High Angular Resolution X-Ray Astronomy with Diffractive-Refractive Elements

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No future grazing incidence X-ray telescope is likely to have an angular resolution that is signficantly superior to the Chandra X-Ray Observatory's. Better angular resolution requires a new technology. I describe an X-ray imaging system that has the potential to do based upon diffractive-refractive optics that transmit rather than reflect X-rays. These optics are much less sensitive to figure errors and surface roughness, the factors that limit the resolution of grazing incidence optics. The elements are a Fresnel zone plate and a refractive lens that are configured such that chromatic aberration is corrected over a finite energy band width. The simplest form consists of the two elements in direct contact providing a bandwidth of about 10% where chromatic aberration is less than 100 microarcseconds. A more complex system where the two elements are widely separated can provide an angular resolution of a few microarcseconds over a smaller bandwidth. The major disadvantage of this system is the need for extremely long focal lengths, about 10,000 km for the simpler system where two elements are in direct contact and larger for the separated optics systems. The technology that would enable formation flying between optics and detector over such vast distances does not exist at present. However, there is no inherent reason why it cannot be developed. While the field of view is quite large intrinsically the very long focal length means that it is limited in practice by the size of the detector. On the positive side the optics should not be difficult to fabricate compared to grazing incidence telescopes and would be much lighter weight.