NATIONAL RADIO ASTRONOMY OBSERVATORY
Edgemont Road, Charlottesville

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TO: Bob Havlen

FROM: Alan Bridle

RE: Material for annual report

Bridle continued to examine the systematic properties of jets in extragalactic sources, using data on over 200 jetted sources from his own and other observers' studies. The spreading (lateral expansion) rates of jets were found to decrease with increasing source power. Several correlations were found between the relative prominence of the radio cores and the properties of jets in powerful radio galaxies and QSRs. Jets are detected more frequently, and on the same side of the source as the brighter hot spot, in such sources when they have relatively prominent cores. In contrast, the brightness asymmetries of detectable radio jets in powerful radio galaxies and QSRs with weak radio cores appear unrelated to those of the hot spots.

Bridle and R.A.Perley (NRAO) studied the large scale structures and radio jets in the radio galaxies NGC6251 and 3C219 at 20cm and 6cm, merging data from several VLA configurations. Counterjet emission was detected in both sources. The data on the lateral expansion of the jet in 3C219 show that this jet is not free, but the luminosity of the X-ray source at 3C219 is too low for the jet to be confined thermally at the temperatures typical of galactic X-ray haloes. Either the jet is confined by a very hot cluster gas, or a nonthermal mechanism such as electromagnetic focussing is required.

Bridle, with W.J.Jaegers and H. van der Laan (Leiden), R.H.Sanders (Groningen) and E.B.Fomalont (NRAO) mapped the three parallel radio sources in the field of 3C130 using the VLA. The sources have very different detailed structures, eliminating the hypothesis that they are images of 3C130 produced by gravitational lensing in the Perseus supercluster. 3C130A contains a conspicuous two-sided jet which is being studied further, while the original identification of 3C130C appears to be incorrect. A second example of a faint radio neighbor parallel to a strong cluster radio galaxy was serendipitously discovered near 3C219 by Bridle and Perley. The data appear to favor models of the parallel-source phenomenon that invoke a common origin for the gas that collimates the expulsion of radio plasma from active galaxies in the same cluster.

W. van Breugel (Berkeley), G.Miley (Leiden), T.Heckman (Maryland), H.Butcher (Groningen) and Bridle made a detailed optical and radio study of the radio galaxy 3C277.3, obtaining clear evidence for an interaction between radio jet plasma and optical emission line gas. They concluded that the optical emission lines arise from ambient (local) clouds that have been excited and accelerated by the

passage of the radio jet, both brightening and deflecting the radio feature. Several unusual aspects of the Faraday depolarization of larger scale structure of 3C277.3 can be explained by entrainment of ambient halo clouds into the boundary layers of the radio jet and of the lobes.

SCIENTIFIC PLANS -- A.H.BRIDLE
September 1984

A.H.Bridle will continue using the VLA to obtain multifrequency data on knot structures, spreading rates and magnetic configurations in kiloparsec-scale extragalactic radio jets. These will be compared with theoretical models of pressure-matched supersonic flows, to refine our understanding of the processes of energy transport in large extragalactic sources.

Data on the brightness distributions and magnetic configurations in the rapidly spreading jets in several weak radio galaxies will be compared with analytic models for mildly supersonic, matter-entraining and decelerating turbulent flows developed by several theoretical colleagues. Consistent descriptions of the observed spreading rates, brightness evolution and magnetic field structure will be sought. The interface between the models and the data will be a code developed this summer to compute synchrotron emission from relativistic electrons in magnetic field configurations specified by the models. Unlike these wide jets in weak sources, the narrow jets in strong sources are probably hypersonic flows which are not significantly decelerated by interactions with ambient gas. The hydrodynamics of such flows have recently been explored in some astrophysically relevant cases by M.Norman and colleagues using the Munich Cray. They have studied the time evolution of density, pressure and velocity profiles in a set of situations which systematically explore the Mach number - density contrast plane of jet propagation. Parts of their model data set will be interfaced to AIPS, so that they can (a) be married to prescriptions for the connection between synchrotron emissivity and the thermal flow parameters, and (b) convolved with realistic radio beams and displayed using standard radio astronomical image display techniques, both at NRAO and elsewhere. Possible relations between jet knots, lobe hot spots, etc. and the shock structures in the flow models will then be explored, to understand the radio continuum as a flow visualisation technique and thus to guide the use of VLA maps as flow diagnostics.

These studies will be allied to new VLA observations of fine structure in radio jets at 2cm, preparatory to work at similar resolution with the Space Telescope, in collaboration with G.K.Miley (STSI), R.A.Laing (RGO) and others. We hope to identify, and then map, bright knots in several radio jets, ultimately determining their radio morphology, magnetic structures and optical-radio synchrotron spectra for comparison with shock- and turbulence-driven particle acceleration mechanisms.

With F.O.Clark and J.van Gorkom (NRAO), an attempt will be made to map OH emission from bipolar flows around young stars using the VLA, based on a survey of their OH spectra with the NRAO 140ft. (Preliminary) results of the survey suggest that OH may trace the flows over a wide range of velocities and may give clues to physical conditions in them through the OH excitation mechanism. These galactic jets are examples of supersonic outflows in a background medium whose density, temperature, etc. can be measured by many methods. They may therefore provide a "laboratory" in which to test flow models used in extragalactic sources.