Light Curve Analysis of Nine Algol (EA) Eclipsing Binaries Discovered During the Dauban Survey

Keywords:

AAVSO Keywords = Catalogs, Databases, Surveys; Data Mining; Period Analysis; Binary Stars; Eclipsing Binaries.

ADS Keywords = Binary Stars; Eclipsing Binary Stars; Light Curves; Period Determination; Period Search; Stellar Spectral Types.

Abstract

The Dauban Survey was a project focussed on photometric observations in the Milky Way. This project was a collaboration between Francois Kugel and Jerome Caron utilizing the Observatoire de Chante-Perdrix, Dauban (MPC A77) in France. In total, 96060 images were acquired between September 17, 2012 and July 20, 2014 and processed automatically by survey scripts. With an average of 4000 stars detected on each image, this makes about 400 millions detections. Over that period, 7826 known variable stars and 5521 new, unknown variable stars were detected. In particular, 497 new variables were published in the AAVSO VSX database. These included Mira Ceti, cataclysmic variables, RR Lyrae, cepheids, and nine EA eclipsing systems. It is the nine EA eclipsing binaries that are the focus of this research.

1.0 Introduction and Background

As defined in the AAVSO VSX database, an EA eclipsing binary (also referred to as B Persei or Algol) is a binary with spherical or slightly ellipsoidal components. Between eclipses the light remains almost constant. Periods can range from 0.2 days to greater than 10000 days, and light amplitudes may vary by several magnitudes. Within the Dauban Survey, nine EA eclipsing systems were identified but not fully studied or observed. These systems are called Dauban V239-Dauban V247. The Dauban Survey determined these were all variables, but did not establish a specific period or produce a complete light curve. The research presented herein produced complete light curves as well as established specific periods, eclipse duration, Johnson V and Sloan g ranges, and system temperature and stellar type. This was done with the use of ASAS-SN (All-Sky Automated Survey for SuperNova) data. An ASAS-SN light curve was computed for 2000 days for each of the nine objects and the results were analyzed in the AAVSO VStar.

2.0 Methods:Analysis and Results

The Dauban Survey discovered nine EA-type eclipsing binary systems (Dauban V239-Dauban V247). Each of these nine EA systems will now be presented.

2.1 Dauban V239

The preliminary discovery data for Dauban V239 confirmed variability and the occurrence of eclipses. This system is located in Vulpecula at 19:36:08.39, +25:45:10.2. The Dauban period search indicated possible periods of 3.166 days, 1.583 days, and 1.0553 days. Other names for Dauban V239 are 2MASS J19360839+2545102 and ZTF J193608.37+254510.1. VSX indicates a period of 2.911974 days. ASAS-SN computed a period of 2.913123 days which yields the best fit. This is shown in Figure 1. None of the Dauban period estimates were accurate. The eclipse's duration was estimated to be 17.86%. Based upon the 2MASS J-K = 0.43, the system temperature is 5490K which is a G8V stellar type. The range of Johnson V magnitude is 13.544-15.334 and the Sloan g magnitude range is 12.604-15.506. The orbit is slightly elliptical since the secondary eclipse is not at phase 0.5 (phase 0.5 suggests that the orbit is circular).

