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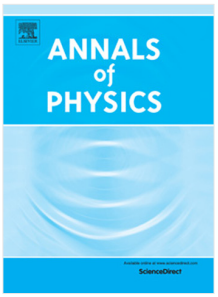

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Emergent Scenario in first and second order non-equilibrium thermodynamics and stability analysis

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First and second order non-equilibrium thermodynamics are studied in the context of particle creation mechanism for homogeneous and isotropic FLRW model and a general formulation of the emergent scenario is investigated. Finally, the stability of the non-equilibrium thermodynamics is examined.

Keywords: Non-equilibrium thermodynamics, Emergent scenario, Particle creation, Bulk viscous pressure.

PACS Numbers: 95.30.Sf, 98.80.Cq, 11.90.+t, 05.70.Ce

I. INTRODUCTION

Non-equilibrium thermodynamics seems to play a vital role for the description of the Universe in the early eras. Schrödinger [1] initiated such study in the context of the microscopic description of the gravitationally induced particle production in an expanding universe. From the point of view of quantum field theory in a curved space-time, Parker and others [2–4] reconsidered this issue. From thermodynamic viewpoint, the study of non-equilibrium thermodynamics can be classified as first order formalism and second order deviation from equilibrium era. The first order theory due to Eckart [5] and Landau and Lifshitz [6] has drawback in relation to causality and stability. These problems are eliminated in the second order theory due to Muller [7], Israel [8], Israel and Stewart [9, 10] and Pavon *et al* [11]. According to them, dissipative phenomena in the form of bulk and shear viscous pressure and heat flux are considered as dynamical variables with causal evolution equations having subluminal speed of viscous perturbations.

However, in cosmological context, as space-time is usually assumed to be homogeneous and isotropic, so dissipative phenomenon is only in the form of bulk viscous pressure which may

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