Polariton Bose-Einstein condensate from a Bound State in the Continuum

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Abstract

Optical bound states in the continuum (BIC) [1] are peculiar topological states that, when realized in a planar photonic crystal lattice, are symmetry-protected from radiating in the far field despite lying within the light cone. These BICs possess an invariant topological charge given by the winding number of the polarization vectors, similarly to vortices in quantum fluids, such as superfluid helium and atomic Bose-Einstein condensates. Here we show Bose-Einstein condensation of polaritons, hybrid light-matter excitations, occurring in a BIC thanks to its peculiar non-radiative nature. Because of the high-quality factor of the polariton BIC, condensation takes place even without an absolute energy minimum in the dispersion: by directly accessing the system dispersion through angle and energy resolved PL measurements, we have observed that the BIC in a simple waveguide-grating system is part of a more complex, saddle-like dispersion. Our work opens a promising route for controlling the polariton condensate properties in a new way, i.e., by transferring topological properties from a photonic structure [2] to a macroscopic quantum fluid of light, with potential applications to metasurfaces exciton-polaritons in alternative material platforms [3] using simple shallow patterning of planar waveguides. Such an observation may open a route towards energy-efficient polariton condensation in cost-effective integrated devices, ultimately suited for the development of hybrid light-matter optical circuits.

References

[1] Chia Wei Hs et all. Nat Rev Mater 1, 9, (2016),16048.
[2] Bo Zhen et all. Physical Review Letters, 25, (2014), 257401.
[3] Long Zhang et all. Nature Communications, 9, (2018), 713.

Figures

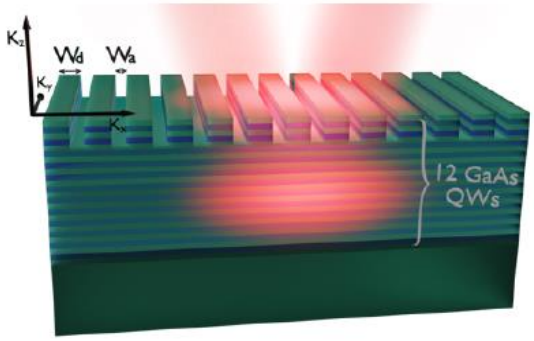

Figure 1: representation of the polariton waveguide with partially etched 1D lattice

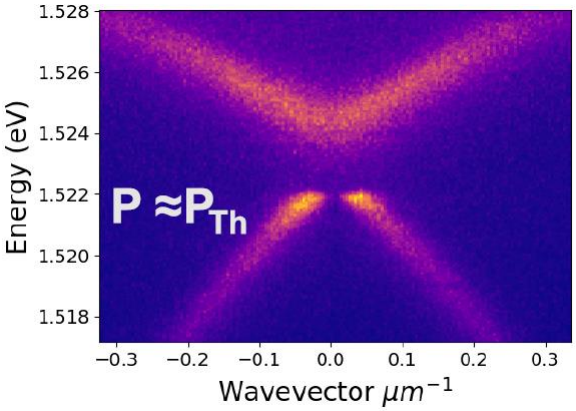

Figure 2: Angular resolved PL emission under non-resonant ps (pulsed) excitation (snapshot from a time-resolved streak camera). Around threshold a double peaked emission occurs around k~ 0. When the pumping power is increased this emission becomes dominant.