Contribution ID: **12** Type: **Poster**

Fractal spectrum and dimension extension of twisted bilayer optical lattices in ultracold atoms

Wednesday 4 September 2024 17:00 (2 hours)

The experimental realization of twisted bilayer optical lattices in ultracold atomic gases (Nature 615, 231 (2023)) has paved the way towards the investigation of moiré physics in cold quantum gases. I will present two recent theoretical works in this system. In the first work (arXiv:2404.08211), we point out that the geometric moiré effect can induce fractal band structures. The fractals are controlled by the twist angle between two monolayers and are closely connected to the celebrated butterfly spectrum of two-dimensional Bloch electrons in a magnetic field. We also provide numerical evidence on the infinite recursive structures of the spectrum and give an algorithm for computing these structures. In the second work (2404.19608), we propose that by utilizing the current, it is possible to construct a twisted three-dimensional optical lattice in ultracold atomic gases, which extends the moiré physics to higher dimensions. It is worth emphasizing that such lattices cannot be realized in condensed-matter systems, for it is impractical to overlay two pieces of three-dimensional solid-state material. We develop the general theory describing the commensurate conditions, lattice structures, and crystalline symmetries of these lattices. We highlight the fundamental difference between moiré physics in two and three dimensions. That is, three-dimensional moiré lattices can possess more versatile crystalline structures because of the non-commutative nature of SO(3).

References

https://arxiv.org/abs/2404.08211
https://arxiv.org/abs/2404.19608

Short bio (50 words) or link to website

https://faculty.ecnu.edu.cn/_s29/szy_en/main.psp

Relevant publications (optional)

Career stage

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Presenter: SHI, Zheyu

Session Classification: Posters II

Track Classification: FINESS