80.02

Collimation and Stability of Three Dimensional Jets

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Three-dimensional numerical simulations of cylindrical jets established in equilibrium with a surrounding uniform medium have been performed. Large scale structures such as helical twisting of the jet, elliptical distortion and bifurcation of the jet, and triangular distortion and trifurcation of the jet have been seen in the simulations. The grid resolution has been sufficient to allow the development of structures on smaller scales and has revealed higher order distortions of the jet surface and complex structure internal to the jet. However, smaller scale surface distortion and internal jet structure do not significantly modify the large scale dynamics. It is the large scale surface distortions and accompanying filamentation that dominate the jet dynamics. Decollimation occurs as the jet bifucates or trifurcates. Jets with density less than the immediately surrounding medium rapidly decollimate and expand as the jet filaments into multiple streams leading to shock heating and mass entrainment. The resulting morphology resembles a turbulent plume and might be relevant to some FRI type radio sources. Jet densities higher than the immediately surrounding medium are required to produce FRII type radio source jet morphology and protostellar jet morphology. Thus, while jets may be denser or lighter than the external medium through which they propagate, it is the conditions in the cocoon or lobe around the jet that governs the dynamics far behind the jet front. This work was supported by NSF grant AST-8919180, EPSCoR grant EHR-9108761 and NSF-REU grant AST-9300413.

80.03

Shock-Disruption of Three-Dimensional Jets

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We present the results of three-dimensional numerical simulations of radio jets encountering perpendicular and oblique shocks. The 2D version of the problem was studied by Norman, Burns, & Sulkanen (1988) who showed that jets would flare and disrupt upon crossing a shock if the jet internal Mach number was less than the shock Mach number. Our 3D results for a jet encountering a normal shock are qualitatively the same as the 2D results although the size scales are dramatically different. In the case of an oblique shock, the ambient gas streamlines bend towards the shock and so an extended, turbulent tail is dragged downstream after the jet disrupts. We discuss the applicability of this model to the formation of Wide-Angle Tailed (WAT) radio sources.

80.04

"Tired" Jets in Extended 3CR Quasars

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We have imaged 13 extended 3CR quasars with high sensitivity and resolution using the VLA at 4.9 GHz.

We find a strong correlation between the prominence (relative to the extended lobe emission) of the milli-arc-second scale central features and of the inner, straight segments of the radio jets. The outer, bent, jet segments do not share this correlation, however.

Jet bending favors the detection of counterjet candidates, and inhibits the formation of prominent hot spots. There are no counterjet candidates opposite long, uninterrupted straight segments of the jets, and there is no evidence that the prominence of counterjet candidates anti-correlates with that of the jets, as it would if relativistic beaming controls the jet/counterjet asymmetry far from the quasar.

These data favor "tired jet" models in which the flows through the parsec-scale radio features are highly relativistic but those in larger-scale jets are only mildly relativistic. Further decreases in average jet velocity on kiloparsec scales may then (a) allow the jets to bend, (b) allow counterjets to become more visible, and (c) reduce the jets' ability to form compact hot spots.

We find a further correlation that may conflict with the *simplest* tired-jet interpretation, however. When there is a strong asymmetry in compactness between the jetted and counterjetted hot spots, it is always the jetted spot that is more compact. The hot spots thus retain some memory of the jet-sidedness asymmetry, but the mechanism for this is not clear.

80.05

High-resolution VLA Images of the Jets and Filaments in 3C353

M.R.Swain, A.H.Bridle (NRAO), S.A.Baum (STScI)

3C 353, a wide-lobed double source that is the fourth brightest radio galaxy in the 3C Catalog (57 Jy at 1.4 GHz) is associated with an elliptical galaxy in a Zwicky cluster at z=0.0304. Previous VLA observations detected a jet and counterjet, well defined but weak hot spots (typical of sources just above the Fanaroff-Riley Type I to II transition), and a rich complex of large-scale filaments throughout both lobes, which cover over 5 arcmin on the sky.

We present sensitive new high-resolution (0.4″ FWHM) images of 3C 353 in total and polarized intensity obtained by combining data from the VLA's A,B,C and D configurations at 4.9 GHz. These images reveal further structural complexity in both the jets and the filaments.

The jet contains compact linear features oblique to its symmetry axis, and several asymmetrically-placed knots within a smooth, well-collimated envelope of emission. The counterjet is similarly well-resolved and also well-collimated.

The filaments contain a hierarchy of transverse scales, with some apparent pairing of sub-filaments (or center-darkening of ribbon-like features). Some filaments are fully-resolved but others contain regions of relatively bright, unresolved substructure. Work is in progress to determine the spectral and polarimetric characteristics of this hierarchy of structures in the filaments.

A "dark spot" that is prominent on lower-resolution radio images at all radio wavelengths is now seen to be connected to other structure in the east lobe. Its origin remains unclear.

80.06

High-Resolution Far Infrared Images of Centaurus A

R. LeWinter (Wesleyan U.), M. Rupen (NRAO), Z. Wang (CfA)

We present high-resolution images of Centaurus A at 12, 25, 60, and 100μm, created using the HiRes algorithm from the IRAS survey data. The resulting resolution varies between 1×0.5 (12μm) and 2×1.5arcmin (100μm). The dust emission clearly follows the optical dust lane and the neutral hydrogen distribution; we detect for the first time at far infrared (FIR) wavelengths the outer warp, and there is some indication of a "halo" of cold dust emitting outside the disk. While the 12/25μm colour is virtually constant across the galaxy, the 60/100μm colour temperatures increase from 28K near the edge to 40K at the center of the disk, consistent with other evidence for massive star formation near the nucleus. Comparison with atomic (HI) and molecular (CO) observations shows that the FIR emission tracks the sum of both rather than the individual gaseous components, both in general trends (radial decline, warping) and specific features (asymmetry to the east, possible southern extension near the center). There is no obvious correspondence between the FIR and radio morphologies, which is not surprising given the dominance of the central AGN and large-scale jet at radio wavelengths. If the disk of CenA follows the far infrared/radio correlation observed in spiral galaxies, radio images with dynamic ranges of $>$ 5000-to-1 will be required to detect its radio emission.

80.07

Hot, Entrained Gas in the 5-arcmin-long X-ray Jet of the Nearby Spiral Galaxy NGC 4258

G.Cecil, C.DePree (UNC-CH), A.S.Wilson (STScI)

The famous, large-scale, bisymmetric "braided" jets are found to emit most of the X-rays from this nearby SABbc LINER/Seyfert galaxy. After removing wobble-related errors of up to ±6″ in our 27 ksec ROSAT HRI image, we find that the SE branch of the jet is spatially unresolved across its width along