EVOLUTION OF POWERFUL EXTENDED RADIO SOURCES

Implications for Cosmology and Cosmogony

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Abstract. Powerful extended radio sources are observed out to relatively large redshift. They may be used to study the properties and redshift evolution of the gaseous environment in the vicinity of each source, the active galactic nucleus (AGN), and the source size. This information may then be used to study and constrain cosmological and cosmogonical models. It is interesting to note that the rate of change of quantities with redshift allows constraints to be placed on global cosmological parameters and on models of structure formation and evolution that are completely independent of those inferred using the cosmic microwave background or local dynamical studies, and thus provide an important complement to these studies. The method does require that we understand the physics of the sources well enough to account for intrinsic source evolution. The physics of powerful extended radio sources that propagate supersonically appears to be relatively straight-forward. We have used the radio properties of the sources to deduce the ambient gas density, the beam power of the AGN, the characteristic time a particular AGN is on, and a characteristic source size that allows the sources to be used to probe global cosmological parameters. We plan to use the radio properties of the sources to deduce the ambient gas temperature, which will be combined with the ambient gas density to constrain cosmogonical models, that is, models of structure formation and evolution.

1. Results

In the short space allotted here we can only summarize results that are presented elsewhere; for details please see the papers by Daly (1994, 1995),

R. Ekers et al. (eds.), Extragalactic Radio Sources, 319–320.

Guerra & Daly (1995, 1996), Wan & Daly (1996a,b,c), Wellman & Daly (1995, 1996a,b), and references therein.

The data of Leahy, Muxlow, & Stephens (1989) and Liu, Pooley, and Riley (1992) were reanalyzed, and the lobe width a_L, the lobe magnetic field B_L, and the lobe propagation velocity v_L were estimated for each radio lobe in a consistent way (Wellman & Daly 1995, 1996). The final sample consists of 27 radio lobes from 14 radio galaxies, and 14 radio lobes from 8 radio loud quasars. The sources have projected core-lobe separations between 25 and 200 h^{-1} kpc, and redshifts between zero and two.

The beam powers are similar to that of Cygnus A, and are proportional to the radio power of the source. The ambient gas density in the vicinity of the radio lobe and hotspot range from about 10^{-2} to 10^{-3} cm^{-3}; galaxies and quasars are in similar gaseous environments; the composite density profile resembles that in low-redshift clusters of galaxies (such as the gas around Cygnus A); and the fit is significantly improved if the core density is allowed to evolve with redshift in the sense that the core density decreases with increasing redshift. A statistically significant result is obtained when the sources are used as a cosmological tool: the present data favor a low density universe with or without a cosmological constant over a flat matter-dominated universe. In addition, it appears that the characteristic time the AGN puts out a collimated outflow decreases with increasing redshift, or with increasing beam power, suggesting that higher redshift sources are smaller because they are on for a shorter period of time.

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