41.05

A Low Frequency Spectral Flattening of the Hot Spots in 3C 405

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VLA and MERLIN observations at 4.5" resolution of Cygnus A at 8 frequencies between 0.15 and 15 GHz have revealed a low frequency flattening in the spectra of the hot spots. The effect is rather dramatic, with the spectal indicies changing from about -0.6 between 6 and 20cm to -0.3 between 90 and 200cm, and the effect is isolated to the hot spots.

We believe the flattening is a result of a low energy rolloff in the electron energy spectrum, since synchrotron self absorption demands magnetic fields be very large (> 0.1G), and thermal absorption requires unreasonable densities. Using a turnover frequency of about 300 MHz, and minimum energy fields of 300uG, we calculate a mean cutoff energy of 600 MeV. In retrospect, there are good physical reasons to expect flattening at energies near the proton rest mass (938MeV) from first order Fermi acceleration, if the jets contain protons and are transrelativistic. Specifically, particles with energies near or below the incoming proton energies (in the shock frame) will dissipate energy within the shock. Such particles do not see the shock as a velocity discontinuity, which is a requirement for acceleration (Bell, 1978, MNRAS 182,443). Other processes which can alter the electron energy distibution include streaming of fast particles up stream from the shock, and damping of Alfven waves by ambient protons. The first process will affect shock structure, and hence acceleration efficiency (Drury and Volk, 1981, Ap.J. 248, 344), while the second will affect pitch angle scattering of the fast particles, which again, influences particle acceleration (S. Spangler, private communication). Lastly, the fact that the flattening is isolated to the hot spots is probably a result of adiabatic loses as the fluid expands into the lobes. Such loses will shift the rolloff to much lower frequencies.

If our interpretation for the low frequency behavior is correct, then we have two fundamental results: 1) jets contain protons, and 2) minimum energy holds to within a factor of two. On the other hand, if the flattening is due to synchrotron self absorption, we have a direct measure of internal magnetic feilds.

41.06

Physical Characteristics of Lobes of Luminous Radio Galaxies

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We report further studies of the lobes of luminous radio galaxies. From dual frequency VLA observations we have obtained the following results.

1. 3C223.1 and 3C379.1 show an X-shaped extended structure away from the source axis.
2. The backflowing electrons in the lobes lose energy as they move away from the hot spot. This energy loss is observable as a spectral index gradient in the lobe. Separation speeds of the hot spot from the lobe of 8000 km/s to 15000 km/s have been obtained.
3. The electron density and magnetic field configuration are expected to be turbulent. Assuming Gaussian statistics, we can estimate the thermal electron density within the lobes, utilizing measurements of Faraday rotation gradients across the source. The densities were found to be of the order of 10^{-5} cm^{-3}.
4. From the total intensity profile across the lobe, we can obtain information about the uniformity of the synchrotron volume emissivity, which is found to be quite homogeneous for several sources.
5. If the lobe magnetic fields are disordered, but two dimensional, there should be higher fractional polarization near the edge than at the center. This appears to be true in general, however there were cases where the fractional polarization is higher at the center.

41.07

Counterjets in Classical Double Radio Quasars

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The lobes of powerful classical double radio sources are usually roughly symmetrical in brightness and in shape, but their jets are usually much brighter on one side of the nucleus than on the other. As very few counterjets have been detected in sources with powers above 10^{26} W Hz^{-1} at 1.4 GHz, there are only upper limits to the jet-counterjet intensity ratios for most such sources. We have made 5 GHz images of 12 3CR quasars with angular sizes $> 10''$ drawn from the sample of Laing, Riley, and Longair (1983, *MNRAS*, **204**, 151). We have combined data from the VLA in its A and B configurations to obtain typical rms noise fluctuations of 20 μJy/beam at an angular resolution of $0''.35$. These 12 sources, together with 3C47 observed separately by D. Clarke and J.O.B., include all 10 3CR quasars with largest projected linear sizes $> 100h^{-1}$ kpc ($H_0 = 100h$ km s^{-1} Mpc^{-1}, $q_0 = 0.5$). We detect jets in all of them, including 7 in which no jet was previously known. In 5 sources, we detect probable counterjet emission between the nucleus and the lobe on the side opposite to the obvious jet. This is the first time that probable counterjet structures have been systematically found in extended 3CR quasars. The jet/counterjet brightness ratios are typically below a few tens to one, and can be explained by Doppler favoritism with more modest Lorentz factors than those needed to account for superluminal motion in compact radio cores. Even if Doppler favoritism produces the jet brightness asymmetries in these 5 quasars, their jets must emit higher intrinsic radio powers than the symmetric jets in lower-power radio galaxies. Our images also reveal much new fine detail in the radio lobes of these quasars, including multiple hot spots and filamentary structures. (D.H.H. is a National Research Council-NASA Resident Research Associate at the Jet Propulsion Laboratory.)

41.08

X-ray Spectra of Compact Extragalactic Radio Sources with the Einstein Observatory IPC

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We have compared the 0.2–3.5 keV power-law energy spectral indices, α, of 24 radio-selected BL Lac Objects, 12 Highly Polarized QSOs (HPQs), and 19 low polarization Flat Radio Spectrum, core-compact, QSOs (FRS QSOs). Our method assumes that the intrinsic distribution of spectral indices for each object class is Gaussian, and we use the maximum likelihood statistic to find confidence regions for the mean and sigma of the Gaussian. The amount of low energy absorption to each source is treated as a free parameter.

Results for the HPQs and FRS QSOs are similar, with a best-fit index of $\alpha \approx 0.5$, whereas for the BL Lacs, $\alpha \approx 1.0$. Each of the three samples is consistent with all of its objects emitting a spectrum with the same spectral index. This is in contrast with X-ray selected BL Lac objects where IPC observations are inconsistent with a single spectral index.

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