MPIDS Seminar

MAX-PLANCK-GESELLSCHAFT

Collective Phenomena in lattices of nanoelectromechanical oscillators

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Understanding the macroscopic behavior of networks of coupled oscillators from their microscopic properties has fundamental value to many areas of science. The most basic phenomena observed is synchronization, when the phases or frequencies of oscillators become ordered as coupling becomes large [1]. A parallel can be drawn between this ordering and ferromagnetism/antiferromagnetism in condensed matter systems. Carrying the connection between coupled oscillators and condensed matter further, collective modes which spontaneously break lattice symmetry become stable when on-site and interaction terms are appropriately tuned. Here, I show these states are experimentally accessible in a chain of nanoelectromechanical oscillators with periodic boundary conditions. Through full control over individual oscillator parameters in situ [2], I demonstrate control over macroscopic state properties and spontaneously symmetry breaking [3].

[1] Matheny, M.H. , Grau, M., Villanueva, L.G., Karabalin, R.B., Cross, M.C., and Roukes, M.L. (2014). Phase Synchronization of Two Anharmonic Nanomechanical Oscillators. Phys. Rev. Lett. 112, 014101.
[2] Fon, W., Matheny, M.H., Li, J., Krayzman, L., Cross, M.C., D'Souza, R.M., Crutchfield, J.P. and Roukes, M.L (2017). Complex dynamical networks constructed with fully controllable nonlinear nanomechanical oscillators. Nano letters, 17(10), 5977-5983.
[3] Matheny, M. H., Emenheiser, J., Fon, W., Chapman, A., Rohden, M. , Salova, A. Li, J. de Badyn, M. H., Duenas-Osorio, L., Mesbahi, M. Crutchfield, J. P., Cross, M. C., D'Souza, R. M. and Roukes, M. L. (2019). Exotic states in a simple network of nanoelectromechanical oscillators. Science, 363(6431), eaav7932.

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