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Efficient Coverings of Fractal sets by curves

A classic theorem of Davies states that a set of positive Lebesgue measure can be covered by lines in such a way that the union of the set of lines has the same measure as the original set. This surprising and counter-intuitive result has a dual formulation in the form of a prescribed projection theorem. We investigate an analogue of these results in which lines are replaced by shifts of a fixed curve. In particular, we show that a measurable set in the plane can be covered by translations of a fixed open curve, obeying some mild curvature assumptions, in such a way that the union of the translated curves has the same measure as the original set. Our results rely on a Venetian blind construction and extend to transversal families of projections. As an application, we consider how duality between curves and points can be used to construct nonlinear Kakeya sets.