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Dissipative Optomechanical Preparation of Macroscopic Quantum Superposition States CARLOS NAVARRETE-BENLLOCH, Max-Planck Institute for the Science of Light, MEHDI ABDI, University of Ulm, PETER DEGENFELD-SCHONBURG, Bosch, MAHDI SAMETI, MICHAEL J. HARTMANN, Heriot-Watt University — The transition from quantum to classical physics remains an intensely debated question even though it has been investigated for more than a century. Further clarifications could be obtained by preparing macroscopic objects in spatial quantum superpositions and proposals for generating such states for nanomechanical devices either in a transient or a probabilistic fashion have been put forward. Here, we introduce a method to deterministically obtain spatial superpositions of arbitrary lifetime via dissipative state preparation. In our approach, we engineer a double-well potential for the motion of the mechanical element and drive it towards the ground state, which shows the desired spatial superposition, via optomechanical sideband cooling. We propose a specific implementation based on a superconducting circuit coupled to the mechanical motion of a lithium-decorated monolayer graphene sheet, introduce a method to verify the mechanical state by coupling it to a superconducting qubit, and discuss its prospects for testing collapse models for the quantum to classical transition.

Carlos Navarrete-Benlloch
Max-Planck Institute for the Science of Light

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