

Laughlin-like states of few atomic excitations in small subwavelength atom arrays

Błażej Jaworowski

Darrick E. Chang

ICFO - Institut de Ciències Fòniques, The Barcelona Institute of Science and Technology, Castelldefels (Barcelona) 08860, Spain

blazej.jaworowski@icfo.eu

Atom arrays with sub-wavelength lattice constant can exhibit fascinating optical properties. For example, the combination of V-type level structure and magnetic fields can yield topological band structures, making the neutral atomic excitations behave like charged particles in a magnetic field. Up to now, much of our understanding of these systems (and arrays in general) focuses on the single-excitation regime. Here [1], we go beyond the single-excitation level to show that such systems can give rise to few-particle Laughlin-like states. In particular, we consider small honeycomb “flakes,” where the harmful divergences near the light cone can be smeared out by finite-size effects. By choosing an appropriate value of magnetic field we thereby obtain an energy spectrum and eigenstates resembling those of Landau levels. The native hard-core nature of atomic excitations then gives rise to multi-excitation Laughlin-like states. This phenomenon occurs not only in samples of tens of sites, but also in a minimal nanoring system of only six sites. Next, considering two-particle Laughlin-like states, we show that they can be driven by uniform light, and that correlations of the output light contain identifying fingerprints

of these states. We believe that these results are a step towards new paradigms of engineering and understanding strongly-correlated many-body states in atom-light interfaces.

References

- [1] B. Jaworowski, D. E. Chang, arXiv:2504.17014 (2025)