Mixing dynamics of two-component Bose-Einstein condensates in countersuperflow

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Counterflow is a powerful tool for generation of quantum turbulence in a superfluid helium system [1]. Old studies on quantum turbulence in superfluid ^{4}He focused primarily on thermal counterflow. Recently, countersuperflow instabilities have been theoretically studied in two miscible gaseous BECs [2, 3], which leads to isotropic quantum turbulence consists of two superflows [4].

We experimentally investigated the dynamics of two-component ^{87}Rb BECs of $|F = 1, m_F = 0\rangle = |1\rangle$ and $|2, -2\rangle = |2\rangle$ states which are expected to be miscible at zero magnetic field [5, 6]. The $|2\rangle$ state is highly sensitive to a magnetic field gradient while $|1\rangle$ state is insensitive. We prepared $|2\rangle$ BEC in an optical trap at 20 G of magnetic field. Half of condensate was transferred to $|1\rangle$ by radio-frequency and microwave fields. Our result suggests that $|1\rangle$ and $|2\rangle$ BECs in the optical trap are spatially separated by a magnetic field gradient. During separation, soliton trains (solitary waves) in two-component BECs are observed above threshold magnetic field gradient.

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