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Interaction-induced multiparticle bound state in continuum and topological pumping

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Bound states in the continuum (BICs) are localized modes residing in the radiation continuum. They were first predicted for single-particle states, and became a general feature of many wave systems. In many-body quantum physics, it is still unclear what would be a close analog of BICs, and whether interparticle interaction may induce BICs. Here, we predict a novel type of multiparticle states in the interaction-modulated Bose-Hubbard model that can be associated with the BIC concept. Under periodic boundary condition, by constructing multiparticle Wannier states via projection position operator, a so-called quasi-BIC appears as a bound pair residing in a standing wave formed by the third particle. Under open boundary condition, such a hybrid state becomes an eigenstate of the system. We demonstrate that the Thouless pumping of the quasi-BICs can be realized by modulating the onsite interactions in space and time [1]. Surprisingly, while the center-of-mass of the quasi-BIC is shifted by a unit cell in one cycle, the bounded pair moves into bound pair moves in the opposite direction with the standing waves [2]. This is in stark contrast to Thouless pumping of bound states or topologically resonant pumping [3], where all particles move in the same direction. Our work not only paves an avenue to construct multiparticle BICs, but also may provide a new possibility to realize the Hilbert space fragmentation, many-body scars, and ergodicity breaking.

References

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