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A close-in X-ray view of the planets

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Abstract

In recent years XMM-Newton and Chandra have revealed the diagnostic potential of X-ray observations in exploring the physical processes occurring in the environs of the planets in the solar system. For example, X-ray spectral studies of Jupiter's aurorae have provided unexpected insights into the charged particle populations of the Jovian magnetosphere, their dynamics and energetics; X-ray observations, combined with those at longer wavelengths and in-situ particle measurements, constitute a very powerful tool for investigating and establishing the origin of the particles, their acceleration and emission mechanisms, and the details of their magnetospheric and ionospheric interactions. Unlike the Jovian aurorae, the X-ray spectra of the planetary disks of Jupiter and Saturn resemble that of the active Sun, implying an origin in the scattering and fluorescence of solar X-rays. Bombardment by energetic ions from the region of the Io Plasma Torus could give origin to the Galilean satellites X-ray emission, while non-thermal electron bremsstrahlung may account for a large part of the soft X-ray flux observed from the Io Plasma Torus itself.

High resolution X-ray spectroscopy of Mars has revealed the importance of solar wind charge exchange taking place in its exosphere, clearly separating it from the fluorescent scattering of solar X-rays in the upper atmosphere. A similar dichotomy has been found on Venus; in both cases X-ray observations offer a novel way to explore the uppermost atmospheric levels that are hard to investigate otherwise. X-ray observations of the Earth's aurorae have been mainly carried out at high energies, so that the extent to which charge exchange contributes to the soft X-ray emission is still unknown.

This presentation will stress how the X-ray view of the planets in the solar system is a fundamental piece in their jigsaw: it adds value to and tests the consistency of models constructed on the basis of more traditional techniques, such as FUV observations and plasma measurements. While we are close to the limit of what Earth-bound X-ray observatories can achieve, the potential of in-situ observations, as part of large missions to the outer planets at one end, or using cubesats in Earth's orbit at the other, is still untapped and is clearly the next stepping stone to a deeper understanding of our solar system.