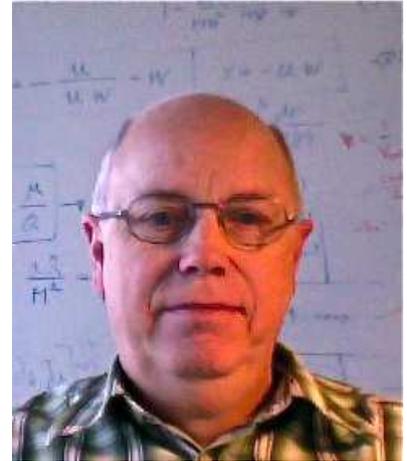# Rosquist, Kjell

Position: professor
Period covered: 2009-2010

I. Scientific Work

Ongoing projects

1.   Spatial curvature in cosmology

Spatial curvature is a key factor in cosmological theory. We are investigating properties of spatial curvature, such as estimating its size directly from the mass distribution in the universe and we are also analyzing theoretically how the spatial curvature depends on the observer.

Collaborators: L. Samuelsson, Umeå University, Sweden and H. Quevedo, ICRANet

2.   Inhomogeneous cosmology

The matter in the present universe occurs in discrete lumps such as stars and galaxies. However, current models of the universe treat the matter as a homogeneous fluid. The purpose of this project is to attempt to quantify how the discrete nature of the matter influences the evolution of the universe. We have some very interesting results, in particular about implications of the Einstein constraint equations concerning the validity of the fluid approximation in cosmology. This is a long-standing problem ("averaging problem") in general relativity. We have found indications that the dynamics of the discrete models is distinctly different from that of the fluid models. We are now investigating the dynamics of the discrete models in more detail in order to obtain a more accurate form of the cosmological evolution equations.

Collaborators: L. Samuelsson, Umeå University, Sweden, Marcel Reboucas and Bruno Mota, CBPF, Rio de Janeiro, Brazil, Reza Tavakol, Queen Mary, University of London

3.   Microphysical gravitomagnetic effects

In Einstein gravity, the source of the gravitational field has an additional part, namely the spin (or angular momentum) which is responsible for the gravitomagnetic field in analogy with the magnetic field in electromagnetism. In this project we work with the Einstein-Maxwell field equations which are responsible for the interaction between the gravitational and electromagnetic fields. We use solutions of the field equations to examine how the gravitomagnetic field induces modifications of the Coulomb electromagnetic field at the Compton scale. The results are amenable to experimental verification.

Collaborators: L. Samuelsson, Umeå University, Sweden, M. von Strauss, Stockholm University, Sweden
Consultant: R. Ruffini, ICRANet

4.   Black holes as accelerators

When particles collide near black holes, they can in principle attain extremely high center-of-mass energies. We are estimating the practical limits on the energy of particles escaping from such collisions near black holes.

Collaborator: M. von Strauss, University of Stockholm, Sweden

5.   Gravitomagnetic jets

The acceleration of particles in the form of jets is a common phenomenon in observational astrophysics. The underlying mechanisms which drive the jets are still poorly understood. In this work, we investigate how gravitational fields are able to accelerate particles up to velocities close to the speed of light. We do this by examining a number of exact solutions which exhibit acceleration of test particles.

Collaborators: B. Mashhoon, C. Chicone

II. Conferences and educational activities

II a. Conferences and Other External Scientific Works
• Talk given at the 2nd Galileo - Xu Guangqi conference, Ventimiglia, Italy, July 2010-10
• Invited lectures given at the XIV BRAZILIAN SCHOOL OF COSMOLOGY AND GRAVITATION, Mangaratiba, Brazil

II b. Work With Students
1 student

II c. Diploma thesis supervision
3 students

II d. Other Teaching Duties
Two undergraduate courses

III. Service activities

III a. Within ICRANet
Member of IRAP faculty and work with Erasmus Mundus program
Preparation for MG13, 13th Marcel Grossmann conference, to be held in Stockholm 2012

2010 List of Publications

Some consequences of gravitationally induced electromagnetic effects in microphysics
J. Korean Phys. Soc., 56 (2010) 1612 (E-print arXiv:0802.2914).

Generating spatial curvature in an inhomogeneous universe: A bottom-up approach to cosmology
in Proceedings of the 11th Italian-Korean Symposium on Relativistic Astrophysics,
J. Korean Phys. Soc., 57 (2010) 586 (with L. Samuelsson).

A direct estimate of the spatial curvature of the universe
in Proceedings of the 12th Marcel Grossmann Conference on General Relativity, World Scientific, in press (2010), (with L. Samuelsson).

How matter generates spatial curvature
in Proceedings of the 1st Galileo – Xu Guangqi Meeting, Int. J. Mod. Phys. D, in press (2010), (with L. Samuelsson).

Interacting Kerr-Newman fields
in Proceedings of the 12th Marcel Grossmann Conference on General Relativity, World Scientific, in press (2010), (with L. Samuelsson and M. von Strauss)