Edge states in molecular solid $\alpha$-(BEDT-TTF)$_2$I$_3$: Effects from electron-electron interaction

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The Dirac electrons in condensed matters have attracted attention in basic science and device application, and found in several materials, e.g., graphene and bismuth alloy. The quasi-two-dimensional organic conductor $\alpha$-(BEDT-TTF)$_2$I$_3$ is also one of such materials: It exhibits the zero-gap state with the massless Dirac electron under pressure [1]. Compared with other materials, it is worthy of notice that this system has strong long-range Coulomb interaction due to the weak screening. Actually, the nearest-neighbor Coulomb repulsion in this system causes a metal-insulator transition at $T_{MI}=135K$ at ambient pressure [2], and the insulating phase is the stripe charge ordered state confirmed by NMR experiment [3], as theoretically proposed [4].

In this study, we examine the properties of the Dirac electrons in the material $\alpha$-(BEDT-TTF)$_2$I$_3$ from the view of the edge states, especially with interest in effects from electron-electron interaction. The edge state in the material was studied in theoretical previous work [5], in which, however, the interaction terms were not considered. Based on the analysis of the extended Hubbard model with the Hartree-Fock approximation, we show the edge states and its conduction characteristics. We also discuss particular flux state due to the next-nearest-neighbor repulsion, in relation to the topological Mott insulator state [6].