Title:	Geometrical meaning of statistical isotropy of smooth random fields in two dimensions.
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Abstract:	We revisit the geometrical meaning of statistical isotropy that is manifest in excursion sets of smooth random fields in two dimensions. Using the contour Minkowski tensor, W1, as our basic tool we first examine geometrical properties of single structures. For simple closed curves in two dimensions we show that W1 is proportional to the identity matrix if the curve has m-fold symmetry, with m ≥ 3. Then we elaborate on how W1 maps any arbitrary shaped simple closed curve to an ellipse that is unique up to translations of its centroid. We also carry out a comparison of the shape parameters, α and β, defined using W1, with the filamentarity parameter defined using two scalar Minkowski functionals—area and contour length. We show that they contain complementary shape information, with W1 containing additional information of orientation of structures. Next, we apply our method to boundaries of excursion sets of random fields and examine what statistical isotropy means for the geometry of the excursion sets. Focusing on Gaussian isotropic fields, and using a seminumerical approach we quantify the effect of finite sampling of the field on the geometry of the excursion sets. In doing so we obtain an analytic expression for α which takes into account the effect of finite sampling. Finally we derive an analytic expression for the ensemble expectation of W1 for Gaussian anisotropic random fields. Our results provide insights that are useful for designing tests of statistical isotropy using cosmological data.
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