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Sporadic Reinhardt polygons

Let n be a positive integer, not a power of two. A *Reinhardt polygon* is a convex n-gon that is optimal in three different geometric optimization problems: it has maximal perimeter relative to its diameter, maximal width relative to its diameter, and maximal width relative to its perimeter. There is a correspondence between Reinhardt polygons and polynomials with specific divisibility properties and with tight restrictions on their coefficients. This correspondence is useful in the construction of such polygons. For almost all n, there are many Reinhardt polygons with n sides, and many of them exhibit a particular periodic structure. While these periodic polygons are well understood, for certain values of n, additional Reinhardt polygons exist that do not possess this structured form. We call these polygons *sporadic*. We completely characterize the integers n for which sporadic Reinhardt polygons exist, showing that these polygons occur precisely when $n = pqr$ with p and q distinct odd primes and $r \geq 2$. We also prove that a positive proportion of the Reinhardt polygons with n sides are sporadic for almost all integers n, and we investigate the precise number of sporadic Reinhardt polygons that are produced for several values of n by a construction that we introduce.