

Isocurvature perturbations in extra radiation

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(Submitted on 25 Jul 2011 (v1), last revised 23 Jan 2012 (this version, v2))

Recent cosmological observations, including measurements of the CMB anisotropy and the primordial helium abundance, indicate the existence of an extra radiation component in the Universe beyond the standard three neutrino species. In this paper we explore the possibility that the extra radiation has isocurvature fluctuations. A general formalism to evaluate isocurvature perturbations in the extra radiation is provided in the mixed inflaton-curvaton system, where the extra radiation is produced by the decay of both scalar fields. We also derive constraints on the abundance of the extra radiation and the amount of its isocurvature perturbation. Current observational data favors the existence of an extra radiation component, but does not indicate its having isocurvature perturbation. These constraints are applied to some particle physics motivated models. If future observations detect isocurvature perturbations in the extra radiation, it will give us a hint to the origin of the extra radiation.

Comments: 41 pages, 8 figures; version accepted for publication in JCAP
Subjects: **Cosmology and Extragalactic Astrophysics (astro-ph.CO)**; High Energy Physics - Phenomenology (hep-ph)
Report number: IPMU 11-0124; UT-11-22
Cite as: [arXiv:1107.4962](https://arxiv.org/abs/1107.4962) [astro-ph.CO]
(or [arXiv:1107.4962v2](https://arxiv.org/abs/1107.4962v2) [astro-ph.CO] for this version)

Submission history

From: Kazunori Nakayama [[view email](#)]

[v1] Mon, 25 Jul 2011 14:44:30 GMT (1192kb,D)

[v2] Mon, 23 Jan 2012 03:13:17 GMT (1286kb,D)

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