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Effect of the number of primary lens level on the MTF of diffractive imaging system

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For space telescopes with large apertures and light-weight, phase-type Fresnel lenses has been proposed to replace the primary mirror. However, the diffraction efficiency of 2-level phase-type Fresnel lenses fabricated by binary optics technology can only achieve 40.5% and 81% for 4-level. The non design orders diffractive light may affect the modulation transfer function (MTF) of diffractive imaging system. In this paper, the wave propagation method was used to simulate the propagation of diffractive light. By coherent superposition of finite diffractive waves, the point spread function (PSF) was calculated at several signal wavelength which evenly covers the spectral range of system. The Fourier transform of the PSF was MTF. The MTFs of an 80 mm diffractive imaging system were analyzed when the number of Fresnel primary lens' level was 2, 4 and 8. The MTF decreased at low frequency with 2-level Fresnel primary lens and the biggest decrease was 6.6%. The deviation from the design value is less than 0.5% when the level is 4 and 8. The results show that the effect of diffractive stray light on the MTF of the system decreases with the increase of the number of level. During the analysis, we found that only the incident light illuminating the primary lens's central area can directly attach the image plane by non design diffractive orders. So, a hybrid-level Fresnel lens was put forward to reduce the effect of diffractive stray light. The MTF increased apparently after optimized and was close to the design value.

Biography

Dun Liu is a PhD student at the University of Chinese Academy of Sciences. In 2013, he received his Bachelor's degree at Wuhan University. He has been conducting the research of diffractive telescope technology at the Institute of Optics and Electronics, Chinese Academy of Sciences, from 2013 till now. His current research interests include optical design, stray light analysis and test.

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