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Observation of a Red-Blue Detuning Asymmetry in Matter-Wave Superradiance LU DENG, EDWARD W. HAGLEY, NIST, QIANG CAO, XI-AORUI WANG, XINYU LUO, RUQUAN WANG, Institute of Physics, Chinese Academy of Sciences, Beijing 100190, China, MARVIN G. PAYNE, NIST, FAN YANG, XIAOJI ZHOU, School of Electronics Engineering & Computer Science, Peking University, Beijing 100871, China, XUZONG CHEN, MINGSHENG ZHAN, State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics, Wuhan Institute of Physics and Mathematics, Chinese Academy of Sciences — We report the first experimental observation of strong suppression of matter-wave superradiance using blue-detuned pump light and demonstrate a pump-laser detuning asymmetry in the collective atomic recoil motion. In contrast to all previous theoretical frameworks, which predict that the process should be symmetric with respect to the sign of the detuning of the pump laser from the one-photon resonance, we find that for condensates the symmetry is broken. With high condensate densities and red-detuned pump light the distinctive multi-order, matter-wave scattering pattern is clearly visible, whereas with blue-detuned pump light superradiance is strongly suppressed. However, in the limit of a dilute atomic gas symmetry is restored.

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