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A Non Local Quantitative Characterization of ellipses Leading to a Solvable Differential Relation

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Abstract:

In this paper we prove that there are no domains $\mathcal{E} \subset \mathbb{R}^2$, other than the ellipses, such that the Lebesgue measure of the intersection of $\mathcal{E}$ and its homothetic image $\varepsilon\mathcal{E}$ translated to a boundary point $q \in \partial\mathcal{E}$ is independent of q, provided that $\mathcal{E}$ is "centered" at a certain interior point $O \in \mathcal{E}$ (the center of homothety).
Similar problems arise in various fields of mathematics, including, for example, the study of stationary isothermal surfaces and rearrangements.