Vladimir ELTSOV, Aalto University, Finland

Interacting superfluid time crystals

In superfluid 3He at ultra-low temperatures, spin-wave excitations (magnon quasiparticles) can live for minutes. We create a 3-dimensional trap for magnons within the superfluid and inject sufficient density of magnons with a short pumping pulse, so that later magnons form a Bose-Einstein condensate at the ground level of the trap. Magnon BEC is manifested in the experiments by spontaneously emerging coherent spin precession, which breaks continuous time translation symmetry and satisfies criteria of a time crystal [1]. In a configuration with two spatially separated time crystals with distinct chemical potentials we observe the ac Josephson effect originating in spin superfluidity of the interacting condensates [2]. Additionally, we can arrange the chemical potentials of the two crystals to cross during the time evolution. In this case the transfer of magnon population between the condensates is described by a macroscopic version of the Landau-Zener effect.

[1] S. Autti et al, Phys. Rev. Lett. 120, 215301 (2018).
[2] S. Autti et al, Nature Mater. 20, 171 (2021).