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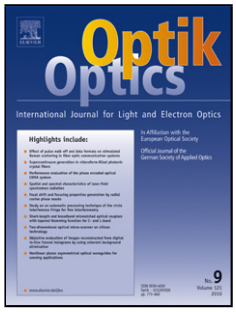

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Study on Mathematical Essence of Huygens' principle

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Abstract:
Huygens put forward his wave theory of light in as early as the 17th century, and he explained the process of light propagation with wavelet envelopes. So far, Huygens' principle has served as an explanation of the light propagation process and is mainly applied in the research of light diffraction. From the point of physics process, Huygens' principle transforms the process of light propagation into that of light radiation. We analyze the Huygens' principle from the wave equation. We find that its mathematical essence is the transformation among the different solutions of the wave equation. Built on the mathematical nature of the Huygens' principle, the direction, amplitude and phase of the Huygens wavelet were studied. Referring to the Poynting vector of electromagnetic waves, the tilt factor of the Huygens wavelet was obtained by vector analysis. Then according to the properties of plane waves and the Fresnel zone method and using the self-consistent principle, we lead to the conclusions that the phase of the Huygens wavelet is $\pi/2$ advanced of the incident light, and the wavelet amplitude is inversely proportional to the wavelength of the light. Finally, the relationship between wave optics and the primitive function is discussed.

Key words: Huygens' principle; Huygens Wavelet; Fresnel zone; Diffraction; Scalar diffraction

0 Introduction

In 1690, in order to explain the basic propagation mechanism of waves, Huygens assumed that every point on the wave front could be seen as a secondary disturbance center emitting spherical wavelets, and at a later time the envelope of these wavelets is the new wave front [1,2]. Since the Huygens' principle is a basic propagation principle of waves propagation, it has been widely used in the analysis of electromagnetic waves [3], elastic waves [4], optical communications [5,6], antenna design [7] and so on [8~12]. It can also be applied to the study of light and particle interactions [13], such as studying the gain and loss processes and confirming that the stimulated

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