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Generative models of astrophysical fields with scattering transforms on the sphere

Scattering transforms are a new type of summary statistics recently developed for the study of highly non-Gaussian processes, which have been shown to be very promising for astrophysical studies. In particular, they allow one to build generative models of complex non-linear fields from a limited amount of data, and have also been used as the basis of new statistical component separation algorithms. In the context of upcoming cosmological surveys, such as LiteBIRD for the cosmic microwave background polarization or Rubin-LSST and Euclid for study of the large scale structures of the Universe, the extension of these tools to spherical data is necessary. We develop scattering transforms on the sphere and focus on the construction of maximum-entropy generative models of several astrophysical fields. We construct, from a single target field, generative models of homogeneous astrophysical and cosmological fields, whose samples are quantitatively compared to the target fields using common statistics (power spectrum, pixel probability density function and Minkowski functionals). Our sampled fields agree well with the target fields, both statistically and visually. These generative models therefore open up a wide range of new applications for future astrophysical and cosmological studies; particularly those for which very little simulated data is available. We make our code available to the community so that this work can be easily reproduced and developed further.

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