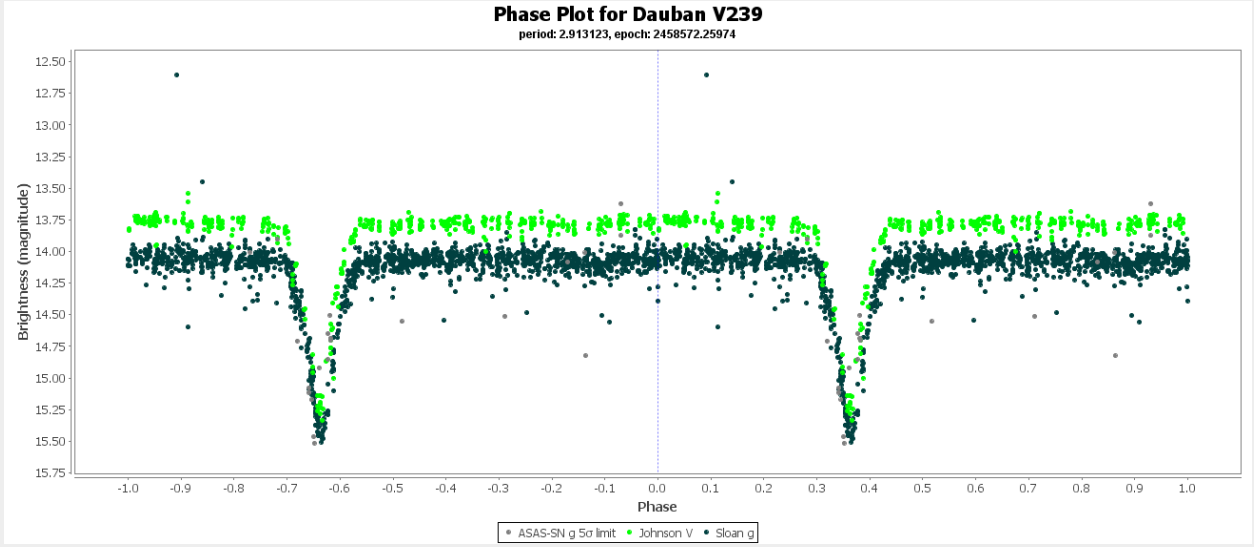

Figure 1: Light Curve for Dauban V239

2.2 Dauban V240

The preliminary discovery data for Dauban V240 confirmed variability and the occurrence of eclipses. This system is located in Vulpecula at 19:33:44.62, +25:08:20.0. The Dauban period search indicated possible periods of 5.066 days, 2.53283 days, and 1.6885 days. Another name for Dauban V240 is 2MASS J19334461+2508200. VSX did not have any period indicated. ASAS-SN predicted a period of 5.0631069 days. This is shown in Figure 2. The eclipse's duration was estimated to be 10.35%. Based upon the 2MASS J-K = 0.52, the system temperature is 5170K which is a K1V stellar type. The range of Johnson V magnitude is 13.132-14.214 and the Sloan g magnitude range is 13.153-14.896. The orbit is slightly elliptical.

