Symmetry analysis of the chiral solitons in the extended SuSchrieffer-Heeger model :
Particle-antiparticle duality and fractionalization

Sang-Hoon Han*, Chang-geun Oh**, Seung-Gyo Jeong***, Tae-Hwan Kim***
and Sangmo Cheon*

*Department of Physics, Hanyang University, Seoul 04763, South Korea
*Research Institute for Natural Sciences, Hanyang University, Seoul, Korea
** Research Institute for Basic Science, Ajou University, Suwon 16499, Korea
***Department of Physics, Pohang University of Science and Technology (POSTECH), Pohang 790-784, Korea.

Email: oksk0729@gmail.com

Topological phases and their topological features are enriched by the fundamental time-reversal, particle-hole, and chiral as well as crystalline symmetries. While one-dimensional (1D) generalized Su-Schrieffer-Heeger (SSH) systems show various topological phenomena such as topological solitons and fractional fermion charges[1,2], it remains unclear how such symmetry protects and relates such topological phenomena.

Here we show that the generalized time-reversal, particle-hole, and chiral symmetry operators consistently explain not only the symmetry transformation properties between the ground states but also the topological features of the topological solitons in prototypical quasi-1D systems such as the SSH, Rice-Mele, and double-chain models.[3] Furthermore, we demonstrate that each chiral soliton is re-fractionalized into two subsolitons, which we will refer to as "2nd fractionalization." [4].

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