Seventh Rencontres du Vietnam
Proceedings of the Xth International conference on Gravitation, Astrophysics and Cosmology (ICGAC10)

GRAVITATION, ASTROPHYSICS AND COSMOLOGY

EDITED BY

Roland Triay
Jean Trân Thanh Vân
Ludwik M.Celnikier

THẾ GIỚI PUBLISHERS

VIIth Rencontres du Vietnam

Quy Nhon, Vietnam – December 15 - 21, 2011

10th International Conference on Gravitation, Astrophysics and Cosmology

Sponsors

. Asia Pacific Center for Theoretical Physics (APCTP)

. Aix Marseille University (AMU)

ISBN: 978-604-77-0619-8
Thế Giới Publishers
Printed in Vietnam
GPXB: 247-2013/CXB/04-07/ThG (25.02.2013)
VN-TG-407-1

© Rencontres du Vietnam
All rights reserved. This book, or parts thereof, may not be reproduced in any form or by any means, electronic or mechanical, including photocopying, recording or any information storage and retrieval system now known or to be invented, without written permission from the Publisher.

Proceedings of the Xth International conference on
Gravitation, Astrophysics and Cosmology (ICGAC10)
Quy Nhon, December 17-22, 2011

Gravitation, Astrophysics and Cosmology

edited by

Roland Triay, Aix-Marseille University
Jean Trân Thanh Vân, Rencontres du Vietnam
Ludwik M.Celnikier, Observatoire de Meudon

THE GIOI
PUBLISHERS

Contents

Foreword 7

Astronomy & Relativistic Astrophysics 15

† **Chromatic gravitational lensing** 17
O.Yu. Tsupko & G.S. Bisnovatyi-Kogan

† **Accretion into black holes, and relativistic jets** 23
G.S. Bisnovatyi-Kogan, A.S.Klepnev & R.V.E. Lovelace

† **Evidence for non–standard Big Bang nucleosynthesis from the primordial abundance of ^{4}He** 33
Trinh X. Thuan

† **The Coldest Stars in the Universe** 39
Ngoc Phan-Bao, Cuong Dang-Duc, Thu Nguyen-Anh, Duy Hoang-Ngoc & Tuan Cao-Anh

† **The Origin of Long, Short and Low-luminosity Gamma-Ray Bursts** 47
Tsvi Piran, Omer Bromberg, Ehud Nakar & Re'em Sar

† **Relativistic Poynting-Flux Jets as Transmission Lines** 57
R.V.E. Lovelace, S. Dyda & P.P. Kronberg

Impact of nuclear input parameters for r-process nucleosynthesis studies 62
Ilka Petermann

Differentially rotating neutron stars 64
D. Gondek-Rosinska, M. Kucaba, A. Snopek, M. Szkudlarek, L. Villain & M. Ansorg

Hidden markov model (HMM) and stochastic differential equation (SDE) of solar radiation sequences 66
Ly Van Tran, Richard Emilion, Romain Abraham

Astroparticle Physics 69

† **KAGRA Design Status** 71
Shinji Miyoki

† **Recent results from the Pierre Auger Observatory on ultra-high energy cosmic rays** 77
P.T. Nhung, for the Pierre Auger Collaboration

† **Ultra-High Energy Hadronic Interaction Models and LHC Data** 85
T. Pierog

†*Indicates an invited talk*

A new theory of relativistic reference frames: the case of an accelerated observer in Minkowski space-time 268
Olivier Minazzoli

On the choice of reference for the covariant Hamiltonian boundary term 272
James M. Nester, Chiang-Mei Chen

Quantum Gravity 275

† **Black holes in loop quantum gravity** 277
Hanno Sahlmann

† **On the unitarity and renormalizability of higher derivative gravity in 3 and higher dimensions** 283
Nobuyoshi Ohta

† **Cosmology and GR limit of Hořava-Lifshitz gravity** 289
Shinji Mukohyama

† **Revisit to Bubbles and Walls** 295
Bum-Hoon Lee & Wonwoo Lee

Quantum Gravity Corrections to the Cosmological Term 300
Takeo Inami & Yoji Koyama

Inhomogeneous loop quantum cosmology: approximated FRW cosmologies from the hybrid Gowdy model with matter 302
Daniel Martín-de Blas, Mercedes Martín-Benito, Guillermo A. Mena Marugán