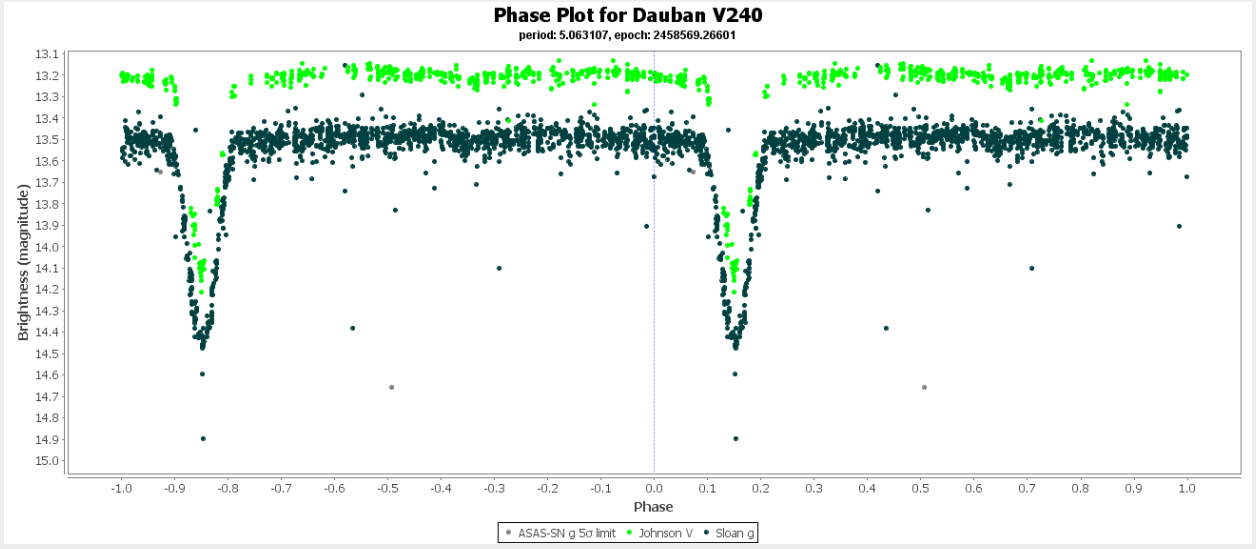

Figure 2: Light Curve for Dauban V240

2.3 Dauban V241

The preliminary discovery data for Dauban V241 confirmed variability and the occurrence of eclipses. This system is located in Vulpecula at 19:43:58.12, +26:20:59.0. The Dauban period search indicated possible periods of 6.9775 days, 3.4888 days, and 2.3258 days. Other names for Dauban V241 are ZTF J194358.12+262059.2 and 2MASS J19435812+2620591. VSX indicated a period of 3.48806 days and ASAS-SN predicted a period of 3.4888497 days which is a better fit. This is shown in Figure 3. The eclipse's duration was estimated to be 11.04%. Based upon the 2MASS J-K = 0.63, the system temperature is 4790K which is a K3V stellar type. The range of Johnson V magnitude is 13.788-14.82 and the Sloan g magnitude range is 13.848-15.70. The orbit is slightly elliptical.

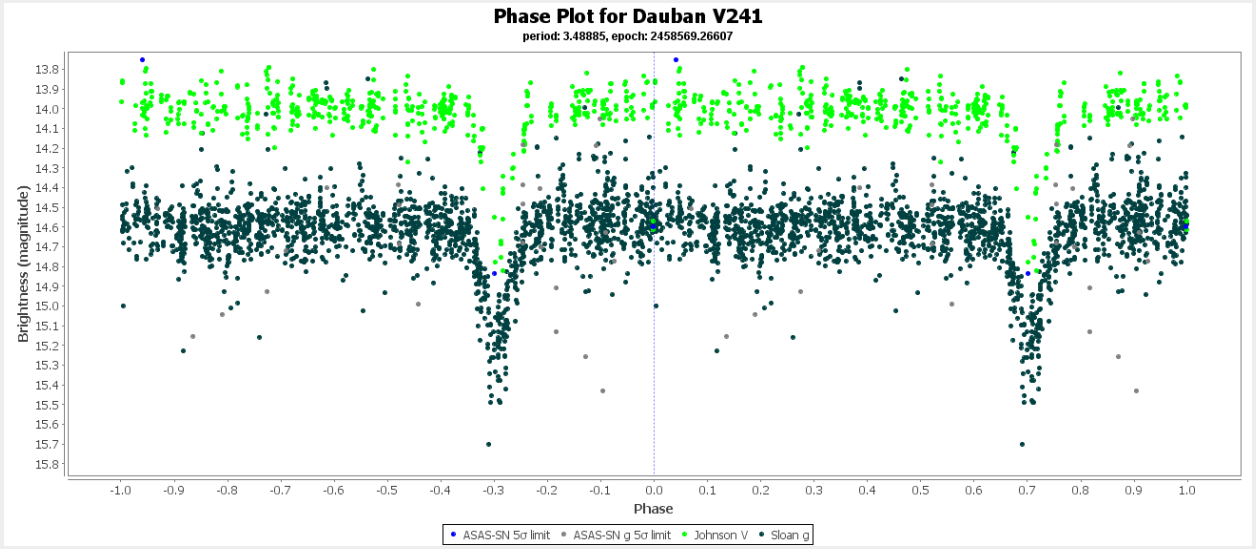

Figure 3: Light Curve for Dauban V241

2.4 Dauban V242

The preliminary discovery data for Dauban V242 confirmed variability and the occurrence of eclipses. This system is located in Lyra at 19:05:31.28, +28:55:24.3. No Dauban period search was performed. Another name for Dauban V242 is 2MASS J19053128+2855242. VSX did not have any period indicated and ASAS-SN predicted a period of 3.2662294 days. This is shown in Figure 4. The eclipse's duration was estimated to be 14.04%. Based upon the 2MASS J-K = 0.51, the system temperature is 5170K which is a K1V stellar type. The range of Johnson V magnitude is 13.92-16.468 and the Sloan g magnitude range is 14.458-17.723. The orbit is slightly elliptical.

