ON THE X-RAY EMISSION FROM THE POWERFUL RADIO GALAXIES

G. BRUNETTI, G. SETTI, A. COMASTRI
Istituto di Radioastronomia
Via Gobetti, 101, 40129 Bologna, Italy

There is a growing evidence that radio loud quasars and powerful FR II radio galaxies belong to the same population. While X-ray observations of low redshift radio galaxies [1],[2] generally support the unified scheme relating the FR II radio galaxies to the radio quasars, nevertheless detailed studies of the X-ray properties of distant radio galaxies are made difficult due to both the low sensitivity of X-ray-satellites and to the emission of the hot intracluster gas in which they are normally embedded. We point out that significant fluxes of X-rays are produced in the strong radio galaxies by the Inverse Compton (IC) process. In the framework of the unified scheme the radio galaxies are pervaded both by an intense radiation flux from the misdirected hidden quasar and the cosmic microwave background radiation flux (CMB). From the standpoint of IC computation the far and near-IR emissions of the hidden quasar are of particular importance.
Based on the studies of various statistical samples [3],[4] we have adopted a typical quasar continuum spectrum as a combination of several power laws ($F(\nu) \propto \nu^{-\alpha}$): α =0.2, 0.9, 1.34 and 0.6 respectively in the intervals 100 - 50 μm, 50 - 6 μm, 6000 - 650 nm and 650 - 350 nm with an integrated mean luminosity ($L_{<Q>}$) of 6.9 $\times 10^{46}$ $erg\ s^{-1}$ ($H_0 = 75\ km\ s^{-1}\ Mpc^{-1}$, $q_0 = 0.5$ are used throughout). We assume that the quasar unabsorbed optical–UV photons are emitted within a cone with half–opening angle = 45^o [5] whose axis coincides with the radio axis defined by the hot spots. Since several studies [3],[4] indicate that the mean IR emission of NLRGs is $\sim$ 4 times lower than that of RL quasar, we shall adopt the same geometry for the quasar IR emission cone. We assume that the radio galaxies contain an uniform distribution of relativistic electrons and protons with the same energy density (k=1) and that there is equipartition between the particles and the magnetic fields. Since the IC contribution to the soft X-ray spectrum in our model is mainly due to low energy electrons ($\gamma \sim 50 - 1000$), the strength of

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the equipartition fields quantities are computed by taking into account the contribution of such particles to the energy density. Ionization losses may become important at low energies and have been taken into account. The spatial distribution of particles and fields has been modelled with a prolate ellipsoid centered on the nucleus and aligned with the radio structure. We have applied our model to the computation of expected soft X-rays fluxes for a sample of very powerful high redshift radio galaxies. In the case of 3C 277.2, 280 and 356 the derived luminosities of the hidden quasars required to match the observed X-ray luminosities of the radio galaxies are close to the average luminosity $L_{<Q>}$. For 3C 277.2 the requested quasar luminosity is $\sim 0.5\ L_{<Q>}$. The visual magnitude of this quasar would be V$\simeq$16.7, which is very close to the estimate (V=17.2) obtained from spectropolarimetric studies [6]. The ratio between the IC contribution due to the CMB photons and to the hidden quasar radiation field is $\sim$1.2. In the case of 3C 280, by matching the quoted point source flux [7] with our IC model, we require a hidden quasar luminosity $\sim 0.56\ L_{<Q>}$. The ratio between the IC contribution due to the CMB photons and to the hidden quasar would be 0.6. Finally, in the case of 3C 356 the requested quasar luminosity is $\sim 2.5\ L_{<Q>}$, which would entail a ratio between the IC contribution due to CMB and to the hidden quasar of $\sim$0.7. Both the predicted soft X–ray spectrum and brightness distribution are in agreement with the observed ones. This scenario may provide a possible alternative interpretation of the X-ray data to that of the cooling flow hypothesis [1]. We have considered other five high redshift powerful radio galaxies (3C 22, 175.1, 268.1, 352, 441) for which X–ray data are not available yet and have estimated the soft X-ray luminosities predicted by our IC model under the assumption that the hidden quasars have the average luminosity $L_{<Q>}$. The estimated soft X-ray luminosities (in 10^{43} erg/sec) are respectively 2, 0.3, 0.8, 3 and 0.6. As a general remark it should be stressed that the X–ray fluxes (given the radio galaxies volume and the relativistic electrons spectrum) have been computed under the hypothesis of energy equipartition between particles and magnetic fields, so that our model calculations could be considered as a lower limit to the IC contribution.

References

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