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Properties of Twisted Bilayer Graphene and Impact of Symmetry Breaking

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ABSTRACT We have studied the properties of twisted bilayer graphene and impact of symmetry breaking. The twisted bilayer graphene feature is degenerate flat bands for twist angle. The chiral symmetry is responsible for breaking the magic value is responsible for flat bands. It was found that breaking in twisted bilayer graphene is weaker. It was also found that half chiral model helps to determine phases of twisted bilayer graphene. The formation of flat bands the presence of strong coupling is essential and it removes symmetry breaking. It was found that when perturbation was used for the obtaining results then induction of band width and change of magic number was not possible. The breaking due to low harmonic produced phases towards potential creation. The chiral symmetry generated insulating states.

KEYWORDS Twisted Bilayer Graphene, Symmetric Breaking, Degenerate Flat Band, Half Chiral Model, Coupling, Perturbation, Magic Value.

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INTRODUCTION

Lopesdos Santos et al. [1] studied the correlation of twisted bilayer graphene for eight fold degenerate graphene having different magic values. Tarnopolsky et al. [2] and Berneving et al. [3] studied the degeneracy of flat bands for chiral symmetry breaking and it was found that breaking was weak. Some investigators [4-7] studied and explained the formation of insulating states due to chiral symmetry and was helpful for detecting quantum anomalous Hall effect. Wang et al. [8] and Sheffer et al. [9] explained that chiral flat bands are part of Landau level and worked as Chern insulators [10]. Bultinck et al. [11] and Hofmann et al. [12] presented the transfer of chiral model to twisted bilayer graphene and was useful for drawing phase diagram. Crepel ad Fu [13] presented the anomalous Hall metal and fractional Chern insulator in twisted transition metal dichalcogenides. Mao et al. [14] presented low energy effective theory of twisted graphene of moiré materials. Guk Ahn et al. [15] studied the wrinkle graphene using density functional theory. It was found that for explanation of interfacial interaction between graphene and substrate was essential for quantum confinement.

METHOD

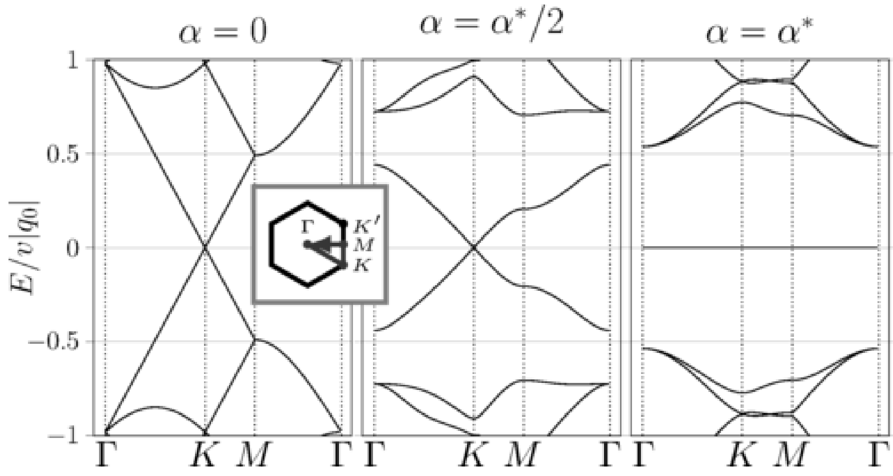
We have considered the chiral model for the study of our problem. The simulation technique have been applied to obtain the results of proposed problem. The design of moiré materials were used for finding chiral model. The skyrmions for twisted bilayer through moiré analog was taken into consideration having half degrees of freedom. We have explained realization of half-chiral model of superlattice potential was used. The variation of potentials were obtained for graphene monolayer. We have studied the impact of interactions and presentation of many body ground states were utilized having integer of Quantum Hall anomalous states. The impact of symmetry breaking was studied. We have taken graphene substrate hetrostructure fabrication for matching potentials. The coupling of two valleys of graphene on moiré scale was used. The potential of onsite diagonal for sublattice index was studied. The Dirac cone velocity was determined for flat bands. The various energy scales were used for determining Dirac cones of graphene without perturbation. The effective Hamiltonian was utilized to obtain results. The relation is was used for the study.

$$H_K\left(\bar{k}\right)=\upsilon\bar{k}\times\tau,\ \ H_{K'}\left(\bar{k}\right)=\upsilon\bar{k}\times\tau$$