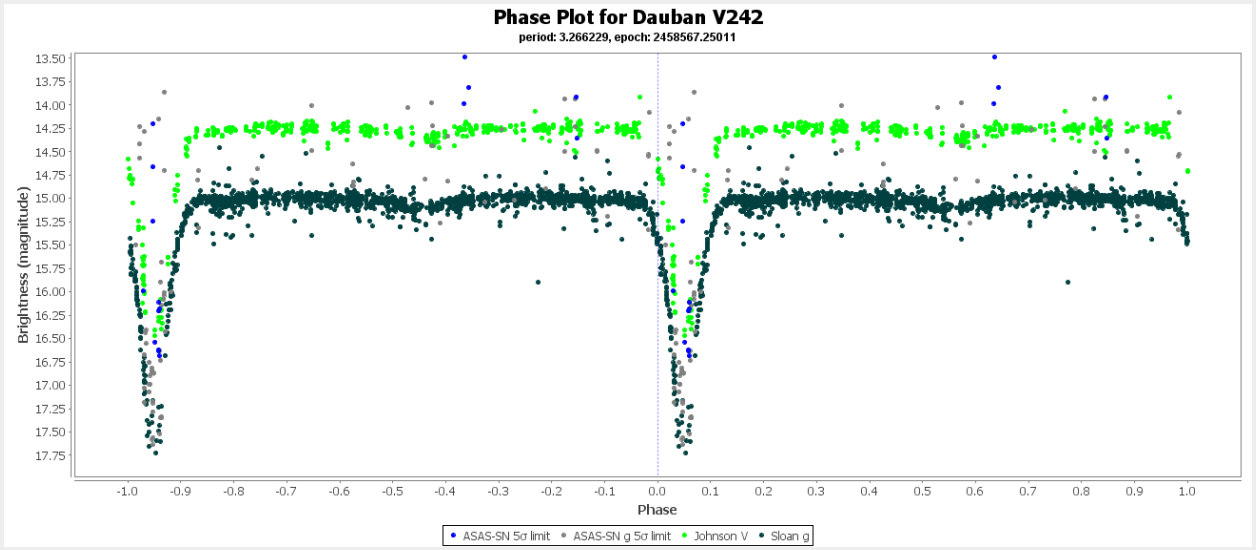

Figure 4: Light Curve for Dauban V242

2.5 Dauban V243

The preliminary discovery data for Dauban V243 confirmed variability and the occurrence of eclipses. This system is in Vulpecula at 20:23:19.16, +21:50:52.4. The Dauban period search indicated possible periods of 3.3922 days, 2.2537 days, 2.3420 days, 6.718 days, and 6.853 days. Another name for Dauban V243 is 2MASS J20231916+2150524. VSX did not have any period indicated and ASAS-SN predicted a period of 2.2539702 days. This is shown in Figure 5. The eclipse's duration was estimated to be 14.04%. Based upon the 2MASS J-K = 0.38, the system temperature is 5740K which is a G5V stellar type. The range of Johnson V magnitude is 12.86-14.215 and the Sloan g magnitude range is 13.38-15.649. The orbit is slightly elliptical.

