شبكة المعلومات الجامعية

# بسم الله الرحمن الرحيم


HOSSAM MAGHRABY

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# التوثيق الالكتروني والميكروفيلم

HOSSAM MAGHRABY

شبكة المعلومات الجامعية

# جامعة عين شمس

## التوثيق الإلكتروني والميكروفيلم

## قسم

نقسم بالله العظيم أن المادة التي تم توثيقها وتسجيلها

علي هذه الأقراص المدمجة قد أعدت دون أية تغيرات

## يجب أن

تحفظ هذه الأقراص المدمجة بعيدا عن الغبار

HOSSAM MAGHRABY


# VISCOUS PROPERTIES OF QUARK-GLUON PLASMA AND THEIR COSMIC IMPACTS

**Thesis submitted for the degree of Master in physics to**

**Physics Department**
**Faculty of Women for Arts, Science and Education,**
**Ain Shams University**

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**(2021)**

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# CONTENTS

# Acknowledgments

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# Abstract

# Abstract

We condensate on the application and impacts of viscous Quark-gluon-plasma into the early Universe cosmology, Considering Friedmann-Lemaitre-Robertson-Walker Universe which the evolution is a flat, isotropic and homogeneous. First, take a simple system (closed system) which consists of one particle and one photon which particle represent matter and photon represent radiation. Other components such as dark matter and dark energy (cosmological constant) are not taken into consideration. By introducing a toy model based on a thermodynamical approach in order to propose a framework for finite bulk viscosity for the cosmic background (Friedmann-model). By applying thermodynamics in order to drive expressions for various cosmological quantities, such as the scale factor $a(t)$ and the Hubble parameter $H(t)$, energy density $\rho$ and bulk viscosity $\zeta$. Throughout this work, assume natural units for all physical quantities. Then, take open system and determine the equation of state and related with temperature and time dependence, properties of QGP, evolution of the cosmic parameters, the bulk viscose pressure related with Hubble parameter and time plank. From LQCD data, finding proposal equations represented in relation of energy density $\rho$, pressure $p$, with temperature $T$ and related by equation of state (EoS). Entropy density $s$, speed of sound squared ${C_s}^2$, bulk viscosity $\zeta$, shear viscosity $\eta$ and ratios of coefficient of viscosity related to temperature $T$. Proposal equation between temperature $T$ and time $t$, wherefore determine proposal equation of Hubble parameter $H(t)$ and the scale factor $a(t)$ related with temperature $T$. Finally, the cosmological parameter of second order of causal Eckart frame is determined i.e. (first derivative of the Hubble parameter $H(t)$, energy density $\rho$ and bulk viscosity $\zeta$ and shear viscosity $\eta$ and bulk viscous pressure $\Pi$.

# LIST OF FIGURES

# Summary