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Special Topic Issue Grassmannian Paths to Cosmology

Guest Editors:

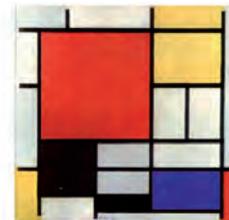
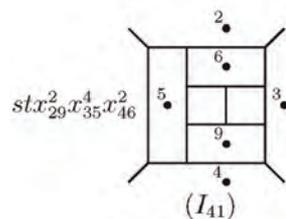
M. P. Dąbrowski (Szczecin), K. A. Meissner (Warsaw), and Yu. V. Shtanov (Kiev)

EDITORIAL

Page **147–149** ——— M. P. Dąbrowski, K. A. Meissner, and Yu. V. Shtanov

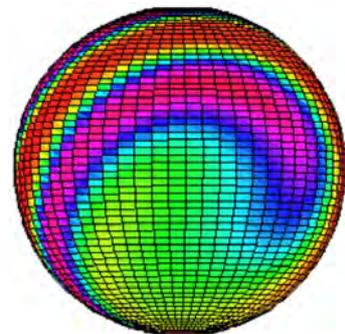
INVITED PAPERS

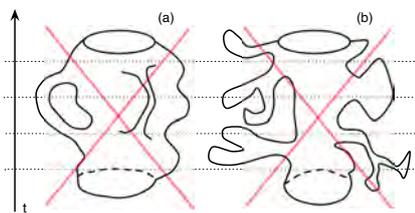
Page **150–160** ——— Hermann Nicolai
 From Grassmann to maximal ($N = 8$) supergravity



Page **161–176** ——— Anthony Lasenby
 Grassmann, geometric algebra and cosmology

Starting with Grassmann's work, a short review is given of the development of 'Geometric Algebra', and the reasons why it is a useful system for describing much of physics. Applications are then discussed in cosmology, including a novel boundary condition for the universe, and efficient ways to encode Bianchi cosmology. Predictions for the Cosmic Microwave Background in such models, and in another area owing much to Grassmann (String Theory), are also discussed.



- Page **177–185** ——— A. A. Zheltukhin
 Dmitrij Volkov, super-Poincaré group and Grassmann variables
- A fundamental role of the Hermann Grassmann anticommuting variables both in physics and mathematics is discussed on the example of supersymmetry. The talk describes how the D. Volkov question about possibility of the existence of Nambu-Goldstone fermions, realized by the Grassmannian variables, resulted in the discovery of the super-Poincaré group, its spontaneous breaking and gauging.
- Page **186–195** ——— J. Ambjørn, J. Jurkiewicz, and R. Loll
 Deriving spacetime from first principles
- Causal Dynamical Triangulation is a back-to-basics approach to nonperturbative, background-independent quantum gravity, which relies on few ingredients and initial assumptions, has few free parameters and – crucially – is amenable to numerical simulations. After putting the approach in context, the authors briefly describe its set-up and highlight some of its major, and sometimes unexpected findings. Prominent among them is the dynamical generation of a classical de Sitter universe from Planckian quantum fluctuations.
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- Page **196–201** ——— Michael Heller
 A noncommutative Friedman cosmological model
- The closed Friedman cosmological model, based on noncommutative geometry, is presented. Two global effects exhibited by the model are discussed. The first effect is the “generation of matter out of geometry”. Gravitational field equation in this model has the form of the eigenvalue equation for the Einstein operator. It turns out that the eigenvalues of this operator reproduce components of the energy-momentum tensor. The second effect concerns the existence of the initial and final singularities. Because of the strongly probabilistic character of the noncommutative dynamics on the fundamental level, although singularities do exist, they are probabilistically irrelevant.
- Page **202–210** ——— John D. Barrow
 Varying alpha
- Properties of cosmological theories for the variation of the fine structure ‘constant’ are reviewed. Some general features of the cosmological models are highlighted that exist in these theories with reference to recent quasar data that are consistent with time-variation in the fine structure ‘constant’ since a redshift of 3.5.

Page 211–218 ——— Claus Kiefer

Can singularities be avoided in quantum cosmology?

Many cosmological models based on general relativity contain singularities. In this contribution the question is addressed whether consistent models without singularities can exist in quantum cosmology. The discussion is based on the Wheeler–DeWitt equation of quantum geometrodynamics. The models under consideration are motivated by recent discussions of dark energy. Employing some natural criteria of singularity avoidance in the quantum theory, it is shown that this can indeed happen in these models.

Page 219–229 ——— David Polarski

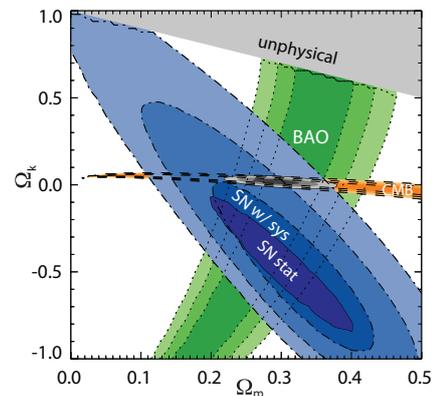
What is the dark energy paradigm?

