THE COSMOLOGICAL APPLICATION OF VERY HIGH ANGULAR RESOLUTION IN RADIO ASTRONOMY

L. I. GURVITS*
National Astronomy and Ionosphere Center
Arecibo Observatory, P.O.Box 995, Arecibo, Puerto Rico 00613

Abstract. An approach providing an estimate of the cosmological deceleration parameter q_o from VLBI survey data is described.

Key words: VLBI – AGN – Cosmology

1. Introduction

Radio Astronomy of extremely high angular resolution has been developing during last twenty five years by mean of Very Long Baseline Interferometry (VLBI). VLBI is characterized by the highest angular resolution and accuracy of the celestial position measurements, the widest range of cosmological distances, currently exceeding redshift $z = 4$. This combination of high accuracy and long-range ability promises useful cosmological applications. Brief but comprehensive review of recent attempts to implement these applications is given by Roland *et al.* (1992). In this paper I am showing an approach which along with few other works (Gurvits, 1993; Kellermann, 1993) gives a possibility to estimate the cosmological deceleration parameter q_o from VLBI survey data.

2. Observational Data and Interpretation

The experimental data used are from a large 2.3 GHz VLBI survey (Preston *et al.*, 1985) of 1398 predominantly – extragalactic sources. Typical angular resolution of the survey is about 3 mas. A total of 917 sources were detected, *i.e.* correlated radio flux density associated with a compact structure was measured. The sub-sample of sources suitable for our purposes is composed of the 337 sources from the survey which have known redshifts (Véron-Cetty and Véron, 1991) plus measured total (S_{tot}) and correlated (S_{corr}) flux densities. The ratio $\Gamma = S_{corr}/S_{tot}$, a modulus of fringe visibility, is a measure of source compactness. The sub-sample of 337 sources consists exclusively of active galaxies nuclei (AGN) in the redshift range of $0.005 \leq z \leq 3.8$

One can use Γ to calculate an angular size $\theta = 2\sqrt{-ln\Gamma \cdot ln2}/(\pi B)$, where B is the interferometer baseline, measured in wavelengths. This size represents a single parameter Gaussian, which can be assumed as a rough presentation of a source characteristic angular size. Such a presentation for each source may be rather far from it's real size due to individual brightness distribution. However averaging of θ over large enough group of sources creates some value, which might be assumed as a characteristic angular scale of the group of sources.

* On leave from Astro Space Center of P.N.Lebedev Physical Institute, Leninsky Pr. 53, Moscow, 117924, Russia

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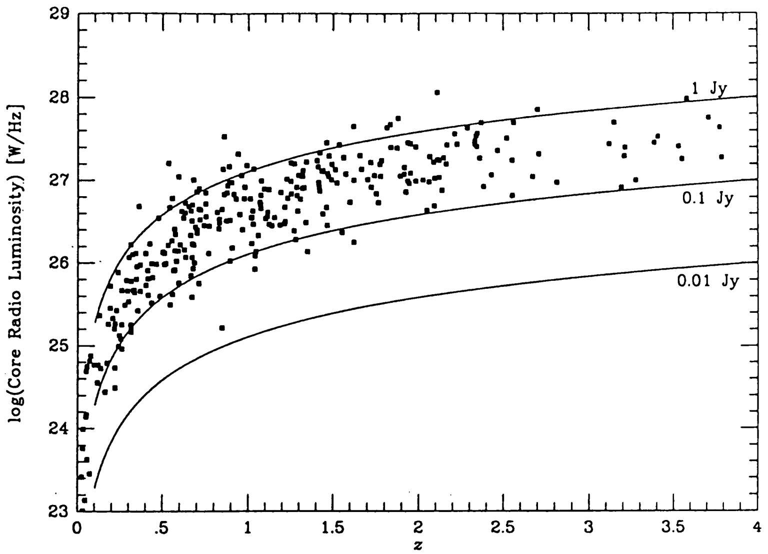

Fig. 1. Measured radio luminosity of source cores L_{cor} as a function of redshift z. Solid lines show radio luminosities of sources with observed flux density 1, 0.1, and 0.01 Jy.

