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On periodic orbits in complex billiards

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A conjecture of Victor Ivrii (1980) says that in every billiard with smooth boundary the set of periodic orbits has measure zero. This conjecture is closely related to spectral theory. Its particular case for triangular orbits was proved by M. Rychlik (1989), Ya. Vorobets (1994) and other mathematicians, and for quadrilateral orbits in our joint work with Yu. Kudryashov (2012).
We present a new approach to planar Ivrii's conjecture for billiards with piecewise-analytic boundary: to study its complexified version with reflections from holomorphic curves. The direct complexification of Ivrii's conjecture is false in general.
It would be interesting for real applications to classify the counterexamples: complex billiards with open sets of periodic orbits of a given period. We will show that the only "nontrivial" counterexamples with four reflections are formed by couples of confocal conics. We will discuss a small result concerning odd number of reflections. We provide applications of these results to real billiards, including Plakhov's Invisibility Conjecture and Tabachnikov's commuting billiard problem.

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