isart from the University of Innsbruck and the Institute of Quantum Optics and Quantum Information (IQOQI) of the Austrian Academy of Sciences, in collaboration with experimentalist **Jan Gieseler** from Harvard University and ICFO in Barcelona, have reported on a theoretical approach that implements acoustomechanical coupling or sound waves to cool objects down close to absolute zero.

In two papers published back to back in Physical Review Letters and Physical Review B, the team of scientists has demonstrated that the motion of magnetic particles can interact with the internal acoustic waves that are confined inside every particle.

Analogous to photons, which are the quanta of light, the acoustic vibrations in a solid body can be described as so-called phonons. These small sound wave packets propagate through the crystal lattice of the solid and interact with the movement of the particles through the magnetic field that is being applied to the material. In their theoretical approach, Ballesteros and colleagues proved that this interaction can be controlled by an external magnetic field. That is, by varying the magnetic field, it is possible to control and decrease the movement of the particles and thus lower the temperature of the system.

The results of these studies prove an alternative method to photons for cooling down a system to its lowest energy level possible. In addition, the strong interaction between motion and phonons provides a path to probe and manipulate the elusive and exotic dynamics of acoustic and magnetic waves inside a single nano-particle. Such a method could open new pathways in the fields of magnetometry or quantum information processing, to use phonons, for example, as quantum memories.