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A line-of-sight integrator for nearly isotropic Bianchi models

Bianchi models are a class of spatially homogeneous and anisotropic cosmologies. These models represent the simplest generalization of a FLRW universe; some have a homogeneous and isotropic limit. Consequently, the “almost FLRW” Bianchi models can be described as linear perturbations over a homogeneous and isotropic background. This allows for a systematic study of these models within the context of standard perturbation theory, where each model can be matched with a specific perturbation mode. This methodology offers a framework to understand how these special Bianchi models influence the large-angle anisotropies in the Cosmic Microwave Background: it is sufficient to write the Boltzmann equation and solve it for the particular Fourier mode in which the Bianchi model corresponds to a large FLRW perturbation. This approach involves solving the Boltzmann hierarchy for small multipoles and then computing the line-of-sight integration to obtain higher ones. We have developed two software applications, AniLoS (Anisotropic Line-of-Sight integrator) and AniCLASS, which efficiently compute the line-of-sight integration of perturbations in nearly-isotropic Bianchi universes. AniLoS is an easily modifiable code written in Python, while AniCLASS is a modification of CLASS optimized for statistical analysis. These implementations provide a fast method to compute deterministic anisotropic patterns in the CMB in Bianchi VII_h , VII_0 , V , and IX cosmologies, with tensor and non-decaying vector perturbations currently implemented.

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