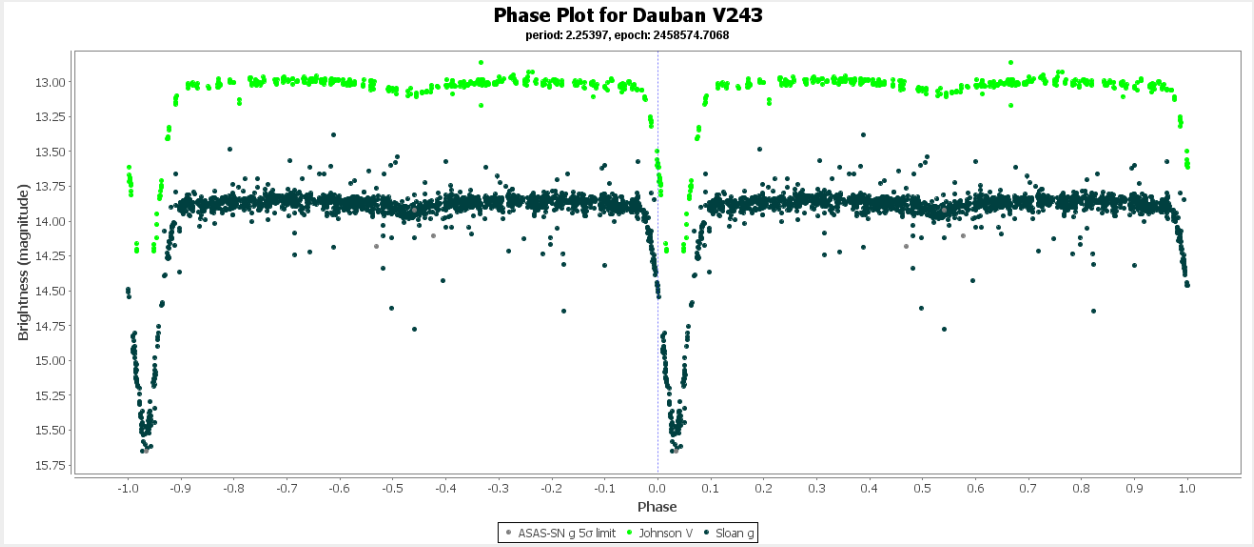

Figure 5: Light Curve for Dauban V243

2.6 Dauban V244

The preliminary discovery data for Dauban V244 confirmed variability and the occurrence of eclipses. This system is located in Cygnus at 19:32:45.98, +36:06:13.1. The Dauban period search indicated possible periods of 12.15 days, 6.074 days, 5.935 days, 4.050 days, 3.987 days, and 3.002 days. Another name for Dauban V244 is 2MASS J20231916+2150524. VSX did not have any period indicated and ASAS-SN predicted a period of 2.4067269 days. This is shown in Figure 6. The eclipse's duration was estimated to be 17.54%. Based upon the 2MASS J-K = 0.30, the system temperature is 6040K which is an F9V stellar type. The range of Johnson V magnitude is 13.504-14.888 and the Sloan g magnitude range is 13.557-15.649. The orbit is slightly elliptical.

