THE RADIO SOURCE PROJECTED NEAR THE ABSORPTION-LINE QSO PHL 5200

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Abstract

Some recently discovered properties of the radio source 4C -05.93 are summarised. Their relevance to the observed absorption-line spectrum of the QSO PHL 5200, which is located only 1 arcmin away from the radio source, is discussed.

Optical spectrum of the QSO PHL 5200 shows emission lines at a redshift of 1.981 and two systems of narrow absorption lines corresponding to redshifts of 1.89 and 1.95 (Lynds 1967; Burbidge 1969). Its original identification with the radio source 4C -05·93 by Scheuer and Wills (1966) was not supported by the Molonglo observations (Munro 1971) which indicated a separation of nearly 1 arcmin between the radio centroid and the QSO. Radio structure of this interesting source has recently been determined at 327 MHz from its lunar occultations observed at Ooty, which provided a high resolution of ~10 arcesec (Singal *et. al.* 1978). The main results of these 327 MHz observations are :

(1) The radio source has an overall extent of ~ 50 ′15 arcsec, oriented roughly north-sourth, and exhibits a basically double structure. The individual lobes are well-resolved and probably comprise areas of diffuse, low-level emission.

(2) The radio centroid (RA = $22^h\ 25^m\ 50^s 55 \pm 0^s_. 2$, Dec. = -05° 33′ 53″ ± 3″, 1950 epoch) is separated from the QSO PHL 5200 by 1.0 ± 0.1 arcmin at position angle ~ 294°. On the Palomar Sky Survey prints, a 19.5-mag red object is seen within a few arcsec of the radio axis. However, since the separation between the radio lobes is rather large, the probability of chance-concidence is not negligible and hence the optical identification remains uncertain until a compact radio core is detected towards the optical object at centimetre wavelengths. Measurement of redshift of this object would also be valuable in understanding the relationship of the radio source to the QSO PHL 5200 and its absorpttion-line spectrum.

(3) No bridge of radio emission is detected between the source 4C -05.93 and the QSO PHL 5200.

(4) The source has an integrated flux density of 1.1 ± 0.2 Jy at 327 MHz, on the flux scale defined by Veron *et. al.* (1974).

To derive metre-wavelength spectrum of the source, the 327 MHz Octy measurement can be combined with those made at 178 MHz (Cambridge) (Gower *et. al.* 1967) and at 408 MHz (Molonglo) (Munro 1971), after multiplying the latter two flux values respectively with small scaling factors of 1·1 and 0.9, as given by Veron *et. al.* (1974). These data indicate a very steep spectrum with α (178-408MHz) = -1.8 ± 0.4. At higher frequencies, the spectral index increases to a value of -0.9, as indicated by the recent flux measurement of 0.17 ± 0.02 Jy at 2700 MHz using the Effelsberg radio telescope (A. Witzel, personal communication).

Discussion

The steep metre-wavelength spectrum, as indicated for the source 4C -05.93 by the presently available data is known to be primarily associated with radio sources located in clusters of galaxies (Baldwin and Scott 1973; Slingo 1974). Hence a more precise determination of the spectrum of 4C -05.93 would be of considerable interest. Secondly, the rather diffuse radio structure observed at 327 MHz should be mapped in detail in order to find evidence for any distorted radio morphology, which again is known to be a common feature of radio sources in clusters of galaxies (Rudnick and Owen 1977). Since this radio source lies at a very small projected separation of only 1 arcmin from the QSO, any cluster associated with the source is likely to be crossing the line of sight to the QSO and the narrow absorption lines seen in the QSO spectrum could conceivably arise in the medium of this intervening cluster. This so called "cos mological hypothesis" of the origin of absorption lines in QSO spectra has been reviewed extensively, vis-a-vis the "intrinsic hypothesis" according to which the absorption lines are formed in gas clouds ejected from the QSO and accelerated outward by deriving momentum from the QSO radiation (Bahcall 1978; Boksenberg 1978). The choice between these two radically different hypotheses relating to an important astrophysical quetion is still not clear despite a major observational and theoretical effort to study in detail the absorption-line spectra at optical, UV and X-ray wavelengths.

Some positive support for the cosmological hypothesis comes from the recent discovery of an X-ray emission line due to Fe XXV and Fe XXVI ions in several rich clusters of galaxies (Mitchell *et. al.* 1976; Serlemitsos *et. al.* 1977; Mitchell and Culhane 1977). This detection implies a high gas temperature of 10^7 - 10^8 K and also demonstrates that intra-cluster medium can be rich in heavy elements like Fe and presumably also

