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Gravitational anomalies, dark matter and leptogenesis

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We consider physics beyond the standard model, which incorporates a see-saw mechanism for neutrino masses. This physics is augmented by incorporating gravitational degrees of freedom (dilaton, graviton and Kalb-Ramond field) found in the theory of closed strings. In the inflationary era the gravitational degrees of freedom and inflatons dominate. Due to quantum effects there is a gravitational anomaly term (breaking of diffeomorphism invariance). This leads to a background which breaks local Lorentz invariance in the radiation and matter domination era. This lays the foundation for a model for leptogenesis based on spontaneous breaking of Lorentz and CPT symmetry. The model involves, apart from standard model particles, a single very heavy right-handed neutrino and the above axion background. We explicitly show how leptogenesis leads to baryogenesis. With current bounds, our model is a viable model for baryogenesis. This model is more economical, in requiring only one right handed neutrino particle, than other similar models for leptogenesis. Furthermore, the coupling of our axions to standard model gauge fields may allow these axions to be dark matter candidates.

Primary author: SARKAR, Sarben (King's College London, Strand, London WC2R 2LS)

Presenter: SARKAR, Sarben (King's College London, Strand, London WC2R 2LS)

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