Experimentelle Physik 2

Seminar Festkörperphysik (CMP Seminar)

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Exploring Nonlinear Dynamics in a Periodically Driven Time Crystal: From Synchronized to Chaotic Motion

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In this seminar, I will present our recent exploration of nonlinear dynamics within a coupled electron-nuclear spin system in an InGaAs semiconductor, a unique platform for studying time crystals and nonequilibrium matter. Building on our foundational work on a continuous time crystal achieved via constant optical pumping [1], we introduce periodic modulation of excitation polarization as a new degree of freedom, uncovering a range of complex dynamical behaviors [2].

Key findings include frequency entrainment and the formation of Arnold tongues, where the system's oscillations become locked to the modulation frequency in a controllable manner. Beyond entrainment, we observe fractional subharmonic responses organized in bifurcation jets, creating a devil's staircase structure in the frequency spectrum. Notably, as the system nears an entrainment region, it undergoes a chaotic transition, revealing the intricate boundary between synchronized and chaotic dynamics.

These results deepen our understanding of nonlinear systems and highlight potential applications in semiconductor technology. By bridging experimental realizations with theoretical predictions, this work offers insights into complex, synchronized phenomena in natural and technological systems.

[1] A. Greilich et al., Nat. Phys. 20, 631 (2024)
[2] A. Greilich et al., arXiv:2406.06243v1 (2024)