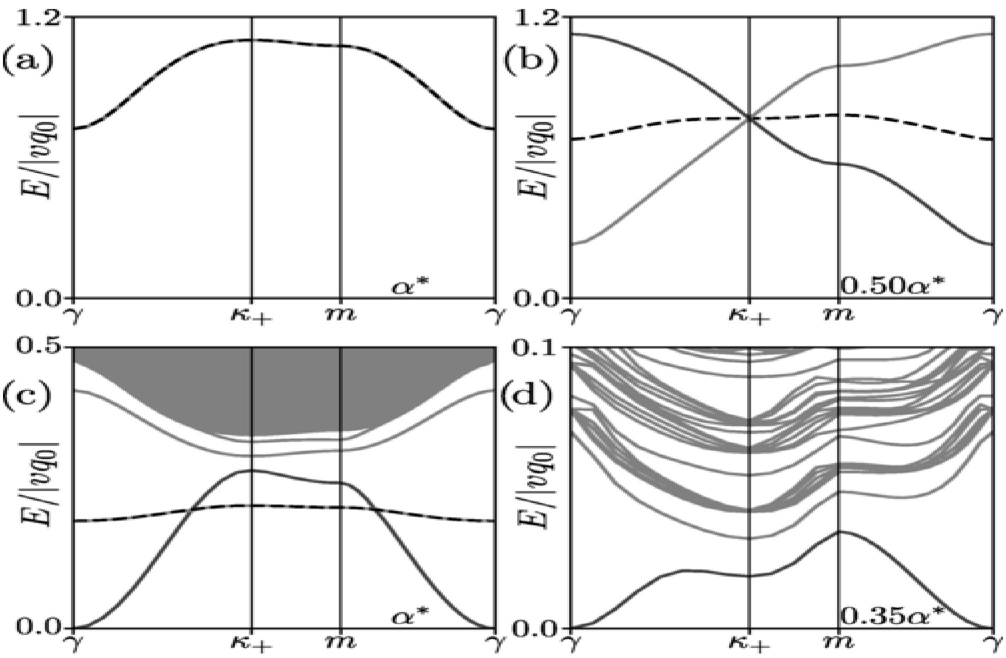
Where $\bar{k}$ is the deviation of the ratio $\frac{K}{K'}$ ratio, τ is the vector and υ is the Fermi velocity of graphene. The coupling of matched onsite potential was examined. The unitary transformations were considered for chiral model valley for twisted bilayer graphene. The flat bands due to twist angle and hopping strength were tuned, considering lower magic values. The form factor of interaction was determined for symmetry constraints. The account of lower internal degeneracy of the model was made. The study of chern insulators were made and found for odd number of flat bands.

RESULTS AND DISCUSSION

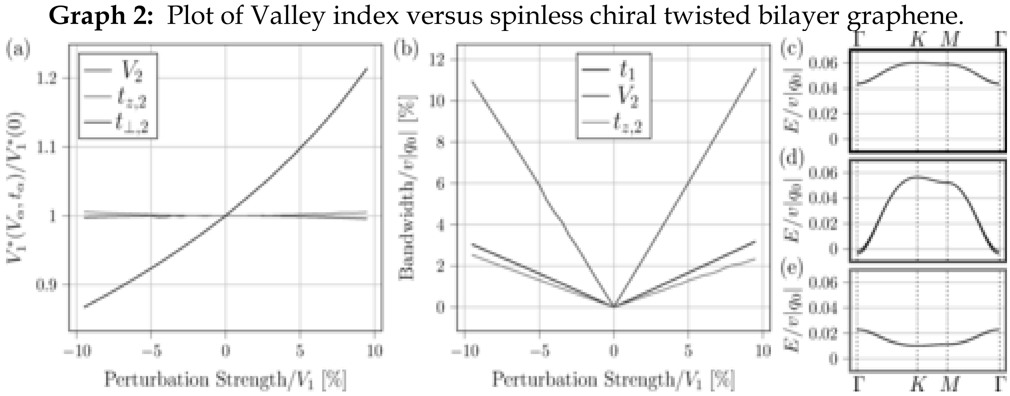
We have studied the properties of twisted bilayer graphene and impact of symmetry breaking. The realization of half chiral model by superlattice potential was made. The variation of potential with lattice constant was made. The matching of substrate induced potential with half chiral model was made. The impact of interactions produced many body ground states for integer filling. Graph (1) shows the plot of band structure of two spin degenerate flat bands. The flat bands contained non zero chern number. The symmetries of the two models coupled with flat bands. Graph (2) shows the play of valley index for spinless chiral twisted bilayer graphene. Graph (3) (a) and (3) (b) shows the spectra of charge excitations versus ground state polarization. Graph (3) (c) and Graph (3) (d) show the spectrum of neutral excitation. The broken symmetry is also seen in this graph. It is also seen that branch of gap excitations were opposite of the ground state. In this study it was found that screening of interaction produced ferromagnetic state and was found unstable when dispersion was longer. It was found that when periodic potential on graphene was acted then artificial patterning was found. The obtained results were compared with previously obtained results and were found in good agreement.



Graph 1: Plot of band structure of two spin degenerate flat bands.



Graph 2: Plot of Valley index versus spinless chiral twisted bilayer graphene.



Graph 3: Plot of spectra of charge excitations vs ground state polarization.

CONCLUSION

We have studied the properties of twisted bilayer graphene and impact of symmetry breaking. It was found that the symmetry breaking is due to stabilization of integer filling at different phases. The flat band and superlattice potential in the case of twisted bilayer graphene were produced due to substrate. The impact of interactions produced many body ground states realization. The obtained results were found in good agreement with previously found results.

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