The Casimir Force in a Schwarzschild Metric: A Proposed Experiment 305
Munawar Karim, Ashfaque H. Bokhari

A Conflict of Quantum Predictions Related to the Equivalence Principle 307
Steve Wilburn & Douglas Singleton

Length Scale in Horava Gravity Through Landau Phase Transition 310
Sudipta Das & Subir Ghosh

New formulation of Horava-Lifshitz quantum gravity as a master constraint theory 315
Hoi-Lai Yu, Chopin Soo & Jinsong Yang

Strings, Branes and Extra Dimensions 321

† **Universality Classes of Symmetry Energy in Holographic QCD** 323
Sang-Jin Sin & Yunseok Seo

†*Indicates an invited talk*

Inhomogeneous loop quantum cosmology: approximated FRW cosmologies from the hybrid Gowdy model with matter

Daniel Martín-de Blas[1], *Mercedes Martín-Benito*[2], *Guillermo A. Mena Marugán*[1]

[1] *Instituto de Estructura de la Materia, IEM-CSIC, Serrano 121, 28006 Madrid, Spain.*

[2] *MPI für Gravitational Physiscs, AEI, Am Mühlenberg 1. D-14476 Potsdam, Germany.*

Email : daniel.martin@iem.cfmac.csic.es

Abstract

We quantize the linearly polarized Gowdy T^3 model with a massless scalar field by applying a hybrid quantization that combines Loop Quantum Cosmology and Fock quantizations. This model allows us to modelize flat Friedmann-Robertson-Walker cosmologies filled with inhomogeneities, providing a perfect scenario to study the quantum back-reaction of inhomogeneities on a loop quantized homogeneous and isotropic background.

1 Introduction

Loop Quantum Cosmology (LQC) [1] applies a polymeric representation to quantize symmetry reduced systems. Cosmological singularities are resolved by employing this quantization. To extend LQC to inhomogeneous cosmological systems, a hybrid quantization has been developed using the vacuum Gowdy T^3 model [2]. This hybrid quantization combines a Fock quantization for the inhomogeneities with the LQC quantization for the homogeneous degrees of freedom.

With the aim of extending this hybrid quantization to more realistic models, we introduce in the Gowdy T^3 model a minimally coupled massless scalar field with the same symmetries as the geometry. Owing to the inclusion of matter, the model admits as subset of homogeneous and isotropic solutions those of the flat Friedmann-Robertson-Walker (FRW) model. This allows us to regard the model as a(n approximated) loop quantum FRW background with inhomogeneities propagating on it. The hybrid quantization of this model leads to the resolution of the initial singularity and the recovering of the standard Fock quantization for the inhomogeneities. We summarize here this approach, which has been detailed in Ref. [3].

2 The model and its hybrid quantization

The Gowdy T^3 model represents globally hyperbolic spacetimes with three torus spatial topology and two axial commuting Killing vector fields. After a symmetry reduction and a partial gauge fixing [2] the model can be regarded as a Bianchi I geometry with a homogeneous massless scalar field, as homogeneous background, filled with matter inhomogeneities and gravitational waves propagating along one spatial direction $\theta \in S^1$ [3]. For simplicity, we will consider the case with local rotational symmetry (LRS) where the scale factors in the two homogeneous directions evolve in identical way. Two global constraints remain to be imposed at

the quantum level, the mo
constraint, $\mathcal{C}$.

We quantize the mode
adopt the *improved dynan*
of the densitized triad and
space is the completion of
label v is proportional to
triad operators act diagon

We quantize both matt
obtained by demanding un
These requirements select
two identical Fock spaces
is provided by the n-part
standard Schrödinger repr

The representation of
straightforward. The sta
subspace of $\mathcal{F}^M \otimes \mathcal{F}^G$.

The Hamiltonian const
the flat FRW model couple
for the inhomogeneities (s
contribute to the constrai
decouples the states of ze
the classical singularity.
a separable *superselection*
The solutions are determi
physical Hilbert space wit

3 Conclusions

The linearly polarized Go
using a hybrid quantizatio
and the standard Fock qu

The inclusion of the
quantization since both k
obtained is physically mo
admits now flat FRW sol
back-reaction of inhomoge
approximated methods in

Acknowledgeme

This work was supported
FIS2011-30145-C03-02, an
ported by CSIC and the E

the quantum level, the momentum constraint, $\mathcal{C}_\theta$, that generates rigid rotations in θ, and the Hamiltonian constraint, $\mathcal{C}$.

