Solar System X-rays from Plasma Processes

C.M. Lisse[1], A. Bhardwaj, K. Dennerl[3], D. J. Christian[4], S. J. Wolk[5], D. Bodewits[6], T.H. Zurbuchen[7]

[1] Johns Hopkins University Applied Physics Laboratory, Laurel, MD, 20723, USA
[2]Space Physics Laboratory, Vikram Sarabhai Space Centre, Trivandrum 695022, India.
[3]MPE, Giessenbachstrasse, 85748 Garching, Germany
[4] Queens University Belfast, Belfast, BT7 1NN , UK
[5]Chandra X-ray Center, Harvard-Smithsonian Center for Astrophysics, Cambridge, MA
[6]KVI Atomic Physics, Rijkuniversiteit Groningen, 9747 AA Groningen, the Netherlands
[7] The University of Michigan, Ann Arbor, MI 48109-2143, USA

The discovery of high energy x-ray emission in 1996 from comet C/1996 B2 (Hyakutake) created a new class of solar system x-ray emitting objects [1]. Subsequent detections of the morphology, spectra, and time dependence of the x-rays from more than 20 comets have shown that the very soft (E < 1 keV) emission is due to a charge-exchange interaction between highly charged solar wind minor ions and the comet's extended neutral atmosphere [2,3]. Many solar system objects are now known to shine in the X-ray, including Venus [4], Mars [5], the Moon [6], the Earth, Jupiter [7], and Saturn [8], with total power outputs on the MW - GW scale [9]. Like comets, the X-ray emission from the Earth's geo-corona, the Jovian aurora, and the Martian halo are all driven by charge exchange between highly charged minor (heavy) ions in the solar wind and gaseous neutral species in the bodies' atmosphere. The non-auroral X-ray emissions from Jupiter, Saturn, and Earth, and those from disks of Mars, Venus, and the Moon are produced by scattering of solar X-rays. The first soft X-ray observation of Earth's aurora by Chandra shows that it is highly variable, and the Jovian and Saturnian aurorae are fascinating puzzles that are just beginning to yield their secrets – and may be the only x-ray sources not driven by the Sun in the whole system.

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