# SFB-Seminar: "The BKL picture of spacetime singularities"

**ZEIT:**

8.1.2013, 14:00 Uhr - 18:00 Uhr

**ORT:**

Albert-Einstein-Institut
(Max-Planck-Institut für Gravitationsphysik)
Hörsaal im Zentralgebäude
Am Mühlenberg 1
14476 Potsdam-Golm

**PROGRAMM:**

14:00 - 15:00   **PD Dr. Alan Rendall**

### Introduction to the BKL picture

The BKL picture of spacetime singularities was developed by Belinskii, Khalatnikov and Lifshitz about forty years ago. Despite a great deal of work by many people since then, it is still not clear to what extent this heuristic picture is correct. Nevertheless, the BKL picture has driven a lot of research into the nature of singularities in solutions of the Einstein equations and is a central topic in the field of mathematical relativity. The only rigorous mathematical results available up to now concern either the spatially homogeneous case (where the PDE are replaced by ODE) or cases where the complicated oscillatory behaviour expected in general is replaced by monotone behaviour. This talk is intended to serve as an introduction to this topic as well as briefly introducing the few rigorous results. The present understanding of the inhomogeneous case, which makes use of heuristic and numerical techniques, will be explained in the talk of Claes Uggla.

15:15 - 16:15   **Prof. Dr. Claes Uggla**

### Oscillatory singularities in inhomogeneous cosmology

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In this talk I will give a broad outline of recent progress concerning analytical and numerical progress as regards oscillatory singularities in inhomogeneous cosmology in general relativity. In particular I will focus on the relationship and differences between the usual BKL scenario and so-called recurring spike formation, which is needed in order to form a complete picture of generic asymptotic oscillatory dynamics. I also discuss the character and underlying physical reasons for the hierarchical state space structure that is essential for understanding both types of behaviour, and why this structure hints at the existence of hidden asymptotic symmetries. In addition I comment on relationships between different methods such as dynamical systems methods and Hamiltionian billiards. Finally, I conclude with some speculations and point at some open issues, which will hopefully be helpful for possible future investigations.

16:15 - 16:45   Kaffeepause

16:45 - 17:30   **Prof. Dr. Hermann Nicolai**

**Hidden Symmetries: from BKL to Kac-Moody**

17:30 - 18:00   **Dr. Stefan Liebscher**

**Cosmological Models in the Big-Bang Limit**
We consider cosmological models of Bianchi type. They yield spatially homogeneous, anisotropic solutions of the Einstein field equations.
In particular, we are interested in the alpha-limit dynamics of the Bianchi model corresponding to the big-bang singular limit of the Einstein equations.
Emphasis is on transient behaviour of solutions near the (backward) Bianchi attractor composed of the Kasner circle of equilibria and attached heteroclinic connections. The heteroclinic orbits in the Bianchi attractor form formal sequences of shift type.
We prove the existence of unstable manifolds to heteroclinic sequences.
This relates alpha-limit transients of cosmologies of Bianchi type to formal sequences of Kasner heteroclinics.
Results on Bianchi VIII+IX models with perfect fluid are joint work with J.Härterich, K.Webster, M.Georgi; results on Bianchi VI_0 models with magnetic field are joint work with A.Rendall, B.Tchapnda.