The present accelerated expansion of the universe is a major challenge for cosmology. Dark Energy models aim to explain this unconventional expansion. We have at the present time a large variety of models which are conceptually very different. Here some of them are reviewed, especially those based on a modification of the laws of gravity. Future high precision observations probing both the background and the perturbations will significantly reduce the class of viable models.

Page 230–237 ——— Marek Kowalski

Testing dark energy with supernovae

The use of Type Ia Supernovae as cosmic standard candles pose still perhaps the most direct way to probe the Cosmic acceleration history. In this contribution the present status of Supernova cosmology is reviewed. The author focuses on current observations and what they can tell us about the properties of Dark Energy, i.e. our (in-)ability to distinguish dark energy models from cosmological constant. In the last part a brief outlook at what to expect from future surveys is given.



- Page **238–248** ——— Salvatore Capozziello and Stefano Vignolo
Metric-affine $f(R)$ -gravity with torsion: an overview
- Torsion and curvature could play a fundamental role in explaining cosmological dynamics. $f(R)$ -gravity with torsion is an approach aimed to encompass in a comprehensive scheme all the Dark Side of the Universe (Dark Energy and Dark Matter). The field equations in empty space and in presence of perfect fluid matter are discussed taking into account the analogy with the metric-affine formalism. The result is that the extra curvature and torsion degrees of freedom can be dealt under the standard of an effective scalar field of fully geometric origin. The initial value problem for such theories is also discussed.

CONTRIBUTED PAPERS

- Page **249–253** ——— Zoltán Keresztes and László Á. Gergely
3+1+1 dimensional covariant gravitational dynamics on an asymmetrically embedded brane: The average equations
- Page **254–257** ——— Bogdan G. Dimitrov
Algebraic geometry approach in gravity theory and new relations between the parameters in type I low-energy string theory action in theories with extra dimensions
- Page **258–262** ——— Walter Tarantino
Flavour mixing in an expanding universe
- Page **263–267** ——— Janusz Garecki
Superenergy, conformal transformations, and Friedman universes
- Page **268–270** ——— Alexey Toporensky
Stable periodic regime in a scalar field cosmology
- Page **271–275** ——— Adam Balcerzak
Fourth-order braneworld gravity
- Page **276–280** ——— S. M. M. Rasouli and S. Jalalzadeh
On the energy conditions in non-compact Kaluza-Klein gravity
- Page **281–284** ——— Włodzimierz Piechocki
Non-standard loop quantum cosmology
- Page **285–289** ——— Pouria Pedram
On the initial condition in quantum cosmology

- Page **290–293** ——— Piotr Dzierzak and Włodzimierz Piechocki
Bianchi I model of the universe in terms of nonstandard LQC
- Page **294–298** ——— Evangelos Melas
Generalization of Hajicek and Kuchař's canonical quantization scheme to the 3+1 geometries admitting maximally symmetric two-dimensional surfaces
- Page **299–303** ——— Mariusz P. Dąbrowski
Dark energy from temporal and spatial singularities of pressure
- Page **304–307** ——— Przemysław Małkiewicz
Propagation of extended objects across singularity of time dependent orbifold
- Page **308–311** ——— Hoda Ghodsi and Martin A. Hendry
Constraining sudden future singularity models
- Page **312–315** ——— Bogusław Broda and Michał Szanecki
Dark energy from quantum fluctuations
- Page **316–319** ——— Arman Shafieloo, Varun Sahni, and Alexei A. Starobinsky
Presently decaying dark energy?
- Page **320–323** ——— Orest Hrycyna and Marek Szydłowski
Three steps to accelerated expansion
- Page **324–327** ——— Ivan Debono, Anaïs Rassat, Alexandre Réfrégier, Adam Amara, and Thomas D. Kitching
Weak lensing forecasts for dark energy, neutrinos and initial conditions
- Page **328–331** ——— Stefano Camera
Constraining unified dark matter models with weak lensing
- Page **332–335** ——— Yuri Shtanov
Statistical anisotropy as a consequence of inflation
- Page **336–339** ——— Aleksandar Rakić, Dennis Simon, Julian Adamek, and Jens C. Niemeyer
On the fate of vacuum bubbles on matter backgrounds
- Page **340–343** ——— Boudewijn F. Roukema
Some spaces are more equal than others
- Page **344–346** ——— Leszek M. Sokołowski
On the abuse of gravity theories in cosmology

- Page **347–350** ——— Mariafelicia De Laurentis, Salvatore Capozziello, Shin'ichi Nojiri, and Sergei Odintsov
PPN limit and cosmological gravitational waves as tools to constrain $f(R)$ -gravity
- Page **351–354** ——— Wojciech A. Hellwing
Galactic halos in cosmology with long-range scalar DM interaction
- Page **355–358** ——— Jerzy Król
(Quantum) gravity effects via exotic \mathbb{R}^4
- Page **359–363** ——— Babak Vakili
Noether symmetric minisuperspace model of $f(R)$ cosmology
- Page **364–367** ——— Masahiro Morikawa
Bose-Einstein condensation in the early universe

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