Astrophys Space Sci (2013) 348:193–198
DOI 10.1007/s10509-013-1549-4

ORIGINAL ARTICLE

Doppler factor, Lorentz factor and viewing angle of superluminal quasars

C.C. Onuchukwu · A.A. Ubachukwu

Received: 15 April 2013 / Accepted: 22 June 2013 / Published online: 17 July 2013

Abstract We carried out the investigation of the properties of features seen within superluminal sources often referred to as components. Our result indicates a fairly strong correlation of $r \sim 0.76$ between component radial distance L and component size $\Re$. Assumption of simple ballistic motion and free adiabatic expansion, enabled us to use the observed jet component parameters to constrain the Doppler factor, Lorentz factor and the lower limit to the viewing angle with respect to a distant observer. The estimated average Doppler factor, Lorentz factor and viewing angle respectively are 10.3 ± 5.0, 18.3 ± 6.2 and 3.7 ± 2.3 for $\Gamma = 4/3$; while the values obtained for $\Gamma = 5/3$ are 12.2 ± 5.9, 17.2 ± 5.1 and 2.9 ± 1.6, where Γ is the adiabatic index. The large scatter in our results may be due to the uncertainties introduced by the assumptions made.

Keywords Galaxies: general · Galaxies: active · Galaxies: jets · Methods analytical · Methods: statistical · Methods: data analysis

1 Introduction

The early days of Very Long Baseline Interferometer (VLBI) technique applications to Active Galactic Nuclei (AGN), led to observations of apparent superluminal speed in parsec jets of extragalactic radio sources (e.g. Cohen et al. 1971; Whitney et al. 1971). These superluminal motions are usually explained by assuming that these jets are moving relativistically nearly along the line of sight of a distant observer. Multi-epoch observations of many sources with superluminal jets provide us with various apparent properties of the moving features often referred to as components. These observed apparent properties can be used to place useful constraints on the intrinsic properties of these radio jets and jets of X-ray binaries as well, their characterization and use in applications ranging from unified models of AGN to cosmology (Piner et al. 2007).

Early efforts to assemble such multi-epoch data for many sources relied on collecting single-sources results from literatures (e.g. Ghisellini et al. 1993; Vermeulen and Cohen 1994), but such assemblages can be biased because they include only the data that the observers have elected to publish. Recently, several multi-epoch surveys—e.g. Caltech-Jodrell Bank Flat spectrum survey (Vermeulen et al. 2003; Britzen et al. 2008), the 2 cm survey (Kellermann et al. 2004; Kovalev et al. 2005), the Radio Reference Frame Image Database (Piner et al. 2007) and the MOJAVE program (e.g. Lister and Homan 2005; Lister et al. 2009) have provided us with various observational parameters useful for statistical studies and inferences of these radio sources. In general, assumption of ballistic motion is usually made in the analyses and interpretation of the observational features of jet motions in these radio sources, though Kellermann et al. (2004) and Lister et al. (2009) have pointed out the increasing feature of non-radial jet motions in their samples. For such non radial jet motions, Gong (2008) and Gong et al. (2011) showed that these non-radial motions may better be interpreted by the assumption of non ballistic model.

VLBI observations of radio jets provide us with many values of the apparent luminosity, size, radial distance away from the core and proper motion/apparent trans-

C.C. Onuchukwu (✉) · A.A. Ubachukwu
Department of Industrial Physics, Anambra State University, Uli, Nigeria
e-mail: onuchukwu71chika@yahoo.com

C.C. Onuchukwu
Department of Physics and Astronomy, University of Nigeria, Nsukka, Nigeria