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Quasi-Particles at Finite Temperatures

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Abstract. We study the consequences of the KMS-condition on the properties of quasi-particles, assuming their existence. We establish

(i) If the correlation functions decay sufficiently, we can create them by quasi-free field operators.

(ii) The outgoing and incoming quasi-free fields coincide, there is no scattering.

(iii) There are may age-operators T conjugate to H. For special forms of the dispersion law $\varepsilon(k)$ of the quasi-particles there is a T commuting with the number of quasi-particles and its time-monotonicity describes how the quasi-particles travel to infinity.

1. Introduction

In this paper we shall explore the hypothesis that the elementary excitations of an infinite quantum system in a KMS-state consist of quasi-particles. The many-body folklore is full of these objects like phonons, magnons, plasmons, solitons, cooper-pairs etc. and there is some empirical evidence for their existence [1]. Landau [2] based his theory of quantum liquids on this assumption but to our knowledge the consequences of the KMS-structure for their behaviour has not been worked out as yet. The physical idea is that although the equilibrium state provides a complicated background of interacting particles like the vacuum in quantum field theory a local disturbance will spread out to infinity like wave-packets in elementary quantum mechanics. Mathematically this is reflected by the spectrum of energy and momentum. For a fixed momentum k the energy spectrum is assumed to consist of a pure point spectrum $\varepsilon(k)$ plus a continuous background. In contradistinction to relativistic quantum field theory where Poincaré invariance requires $\varepsilon(k)=\sqrt{m^2+k^2}$, we don't have any a priori knowledge about the function $\varepsilon(k)$, but assume that it behaves reasonably.

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