Formation of Quantum Turbulence from Dark Solitons in Atomic Bose-Einstein Condensates

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We theroretically propose a new method of making quantum turbulence from many dark solitons in atomic Bose-Einstein condensates. We solve numerically the two-dimensional Gross-Pitaevskii equation. We set many solitons which are parallel and perpendicular to each other for initial states. A dark soliton is known to be stable in one-dimensional system, but unstable in two- or three-dimensional systems and decay to vortices. Our simulation shows that these solitons decay to a lot of vortices which move around the system and eventually lead to two-dimensional quantum turbulence. The probability distribution function of the superfluid velocity obeys a Gaussian distribution in the low-velocity region and a power-law distribution in the high-velocity region. This scenario may be experimantally realized through interference of Bose-Einstein condensates in a trap potential.