X-ray observations of the spiral galaxy M83

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The nearly face-on SBc galaxy M83 (NGC 5236) was observed for 25 ksec with the ROSAT PSPC. We detected 13 point-like sources in this galaxy, 10 of which were previously unknown. Eight of these sources are positionally associated with H II regions and/or H I voids, suggesting an association with the younger stellar population, variable X-ray binaries or with hot expanding gaseous bubbles.

Comparing the diffuse soft and hard X-ray emission components, we observed a different asymmetric distribution and a slower radial decrease of the intensity profile of the soft X-ray emission. Both these results support the existence of a huge spherical gas halo of $\sim 10-15$ kpc radius. On the other hand, the radial scale lengths of the hard X-ray radiation, that of the thermal radio emission and the profile of the optical surface brightness are similar, favouring the idea that all these emission processes are connected to star formation in the galaxy's disk.

M83 is the first face-on galaxy where the diffuse X-ray emission spectrum can be characterized by a two-temperature thermal plasma: a soft X-ray emitting warm 'halo component' of plasma temperature $2.1 \cdot 10^6$ K and an internally absorbed hot 'disk component' at $5.7 \cdot 10^6$ K which is dominating the emission in the hard $(0.5 - 2.0$ keV) *ROSAT* energy range. The (distance-independent) mean surface brightness of the soft diffuse emission of M83 is about twice that of NGC 253.

The electron densities in the galactic halo of M83 ($\sim 1.2 \cdot 10^{-3}/\sqrt{\eta}$ cm^{-3}, with a volume filling factor η) are in general too low to explain the observed depolarization of the radio emission. This indicates that the ionization equilibrium might be violated, leading to higher electron densities. The combination of X-ray and radio polarization observations allows an estimate of the plasma parameter $\beta = U_{\rm therm}/U_{\rm magn}$ which is found to be 0.2 ± 0.1. This result supports the hypothesis that magnetic fields play an important role for the evolution and structure of galactic gas haloes. The high energy input rate in the active star-forming disk of M83 seems to be responsible for the outflow of hot gas and the halo formation.

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