Predator-prey dynamics in driven magnon systems

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The dynamics of driven magnon systems provide a powerful testbed for exploring a broad range of nonlinear phenomena in a many-body setting. In parametrically driven systems, a particularly intriguing manifestation is predator–prey dynamics, where competing magnon populations interact nonlinearly to produce rich behavior, including limit cycles characterized by periodic population growth and decay, stable fixed points, and chaotic dynamics [1]. In this contribution, we discuss two recent examples in which predator–prey dynamics emerge in systems of direct relevance to magnonics.

The first example concerns parametrically excited modes in in-plane magnetized YIG microdisks [2]. In this geometry, parallel pumping with spatially uniform fields can excite pairs of distinct eigenmodes, which, under specific off-resonant conditions, exhibit pronounced limit-cycle dynamics. The second example involves driven optical modes in synthetic antiferromagnets [3]. Here, under suitable off-resonant driving, three-wave scattering enables periodic energy exchange between acoustic and optical modes, again giving rise to clear limit cycles.

In contrast to uniformly magnetized disks, the periodic growth and decay of the acoustic mode in synthetic antiferromagnets leads to a modulation of the net magnetization and, consequently, of the dynamic ground state. This results in the emergence of frequency combs, providing a further realization of a self-induced Floquet mechanism, previously identified for magnons around gyrating vortices [4].

References:

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