SUPERFLUIDITY IN A DRIVEN-DISSIPATIVE COLD EXCITON GAS

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Indirect excitons is a perfect solid-state platform for studying many-body effects, thanks to their long lifetimes, high critical temperatures, and the possibility to control the density by laser excitation [1]. To describe the motion of such cold excitonic systems, a formalism based on transport equations was developed in a series of works [2]. However this approach breaks down in the limit of very low temperatures where collective effects take place.

In our work, we develop a formalism based on quantum hydrodynamics approach [3], extending the description from conservative to driven-dissipative systems. Relating to the geometry of the experiment [1] with spatially-separated pumping and losses, we account for pumping as boundary conditions on density and velocity of the exciton incoming flow, while the losses are assumed present in all 2D space in consideration. We introduce the free energy functional of the system with terms describing dissipation, and study its properties in the hydrodynamic approximation. Stationary profiles of the condensate density and velocity are obtained from the applied model (Fig. 1), indicating the existence of the static superfluidity in the system. Furthermore, we derive the quadratic Hamiltonian and obtain the Bogoliubov spectrum of excitations which indicates that the excitations do not decay despite the losses in the system.

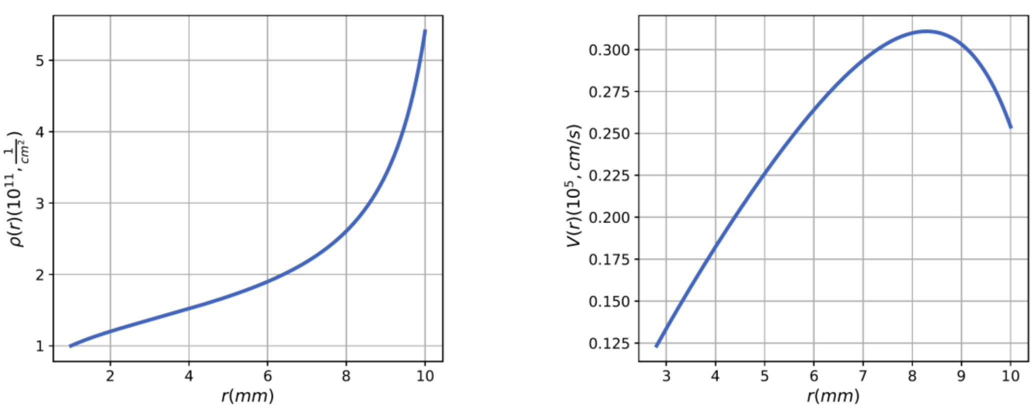

Fig. 1. Stationary profiles of the density (left) and velocity (right), with the lifetime $\tau = 42$ ns and effective mass of the indirect exciton $m = 0.22\, m_e$ (experimental data from [1]).

References

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