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Non-equilibrium processes and localised states in exciton-polariton condensates

This thesis focuses on localised states and processes mediated by vortices, present in non-equilibrium exciton-polariton condensates.

First chapter is an introduction to concept of exciton-polaritons. The basis of what the particle is, it's physical properties and experimental setup is described in detail. Theoretical description of Bose-Einstein condensation and equation governing dynamics of the condensate are the described later in the chapter. Last subject in this chapter is the condensation of polaritons themselves, the way it is achieved experimentally in different setups and equations describing it's evolution.

Second chapter focuses on the stationary solutions, to one dimensional open-dissipative gross-pitaevski equation, called Sinks. This chapter includes thorough description of what a sink solution is, for example in comparison to other known stationary solutions of this equation. Phase diagram describing the existence of sink solution is presented together with analysis of the properties of sinks. Later in the chapter we introduce numerical methods for finding sinks and approximate analytical solutions. At the end we investigate possibility of existence of sinks in two dimensions.

Third chapter introduces concept of phase ordering kinetics and universality scaling in broader therms and in case of Bose-Einstein condensation. We investigate correlation function scaling in case of open-dissipative GPE. We show that for two sets of parameters the scaling coefficient are different but comparable to either conservative or dissipative systems.

Fourth chapter deals with the idea of two dimensional topological phase transition called Berezinskii–Kosterlitz–Thouless transition. We start with explaining the physics behind the BKT transition based on two dimensional XY model. We than move to numerical simulations starting by introducing numerical conditions necessary for proper simulation. We show to sets of results, one achieved by using unphysical parameters and others based on parameters of the sample used by group of professor Yamamoto. We show the existence of phase transition by the fact of the change of correlation function from exponential drop to algebraic drop for both sets of parameters.

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