We quantize the model by means of a hybrid approach [2, 3]. For the (LRS-)Bianchi I background we adopt the *improved dynamics* of LQC [1], namely we describe the Bianchi I phase space with the coefficients of the densitized triad and the holonomies of its conjugate variable. The (LRS-)Bianchi I kinematical Hilbert space is the completion of the space spanned by the states $|\Lambda, v\rangle$ ($\Lambda \in \mathbb{R}$, $v \in \mathbb{R}^+$) in the discrete norm. The label v is proportional to the Bianchi I volume while Λ parameterizes the anisotropy in direction θ. The triad operators act diagonally on these states while the holonomy operators shift the v and Λ labels.

We quantize both matter (M) and gravitational (G) inhomogeneities using a privileged Fock quantization, obtained by demanding unitarity of the evolution and invariance of the vacuum under the gauge symmetries. These requirements select uniquely the field parameterizations and the vacuum state. As a result, we obtain two identical Fock spaces, $\mathcal{F}^f (f = M, G)$, one for each kind of inhomogeneities. An orthonormal basis is provided by the n-particle states. Finally, for the homogeneous mode of the matter field, we employ a standard Schrödinger representation.

The representation of the momentum constraint in terms of the creation and annihilation operators is straightforward. The states that satisfy the condition imposed by this constraint define a proper Fock subspace of $\mathcal{F}^M \otimes \mathcal{F}^G$.

The Hamiltonian constraint operator can be written as a sum of three terms: the Hamiltonian constraint of the flat FRW model coupled to a massless scalar, a term accounting for the anisotropies and a term accounting for the inhomogeneities (see [3] for the details). It turns out that matter and gravitational inhomogeneities contribute to the constraint in identical way. This constraint operator is constructed in such a way that it decouples the states of zero homogeneous volume ($v = 0$), and then we can remove the states analogue to the classical singularity. Moreover, it superselects the Λ and v labels, allowing us to restrict our study to a separable *superselection sector* [2]. The imposition of this constraint leads to a difference equation in v. The solutions are determined by initial data on the section of minimum v, and then we can characterize the physical Hilbert space with the Hilbert space of these initial data.

3 Conclusions

The linearly polarized Gowdy T^3 model with a minimally coupled massless scalar field is fully quantized by using a hybrid quantization that combines LQC and Fock quantizations. The initial singularity is resolved and the standard Fock quantization of the inhomogeneities is recovered.

The inclusion of the matter field does not add technical difficulties in the application of the hybrid quantization since both kind of inhomogeneities are treated in the very same way. However, the system obtained is physically more interesting than the vacuum one. In fact, the homogeneous sector of the model admits now flat FRW solutions and therefore the model provides a perfect scenario to study the quantum back-reaction of inhomogeneities on a loop-quantized flat FRW background, as well as the development of approximated methods in LQC aimed at extracting physical predictions from the theory.

Acknowledgements

This work was supported by the Spanish MICINN/MINECO Projects No. FIS2008-06078-C03-03 and No. FIS2011-30145-C03-02, and the Consolider-Ingenio Program CPAN No. CSD2007-00042. D. M-dB is supported by CSIC and the ESF under the Grant No. JAEPre-09-01796.

References

[1] A. Ashtekar and P. Singh, *Class. Quant. Grav.* **28**, 213001 (2011).

[2] L. J. Garay, M. Martín-Benito and G. A. Mena Marugán, *Phys. Rev.* D **82**, 044048 (2010).

[3] M. Martín-Benito, D. Martín-de Blas and G. A. Mena Marugán, *Phys. Rev.* D **83**, 084050 (2011).

THE CASIM

[1] *Depa*

King Fahd

We propose an experim
apparatus, method of mea

1 Introduction

We propose an experiment
apparatus is a pair of para
the first pair. We measure
Earth's surface, aligned eas
elements are calculated fro

1.1 Description of

The Casimir force is the r
Casimir force. The tensor

It is not known whether
(equivalently if vacuum flu

The experiment is a de
R_θ^θ on the two Casimir pla

The apparatus is rotat
appears at twice the freque

1.2 Apparatus and

The pairs of Casimir plate
an imbalance in the null s
sensitivity of the force diffe
will provide the answer to