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Bright-like dark solitons and current-phase characteristics of superfluid Bose mixtures near the first-order Mott transition[1] IPPEI DANSHITA, Yukawa Institute for Theoretical Physics, Kyoto University, DAISUKE YAMAMOTO, Condensed Matter Theory Laboratory, RIKEN, YASUYUKI KATO, RIKEN Center for Emergent Matter Science — We consider a superfluid phase of binary Bose mixtures in an optical lattice. It is well known that the superfluid-Mott insulator transition in this system is of first order when the filling factor is even and the inter-species repulsion is smaller than but close to the intra-species repulsion. We show that in the vicinity of the first-order boundaries to the Mott insulators the superfluid order parameters obey the nonlinear Schrödinger equation (NLSE) with not only cubic but also quintic nonlinearity. We analytically solve the cubic-quintic NLSE to obtain soliton solutions. In particular, when the superfluid state changes from a ground state to a metastable one, a standard dark soliton turns into a bright-like dark soliton, which has a non-vanishing density dip and no π phase kink even in the case of a standing soliton. In the presence of a potential barrier, we find the critical barrier strength above which there is no superfluid solution and unconventional current-phase characteristics, owing to the bright-like dark soliton.

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