Proper motion in OQ208

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1. Introduction

Compact Symmetric Objects (CSOs) show high brightness radio emission regions separated by less than 1 kpc, symmetrically located on both sides of a weak radio core. These high brightness regions are thought to be the minilobes or hotspots produced by oppositely directed jets, as observed in the powerful giant radio sources, but on scales 3–4 orders of magnitude smaller. There is compelling evidence that CSOs represent the first evolutionary stage of the life of extragalactic radio sources (O'Dea & Baum, 1997, AJ 113, 148; Fanti et al. 1995 A&A 302, 317).

Owsianik and Conway (1998 A&A 337, 69) and Owsianik et al. (1998 A&A 336, L37) estimated the hot-spot separation speed in 0108+388 and 0710+439 to be around 0.2 c, implying a dynamical age of the order of 10^3 years. Other objects have been added to these, but the results are restricted so far to a few sources only, and it is therefore important to estimate the expansion speed in other CSOs, possibly on a wider range of linear scales.

OQ208 (1404+286) is a compact radio source associated with the bright galaxy Mkn668 of m_r=14.6 at z = 0.077 (Stanghellini et al. 1993 ApJ 88, 1). The redshift of OQ208 locates the source at a distance of $\sim$ 240 Mpc (H_0=100). The compactness of OQ208 and its proximity to us makes it a good candidate for the detection of proper motions in its components, and for studies of how this class of sources develop.

Another open question is what causes the low frequency turnover of the radio spectrum in GPS sources. Alternatives to the self synchrotron hypothesis have been taken into account by many authors (O'Dea, 1998, PASP 110, 493 and references therein) .

Recently it has been claimed (Horiuchi et al. 1999) on the basis of VSOP observations at 1.6 GHz, that the weaker region of OQ208 has a steep inverted spectrum inconsistent with the self synchrotron absorption (SSA), and likely due to free–free absorption (FFA). The size of OQ208 makes possible to check this result with 1.6 GHz earth-only VLBI observations.

2. Is OQ208 expanding?

Observations of the radio source OQ208 at 8.4 GHz have been made available to us for several epochs from the Radio Reference Frame Image Database (RRFID; Fey et al. ,1996, ApJS 105, 299)

In January 2000 we observed OQ208 with the VLBA at several frequencies, aiming to search for proper motions between the components of this radio source, as already measured in the 2 CSOs mentioned above, and to determine the spectral shape of the components. We finally have various VLBI observations, with epochs spanning the time range 1994–2000.

We fitted the images with 4 components (2 for each region) as done in Stanghellini et al. (1997, A&A 318, 376). We used the task IMFIT in AIPS to fit the flux densities, positions, and sizes of the components in the image plane; the tasks OMFIT and SLIME in AIPS, and MODELFIT in DIFMAP to fit the same parameters on the UV data.

We used the standard deviation between the positions found by the different tasks for the same components as an estimate of the position errors. Typical values for the position errors are between 0.05 and 0.2 mas, depending on the amount of uv-data.

We were able to find a possible positive correlation with time of the separation of components A and C, and estimated a speed of 0.033±0.013 mas/year.

At the redshift of OQ208 1 mas correspond to 1 pc, thus we obtain a projected speed of $0.10\pm0.04c$. Assuming an inclination of 45° between the jets and the line of sight, we have an actual separation velocity of $0.14\pm0.05c$. The error is still large, the estimate still uncertain, but we are confident to improve its determination.

The current estimate of the velocity at which the hot-spot propagate in the ambient medium is in any case consistent with the values expected, and very similar to the values found in other CSOs.

3. The low frequency radio spectrum

We obtained VLBA observations in January 2000 also at L, S and C bands. The lowest frequency observations do not have enough resolution to isolate all the 4 components, but allow us to plot a separate radio spectrum for the 2 main regions of the source. At present, the data amplitudes have been calibrated using only the antenna gains and system temperatures provided by the VLBA telescopes, and we assume the uncertainty due to this of the flux density derived for the components is around 5–10%. We find a flux density of the weaker region of OQ208 at 1.6 GHz of about 13±2 mJy while at 2.3 GHz we find a flux density of 44±4 mJy, therefore giving a very steep spectrum $\alpha = 3.8\pm0.7$. From 2.3 to 5 GHz the spectral index is still steep (1.8±0.2) but not unusual. The radio spectrum of the brighter region is consistent with a less prominent SSA, given that its slope is not as steep as the weaker lobe. If this is the case, the weaker component would represent the receding part of the radio source, and then the one where SSA is more effective.

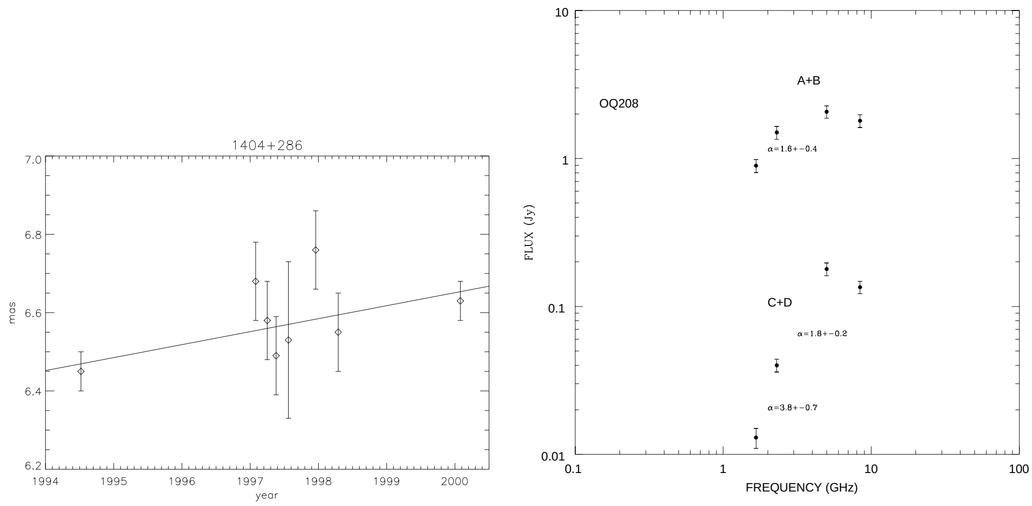

FIGURE 1. Left: separation between components A and C. Right: the radio spectrum of the two regions