Short Timescale Variability in the FSVS

L. Morales-Rueda, P. J. Groot, T. Augusteijn, G. Nelemans, P. M. Vreeswijk, E.J.M. van den Besselaar
IMAPP, Radboud University Nijmegen, The Netherlands. E-mail: lm@astro.ru.nl
2. Nordic Optical Telescope, Spain. 3. European Southern Observatory, Chile

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 Lyra 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 ~23 deg², 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 5-13 V band images taken over a range of 2 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 V = 24 mag in V.

2. VARIABILITY ANALYSIS TOOLS

1. We use the χ² test [1] to determine if a source is variable. It consists of calculating the reduced χ² 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 χ² test. The FMP consists of filtering 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 χ² 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 on average ~1% of the point sources are variable. We find a larger percentage, ~3.5%, of variable point sources above the main sequence (B−V) > 0.38. These fractions are presented in Fig. 1.

3. RESULTS: TIMESCALES AND AMPMltudes

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 (29 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.

4. COMPLETEENESS

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 17 853 deg² of the area as long as the amplitude of the variability is at least 0.7 mag. This includes most RR Lyra stars. We will only be able to detect RR Lyra down to V = 23 when their variability amplitudes are at least 1.4 mag.

We find 12 RR Lyra candidates in the FSVS. Assuming that we have detected all RR Lyra between V = 19 - 22, we determine a space density of ~1.70 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.

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.

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

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