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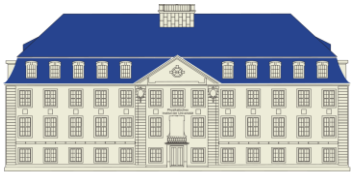

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COLLOQUIUM „OPTICS AND CONDENSED MATTER“

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Entrainment of a continuous time crystal

Non-linear oscillators are ubiquitous in nature, with examples reaching from lasers to the circadian clocks of biological organisms. Such oscillators can give rise to intriguing and useful synchronization phenomena referred to as injection locking in laser physics or entrainment in biological systems. A new class of self-sustained non-linear oscillators, referred to as time crystals, has recently been discovered in quantum many-body systems. Here, the oscillatory state is accessed via a phase transition triggered by spontaneous breaking of time translation symmetry, induced by quantum and thermal fluctuations. This resembles the freezing of water to form crystalline ice via a spontaneous breaking of spatial translation symmetry. In our article we show that time crystals, similarly as lasers or biological clocks, can be steered by external driving to lock to a subharmonic of the driving frequency.
We begin with the preparation of a continuous time crystal using a Bose-Einstein condensate strongly coupled to a high finesse optical cavity. Upon application of an external oscillatory drive, the system robustly locks to the first subharmonic of the modulation frequency. The system thereby undergoes a phase transition from a continuous - to a discrete time crystal. The phase delay between the drive and the system response monotonously varies with the driving frequency, a characteristic feature also observed in biological systems.

January 30th, starting with discussion at 17:00 h, talk at 17:15 h, live IAP lecture hall or via Zoom
https://uni-bonn.zoom.us/j/98441612025?pwd=a01SSjlkY1Q3SDFhL09JQk1qc1V6dz09
Meeting-ID: 984 4161 2025
Kenncode: 294164