FIRST MILLIMETER MAPPING OF THE JET AND NUCLEUS OF M87

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An intriguing question about extragalactic jets is why they are so few being seen at optical wavelengths, or equivalently, why the cutoff frequency of the synchrotron radiation is generally not in the optical, but rather in the infrared or even in the sub- millimeter domain. The answer is undoubtedly related to the efficiency of the acceleration of the relativistic electrons responsible for the synchrotron emission. The presence of a break at low frequency somewhere in the synchrotron spectrum is another feature that constrains the model parameters, but its precise location is unknown for most jets, because of the lack of photometry in the millimeter domain. It was thus necessary to fill the gap between radio and optical wavelengths in the synchrotron spectrum of optical jets. The required observation had to be of high sensitivity and high spatial resolution (of the order of $1''$). Another reason for observing at millimeter wavelengths is that molecular lines and thermal emission from cold dust are detectable in this frequency range.

The present work is described in Despringre et al. (1995). The observations were made with the IRAM Plateau de Bure interferometer with three antennas between November 1992 and January 1993 with the BC set of configurations, and with four antennas in the two compact configurations C2 and D in March, 1994. The central frequency was 88.26 GHz. The final map of M87 at 89 GHz after CLEANing is shown in Fig. 1. The beam is $2''.9 \times 1''.8$ (PA=22°).

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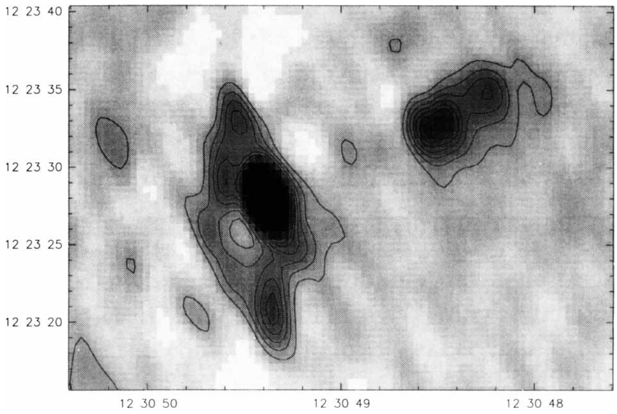

Figure 1. **Grey map of M87 with contour level spacing of 35 mJy/beam and a peak intensity of 1.67 Jy/beam. The beamwidth is 2″.9 × 1″.8 at PA=22°.**

The jet with knots A, B, C and G, is clearly seen. Knots D, E, F, and I, located between the nucleus and knot A, as well as the lobes, are not detected. Within the error bars, our mm intensities for knots A, B, and C fit the linear interpolation between cm and optical wavelengths.

The intensity of the nucleus alone at 89 GHz is 1.88 ± 0.1 Jy. The high resolution spectrum of the nucleus is consistent with a single power law synchrotron spectrum with a break frequency between about 10^{11} and 10^{12} GHz.

It is clear that, in our data, the nucleus is embedded in an extended structure. Since such a component has never been noticed before at any wavelength, we thoroughly looked for any instrumental or deconvolution effect, but found none. Hence, either it is an important artifact caused for a subtle reason not understood at this time, or this feature is real. Indeed, considering other properties of M87, several arguments are in favor of its reality, and its spectrum is rather narrowly peaked at $\simeq$ 100 GHz. This extended feature is characterized by an essentially elongated shape (12″.7 × 6″.5) perpendicular to the jet but not centered on the nucleus, the offset being about 1″.5 to the SE. There are 4 peaks, the maximum brightness being 0.2 Jy/ beam, and a "hole" at the center of the structure. The total intensity (after removal of the nucleus) is 1.4 Jy. Clearly, *thermal radiation from very cold dust at $T \lesssim 10$ K* could explain the properties of this component. Estimating the dust mass from the total intensity for a distance to M87 of 15 Mpc, one obtains: $M_{\rm dust} \simeq 4\ 10^{12}\ M_{\odot}$.

References

Despringre V., Fraix-Burnet D., Davoust E., 1995, *A&A* in press