X-ray emission from NGC 4321 (M 100): Detection of Supernova 1979C

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In a ROSAT HRI X-ray observation of the spiral galaxy NGC 4321 (M 100) X-ray emission from the type $\mathrm{II_L}$ supernova 1979C is discovered, 16.2 years after its outburst, with an (0.1–2.4 keV) X-ray luminosity of $L_{\mathrm{x}} = 1.0 \times 10^{39}$ erg s^{-1}, for a 5 keV thermal bremsstrahlung spectrum, a Galactic hydrogen column density $N_{\mathrm{H}} = 2.3 \times 10^{20}$ cm^{-2} and a distance of 17.1 Mpc [Immler, Pietsch & Aschenbach 1997]. No X-ray emission is observed from the three other historical supernovae in NGC 4321 (SN 1901B, SN 1914A and SN 1959E). An overlay of ROSAT HRI contours (12$''$ FWHM) onto an optical image of NGC 4321 is given in the figure below. SN 1979C is the point source south-east of the nucleus of the galaxy. Despite the high number of known supernova explosions in galaxies, SN 1979C is only the 8$^{\mathrm{th}}$ supernova from which X-rays have been detected to date.

Inside the D_{25} ellipse of NGC 4321, diffuse emission (3.5×10^{40} erg s^{-1}) and seven X-ray point sources (4.2×10^{38} – 6.5×10^{39} erg s^{-1}) are detected in addition to SN 1979C. Apart from two bright sources in the nuclear region of the galaxy, none of the other point-like X-ray sources show significant time variability over the observation.

To compare with our ROSAT results, archival *Einstein* HRI observations of NGC 4321 were reanalysed. Six point-like X-ray sources are detected inside the D_{25} ellipse of the galaxy with *Einstein* (0.1–4.5 keV) luminosities in the range 1.1 – 5.1×10^{39}erg s^{-1}, however no X-ray emission is detected from the historical supernovae. Three of the *Einstein* sources coincide with the positions of ROSAT sources (the two bulge sources and a southern interarm source). Comparison of the luminosities shows that these sources are variable.

The *Einstein* 3σ upper limit to the luminosity of SN 1979C 64–454 days after the explosion is $< 3.1 \times 10^{39}$ erg s^{-1}. The upper limit derived for the early epoch is surprisingly close to the ROSAT luminosity, allowing only a small rate of decline of the X-ray flux. We have used the 'mini-shell' model for the interaction of the supernova ejecta with the circumstellar medium to determine the X-ray luminosity expected from the model. It turns out that the ROSAT measurement would require an *Einstein* luminosity at least a factor of 30 higher than observed.

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