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Contributory: Inflationary trispectrum of gauge fields from scalar and tensor exchanges

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In this paper, we compute the inflationary trispectrum of primordial gauge fields generated through the scalar and tensor exchanges in models with spectator $U(1)$ gauge fields which are kinetically coupled to the inflaton. Focusing on the connected four-point autocorrelation function of gauge fields, we derive exact analytical expressions for the full trispectrum of both electric and magnetic fields using the in-in formalism and cosmological diagrammatic rules, and explore their respective contributions in specific momentum configurations. For the scalar exchange, we find that the trispectrum signal in the equisided configuration grows with the exchange momentum and reaches its maximum in the flattened limit. However, in the counter collinear limit, we show that the non-linearity parameter associated with the trispectrum scales quadratically with the corresponding parameter of the cross-correlation bispectrum of magnetic fields and curvature perturbations, thereby establishing a hierarchical relation between the higher- and lower-order correlation functions. For the tensor exchange, the trispectrum displays a richer angular dependence, reflecting the sensitivity to the orientation of the momentum quadrilateral with respect to the tensor polarisation, producing characteristic angular modulations in the trispectrum. Detecting such angular signatures in future high-precision cosmological observations would provide a novel window into tensor-mediated interactions in the early universe.

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