# X-ray variability of the quasar 3C273

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# X-ray variability of the quasar 3C 273

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**Summary.** Observations of the quasar 3C 273 made during 1975–77 have shown that the X-ray flux varied on a time-scale of several months. No similar variation was present in radio and optical data taken at similar times. If this variation results from luminosity variations of a central compact object, then an upper limit of $\leqslant 4 \times 10^{17}$ cm can be set on its dimensions.

Recent X-ray observations have led to the detection of weak emission from several quasars (Giacconi *et al.* 1972; White & Ricketts 1977; Apparao *et al.* 1978). Observations of 3C 273 were made from 1975 March to 1977 August with the high-energy detector system (2–17 keV) of the *Ariel V* Sky Survey Instrument (SSI). The SSI and data analysis techniques have been fully detailed by Cooke *et al.* (1978). The observations have yielded a position consistent with the 3U survey position and error box (Giacconi *et al.* 1972). All fluxes reported in this paper have been corrected to the optical position of 3C 273.

The X-ray light curve is shown in Fig. 1; all observations with an error $<1$ *Ariel V* SSI count/s, where 3C 273 was less than 6° from the centre of the collimator, have been included. In some cases data from consecutive time periods have been combined together when the scan position angle across the source differed by less than ±20°. The mean flux was $1.40 \pm 0.2$ *Ariel* count/s. A $\chi^2$-test on the hypothesis of a constant source of this strength gave a value of 28.1 for nine degrees of freedom, corresponding to a probability of 0.0009 that the data were consistent with statistical variations. The observations which deviate most from the mean are those between MJD 42717 and 42723 for which the mean value was $0.69 \pm 0.22$ *Ariel* count/s and MJD 42887–42902, which gives an intensity of $0.36 \pm 0.30$ *Ariel* count/s, and lies $3.5\sigma$ below the mean. The *Uhuru* measurement (Giacconi *et al.* 1972) was equivalent to $1.55 \pm 0.2$ *Ariel* count/s.

A number of other weak *Ariel* sources, which appear to be constant in flux, have been examined to search for non-statistical intensity variations. None of these sources show variability at the level of significance observed in the present data, their variations being well represented by statistical Gaussian noise fluctuations. Although the present observations were made at various position angles across 3C 273, when the data were binned together in

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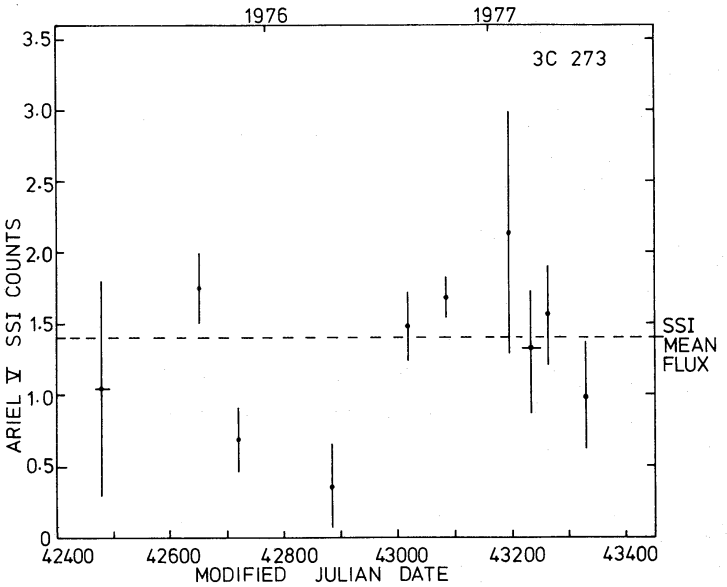


**Figure 1.** The X-ray light curve for 3C 273. The error bars indicated are $\pm 1\,\sigma$.

groups with position angles differing by less than $\pm 20°$, the flux decrease during early 1976 was still clearly present. An examination of the area close to 3C 273 did not reveal the presence of any further weak sources which would be confused with the flux from the quasar.

The X-ray data were compared with radio flux measurements (Andrew *et al.* 1978) and optical *B* photometry (C. Lloyd, unpublished data). The radio flux, at a wavelength of 2.8 cm, reached a peak intensity of 50 Jy during 1975 July, and then slowly fell throughout 1976. The optical magnitude remained constant within a rms value of ~ 0.1 mag up to 1976 May, from its mean value of the previous five years. Near-infrared measurements (G. Neugebauer, personal communication) at 2 $\mu$m also indicate that the source has been relatively quiescent during the past few years.

Although the nature of X-ray emission from 3C 273 is not understood, it is likely to result from the inverse Compton effect between the high relativistic electron fluxes and radiation densities that are likely to exist in quasars (Shklovsky 1966; Rees 1967; Okoye 1973). Several models for X-ray emission from quasars do predict variability on time-scales of weeks to months (Bergeron & Salpeter 1973; Arons, Kulsrud & Ostriker 1975).

If the variation that we have detected results from a change in luminosity of some central object inside the quasar, we are able to set upper limits of $4 \times 10^{17}$ cm on the size of that object, from light travel-time considerations. A variation of this nature would result in an X-ray intensity variation, but should leave the spectrum unaltered. On the other hand, intensity variation could also result from changes to the thermal energy of the Compton scattering electrons. This would also result in spectral changes throughout the intensity variation. In the absence of spectral data at the time of the variation, we are unable to make any more positive statement on the nature of this intensity variation from the present data.

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## References

Andrew, B. H., MacLeod, J. M., Harvey, G. A. & Medd, W. J., 1978. *Astr. J.*, **83**, 863.

Apparao, K. M. V., Bignami, G. F., Maraschi, L., Helkman, H., Margon, B., Hjellming, R., Bradt, H. V. & Dower, R. G., 1978. *Nature*, **273**, 450.

Arons, J., Kulsrud, R. M. & Ostriker, J. P., 1975. *Astrophys. J.*, **198**, 687.

Bergeron, J. & Salpeter, E. E., 1973. *Astr. Astrophys.*, **22**, 385.

Cooke, B. A., Ricketts, M. J., Maccacaro, T., Pye, J. P., Elvis, M., Watson, M. G., Griffiths, R. E., Pounds, K. A., McHardy, I., Maccagni, D., Seward, F. D., Page, C. G. & Turner, M. J. L., 1978. *Mon. Not. R. astr. Soc.*, **182**, 489.

Giacconi, R., Murray, S., Gursky, H., Kellogg, E., Schreier, E. & Tananbaum, H., 1972. *Astrophys. J.*, **178**, 281.

Okoye, S. E., 1973. *Mon. Not. R. astr. Soc.*, **165**, 393.

Rees, M. J., 1967. *Mon. Not. R. astr. Soc.*, **137**, 429.

Shklovsky, I. S., 1966. *Soviet Astr. A. J.*, **9**, 683.

White, G. J. & Ricketts, M. J., 1977. *Mon. Not. R. astr. Soc.*, **181**, 435.