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A.Yu. Anikin

S.Yu. Dobrokhotov

V.E. Nazaikinskii

A.V. Tsvetkova

Uniform asymptotic formulas in the form of special functions in the vicinity of standard and nonstandard caustics in problems involving billiards with semi-rigid walls

Recently, the authors have shown that the asymptotic eigenfunctions of the operator $\nabla D(x)\nabla$ in a bounded domain X on the two-dimensional plane, where $D(x)$ is a smooth function positive inside X and vanishing on the boundary ∂X , are related to billiards with so-called semi-rigid walls. Examples of integrable billiards of this type and the corresponding “nonstandard” Liouville tori, whose projections into X are bounded by standard and nonstandard caustics (in the second case, the caustic is the boundary ∂X), have also been given. In this talk, we discuss a general constructive approach to uniform asymptotics in the vicinity of such caustics in the form of Bessel and Airy functions. We show that the answer is represented in parametric form, and the natural parameters in the answer are coordinates on the corresponding Liouville tori (Lagrangian manifolds).

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