COS B observation of high-energy γ radiation from 3C273

THE discovery of a high-energy γ-ray source at $\alpha(1950) =$ 12h 29 min ± 6 min, $\delta(1950) = +3° \pm 1.5°$ is reported here. Arguments are given for the identification with 3C273. If this identification is correct, the γ-ray luminosity of 3C273 in the energy range 50–500 MeV is 2×10^{46} erg s^{-1} for $H_0 =$ 60 km s^{-1} Mpc^{-1}.

The majority of the reported γ-ray sources are galactic, as can be clearly established from their latitude distribution[1]. The lack of unambiguous identification (with the exception of CG185 − 5 with PSR0531 + 21 and of CG263 − 2 with PSR0833 − 45) leaves a wide range of speculations as to the classification of the sources and to the nature of the emission mechanisms. The outstanding signature of these sources is the fact that their γ-ray luminosity (>50 MeV) exceeds at least the radio and X-ray luminosities. Besides the continuing search for galactic γ-ray sources, some observations of the ESA γ-ray observatory COS B have been devoted to extragalactic targets[2]. The region of the sky centred on α = 12 h 24 min, $\delta = +7°$ with an effective field of view of about 20° radius was observed from 24 May to 24 June 1976. This observation was particularly aimed at a sensitive search for high-energy γ-ray emission from M87 and 3C273.

The data have been analysed using a cross-correlation method: the frequency distribution of arrival directions of γ rays was correlated with the distribution expected for a point source as determined by calibration and confirmed by flight data on the strong source PSR0833 − 45 (ref. 2). The resulting correlation map follows the distribution expected for random data, apart from one clear maximum, which has a probability of 10^{-5} of being caused by random fluctuations at any position in the map. This excess follows the distribution expected for a point source located within a 90% probability error box defined by $\alpha(1950) =$ 12 h 29 min ± 6 min, $\delta(1950) = +3° \pm 1.5°$. Spectral information was obtained by analysing the data in two energy ranges. In each case a significant excess within the same error box was found. The derived characteristics of this source (designated CG291 + 65) are summarised in Table 1. The errors quoted include the estimated systematic errors.

Table 1 Characteristics of CG291 + 65

Position	$\alpha(1950) =$ 12 h 29 min ± 6 min, $\delta(1950) = +3° \pm 1.5°$		
Intensity	50–150 MeV	$(1.2 \pm 0.4) \times 10^{-6}$	photons cm^{-2} s^{-1}
	150–500 MeV	$(0.3 \pm 0.1) \times 10^{-6}$	photons cm^{-2} s^{-1}
Energy flux	50–500 MeV	3×10^{-10}	erg cm^{-2} s^{-1}

Of the two specific targets of this observation, M87 is about 8° outside the error box, and is therefore clearly not the source of the detected γ rays. On the other hand, 3C273 lies well within the error box. Despite the large size of this error box, the following compelling arguments for an identification with 3C273, the second nearest of the powerful QSOs ($z = 0.158$), can be made. The probability of finding a known high-galactic-latitude X-ray source by chance within a 3° × 3° error box is about 2%. However, the X-ray source 4U1226 + 02 (≡2A1225 + 022) lies within the error box of CG291 + 65. This X-ray source has been positively identified with 3C273 (refs 3, 4). Also, it is stressed that the probability of finding a chance coincidence of the error box with a specific object, that is 3C273, is <1%.

If this identification is correct the observed intensities at γ-ray energies can be compared with those at other wavelengths, as shown by the spectrum in Fig. 1. This shows that a major portion of the energy radiated by 3C273 is in the form of γ rays. Its γ-ray luminosity in the range 50–500 MeV is ~2×10^{46} erg s^{-1} for $H_0 =$ 60 km s^{-1} Mpc^{-1}.

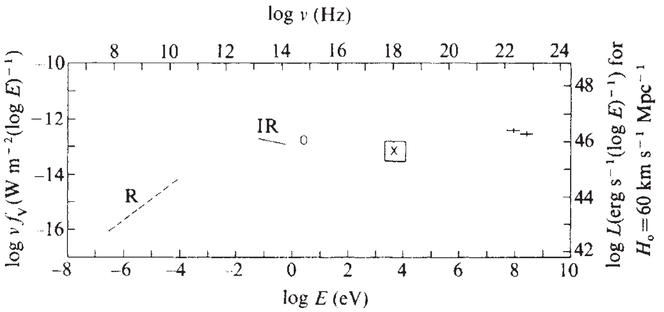

Fig. 1 Spectrum of 3C273 from radio to γ-ray energies. The intensity scale is given in units of power per decade. The radio (R), optical (O) and X-ray (X) data are those given in a compilation by Apparao *et al.*[5]. The IR data are from Rieke and Low[6].

This has important consequences for the understanding of QSOs and warrants extensive efforts to further strengthen the identification. Repeated observations of 3C273 may yield signs of time variability, similar to those clearly established at other wavelengths, with amplitudes which tend to increase with increasing energy[5]. A second observation by COS B is planned for June/July 1978. Somewhat less directly, the identification could be strengthened by an extensive search for γ-ray emission of other QSOs. In this context, note that the newly discovered and nearest QSO, associated with 2S0241 + 622, lies within the error box of CG135 + 1 (ref. 5).

The intriguing fact that all γ-ray sources detected by COS B, including pulsars, unidentified galactic sources and possibly extragalactic sources, have a peak luminosity at γ-ray energies, may indicate some similarity in the emission process, or may reflect a selection caused by the limited dynamic range of detected γ-ray fluxes.

We thank Theo Hydra for assistance.

B. N. SWANENBURG*, K. BENNETT¶, G. F. BIGNAMI†, P. CARAVEO†, W. HERMSEN*, G. KANBACH§, J. L. MASNOU‖, H. A. MAYER-HASSELWANDER§, J. A. PAUL‖, B. SACCO‡, L. SCARSI‡ & R. D. WILLS¶

* *Cosmic Ray Working Group, Huygens Laboratory, Leiden, The Netherlands*
† *Laboratorio di Fisica Cosmica e Tecnologie Relative del CNR, Università di Milano, Italy*
‡ *Laboratorio di Fisica Cosmica e Tecnologie Relative del CNR, Università di Palermo, Italy*
§ *Max-Plank-Institut für Extraterrestrische Physik, Garching bei München, FRG*
‖ *Service d'Electronique Physique, Centre d'Etudes Nucléaires de Saclay, France*
¶ *Space Science Department of the European Space Agency, ESTEC, Noordwijk, The Netherlands*

Received 5 June; accepted 21 July 1978.

1. Hermsen, W. *et al. Nature* **269**, 494–495 (1977).
2. Scarsi, L. *et al. Proc. 12th ESLAB Symp.* 3–12 (ESA SP-124, 1977).
3. Forman, W. *et al. Astrophys. J. Suppl.* (in the press).
4. Cooke, B. A. *et al. Mon. Not. R. astr. Soc.* **182**, 489–515 (1978).
5. Apparao, K. M. V. *et al. Nature* **273**, 450–453 (1978).
6. Rieke, G. H. & Low, F. J. *Astrophys. J.* **176**, L95–100 (1972).

Infrared observations of the most luminous quasar

The QSO Q 0420 − 388 is one of many discovered by Osmer and Smith in their objective prism survey of the southern sky, and one of ~10 now known with $z > 3$. Its brightness and large redshift indicate a luminosity at rest wavelength 1,475 Å somewhat larger than any other measured. The source is particularly noteworthy because of the steepness of its observed visual spectrum over the range 3,600–6,800 Å, where $F_\nu \sim$