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FISHER METRIC FOR DIAGONALIZABLE QUADRATIC HAMILTONIANS AND APPLICATION TO PHASE TRANSITIONS

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Abstract. We derive the extended entanglement entropy and the Fisher information metric in the case of quantum models, described by time-independent diagonal quadratic Hamiltonians. Our research is conducted within the framework of Thermo field dynamics. We also study the properties of the Fisher metric invariants to identify the phase structure of the quasi-particle systems in equilibrium.

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1. Introduction

One of the most challenging problems in modern physics is the intrinsic property of quantum systems to develop entanglement between their subsystems. A well-suited quantity, characterizing this process, is the geometric or entanglement entropy (EE), which is usually obtained by a trace over the degrees of freedom situated in a subspace of the whole system.

To better understand the intrinsic features of this kind of problems one can refer to the powerful tools of information geometry [1, 2]. The key concept here is the so-called Fisher information metric (FIM) [6], which defines a natural distance between different probability distributions, represented as points on a statistical manifold. By construction FIM can be defined as the Hessian of the entanglement entropy. Furthermore, the Fisher metric describes a continuous setting even if the underlying features of the system are discrete, which allows one to apply the classical methods of differential geometry as well.