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in others like C, Mg and Si whose absorption lines are usually seen in QSO spectra. Although the intra-cluster gas temperatures, inferred from the Fe emission feature, seem too high for the typical ionisation-excitation structure of the QSO absorption spectra, the possible presence of moderately hot gas clouds in the intra-cluster medium holds the potential for formation of the absorption lines. Once such a possibility exists, the next step for testing the cosmological hypothesis would be to try to detect clusters of galaxies in the directions of absorption line QSOs. This, however, is an exceedingly difficult observation, because in order to be responsible for the QSO absorption lines. the intervening clusters would have to be located at very high redshifts of 1.5-3 at which absorption lines are usually seen. Due to this, the apparent optical magnitudes of cluster galaxies would normally be too faint to be detected ($m_V \gtrsim 25$). A more promising approach for detecting such distant clusters appears to look for certain "radio signatures" of clusters, such as radio sources with steep low-frequency spectrum or distorted radio morphology, in the directions of absorption-line QSOs. With this objective, sensitive aperture-synthesis mapping of small fields around several absorption-line QSOs including the presently discussed PHL 5200, are planned. From these observations, we would like to detect any distorted radio sources lying within a few arcmin of these QSOs and thus indicating the presence of intervening clusters of galaxies. But, in order to be mapped reliably, the individual sources located at typical absorption-line redshifts are required to have a radio output of not less than 10^{25} Watt Hz^{-1} Sr^{-1} at 5000 MHz ($H=50$ kms $^{-1}$ Mpc^{-1}, $q_o=0.5$). This luminosity is an order of magnitude higher than the limit below which radio sources with distorted morphologies are thought to occur predominently (Gavazzi and Perola 1978). However, recent detailed radio/optical study by Hintzen and Scott (1978) has shown that the criterion of distorted morphology can be useful even for detecting cluster sources of high radio luminosity ($>10^{25}$ Watt $Hz^{-1}Sr^{-1}$ at 5000 MHz). This strengthens the possibility that by detecting distorted radio sources within a few arcmin of absorption-line QSOs, we may find good evidence for very distant clusters located in front of QSOs and giving rise to the observed narrow absorption features in their spectra. X-ray detection of such clusters using the Heao-B satellite (Giacconi 1978) is another exciting possibility for near future.

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References :

Bahcall, J.N. 1978, *Physica Scripta*, **17**, 229.
Baldwin, J.E. and Scott, P.F. 1973, *Mon. Not. R. astr. Soc.*, **165**, 259.
Boksenberg, A. 1978, *Physica Scripta*, **17**, 205.
Burbidge, E.M. 1969, *Astrophys. J. (Letters)*, **155**, L43.
Gavazzi, G. and Perola, G.C. 1978 *Astr. Astrophys.*, **66**, 407.
Giacconi, R. 1978, *Physica Scripta*, **17**, 307.
Gower, J.F.R., Scott, P.F. and Wills, D. 1967, *Mem. R. astr.* Soc., **71**, 49.
Hintzen, P. and Scott, J.S. 1978, *Astrophys. J. (Letters)*, **224**, L 47.
Lynds, C.R. 1967, *Astrophys. J.*, **147**, 396.
Mitchell, R.J., Culhane, J.L., Davison, P.J.N. and Ives J.C. 1976, *Mon. Not. R. astr.* Soc., **175**, 29.
Mitchell, R.J. and Culhane, J.L. 1977, *Mon. Not. R. astr. Soc.*, **178**, 75p.
Munro, R.E.B. 1971, *Aust. J. Phys.* **24**, 263.
Rudnick, L. and Owen, F.N. 1977, *Astr. J.*, **82**, 1.
Scheuer, P.A.G. and Wills, D. 1966, *Astrophys. J.*, **143**, 274.
Serlemitsos, P.J., Smith, B.W., Boldt, E.A., Holt, S.S. and Swank, J.H. 1977, *Astrophys. J. (Letters)*, **211**, L63.
Singal, A.K., Gopal-Krishna and Venugopal, V.R. 1978, *Bull. astr. Soc. India* (submitted).
Veron, M.P., Veron, P. and Witzel, A. 1974, *Astr. Astrophys. Suppl.*, **13**, 1.

ANNOUNCEMENT

TOTAL SOLAR ECLIPSE OF 1980

A brief write-up on the total solar eclipse of 1980 has already appeared in *Bull. Astro. Soc. India*, **6**, 17, 1978. The total eclipse of February 16, 1980 will pass through a wide strip across Southern India. Scientist planning to observe the eclipse from India would like to know the various suitable sites along with the facilities available there, along with the weather conditions at these places during the time of the year the eclipse will take place. This precisely what has been done in a report prepared by Professor J. C. Bhattacharyya, National Co-ordinator for India. People from the Indian Institute of Astrophysics made a detailed survey of possible sites along the path of totality. A detailed account of the climate for many places along the path, which were provided by the Director General of Observatories, are also included in this report. It will be very useful for all those who are planning an experiment to go through the report carefully before finalising their site. This report and other details can be obtained from Professor J. C. Bhattacharyya, National Co-ordinator, Indian Institute of Astrophysics, Bangalore 560 034, India.