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Generative models of astrophysical fields with scattering transforms on the sphere

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“The quest of primordial B-modes in the Cosmic Microwave Background polarization requires to improve our comprehension and modeling of the Galactic foregrounds, in order to isolate the cosmological signal. Also, primordial B-modes are only accessible at very large angular scales on the sky, where the planar approximation is not valid and working with spherical maps is needed. In this context, we have adapted statistical tools, called Scattering Transforms, to a spherical geometry. These statistics, previously developed on planar maps, are able to capture the spatial structures of non-Gaussian fields and allow to build generative models. The adaptation to a spherical geometry has required the use of directional convolutions on the sphere computed with Wigner transforms. We validate the method by constructing generative models of homogeneous astrophysical and cosmological fields. From a single target image, we produce new random realizations and we compare usual statistics (power spectrum, pixel probability density function and Minkowski functionals) between the target and the new realizations. The comparison is very satisfying for most of the fields, both statistically and visually when looking at the maps.”

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