OPTICAL FLICKERING AND SHOT NOISE IN AM HER SYSTEMS

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1. Introduction

The emission from AM Her systems show a variety of time-variable phenomena, including flickering with a typical power spectrum slope of -1 to -2. The optical flickering is usually modeled as, or assumed to be, a shot noise process with many overlapping simultaneous shots. Panek (1980) found that, for AM Her, a consistent model could be constructed with randomly occurring 70...90 s rectangular shots. The power spectrum had a ν^{-2} shape above 0.02 Hz as expected, although it is not clear whether a break in the slope of the power spectrum was actually seen around 0.01 Hz. There are many additional reports in the literature of 'characteristic time-scales' on the order of tens of seconds. However we are not aware of any case where the reported time-scale has been supported by e.g. a break in the power density spectrum. It is easy to show that the usual method of estimating a 'characteristic time-scale' from the auto correlation function of de-trended data will suggest such a characteristic time-scale even if none is present in the original time series. The evidence for shot noise in AM Her light curves therefore needs a re-examination. In this paper we give a short summary of our analysis of optical flickering in V834 Cen, based on high speed photometry obtained at ESO in 1987. Details will be reported elsewhere.

2. Time domain analysis

All peaks in the light curves with some height above the noise level were identified and analyzed by directly fitting a few different pulse shapes. The distribution of pulse parameters were analyzed and compared to the corresponding results for simulated data.

A. Evans and J. H. Wood (eds.), Cataclysmic Variables and Related Objects, 221–222.

The following main results were obtained.

1. The distribution of pulse parameters indicates the presence of a distinct flickering component consisting of high amplitude, narrow pulses.
2. The distinct shots are best fitted by peaked pulses, such as triangular, or $\exp -|(t - t_0)/\tau|$. The mean asymmetry is close to zero.
3. The Full Width Half Maximum (FWHM) distribution for the distinct shots is strongly peaked around 6...7 s.
4. The amount of overlap for the distinct shots is small.

3. Frequency domain analysis

Power spectra were calculated from 1500 s data segments. These were then averaged for all the five observing nights to produce an overall mean power spectrum. The most important feature in the power spectrum is a break at about 0.03 Hz, which provides strong support for a shot noise model. Above this frequency the spectrum steepens to a power law of slope −2.5. This is significantly steeper than the 'canonical' value of −2 that is produced by, for example, sharp edged shots, such as one-sided exponentials.

4. Model

The pulse profiles implied by the data analysis correspond to very steep power spectra, ν^{-4} ! We have confirmed this by calculating power spectra for the individual observed 'flares'. We also calculated the power spectrum produced by double-sided exponentials with a distribution in pulse width taken from our time domain analysis. This was found to flatten the power spectrum slope at high frequencies from −4 to −2.4, which is very close to that of the data. The observed turn over around 0.03 Hz is also reproduced by this model. A power excess over the model at frequencies below 0.01 Hz can be explained by adding a ν^{-2} component, with the same strength as in our previous observations of V834 Cen in 1984 and 1985 when the distinct flickering component was absent. This two-component flickering model is consistent with both the time and frequency domain properties of the time series data. Although the model is not unique it represents a substantial improvement over earlier models that were based on much less direct information.

References

Panek, R., 1980, Ap. J., **241**, 1077