X-ray Observations of Jupiter

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X-rays from Jupiter were first detected in 1983 with the *Einstein* satellite (Metzger et al., 1983). However as the flux rates are very low and it took several decades until *Chandra* and *XMM-Newton* provided enough collecting area and spacial resolution to investigate the origin of these X-rays. With the superior spacial resolution of *Chandra* several different regions around Jupiter that emit X-rays were identified: the polar regions of Jupiter, the planetary disk, the Io plasma torus and the Galilean satellites. From these regions only two are bright enough to analyze the X-ray emission and the conditions and processes generating them (Elsner et al., 2005a).

Various processes can lead to the generation of X-rays, for example bremsstrahlung, synchrotron radiation and Comptonization all lead to a continuum. Additionally, the superposition of lines will produce a continuum, in particular photo-ionization will lead to a continuum and a sharp edge at the end. Around Jupiter most likely various if not all processes take place, however, their relative strengths vary between the regions. For a detailed description of the processes see Elsner et al. (2005b).

The X-ray satellite with the biggest collecting area is *XMM* and it therefore provides the best spectra. The analysis of two long *XMM* exposures in November 2003 (total exposure 245 ksec) shows that the planetary disk region exhibits a different time variability than the auroral regions. The count rate of the disk increased by 40 % between the two observations (within a couple of days) while the auroral count rate decreased by 10 %. The flux of the planetary disk emission is found to be positively correlated with the solar activity. This observed difference in the temporal behavior is apparent in the spectra as well. The disk emission can be described by a coronal plasma model with a plasma temperature of ~ 0.4 keV and two additional Gaussian lines: Mg XI (1.35 keV) and Si XIII (1.86 keV) (Branduardi-Raymont et al., 2007b).

The auroral emission is different, its spectral shape can be described by a line continuum, with a few lines on top, below 2 keV, most likely originating from ion charge exchange and a thermal bremsstrahlung component at higher energies. When the flux is high this component can be better modeled by a simple power law, with a photon index of about 0.15, suggesting that the plasma has undergone some form of transition and the electron distribution has changed, most likely to one including non-thermal electrons. This component was predicted earlier and is detected up until 7 keV (Branduardi-Raymont et al., 2007a).

The existence of the hard X-ray component was also confirmed very recently with *Suzaku* (Ezoe et al., 2010). Despite all these studies the origin and composition of the ions leading to line emission at lower energies as well as the affect of changes in the magnetosphere onto the spectrum are still unknown.

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