Perseus in Sicily: From Black Hole to Cluster Outskirts
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Hints of radio sources evolution

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Abstract. An understanding of the mechanisms that regulate the Active Galactic Nuclei passes through the study of their early life stages, observable in Compact Symmetric Objects. To this purpose, a study was carried out on two compact radio sources, based on data from the VLBA archive at different times and frequencies. The results are compatible with an intermediate scenario between the two main theories about these objects: frustration and youth.

Keywords. Galaxies: active, galaxies: jets, radio continuum: galaxies

1. Introduction

A Compact Symmetric Object (CSO) is a milliarcsecond version of a radiogalaxy, and it is a widely shared opinion that such small dimensions are due to their young age, ranging from hundreds to thousands of years of activity. In order to check the ages both radiative and kinematic studies have been realized by many authors (Owsianik *et al.* (1998), Taylor *et al.* (2000), Conway (2002), Murgia (2003), Gugliucci *et al.* (2005), Britzen *et al.* (2008), An *et al.* (2012)).

To extend the studies on the age of some of these sources I used VLBA archive data at different frequencies and epochs of two CSOs, J1035+5628 and J1358+4737, in order to obtain information on expansion speed and break frequency in their radio spectrum.

2. Kinematic and radiative ages

The most updated analysis of the kinematics of J1035+5628 is in Britzen *et al.* (2008) and refers to C-band data from 1996 to 2000. I collected data for this source in X-band from 1994 to 2011 in the VLBA database. The data were calibrated and then self-calibrated in phase using the AIPS package. The position of the components has been determined by using the DIFMAP modelfit. Only the position of the main component (hot-spot) of each minilobe, i.e. the brightest, has been determined and the trend of the separation between hot-spots over time is shown in Fig. 1 (Left panel). The linear fit is represented by the continuous line and a sinusoidal fit is drawn in dot-dashed line. The sinusoid fits better the data than the line, with a χ^2 value of 0.040 against 0.258. From the linear fit we can determine an expansion motion of the hot-spots of 0.0074 mas/yr, which gives us a kinematic age of 4324 years. The radiative age has been calculated using the Eq.2 in Murgia (2003), assuming the source in equipartition and with simultaneous radio data. The total power spectrum has a break at 8.4 GHz and this leads to a radiative age of 9199 years, more than double of the kinematic age. If the radiative age were equal to the kinematic the source should have a break frequency of more than 32 GHz.

The source J1358+4737 has only two epochs in X-band, so I had to use the C-band data to obtain the position of the hot-spots. The plot in Fig. 1, right panel, clearly shows a contraction of the source in time and this behaviour is obviously not real. As an example, if the data of the previous source were stopped at 2007, we would also observe a contraction for it. The radiative age of this source, calculated in the same way

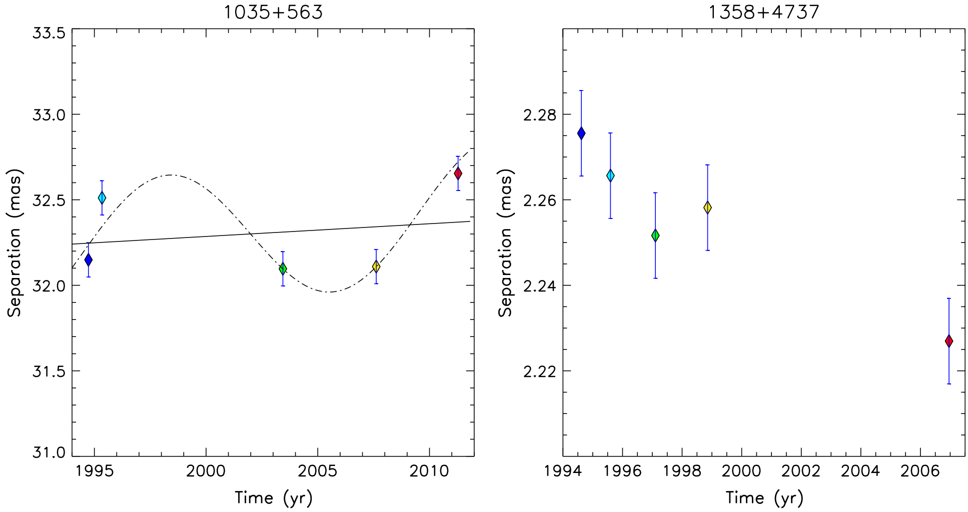

Figure 1. *Left panel* Separation versus time in J1035+5628. Data are taken in X-band. *Right panel* Separation versus time in J1358+4737. Data are taken in C-band

of J1035+5628, is of 4320 yr. If we suppose that this source had the same expansion speed of the previous, the kinematic age would be of only 310 yr, ten times less than the radiative one.

3. Conclusion

As already noticed by An *et al.* (2012), the motion of the components of a CSO is not so straightforward. In this work it is possible to recognize hints of periodic behaviour, as in J1035+5628, or a sharp contraction as we can see in J1358+4737. Moreover the radiative age tells a different story: the sources are more aged than the kinematics allow to infer. This, jointed with the observed motion suggests a more complicated evolution for this kind of sources: the motion appears composed by a linear and a periodic (or quasi-periodic) components, the second one possibly due to a precession of the inner jet. During the precession the hot-spot can encounter some gas clouds and, as a consequence, the expansion of the source slows. In other words, a combination of youth and frustration scenarios.

It appears necessary to deepen the study of the kinematics of the sources with observations closer in time and at high frequencies in order to trace the true hot-spots.

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