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Pomeranchuk effect and spin-gradient cooling of Bose-Bose mixtures in an optical lattice

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We theoretically investigate finite-temperature thermodynamics and demagnetization cooling of two-component Bose-Bose mixtures in a cubic optical lattice, by using bosonic dynamical mean-field theory (BDMFT). We calculate the finite-temperature phase diagram, and remarkably find that the system can be heated from the superfluid into the Mott insulator at low temperature, analogous to the Pomeranchuk effect in ^{3}He. This provides a promising many-body cooling technique. We examine the entropy distribution in the trapped system and discuss its dependence on temperature and an applied magnetic field gradient. Our numerical simulations quantitatively validate the spin- gradient demagnetization cooling scheme proposed in recent experiments.