THE RELIC RADIO SOURCE B2 0924+30

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1. New radio maps

The double radio source B2 0924+30, associated with the luminous E/S0 galaxy IC2476, may be considered a prototypical genuine relic of a 'dead' radio galaxy as it seems to perfectly fulfill the following criteria: It has a rather steep overall radio spectrum (Ekers et al., 1981; Cordey, 1987). Its core luminosity is by far the lowest known so far (Giovannini et al., 1988). No coherent jet structure or other signs of activity are visible. Since only four possibly genuine relics of radio galaxies are known so far (Harris et al., 1993), a study of the archetypical source B2 0924+30 is of eminent importance for the understanding of this rare species of radio galaxies.

We have obtained maps of B2 0924+30 at $\lambda\lambda 49$ and 6.3 cm with the WSRT (HPBW $29'' \times 57''$) and with the Effelsberg 100-m telescope (HPBW $150''$), respectively. A bright source located at the periphery of the western lobe, which is not related to the radio galaxy and identified with a quasar (Ekers et al., 1981; Arp, 1977) was subtracted from the maps prior to further analysis. We have smoothed the $\lambda 49$ cm map to the $150''$ beam size in order to carry out a spectral comparison. A strong decrease of the lobe width at the higher frequency is noticed.

2. Spectral index and particle ages

We have compiled the total flux densities of B2 0924+30 by integrating the two maps in elliptical rings adapted to the overall source shape, with careful inspection of the map zero levels, and the quasar subtracted. A

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pronounced steepening is seen beyond about 2 GHz. Between 151 and 408 MHz the spectral index is $\alpha = 0.91 \pm 0.13$ ($S_\nu \sim \nu^{-\alpha}$), while between 4.75 and 10.55 GHz it is $\alpha = 2.25 \pm 0.52$, implying a steepening by $\Delta\alpha = 1.34$, which is significant in spite of the relatively large error at the highest frequency.

We have computed the spectral index distribution across B2 0924+30 between $\lambda\lambda$49 cm and 6.3 cm. No significant asymmetry of the spectrum of the lobes is evident. A pronounced steepening of the spectrum is seen away from the major axis, where the spectrum steepens to $\alpha = 1.6$. The latter behaviour is reminiscent of the source B2 1321+31 (Klein et al., 1995), although with a less pronounced steepening in that case.

The integrated spectrum of B2 0924+30 and its spectral index distribution have been analyzed in order to determine the characteristic break frequency of the synchrotron emission and corresponding particle ages, assuming that synchrotron and inverse Compton losses are at work. Since particle injection is presumably no longer taking place, we have fitted the model of Jaffe & Perola (1973) to the integrated spectrum yielding a break frequency $\nu_B = 6.5$ GHz and an 'injection' spectral index of $\alpha_i = 0.84$. With an equipartition field strength of 1.4 μG this results in an average particle age of 50 Myrs.

Since we have only two frequencies at our disposal we have applied the Myers-Spangler algorithm (Myers & Spangler, 1985) to the maps. With the inferred equipartition magnetic field we obtain a break frequency of around 4 GHz along the source's main axis, implying an age $\approx$ 70 Myrs, while away from the lobes these values are 3 GHz and $\approx$ 80 Myrs, respectively.

The particle ages derived above are not very high. Since they reflect the lifetime of the relativistic particles after the cease of energization of the former hot spots by the central engine, this means that once the energy transfer to the hot spots is stopped the whole radio source dies relatively quickly. The relatively short time scale resulting for the switch-off of B2 0924+30 naturally explains the relative paucity of such relic sources.

References

Arp H. (1977) *IAU Coll.* **37**, 377, Editions du centre national de la recherche scientifique, Paris
Cordey R. A. (1987) *MNRAS*, **227**, 695
Ekers R. D., Fanti R., Lari C., and Ulrich M.-H. (1975) *Nature*, **258**, 584
Ekers R. D., Fanti R., Lari C., and Parma P. (1981) *A&A*, **101**, 194
Giovannini G., Feretti L., Gregorini L., and Parma P. (1988) *A&A*, **199**, 73
Harris D. E., Stern C. P., Willis A. G., and Dewdney P. E. (1993) *AJ*, **105**, 3
Jaffe W. J. and Perola G. C. (1973) *A&A*, **26**, 423
Klein U., Mack K.-H., Gregorini L., and Parma P. (1995) *A&A*, in press
Myers S. T. and Spangler S. R. (1985) *ApJ*, **291**, 52