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Nonlocal perimeter, curvature and minimal surfaces for measurable sets

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Abstract: We study the nonlocal perimeter associated with a nonnegative radial kernel $J : \mathbb{R}^N \to \mathbb{R}$, compactly supported, verifying $\int_{\mathbb{R}^N} J(z)dz = 1$. The nonlocal perimeter studied here is given by the interactions (measured in terms of the kernel J) of particles from the outside of a measurable set E with particles from the inside, that is,

$$P_J(E) := \int_E \left(\int_{\mathbb{R}^N \setminus E} J(x-y)dy \right) dx.$$

We prove that an isoperimetric inequality holds and that, when the kernel J is appropriately rescaled, the nonlocal perimeter converges to the classical local perimeter. Associated with the kernel J and the previous definition of perimeter we can consider minimal surfaces. We introduce the concept of J-mean curvature at a point x, and we show that again under rescaling we can recover the usual notion of mean curvature. We study the analogous to a Cheeger set in this nonlocal context Moreover, we also provide a result on J-calibrable sets and the nonlocal J-mean curvature that says that a J-calibrable set can not include points with large curvature. Concerning examples, we show that balls are J-calibrable for kernels J that are radially nonincresing, while stadiums are J-calibrable when they are small but they are not when they are large. Joint work with J. Mazon and J. Toledo.