Institut Ruđer Bošković
ZAVOD ZA TEORIJSKU FIZIKU
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SEMINAR ZAVODA ZA TEORIJSKU FIZIKU

(Zajednički seminari Zavoda za teorijsku fiziku,
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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 BianchiIX model. This model is well-known to behave like a billiard ball (Misner called it 'mixmaster behaviour), which goes through an infiniteamount of bounces before reaching the big bang. However, assuming there is at least one massless scalar field, the mixmasterbehaviour 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 demandingcontinuity 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 joinedat the big bang. This makes General Relativity compatible with the picture of the big bang being a 'Janus point of the kind mycollaborators 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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