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Fraunhofer Diffraction at a Slit between Two Isotropic Media under Oblique Incidence of a Plane Electromagnetic Wave

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In this work, the Fraunhofer diffraction of a plane electromagnetic wave obliquely incident from a homogeneous, isotropic, and non-gyrotropic medium onto a slit is theoretically examined. Behind the slit, there is a similar medium that differs in its optical parameters from the medium from which the electromagnetic wave is incident. The refractive indices of both media are arbitrary .

Fig. 1. Schematic of diffraction at a slit between two media under oblique incidence of a plane electromagnetic wave.

When the wave is incident obliquely , the total path difference between the rays diffracted in the direction and rays 1 and 2 is determined as (see Fig. 1), or

(1)

where is the diffraction angle , is the angle of incidence , and is the width of the slit.

The difference in case of oblique incidence is that the medium from which the wave is incident leaves a trace on the diffraction pattern by altering the optical path of the rays.

A formula has been derived, and the conditions for minima have been analyzed. Unlike the case of normal incidence, for oblique incidence, the conditions for minima include the optical parameters of both media, not just the medium into which the electromagnetic wave diffracts.

In the absence of a phase difference between the extreme rays (wavefront preservation), the derived formulae clearly lead to the law of beam refraction.

Authors: Dr SOGHOMONYAN, Arkadi (Institute of Applied Problems of Physics); MARGARYAN, Astghik (Junior researcher)

Co-authors: Dr YERITSYAN, Homeros (Institute of Applied Problems of Physics); Mrs SOGHOMONYAN, Ruzanna (Institute of Applied Problems of Physics); Dr MIRZOYAN, Vachagan (Institute of Applied Problems of Physics)

Presenter: MARGARYAN, Astghik (Junior researcher)

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