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CSS Radio Sources and their Optical Characteristics

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Abstract. An optical study of CSS radio sources is presented.

Compact steep-spectrum (CSS) radio sources could represent the young phase of the large radio sources (Fanti et al. 1995) and therefore they are unique objects deserving detailed observations in every waveband. Recently, we have done such a detailed study of a sample of southern radio sources (the so called 2 Jy sample; Tadhunter et al. 1993, Morganti et al. 1993, 1996) that also includes 7 CSS sources ($D < 30$ kpc for $H_o = 50$ km s^{-1} Mpc^{-1}, $\alpha > 0.5$ for $S = \nu^{-\alpha}$ and $\log P_{2.7\mathrm{GHz}} > 26.0$ W Hz^{-1}). This study has allowed us to investigate the optical characteristics of the CSS sources and compare them with those of extended radio sources of similar radio power and redshift.

For all these objects we have obtained the luminosity of the optical lines (in particular [O III]λ5007, [O II]λ3727 and Hβ), and for most of them we have information on the optical continuum and optical polarization. All the details about the observations of CSS sources are presented in Morganti et al. (1997). The CSS sources have also been observed in the radio with VLBI (Tzioumis et al., in prep.) and they all show a double structure (like in the case of 1306−09 shown in Fig. 1), in agreement with what usually found for these objects (Fanti et al. 1995). Thus, they can be seen as down-scaled version of large double sources.

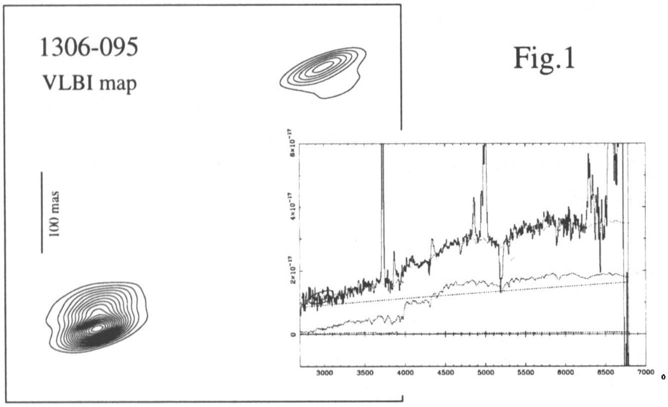

Fig.1

The spectra of the CSS sources are rich in strong emission lines and the ionization level ranges from high to moderate. Both these characteristics are very similar to what was found for extended radio sources of comparable radio power and redshift. The CSS sources follow the well-known correlation between

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radio power and [O III]λ5007 and [O II]λ3727 luminosities found for extended sources although there is tentative evidence that they have lower [O III]λ5007 luminosities for a given radio power. Two CSS sources show significant reddening although very similar to what found in dusty central regions of some extended sources (e.g., Cygnus A). The luminosity of the lines as well as the characteristics of the optical continuum have been obtained after careful modeling of the continuum itself. The continuum was fit by combining a passively evolving elliptical galaxy spectrum (Bruzual & Charlot 1993) and a power-law (or quasar) component (as shown in Fig. 1 for 1306−09). The details about the modeling and study of the continuum are given in Dickson (1997). From the modeling of the optical continuum we find that all the CSS show UV excess, i.e., a significant fraction of non-stellar light. The optical polarimetry has the potential to provide clues on the nature of this UV excess. We have done imaging polarimetry in B-band (corresponding to the rest-frame UV for the typical redshift of our objects) and we found a large variety of polarization characteristics. However, as for the extended sources, none of the sources show a very high polarization (i.e., $> 10\%$) and therefore scattered AGN light does not seem to be the main cause for the UV excess observed in these objects (Tadhunter et al. 1997).

From comparing the results obtained for the CSS sources with those obtained for the rest of the sample (in a similar range of radio power and redshift) we find that the spectroscopic and polarimetric characteristics of the CSS sources are, to first order, similar to those of the extended sources. This result has important implications for understanding the nature of the CSS source phenomenon. For the case in which the emission line regions are predominantly photoionized by the luminous AGN hidden in the cores of the galaxies, the observation of similar optical spectral properties for the extended and the CSS sources provides strong evidence against the hypothesis that the CSS sources are trapped by a very dense medium. We would, in fact, expect to observe a much larger line luminosity (as discussed in Fanti et al. 1995). An enhancement of the line luminosity (and a lower ionization state) would also be expected if jet/cloud interaction and shocks (in a very dense environment) would be the source of ionization.

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