UNIVERSITI PUTRA MALAYSIA

NEW ANISOTROPIC COSMOLOGICAL MODELS AND TWO-FLUID DARK ENERGY MODELS

HASSAN AMIRHASHCHI

FS 2011 20

NEW ANISOTROPIC COSMOLOGICAL MODELS AND TWO-FLUID DARK ENERGY MODELS

By

HASSAN AMIRHASHCHI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

April 2011

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DEDICATIONS

To

my loving wife Farzaneh

my beautiful daughter Tania

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Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

NEW ANISOTROPIC COSMOLOGICAL MODELS AND TWO-FLUID DARK ENERGY MODELS

By

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April 2011

Chair: Associate Professor Hishamuddin b Zainuddin, PhD

Faculty: Science

The global structure of space-times satisfying Einstein's field equations remains an active area of research, more than 80 years after the theory of general relativity was formulated. Space-times that are of physical interest can be separated into two main types, (i) ones of isolated system and (ii) ones that model the whole universe. This thesis is about the second type, cosmological models.

This study is focused on obtaining exact anisotropic solution for Einstein's field equations (EFEs) as a cosmologically accepted physical models for the universe (at least in the early stages). We have investigated the gravitational effects of different types of matter i.e. electromagnetic field, bulk viscus fluid, cosmic strings and cosmological constant as the matter (energy) sources in the energy-momentum tensor of the Einstein's field equations. Also, a new class of exact solutions of Einstein's modified field equations in inhomogeneous space-time for perfect fluid distribution with electromagnetic field is obtained in the context of normal gauge for Lyra's

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manifold. We have obtained solutions by considering the time dependent displacement field.

We have also studied the time varying gravitational constant (G) which has many interesting consequences in astrophysics. G-varying cosmology is consistent with whatsoever cosmological observations available at present. The Newtonian constant of gravitation plays the role of a coupling constant between geometry and matter in the Einstein field equation. The large number hypothesis proposed by Dirac leads to a cosmology when G varies with time. The geometrical and physical behaviors of all models are also discussed. Moreover in my research we have investigated the effect of interaction between barotropic fluid and dark energy on the equation of state parameter in FRW space-time by considering a variable deceleration parameter.

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Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

NEW ANISOTROPIC COSMOLOGICAL MODELS AND TWO-FLUID DARK ENERGY MODELS

Oleh

HASSAN AMIRHASHCHI

April 2011

Pengerusi: Profesor Madya Hishamuddin b Zainuddin, PhD

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Struktur global ruang-masa yang memuaskan persamaan medan Einstein masih lagi aktif dalam bidang penyelidikan, walaupun sudah lebih daripada 80 tahun selepas Teori Kenisbian Am diformulasikan.Ruang-masa yang menarik minat para penyelidik dapat dibahagikan kepada dua kategori yang (i) Sistem terisah (ii) Model keseluruhan alam semesta.Kajian dalam tesis ini mengenai yang ke-(ii) iaitu model kosmologi.

Penelitian dalam kajian ini telah memfokuskan kepada mencari penyelesaian anistropik untuk persamaan medan Einstein (EFEs) sebagai salah satu model fizikal kosmologi yang diterima pakai untuk alam semerta (sekurang-kurangnya pada peringkat awal). Saya telah meneliti kesan graviti dari pelbagai jenis jirim seperti medan elektromagnet,bendalir likat pukal, kosmik tetali dan pemalar kosmologi sebagai sumber jirim (tenaga) dalam persamaan tensor tenaga-momentum Einstein. Selain itu, ia juga sebagai satu kelas penyelesaian baru dalam persamaan medan Einstein yang diubahsuai dalam ruang-masa yang tak homogen bagi pengedaran

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bendalir sempurna dengan medan elektromagnet diperolehi dalam tolok biasa untuk manifold Lyra. Saya juga telah memperoleh penyelesaian dengan mempertimbangkan medan pemindahan kebergantungan masa.

Saya telah mengkaji tentang perubahan masa dengan pemalar graviti (G) dimana ianya menarik dalam bidang astrofizik.Perubahan G dalam kosmologi adalah malar dengan mana-mana pencerapan kosmologi yang sesuai pada masa akan datang.Pemalar graviti Newton juga memainkan peranan penting dalam perilaku geometri dan jirim dalam persamaan medan Einstein. Satu jumlah hipotesis yang besar telah diusulkan oleh Dirac untuk kosmologi apabila G berubah dengan masa. Selain itu, sifat fizikal dan geometri untuk kesemua model juga telah dibincangkan. Tambahan lagi,dalam kajian ini, saya telah meneliti kesan interaksi antara bendalir barotropik dan tenaga gelap sebagai salah satu persamaan parameter keadaan dalam ruang-masa FRW dengan mempertimbangkan parameter pembolehubah nyahpecutan.

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ACKNOWLEDGEMENTS

First of all I would like to express my deepest sincere gratitude to my supervisor Professor Hishamuddin Zainuddin for his scientific support and also his kind attention to my study and life. His knowledge in physics and mathematics is "awesome". It has been an honor for me to work with him during these years. During my study Professor Hishamuddin gave me freedom and has allowed me to do my research as I wish. But when needed, always he has provided me very critical and useful guides. I would also like to express my deepest appreciation and thank to my co-supervisor Professor Anirudh Pradhan. I am extremely indebted to his valuable help. he has motivated me to do my PhD research in theoretical cosmology. I also wish to extend my thanks to the other members of my supervisory committee Prof Jumiah Hassan and Dr Halimah Mohamed Kamari.

I would like to acknowledge my mother, brothers and sister specially my brother Hossien for their loving support and encouragement.

Finally I thank my wife, parents for their kindness in caring about my daughter.

This work has been supported by the FRGS Grant by the Ministry of Higher Education, Malaysia under the Project Number 02-10-10-969 FR. H. Amirhashchi & A. Pradhan also thank the Laboratory of Computational Sciences and Informatics, Institute for Mathematical Research, Universiti Putra Malaysia for providing facility where this work was done.

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I certify that a Thesis Examination Committee has met on (**April 18, 2011**) to conduct the final examination of (**Hassan Amirhashchi**) on his thesis entitled "**NEW ANISOTROPIC COSMOLOGICAL MODELS AND TWO-FLUID DARK ENERGY MODELS**" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the Universiti Putra Malaysia [P.U.(A) 106] 15 March 1998. The Committee recommends that the student be awarded the (**Doctor of Philosophy**).

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DECLARATION

I declare that the thesis is my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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