Rapid Infrared and Optical Variability in 3C 273

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The quasar 3C273 varied by up to 100% on timescales as short as one day in the optical and IR domains during February and March 1988. In February the source changed from a behavior characterised by a stable IR flux and slow optical variations to one of recurrent optical and IR flares. Five optical flares, of amplitude up to 30-40% were observed, along with two IR flares, both of which were simultaneous with optical events. The second IR flare on March 9th rose from 46mJy to 66mJy (twice the normal (quiescent) value) in one day. The data and some of their implications are described in Courvoisier et al. (1988).

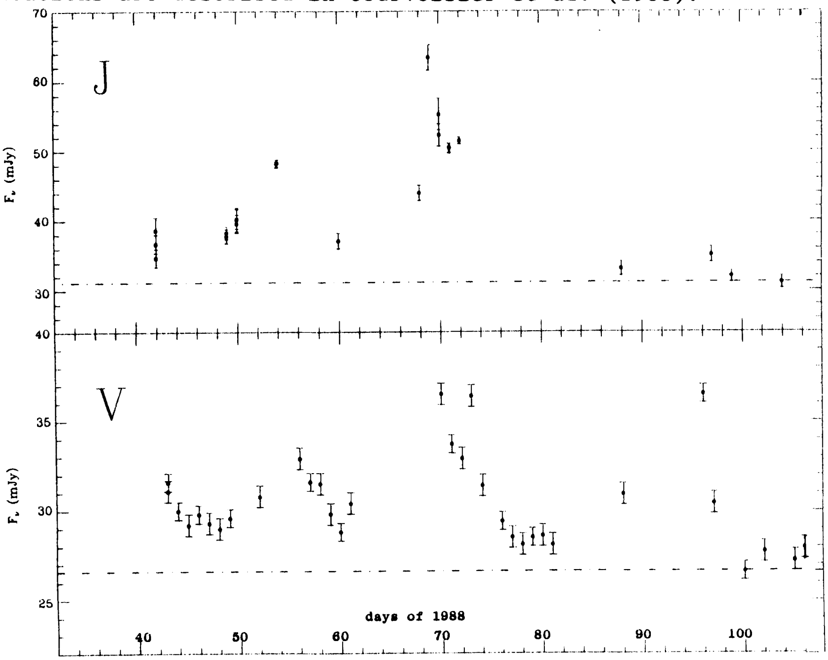

Figure 1. Optical (V) and infrared (J) light curves for early 1988, the quiescent level is shown by the dashed line.

D. E. Osterbrock and J. S. Miller (eds.), Active Galactic Nuclei, 110–111.

Inspection of the light curve of figure 1 shows that the second flare was very rapid, the luminosity changes implied are large, the maximum increase between March 8th and 9th corresponds to $\sim 6 \times 10^{40}$ ergs s^{-2}. The spectral behaviour of the source during the March 9th flare shows a flattening of the IR slope as the flare reaches its maximum, followed by a steepening as the flux decreases again. The optical spectral behaviour also shows a steepening as the flux decreases (the expected flattening was not observed, the Moon being too close to 3C273 at this epoch).

The spectral behaviour of the flare points to a synchrotron origin for the component added to the quiescent emission. Observations showing strong polarization (I=2·5%max compared to the quiescent level of 0·4%) from February 24th-March 2nd strongly support this interpretation. The synchrotron cooling time is obtained by sampling the declining IR light curve and is found to be about 2 days. This then gives the magnetic field in the region of synchrotron emission to be ~0·7 G. It should be noted that in contrast to magnetic field estimates based on measuring the flux and frequency of the turnover of the synchrotron emission spectrum (which varies as the frequency to the power 5 - leading to gross uncertainties in B), this method is very direct and has much smaller uncertainties.

The source size implied by the rapid variations (of the order of 1 light day) and the near IR flux of the flare give a brightness temperature of $\sim 6 \times 10^{4}$ K at J; a value for which the expected self Compton X-ray flux is small. However, 10 and 20 micron data are available on February 24, indicating a steep spectrum to at least $1{\cdot}5 \times 10^{13}$ Hz. If the March 9th flare had a similar spectrum up to the same frequency, then the brightness temperature at 20 micron would be $\sim 1 \times 10^{13}/R^{2}$ K, where R is the source size in light days. Brightness temperatures exceeding 10^{12} K are excluded by synchrotron self Compton theory and imply that the flare is beamed towards the observer. Beaming is also supported by the high polarisation varying on a daily basis in the week following February 24th (Courvoisier et al 1988).

It is clear that even though we have sampled the IR light curve on a daily basis around March 9th, the overall temporal sampling is the limiting factor in our description of the events. Noticeable changes on timescales of an hour would have been clearly detected for this rapid event. This implies that previously observed flares in AGN may have been drastically undersampled, leading to possibly doubtful conclusions.

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References

Courvoisier,T.J-L. et al. 1988, submitted to Nature