A High Resolution X-ray Image of the M87 Jet

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Abstract

We present the first high resolution X-ray image ever obtained of the jet in M87 using the Chandra X-ray Observatory. There is clear structure in the jet and almost all of the previously known knots are detected and are clearly separated. The X-ray and optical positions of the knots are consistent at the 0.1" level. The core is the brightest X-ray feature and is clearly distinguished from known knots in the jet. However, the core is only 2-3 times brighter than knot A (12.3" from the core) and the inner knot HST-1 (1" from the core). Detailed Gaussian fits to the X-ray jet one-dimensional profile show distinct X-ray emission that is not associated with specific optical features. The X-ray/optical flux ratio decreases systematically from the core and X-ray emission is not clearly detected beyond 20" from the core. The X-ray spectra of the core and the two brightest knots, HST-1 and A, are consistent with a simple power law, with energy index 1.36 +/- 0.06. The spectra of other regions are consistent with this, practically ruling out inverse Compton models as the dominant X-ray emission mechanism. The spectral energy distributions (SEDs) of the knots are fit to models of synchrotron emission, which is the mechanism most consistent with the observed data. The particle lifetimes for X-ray synchrotron radiation are only a few years, which creates a particle lifetime problem. We discuss this in the context of particle acceleration or a non-isotropic pitch angle distribution for the emitting particles.

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