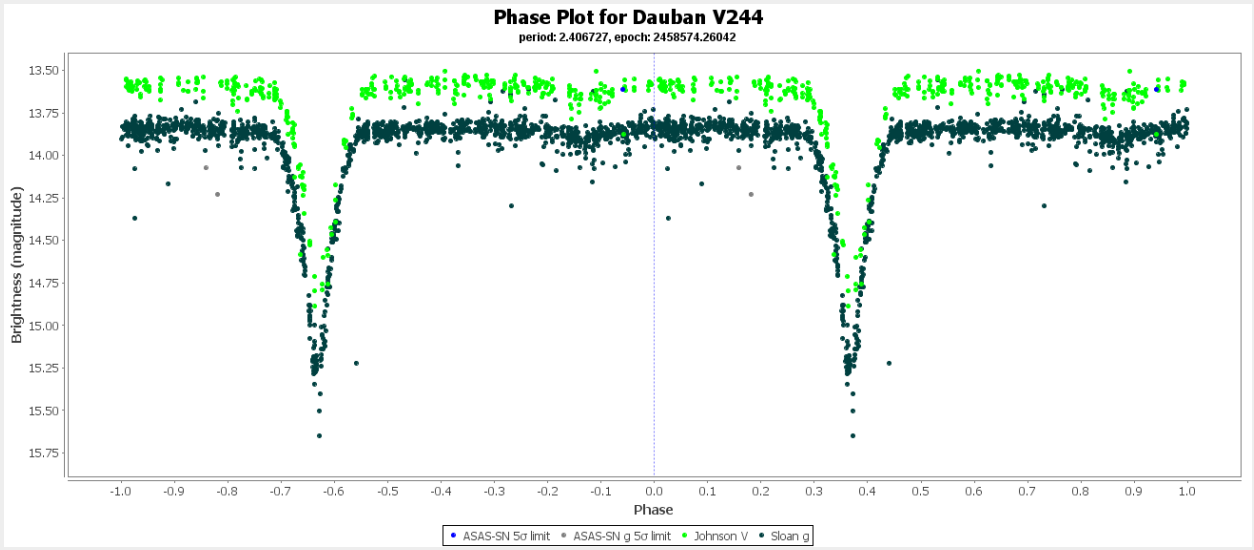

Figure 6: Light Curve for Dauban V244

2.7 Dauban V245

The preliminary discovery data for Dauban V245 confirmed variability and the occurrence of eclipses. This system is in Cygnus at 21:12:06.98, +37:27:53.6. The Dauban period search indicated possible periods of 8.00 days, 4.00 days, 2.6667 days, 2.000 days, and 1.9858 days. Another name for Dauban V245 is 2MASS J21120698+3727535. VSX did not have any period indicated and ASAS-SN predicted a period of 2.640555 days. This is shown in Figure 7. The eclipse's duration was estimated to be 12.07%. Based upon the 2MASS J-K = 0.27, the system temperature is 6270K which is an F7V stellar type. The range of Johnson V magnitude is 12.284-13.322 and the Sloan g magnitude range is 12.286-13.509. The orbit is slightly elliptical.

