

Methodological derivation of the eikonal equation

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Usually, when working with the eikonal equation, reference is made to its derivation in the monograph by Born and Wolf. The derivation of this equation is rather careless. To make sense of this conclusion requires a certain number of implicit assumptions. For a better understanding of the eikonal approximation and for methodological purposes, the authors decided to repeat the derivation of the eikonal equation, explicating all possible assumptions. Methodically, the following algorithm for deriving the eikonal equation is proposed. The wave equation is derived from Maxwell's equation. In this case, all conditions are explicitly introduced under which it is possible to do this. Further, from the wave equation, the transition to the Helmholtz equation is carried out. From the Helmholtz equation, with the application of certain assumptions, a transition is made to the eikonal equation. After analyzing all the assumptions and steps, the transition from the Maxwell equations to the eikonal equation is actually implemented. When deriving the eikonal equation, several formalisms are used. The standard formalism of vector analysis is used as the first formalism. Maxwell's equations and the eikonal equation are written as three-dimensional vectors. After that, both the Maxwell equations and the eikonal equation use the covariant 4-dimensional formalism. The result of the work is a methodically consistent description of the eikonal equation.