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**Quantum phase transitions, symmetry breaking, and the Goldstone mode in metastable Bose-Einstein condensates**[1] L. D. CARR, Physics Department, Colorado School of Mines, Golden, CO, USA, R. KANAMOTO, Physics Department, University of Arizona, Tuscon, AZ, USA, M. UEDA, Department of Physics, Tokyo Institute of Technology, Tokyo, Japan — It is commonly believed that in a superfluid with repulsive interactions the circulation is quantized and there is a discontinuous jump in states between different values of the circulation. In fact, this rule applies only to the ground state: continous transitions are possible for metastable states. We explicitly show this by considering a dilute Bose-Einstein condensate on a quasi one-dimensional torus with tunable atom-atom interactions and/or external rotation. The key to such transitions is the appearance of a dark or grey soliton train degenerate with an excited angular momentum eigenstate. These occurrences are characterized by second order quantum phase transitions between metastable states. In the mean field theory, they are associated with bifurcations; in the quantum field theory, they are connected with the appearance of quasidegenerate states, which construct the broken-symmetry state and Goldstone mode in the presence of an infinitesimal symmetry-breaking perturbation.

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