Exotic magnetism in quasicrystals

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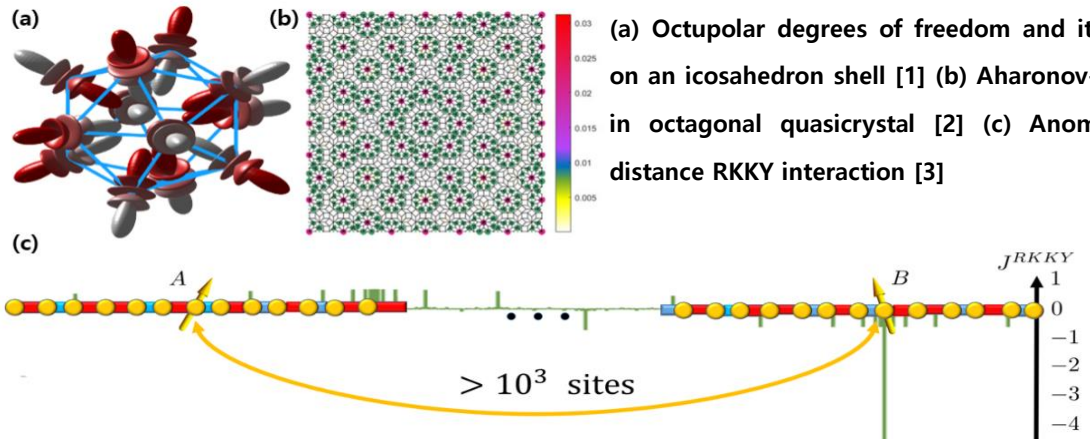
For a long time, the understanding of condensed matter physics has been limited to either periodically ordered crystals or randomly disordered systems. However, there are completely different types of condensed matter systems, in particular quasicrystals, which are ordered without periodicity. In quasicrystals, non-crystallographic symmetries would be allowed, although traditional crystal momentum analysis would not be applicable, and their own fractal structure and quasiperiodicity can lead to new physical phenomena.

This talk presents typical interesting novel phenomena in different dimensional quasicrystals: Multipolar frustration in 3D [1], Aharonov-Bohm cages in 2D [2], and anomalous RKKY interaction in 1D [3]. First, the non-crystallographic symmetries can lead to multipolar degrees of freedom, which are allowed only in quasicrystals but forbidden in conventional crystals. Based on the self-similar icosahedral structure, the long-range frustration and quantum fluctuations are discussed. Next, exotic tiling patterns of quasicrystals would lead to multiple length scales of Aharonov-Bohm cages and their relocalization. Third, we point out the anomalous RKKY interaction in quasicrystals. Instead of the uniform decay, the RKKY interaction becomes significant between the moments in the non-local region in the quasiperiodic chain. It realizes a strong coupling between the widely separated moments. It turns out that such an anomalous RKKY interaction originates from the critical states of electrons, neither localized nor extended, which mediate the RKKY interactions on behalf of the itinerant electrons. Finally, we also discuss a possible non-local manipulation of the moments by the RKKY coupling.



(a) Octupolar degrees of freedom and its frustration on an icosahedron shell [1] (b) Aharonov-Bohm cages in octagonal quasicrystal [2] (c) Anomalous long-distance RKKY interaction [3]

[1] Junmo Jeon, SungBin Lee, *npj Quantum Mater.* 9, 5 (2024)

[2] Junmo Jeon, Moon Jip Park, and SungBin Lee, *Phys.Rev.B* **105**, 045146 (2022)

[3] Junmo Jeon, SungBin Lee, arXiv 2310.15228 (2023)