The Interstellar Medium in M31 and M33
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Chandra Observations of M 33: A First Look

J.C. McDowell, G. Fabbiano,
V. Kalogera, K. Stanek, D. Sasselov

Harvard-Smithsonian Center for Astrophysics,
60 Garden St, Cambridge MA 02138, USA

Abstract. The Chandra X-ray Observatory has begun a series of exposures centered on M 33. Although primarily intended to study the point source population, the data should also provide information on the diffuse X-ray emission.

1 Introduction

This is an early progress report on our Chandra investigation of M 33. M 33 is already well studied in X-rays (Trinchieri, Fabbiano & Peres, 1988; Schulman & Bregman, 1995; Long et al., 1996; Haberl & Pietsch, this volume) and diffuse emission detected. Chandra is the first instrument with the spatial and spectral resolution to study the X-ray ISM in nearby galaxies in detail (e.g. the observation of superbubbles in the Antennae, Fabbiano et al., in prep.).

A preparatory 10 kilosecond Chandra snapshot, observation ID 00787, was taken in January 2000 to study the 10^{39} erg/s nuclear source. This short exposure was centered on the back-illuminated ACIS-S3 chip, and was off axis to reduce the effects of pileup on the spectrum of the bright source. The data were analysed using the CIAO software package developed by the Chandra X-ray Center. We failed to detect much diffuse emission, although there was evidence of some hot gas southwest of the nucleus. The background rate in the 0.2–2.0 keV band was around 0.2 counts per second over the chip, and about 0.1 counts/s on the front-illuminated chips. Two 50 kilosecond exposures were scheduled for July 2000; the first one, ID 01730, was taken at a time of high solar activity and is partly affected by very high background rates. Just before the second scheduled exposure the instrument was safed because of the strongest solar flare in a decade; the exposure, ID 00786, has been rescheduled for late August 2000.

A preliminary analysis of the July exposure confirms that the central 10 arcminutes of M 33 shows no evidence for extensive diffuse soft X-ray emission at a level of 10^{36} erg/s/square arcmin, but there are a few discrete regions of apparent diffuse emission on scales of tens to hundreds of parsecs.

Figure 1 shows the initial exposure of M 33, presented at the meeting. Only a quarter of each chip was read out. All cataloged ROSAT sources within the field were easily detected. The higher count rate on the back illuminated chips S1 and S3 is apparent; these chips are more sensitive to X-rays with energies below 0.3 keV. Two instrumental features are also visible: the 'streak' events on chip S4 at the top of the picture, which appear as a series of dark bands in Fig. 1, and the 'readout streak' extending to either side of the nuclear source, caused by photons from this bright source being detected during the brief period of readout. Both of these artifacts complicate the process of detecting diffuse emission; software to remove them is being tested and will be released to the community in a future version of the CIAO data analysis package.

Figure 2 shows the central region of M 33 in the soft band from the July exposure, smoothed to 4 arcsecond resolution. The diagonal streaks running from bottom left to top right, prominent to the

north of the nucleus, are detector artifacts which will be removed in later processing. The diffuse soft emission to the southwest of the nucleus is well detected; its extent is about 250 pc and its luminosity is around 4×10^{36} erg/s. A similar large X-ray nebula is seen close to the position of IC 131.

Once all the data are in hand, we will provide a new estimate of the diffuse X-ray luminosity in the central part of M 33 and attempt to determine the contribution from faint point sources. We will also attempt to derive the first X-ray spectrum of the hot ISM in M 33.

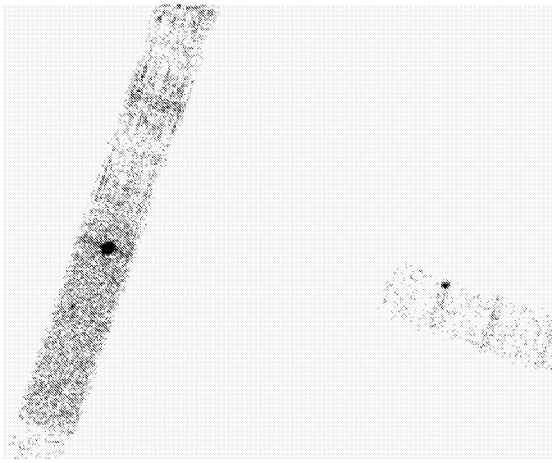

Fig. 1. The 10 ks off axis observation of M 33, showing the nuclear source M 33 X-8 near the top of the long, lefthand strip. Above the source can be seen the instrumental streaks on the S4 chip. Each strip is 2 arcmin wide. The bright source in the upper right hand strip is M 33 X-1.

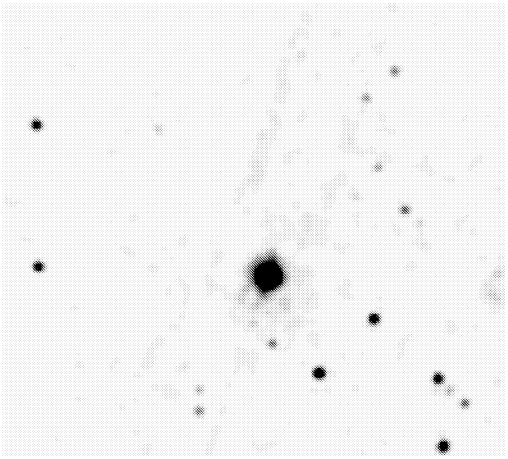

Fig. 2. The central 8.4 arcminutes of M 33 in the 0.2–2.5 keV band as seen by ACIS-I in July 2000, smoothed to 4 arcsec resolution.

References

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