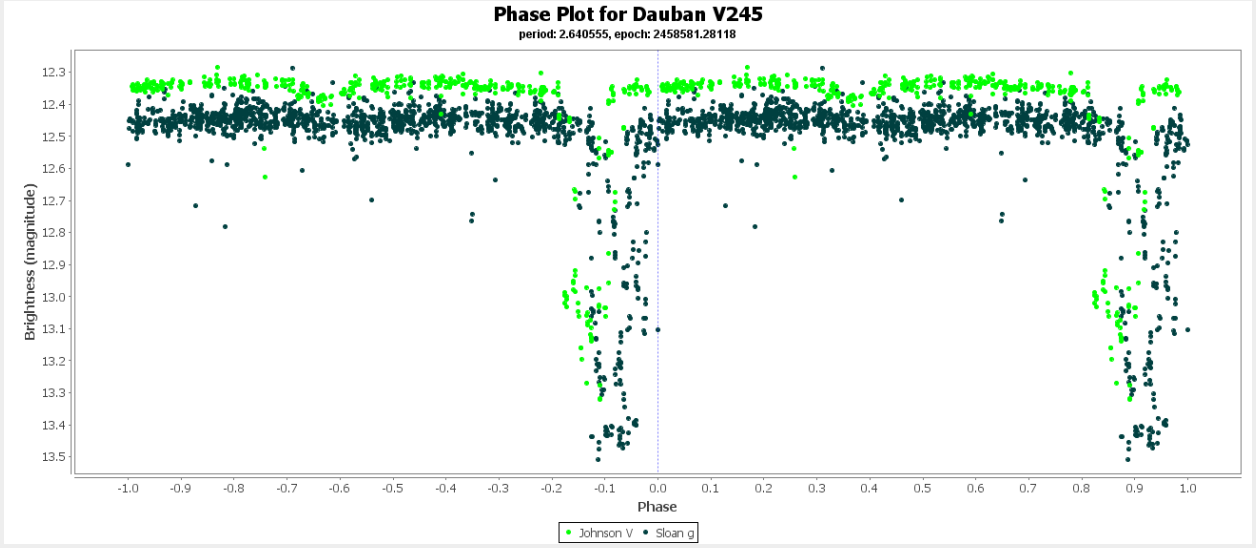

Figure 7: Light Curve for Dauban V245

2.8 Dauban V246

The preliminary discovery data for Dauban V246 confirmed variability and the occurrence of eclipses. This system is located in Cygnus at 21:48:25.76, +39:38:41.4. The Dauban period search indicated possible periods of 0.63687 days and 0.31844 days. Other names for Dauban V246 are 2MASS J21482575+3938414, GSC 03188-00622, and V3170 Cyg. VSX indicated a period of 1.2737272 days. This is shown in Figure 8. The ASAS-SN data included a mean magnitude saturation warning and urged caution with data use. Additionally, it indicated a period of 0.42 days which was extremely inaccurate. The use of the VSX period yielded an excellent light curve plot and is considered to be the correct period. This light curve also showed a clear minimum and maximum eclipse for this object. The eclipse's duration was estimated to

be 13.79%. Based upon the 2MASS J-K = 0.256, the system temperature is 6360K which is an F6V stellar type. The range of Johnson V magnitude for Min I (primary eclipse) is 10.728-11.43 and the Sloan g magnitude range is 10.871-11.746. The range of Johnson V magnitude for Min II (secondary eclipse) is 10.701-11.327 and the Sloan g magnitude range is 10.907-11.668. The orbit is slightly elliptical.

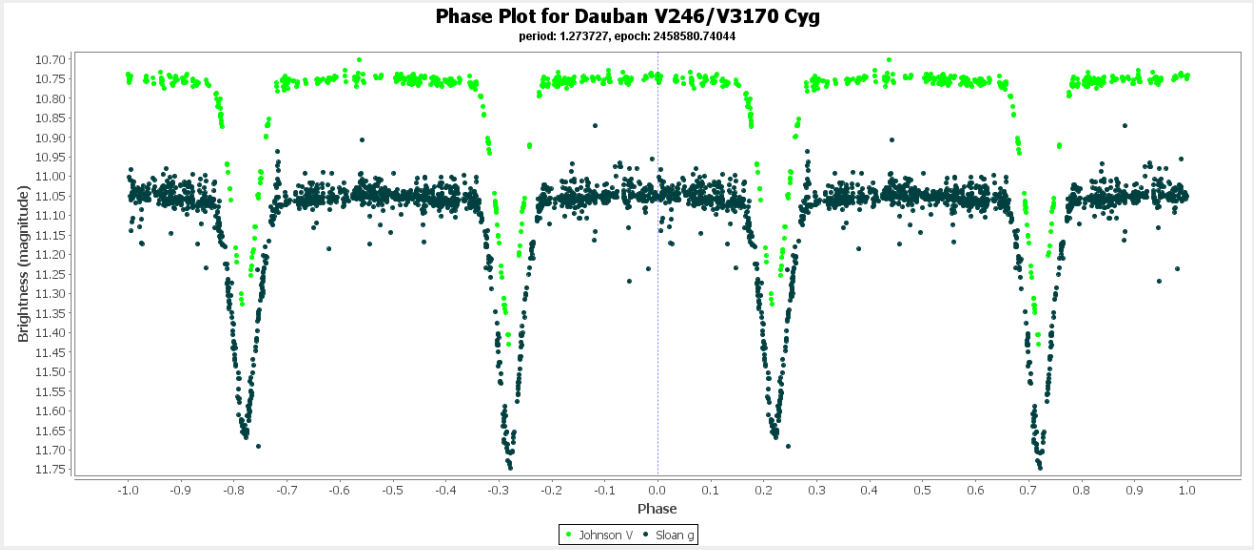

Figure 8: Light Curve for Dauban V246

2.9 Dauban V247

The preliminary discovery data for Dauban V247 confirmed variability and the occurrence of eclipses. This system is located in Andromeda at 02:09:49.92, +43:08:29.3. No Dauban period search was performed. Other names for Dauban V247 are 2MASS J02094992+4308293, GSC 02841-02048, and ASASSN-V J020949.98+430829.2. VSX indicated a period of 2.85433 days and ASAS-SN predicted a period of 2.68543293 days. The VSX period gave a better fit. This is shown in Figure 9. The eclipse's duration was estimated to be 14.04%. Based upon the 2MASS J-K = 0.32, the system temperature is 6000K-6040K which is an F9V-G0V stellar type. The range of Johnson V magnitude is 13.302-16.034 and the Sloan g magnitude is 13.158-16.566. The orbit is slightly elliptical.

