Editors

Physical Review B

Dear Editors,

Attached please find a manuscript entitled “Ferromagnetism and spin excitations in topological Hubbard models with a flatband” by Xiao-Fei Su, Zhao-Long Gu, Zhao-Yang Dong, Shun-Li Yu and Jian-Xin Li, which is submitted for consideration to be published in “Physical Review B”.

Interacting fermionic systems with topological bands constitute a central part of modern condensed matter physics. One particular intriguing situation occurs when the topological bands are nearly flat so that interaction effects are highly enhanced. In such systems, exotic topological phases can emerge out of a fractionally filled band with the aid of itinerant ferromagnetism although the noninteracting counterpart is just a featureless metal. The existence of itinerant ferromagnetism is essential for the emergence of such topological phase but has been less studied before. Therefore, we focus on the stability of the ferromagnetism and spin-flip excitations on these phases. In particular, we study half-filled topological flat bands as a paradigm, where quantum anomalous Hall effect can emerge when itinerant ferromagnetism polarizes all the electron spins. Square lattice π flux models with Hubbard interactions are used for illustration, whose free electron bands can be characterized either by a Chern number or a index depending on the nearest-neighbor hopping. A previous work developed a generalized bosonization scheme with the harmonic approximation to study the ferromagnetic spin excitations of these models. However, the nonflatness of the topological bands, which are nonavoidable in strictly local periodic tight binding models with nonzero Chern numbers, is ignored in their scheme, which means, they cannot capture the physics of the destabilization of the ferromagnetic ground state. In this article, by using the numerical exact diagonalization method with a projection onto the nearly-flat band, we obtain the ferromagnetic spin-1 excitation spectra for both the Chern and Hubbard models, consisting of spin waves and Stoner continuum. The spectra exhibit quite distinct dispersions for both cases, in particular the spin wave is gapless for the Chern Hubbard model, while gapped for the Hubbard model. Remarkably, in both cases, the nonflatness of the free electron bands introduces dips in the lower boundary of the Stoner continuum. It significantly renormalizes the energies of the spin waves around these dips downward and leads to roton-like spin excitations. We elaborate that it is the softening of the roton-like modes that destabilizes the ferromagnetic phase, and determine the parameter region where the ferromagnetic phase is stable.

We believe that our work is suitable for a publication in “Physical Review B”. Thanks in advance for your kind consideration.

Yours sincerely,

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