BENT JETS IN RADIO QUASARS

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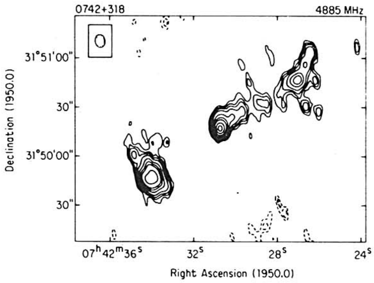
How is energy transported out from the central engine in quasars and radio galaxies to the distant radio lobes? This problem has been around since the early discovery of classical double radio sources, and is still not answered in detail. The idea of relativistic beams was first suggested by Martin Rees as a means of transporting plasma out of the nucleus (Rees, 1971, Blandford and Rees, 1974). This idea gained support first from the discovery of hot spots in the radio lobes of these large classical double sources, and later by observations of the beams themselves in radio galaxies. As more jets were observed, it became obvious that they were often curved, serpentine, or even sharply bent. This behavior has been modeled as precession of the central nozzle (Bridle et al., 1976, Ekers et al., 1978), as nuclear refraction (Henriksen et al., 1981), as a growing plasma instability (Hardee, 1981) and as various combinations of the above. At the present time, it seems safest to conclude that there are some examples of each of these processes known.

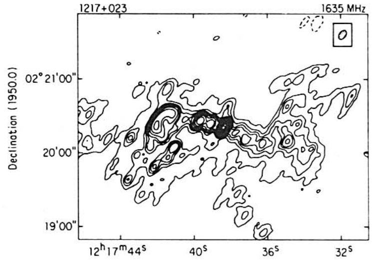
Here I present four examples of quasars with bent jets that were found during a more extensive study of quasars with known compact nuclear radio cores. The observations shown were made at one of two frequencies, using the "snapshot" mode of the partially completed NRAO Very Large Array. The 4.885 GHz observations were done in October, 1979 using up to 16 antennas, and the 1.635 GHz observations were done in June, 1980 using up to 21 antennas. The data were carefully edited, maps were made and cleaned, and finally the self-calibration technique was judiciously applied. In the figures shown below, a strong point source has been removed from the core of each quasar. The maps of 0742+318 and 1217+023 have been tapered slightly to enhance the low surface brightness emission.

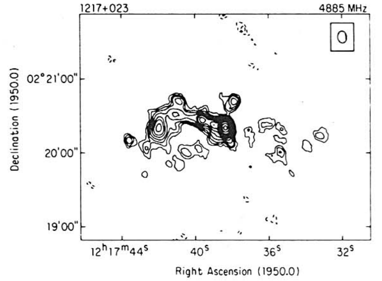
Work is currently in progress to test various theories of bent jets using these observations, but already it is probably possible to rule out those theories that require the jets to be nearly parallel to the line of sight. As in the case of the giant radio galaxy 3C 236 (Willis et al., 1974), these quasars are quite large even if they lie precisely

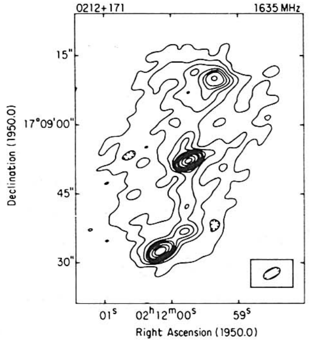
D. S. Heeschen and C. M. Wade (eds.), Extragalactic Radio Sources, 137–138.

https://doi.org/10.1017/S0074180900027546 Published online by Cambridge University Press



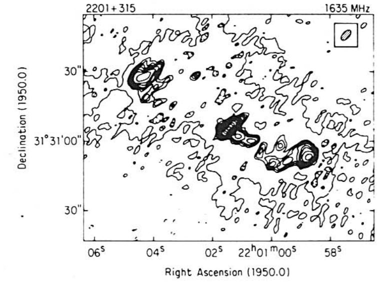






Source	z_{em}	L_{tot} (1.6 GHz) W/Hz	L_{tot} (4.9 GHz) Watts/Hz	Largest Angular Size (arcsec)	Largest Linear size* (kpc)	Core α $S \propto \nu^{-\alpha}$
0212+171	0.472	2×10^{25}	3×10^{25}	39	181	-0.08
0742+318	0.462	4×10^{25}	6×10^{25}	120	549	-0.04
1217+023	0.240	5×10^{24}	8×10^{24}	71	226	-0.17
2201+315 (4C 31.63)	0.297	4×10^{25}	4×10^{25}	91	332	-0.21

*$H_o = 75$, $q_o = 0.5$



in the plane of the sky; tilting them very far out of the plane of the sky merely exacerbates travel time and velocity problems. All of the sources shown are known (from Preston's VLBI Survey, Preston, 1979) to have structure on the scale of a few tens of parsecs. Observations have been proposed to study the detailed small scale structure in those sources with the brightest radio cores.

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