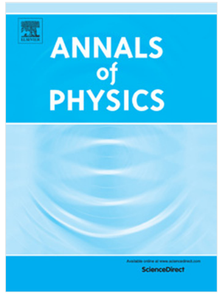

Unified formalism for Thermal Quantum Field Theories: A geometric viewpoint

M. Blasone, P. Jizba, G.G. Luciano

PII: S0003-4916(18)30221-5
DOI: https://doi.org/10.1016/j.aop.2018.08.009
Reference: YAPHY 67737

To appear in: *Annals of Physics*

Received date : 7 May 2018
Accepted date : 19 August 2018

Unified formalism for Thermal Quantum Field Theories: a geometric viewpoint

M. Blasone[a,b], P. Jizba[c,d], G.G. Luciano[a,b,c,*]

[a]Dipartimento di Fisica, Università di Salerno, Via Giovanni Paolo II, 132, 84084 Fisciano, Italy
[b]INFN Sezione di Napoli, Gruppo collegato di Salerno, Italy
[c]FNSPE, Czech Technical University in Prague, Břehová 7, 115 19 Praha 1, Czech Republic
[d]ITP, Freie Universität Berlin, Arnimallee 14, D-14195 Berlin, Germany

Abstract

In this paper we study a unified formalism for Thermal Quantum Field Theories, i.e., for the Matsubara approach, Thermo Field Dynamics and the Path Ordered Method. To do so, we employ a mechanism akin to the Hawking effect which explores a relationship between the concept of temperature and spacetimes endowed with event-horizons. In particular, we consider an eight dimensional static spacetime, the so-called η-ξ spacetime, which we show to form an appropriate geometric background for generic Thermal Quantum Field Theories. Within this framework, the different formalisms of Thermal Field Theory are unified in a very natural way via various analytical continuations and the set of time-paths used in the Path Ordered Method is interpreted in geometric terms. We also explain reported inconsistencies inherent in the Thermo Field Dynamics through the appearance of horizons (and ensuing loss of information) in the η-ξ spacetime.

Keywords: Thermal Field Theories, η-ξ spacetime

1. Introduction

Under the generic name *Thermal Quantum Field Theory* (TQFT) [1, 2, 3, 4, 5, 6] one collects all formalisms of Quantum Field Theory (QFT) at finite temperature and density, i.e., the Matsubara or Imaginary Time (IT) approach [1, 2, 3], Thermo Field Dynamics (TFD) [1, 6, 7, 8] and the Path Ordered Method (POM) [5, 9]. The latter includes, for instance, the familiar Closed Time Path (CTP) formalism of Keldysh and Schwinger [1, 2, 3] as a special case. The existence of these distinct approaches results from conceptually different efforts to introduce a temperature within the framework of QFT. For instance, in the

*Corresponding author
Email addresses: blasone@sa.infn.it (M. Blasone), p.jizba@fjfi.cvut.cz (P. Jizba), gluciano@sa.infn.it (G.G. Luciano)