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ORIGINAL ARTICLE

Analytical alignment tolerances for off-plane reflection grating spectroscopy

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Abstract Future NASA X-ray Observatories will shed light on a variety of high-energy astrophysical phenomena. Off-plane reflection gratings can be used to provide high throughput and spectral resolution in the 0.3–1.5 keV band, allowing for unprecedented diagnostics of energetic astrophysical processes. A grating spectrometer consists of multiple aligned gratings intersecting the converging beam of a Wolter-I telescope. Each grating will be aligned such that the diffracted spectra overlap at the focal plane. Misalignments will degrade both spectral resolution and effective area. In this paper we present an analytical formulation of alignment tolerances that define grating orientations in all six degrees of freedom. We verify our analytical results with raytrace simulations to fully explore the alignment parameter space. We also investigate the effect of misalignments on diffraction efficiency.

Keywords Diffraction gratings · X-ray spectroscopy · Alignment tolerances

1 Introduction

The development of critical technologies is required to accomplish the science goals of future NASA X-ray observatories. One such technology is off-plane reflection gratings to produce high throughput and high spectral resolving power at energies below 1.5 keV. Grating spectrometers are currently used onboard the *Chandra X-ray Observatory* and *XMM-Newton* as the main workhorses for X-ray spectroscopy

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