

Theory of two-dimensional correlated phases of moat-band excitons

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We study two-dimensional systems of interacting excitons with a moat dispersion [1], for which the ground-state energy manifold presents a ring of discrete or continuously degenerate minima around a single point in momentum space. Such a dispersion can arise in systems such as topological insulators with a band inversion [2]. At low densities, the excitons undergo statistical transmutation and stabilize a chiral spin liquid. At higher densities, the moat dispersion favors Bose-Einstein condensation into states occupying multiple momenta, leading to inhomogeneous condensate phases and potentially supersolidity. We discuss the impact of band-structure warping present in realistic systems, which may lower the formation threshold of Bose-Einstein condensate phases. We analyze the superfluid response of the latter, which is unconventionally anisotropic due to the moat band. We also demonstrate that a proper renormalization of the exciton-exciton interaction is essential for describing these phases, and show that even purely repulsive interactions can favor inhomogeneous condensates. Our findings indicate that the presence of degenerate dispersion minima can drive supersolidity already at weak coupling, in contrast to systems with a standard parabolic dispersion. Finally, we discuss our results in the context of real excitonic systems and argue that moat-band-induced supersolidity can be within experimental reach for realistic values of the model parameters.

References

- [1] L. Maisel Licerán, S. H. Boeve, H. T. C. Stoof, *arXiv preprint*, arXiv:2602.18194 (2026)
 [2] L. Maisel Licerán, F. García Flórez, L. D. A. Siebbeles, H. T. C. Stoof, *Scientific Reports*, 13.1 (2023) 6337

Figures

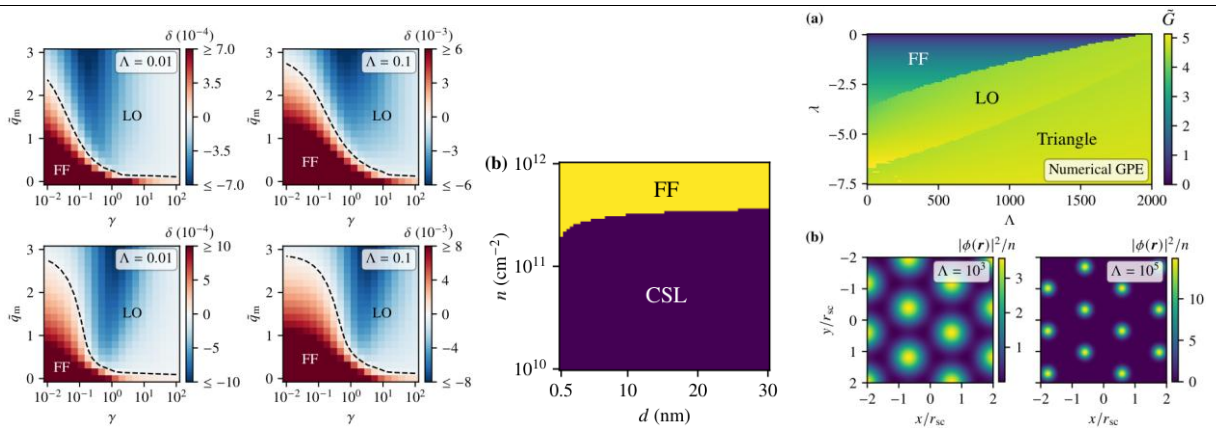


Figure 1: (Left) Phase competition between a homogeneous Fulde-Ferrel (FF) phase and an inhomogeneous Larkin-Ovchinnikov (LO) phase in an electron-hole bilayer system, as a function of the moat radius q_m and the interaction strength γ . (Center) Phase competition between the chiral spin liquid and the condensed phases as a function of the exciton density n and the interlayer distance d . (Right) Phase diagram of Bose-Einstein-condensed exciton phases in an effective Gross-Pitaevskii scheme as a function of the moat parameter $\lambda = -q_m^2$ and an effective interaction strength Λ , showing a region with a triangular condensate exhibiting an unconventional anisotropic superfluid response. Corresponding wave functions are shown below the phase diagram. Cf. Ref. [1].