Institut Ruđer Bošković

ZAVOD ZA TEORIJSKU FIZIKU

Bijenička c. 54

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SEMINAR ZAVODA ZA TEORIJSKU FIZIKU

(Zajednički seminari Zavoda za teorijsku fiziku,
Zavoda za eksperimentalnu fiziku IRB-a i Fizičkog odsjeka PMF-a)

Through the big bang

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Abstract:

I consider the near-big-bang behaviour of a homogeneous but anisotropic cosmological model with S^3 spatial topology - the Bianchi IX model. This model is well-known to behave like a billiard ball (Misner called it 'mixmaster' behaviour), which goes through an infinite amount of bounces before reaching the big bang. However, assuming there is at least one massless scalar field, the mixmaster behaviour stops after a finite amount of bounces, and the shape degrees of freedom of the geometry stabilize around a Kasner-likesolution as the singularity is reached (the so-called 'quiescent' case). I am able to prove that each solution of the quiescent model can be continued uniquely past the big-bang singularity, by demanding continuity of the shape degrees of freedom. The system goes through a degenerate shape (a two-dimensional 'pancake'- or 'cigar'-likeshape), and comes out with an inverted orientation. Continued in this way, each solution of the system looks like two universes joined at the big bang. This makes General Relativity compatible with the picture of the big bang being a 'Janus point of the kind my collaborators and I studied in the context of Newtonian cosmological models in PRL113, 181101, which provides a previously-unnoticed mechanism for the emergence of an arrow of time. This resolution of the big bang singularity is purely classical and does not require quantum effects. Finally I will discuss how, through the BKL conjecture, this new result generalizes to full General Relativity (relaxing the homogeneity hypothesis) with any kind of minimally-coupled matter (because, paraphrasing Wheeler, 'the only matter that matters is massless scalar fields').

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