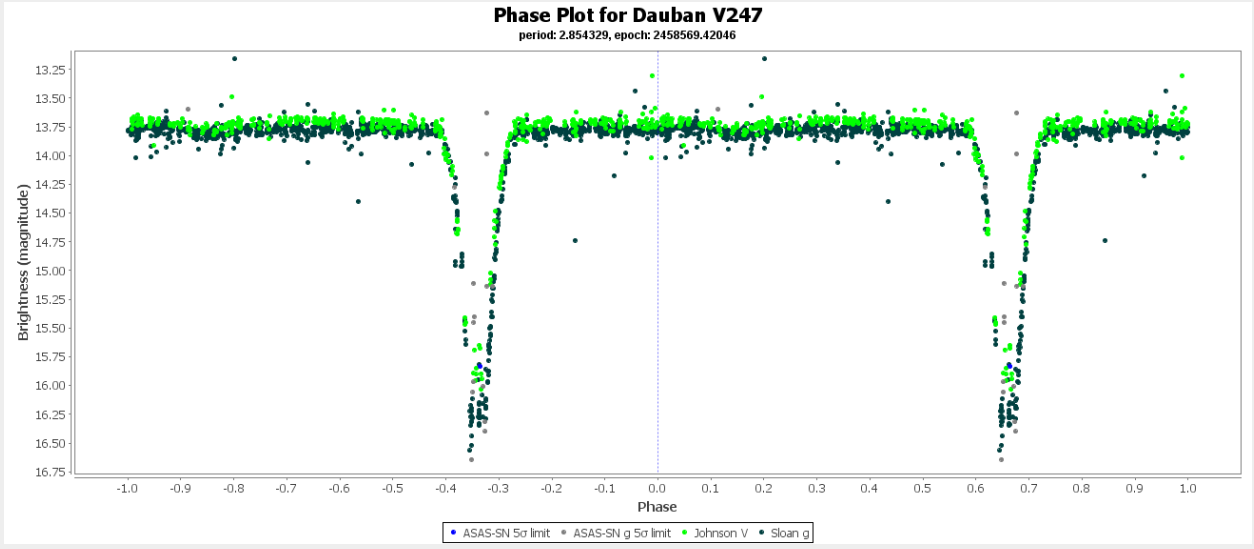

Figure 9: Light Curve for Dauban V247

3.0 Conclusions

The Dauban Survey discovered nine EA eclipsing systems by demonstrating variability but did no further observation or investigation. This study incorporates 2000 days of observation for each object utilizing the ASAS-SN robotic telescope network. The period, eclipse duration, system temperature, stellar type, Johnson V and Sloan g magnitude ranges, and type of orbit was accurately determined for each of the nine systems from the ASAS-SN light curves. This new data should be incorporated into the VSX database. Future work could include generation of O-C curves to determine any change in the orbital periods of these systems.

4.0 Acknowledgements

The author would like to thank Sebastian Otero for the “Colours” spreadsheet he provided which provided detailed data on stellar temperature (via B-V and J-K information) and stellar type. Additional thanks goes to ASAS-SN (Shappee, et al. 2014), and the Dauban Survey (Francois Kugel and Jerome Caron).

References

Benn, D. 2013, VStar data analysis software (https://www.aavso.org/vstar).

Otero, S. private communications (spreadsheet)

Dauban Survey (http://www.aspylib.com/newsurvey/survey.html)

ASAS-SN (Shappee, et al. 2014)