

# Monopoles and Dipoles in Spinor Bose–Einstein Condensates

E. Ruokokoski<sup>a</sup> and M. Möttönen<sup>a,b</sup>

<sup>a</sup>Department of Applied Physics/COMP, Aalto University, P.O. BOX 14100, FI-00076 Aalto, Finland

<sup>b</sup>Low Temperature Laboratory, Aalto University, P.O. Box 13500, FI-00076 AALTO, Finland

Bose–Einstein condensates with spin degree of freedom may host many topologically interesting structures, absent in scalar condensates. For ferromagnetic order parameter manifold the triviality of the second homotopy group implies that isolated monopole defects are not allowed. Monopole defects may, however, appear as endpoints of vortex lines. It has been recently shown that, using a nontrivial magnetic field configuration, one can create a monopole defect into the spin texture of the condensate<sup>1</sup>. The vorticity of this defect is equivalent to the magnetic field of a Dirac monopole. In this work, we show that such a monopole defect may exist as the ground state of the condensate. We also investigate a dipole defect associated with a vortex filament extending throughout the condensate.

<sup>1</sup>V. Pietilä and M. Möttönen, Phys. Rev. Lett. **103**, 030401(2009).