Short Timescale Variability in the FSVS

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ABSTRACT

We present the V band variability analysis of the Faint Sky Variability Survey (FSVS) . The FSVS combines colour and time variability information, from timescales of 24 minutes to tens of days, down to V = 24. We find that ~1% of all point sources are variable along the main sequence reaching ~3.5% variability for bluer sources above the main sequence. The total number of variables is dominated by main sequence sources. We can determine the variability timescales and amplitudes for 40% of the variable sources found. 50% of these show variability timescales shorter than 6 hours. We determine lower limits for the space density of variable point sources. We find 12 RR Lyr candidates in our survey resulting in a space density that agrees with previous determinations.

1. SURVEY DESCRIPTION

The FSVS covers an area in the sky of $\sim$23 deg^2 located at mid and high Galactic latitudes. It consists of a set of B, I and V images used to determine the colours of all the sources, and 5–33 V band images taken over a range of 3 to 13 days used to study their photometric variability. The survey design allows the determination of photometric variability with timescales from 24 min to several days for objects as faint as 24 mag in V.

2. VARIABILITY ANALYSIS TOOLS

1. We use the χ^2 test [1] to determine if a source is variable. It consists of calculating the reduced χ^2 value of each object's individual brightness measurements with respect to its weighted mean brightness value.
2. We use the Floating Mean Periodogram (FMP) [2, 3] to determine the most likely period and amplitude of the variability for the variable sources found with the χ^2 test. The FMP consists of fitting the data with a model composed of a sinusoid plus a constant. For each period of the sinusoid we perform least squares fitting of the data and determine the variability timescale and amplitude by selecting the best fit.

3. RESULTS: THE FRACTION OF VARIABLE SOURCES

By using the χ^2 test we determine which objects are variable and which ones are not and combine this information with their location in a colour-colour diagram. Most of the sources, variable and non-variable, are located along the main sequence. We find that in average $\sim$1% of the point sources are variable. We find a larger percentage, $\sim$3.5%, of variable point sources above the main sequence (B−V)<0.38. These fractions are presented in Fig.1.

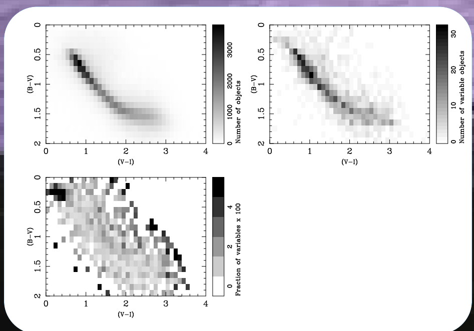

Fig. 1. Top left panel: non-variable point sources in the FSVS. Top right panel: short timescale variable point sources in the FSVS. Bottom panel: fraction of variable sources in percentages. The region in the colour-colour diagram where there is an excess of variable sources lies at (B−V)<0.38.

3. RESULTS: TIMESCALES AND AMPLITUDES

The combination of the sampling and the number of observations allows us to determine the most likely period and amplitude of the variability for 40% of the variable point sources found in the FSVS. In Fig. 2 we present the period and amplitude distributions found in the data (for periods and amplitudes with errors of less than 30%). Most objects lie at short periods and low amplitudes. 50% of the objects show periods below 6 hours with peaks at 24 min (minimum period we can reconstruct), 0.03 days (43 min) and 0.12 days (2.9 hours). We also find peaks at 0.79 days (19 hours), 1.3 days and 4 days. 50% of the objects show amplitudes lower than 0.07 mag.

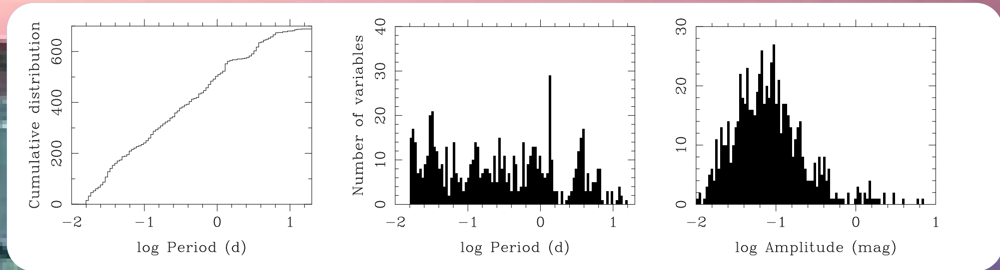

Fig.2. Left panel: Cumulative period distribution of variable point sources in the FSVS. Middle panel: Period distribution. Right panel: Amplitude distribution.

We obtain the space density of variable point sources in the FSVS by combining the number of sources we find per period and amplitude bin with the sensitivity of the FMP search. The highest density of variables show periods below 12 hours. These would include Cataclysmic Variables (CVs), RR Lyr stars, and other short period pulsators such as δScuti stars. The peak centred at 1 day would include CVs, RR Lyr and other pulsators like γDoradus stars and Pop II Cepheids. The peak at 3.75 days also includes longer period CVs, γDoradus stars, Pop II Cepheids as well as longer period pulsators such as subdwarf B stars. At periods around 12.75 days we expect to find Pop II Cepheids and binaries with those orbital periods.

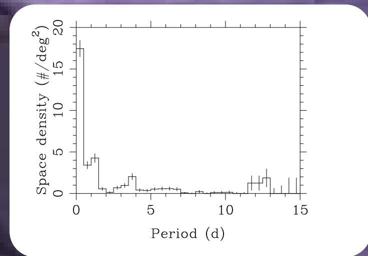

Fig.3. Space density of variable point sources in the FSVS.

4. COMPLETENESS

We are complete down to V = 22 for CVs in the minimum period (80 min) as long as they show variability amplitudes of the order of 0.4 mag. We are complete down to V = 22 for periods between 80 min and 1 day in 17.82 deg^2 of the area as long as the amplitude of the variability is at least 0.7 mag. This includes most RR Lyr stars. We will only be able to detect RR Lyr down to V = 23 when their variability amplitudes are at least 1.4 mag.

We find 12 RR Lyr candidates in the FSVS. Assuming that we have detected all RR Lyr between V = 16 – 22, we determine a space density of $\sim 10^{-3}$ kpc^{-3}. This space density agrees with that determined by Preston, Shectman & Beers [4] at a distance of 100-150 kpc from the Galactic Centre.

[1] Groot. P.J. et al., 2003, MNRAS 339, 427
[2] Morales-Rueda L., Maxted P.F.L., Marsh T.R., North R.C., Heber U., 2003, MNRAS, 338, 752
[3] Morales-Rueda L., Groot P.J., Augusteijn T., Nelemans G., Vreeswijk P.M., van den Besselaar E.J.M, 2006, MNRAS, in press (astro-ph/0607190)
[4] Preston G. W., Shectman S. A., Beers T. C., 1991, ApJ, 375, 121

The FSVS was carried out with the Isaac Newton Telescope, shown in the background.