The initial survey sample of 1398 sources was necessarily biased by a strong selection effect: the sample is flux limited. The sub–sample of 337 sources is clearly affected by this selection. Fig. 1 shows dependence between source compact component radio luminosities and redshifts. These luminosities are calculated from measured correlated flux and can be assumed as luminosity of source cores. Experimental points on Fig. 1 undoubtfully follow the shape of the curve of a fixed flux density at different redshifts (solid lines).

Values of θ were calculated for all sources from the sub–sample. The entire sub–sample was sorted by redshifts and then divided for 16 groups each with 21–22 sources. Each group corresponds to a rather narrow redshift bin. Fig. 2 shows a plot of characteristic angular size versus redshift. Such a plot can be used for fitting with theoretical predictions if one can prove, that the sub–sample contains sources of more or less the same linear sizes (*i.e.* the sub–sample can be assumed as a sample of distributed over different redshifts "standard rods").

3. Conclusion

The mentioned strong selection effect might have a useful application for our study. It allows to make rather sharp distinction between low core luminosity sources ($L_{cor} < 10^{26}$W/Hz) and high luminosity counterparts (10^{26}W/Hz $< L_{cor} < 3 \cdot 10^{27}$W/Hz). This distinction corresponds to redshift ranges $z < 0.5$ and $z > 0.5$. The high redshift part of the sub–sample has a much less dispersed range of luminosities, and hence might be assumed as a composition of intrinsically close if not the same objects. Just due to this reason we try to fit only sources at $z > 0.5$ with the theoretical curves on Fig. 1 The best fit corresponds to $q_o = 0.15 \pm 0.3$.

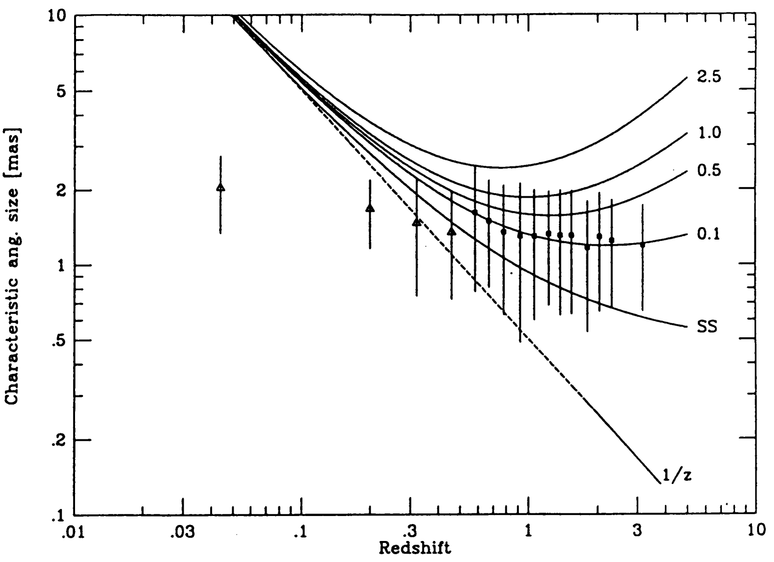

Fig. 2. Characteristic angular size versus redshift. Opened triangles correspond to sources with $L_{cor} < 10^{26}\,\mathrm{W/Hz}$, filled squares – to sources with $10^{26}\,\mathrm{W/Hz} < L_{cor} < 3 \cdot 10^{27}\,\mathrm{W/Hz}$, error bars shows $\pm 3\sigma$. Solid curves represent Friedmann cosmological models with various values of q_o (indicated near curves), Steady State (SS) and $1/z$ law.

The described result still is not free of influences from some other selection effects. But I believe the shown approach is not yet exhausted and may be used for further specification of the deceleration parameter.

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