An Optical Imaging Problem of Layered Biological Tissues

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Abstract: A problem of the optical diagnostics of biological media is studied by the methods of radiation transfer. The radiation transfer equation with Fresnel matching conditions is chosen as a basic mathematical model. The smoothness properties of solutions of the boundary-value problem are examined. A method for the determination of relative refractive indices under known outgoing radiation is proposed.

1. A boundary-value problem for the polarized-radiation transfer equation with Fresnel matching conditions for a layered medium.

The smoothness properties of solutions of the boundary-value problem are examined. Theorems of the unique solvability are proved and estimates of the maximum principle type are obtained. A numerical algorithm based on the Monte Carlo method for solving the boundary-value problem is proposed. Numerical calculations, which demonstrate the influence of refraction, reflection and scattering on the polarization and depolarization of the radiation, are considered.

2. The determination of refraction indices of biological tissue.

Imaging of layered biological tissue to detect tumors and other inclusions can be carried out by determining the refraction indices of the layers. The problem of determination of the refraction indices of a multilayered medium by the measurement of outgoing radiation is examined. The solution of posed problem is based on using the total internal reflection phenomena. Also, polarization properties of radiation flux are taken into account. To solve this problem, smoothness properties of solutions of the boundary-value problem are used. In particular, the proposed formulas for determining the refraction indices are based on singularities of the derivative of the outgoing radiation at certain values of the angular variable. The present work generalizes the method for the scalar equation to the case of the vector equation of polarized radiation transfer. Advantages of this approach are discussed.

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