HOT SPOTS IN COMPACT SOURCES +

T.K. Menon
Department of Geophysics and Astronomy
University of British Columbia
Vancouver, B.C. V6T 1W5 Canada

The low-frequency turnover of a selected sample of quasars is found to be strongly correlated with their redshift (Menon 1983)). Assuming that the components which produce the low-frequency turnover are hot spots in the quasars I have derived the physical parameters of the hot spots and show that there is a continuity in the various parameters as the angular sizes of the hot spots vary from subarc-seconds to milliarcseconds. Hence the low-frequency turnover can be used as a probe into the physical conditions at the earliest phases of quasar activity.

INTRODUCTION

I have recently shown (Menon (1983)) that for a selected sample of 19 quasars the frequency of the low-frequency turnover, in the rest frame of the sources, is strongly correlated with their redshift in the sense that sources at higher redshifts have higher turnover frequencies. The redshifts range from 0.367 to 3.53 and the turnover frequencies range from 64 MHz to 5 GHz. Assuming that the turnover is due to synchrotron self-absorption I have calculated the equipartition angular sizes for these sources for a $q_o = 0.5$, $H_o = 50$ km/s/Mpc cosmological model. The Fig. (2) of Menon (1983) shows that the angular sizes vary from subarc second to a few milliarcseconds and the variation is much faster than predicted by any reasonable cosmological model.

DISCUSSION

It has been suggested that the high surface brightness component which produces the low-frequency turnover in such sources is the outer-most hot spot in the source seen at a small angle to the line of sight. Recent VLBI studies of sources such as 3C147 (Readhead and Wilkinson (1980)) appear to confirm such an interpretation. In such models a source may have a number of self-absorbed components the frequency of maximum flux of each decreasing as the components are further away from

+ Discussion on page 422

R. Fanti et al. (eds.), VLBI and Compact Radio Sources, 45–46.

the nucleus. The linear sizes of these outermost components for the present sample decrease from about 5.9 kpc to about 12 pcs. Since we do not know the projection angles of the components we cannot directly calculate the distance of the components from the centers of activity of the sources. But it seems reasonable to assume that the observed decrease of linear size is accompanied by a decrease in the distance of the component from the center. As an approximation I shall assume that the collimation angle is the same for all sources and I shall use a standard hot spot of 3.5 kpc at a distance of 50 kpc from the center as defining the collimation angle. Hence, knowing the linear size, we can compute the distances of the hot spots from the center. The distances vary from a few parsecs to a few kiloparsecs.

I have next calculated the equipartition energy density in the hot spots using the known radio luminosity. Assuming a ram pressure confinement model for the hot spots and a velocity of motion of 0.1 c. the necessary ambient density at the distance of the hot spots was calculated. A composite diagram of the densities as a function of distance from the center for all quasars in the sample shows that the densities vary continuously from a few hundred atoms per c.c. to 10^{-3} atoms per c.c. These are average densities and as is known from optical studies of emission line regions in quasars and galaxies extreme fluctuations do occur in the density distribution with filling factors as small as 10^{-5} or 10^{-6}. If the collimation angle is smaller closer to the center then the derived densities will be higher closer to the center than in the sample model. In any case the derived data on the dimensions and densities suggest that the energetics of the outermost hot spots as delineated by their low-frequency turnover can be used as a probe to study the physical conditions from the innermost regions to the boundary of the parent galaxies. It is further noteworthy that the derived physical parameters of hot spots show a remarkable continuity from scales of the order of parsecs to tens of kiloparsecs.

The research reported here was supported by a grant from the Natural Sciences and Engineering Research Council of Canada.

REFERENCES

Menon, T.K.: 1983, A.J. 88, 598.
Readhead, A.C.S., and Wilkinson, P.S.: 1980, Astrophys. J. 235, 11.