

THE UBVRI AND INFRARED COLOUR INDICES OF THE SUN AND SUN-LIKE STARS

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Abstract

The Sun is not a point source, the photometric observational techniques that are utilised for observing other stars cannot be utilised for the Sun, meaning that it is difficult to derive its colours accurately for astronomical work from direct measurements in different passbands. The solar twins are the best choices because they are the stars that are ideally the same as the Sun in all parameters, and also, their colours are highly similar to those of the Sun. From the 60 articles on the Sun and Sun-like stars in the literature from 1964 until today, the solar colour indices in the optic and infrared regions have been estimated.

1 INTRODUCTION

The Sun is an average-low-mass star in the main sequence of the Hertzsprung-Russell diagram. Moreover, the Sun is not a point source, the photometric observational techniques that are utilised for observing other stars cannot be utilised for the Sun. Therefore, the colours and colour indices of the sun-like stars are used in order to determine the sun's colour indices. These stars generally become the solar analog stars. The highlighted results of the important researches in the literature were collected 8240 records with the colour indices data of the Sun, solar analog, and solar twin stars.

2 THE ESTIMATION of THE SOLAR COLOUR INDICES

The aim is to determine the sun's colour indices and to create the ASAS catalogue (Pojmanski, 1997) (Paczynski *et al.*, 2006) of the sun-like stars. It is taking the average of the colours and colour indices of the solar twin stars having the same spectral type with the sun. So, it is that the sun's colour indices were determined indirectly. In this study, we have collected the colour indices of solar analog and solar twin stars in the literature. By averaging of these, we have indirectly estimated the colour indices of the sun (Tanriver (2012), Tanriver (2014a), Tanriver (2014b)). For this, it is used the data given in the literature records (8240) Then, we have listed sun-like stars in the ASAS catalogue. These values are given in Table1 as follows. One of the Sun like system is HT Vir multiple system (Tanriver & Özeren, 2016). The range of colours valid for the solar analog and solar twin stars can also be seen in Figures 1 and 2.

3 THE SOLAR ANALOG nad SOLAR TWIN STARS in THE ASAS CATALOGUE

The Sun-like stars in the ASAS catalogue are determined by using the obtained ranges of colour for the solar analog and solar twin stars (Tanriver (2012), Tanriver (2014a), Tanriver (2014b)). The table of the Sun-like variable stars in the ASAS catalogue is given as follows a portion of the table with

Table 1: The obtained average colour indices values of the Sun with standart deviation ($\pm\sigma$) (Tanriver (2012), Tanriver (2014a), Tanriver (2014b)).

B-V	0.6457 ± 0.0421	V-J	1.1413 ± 0.1063
H-K	0.0572 ± 0.0351	U-B	0.1463 ± 0.0596
V-H	1.4613 ± 0.1183	J-K	0.3777 ± 0.0494
R-I	0.3403 ± 0.0356	V-K	1.5210 ± 0.1149
J-L	0.4187 ± 0.0558	U-V	0.7926 ± 0.1032
V-L	1.5167 ± 0.0959	J-M	0.3711 ± 0.0529
V-R	0.4674 ± 0.0639	V-M	1.4621 ± 0.0759
K-L	0.0403 ± 0.0517	V-I	0.7053 ± 0.0872
J-H	0.3196 ± 0.0432	K-M	0.0063 ± 0.0546

3764 records.

4 CONCLUSION and DISCUSSION

There are many studies in the literature concerning solar twin stars, such as 18 Sco, HIP 78399 and HD 98618. There are solar twin candidates suggested in the literature to be highly similar to the Sun, too. The other stars demonstrating consistency with our results from among solar twin stars in the literature are given in Table5 as follows. It can be asserted that these stars in our Sun-like ASAS list are the best solar twin stars, which are photometrically similar to the Sun according to our research. Simultaneously, there can also exist stellar systems with stars that host planets such as our solar system (indicating solar twin stars). Additionally, these stars will be crucial in our pursuit of planets.

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Table 2: A portion of the list of solar analog stars in the ASAS catalogue (the entire table has 3764 rows / stars).

ASAS ID	RA (2000) h:m:s	DEC (2000) o ' "	Period (days)	T0 +1000	Class	J	H	K	V-J	V-H	V-K	J-H	H-K	J-K
085432+0000.1	08:54:32	00:00:06	0.415	870.02	EC	11.95	11.64	11.57	1.03	1.34	1.41	0.31	0.07	0.38
190309+0002.0	19:03:09	00:02:00	2.691	981.58	ED	10.19	9.93	9.81	1.47	1.73	1.85	0.26	0.12	0.38
062224+0002.8	06:22:24	00:02:48	0.732	869.54	EC/ESD	11.69	11.5	11.41	1.09	1.28	1.37	0.19	0.09	0.28
050917+0005.5	05:09:17	00:05:30	0.401	870.13	EC/ESD	11.31	11.07	10.98	1.22	1.46	1.55	0.24	0.09	0.33
023458+0005.9	02:34:58	00:05:54	0.406	919.70	ESD/EC	10.44	10.2	10.16	1.06	1.3	1.34	0.24	0.04	0.28
110909+0007.6	11:09:09	00:07:36	1.371	874.50	ED	11.94	11.54	11.44	1.43	1.83	1.93	0.4	0.1	0.5
182658+0008.3	18:26:58	00:08:18	0.468	963.10	ESD/EC	9.85	9.54	9.46	0.85	1.16	1.24	0.31	0.08	0.39
094227+0008.9	09:42:27	00:08:54	0.736	870.64	ESD/EC	11.09	10.73	10.66	1.27	1.63	1.7	0.36	0.07	0.43
044349+0009.4	04:43:49	00:09:24	0.405	870.07	EC/ESD	10.62	10.38	10.35	0.88	1.12	1.15	0.24	0.03	0.027
072307+0010.9	07:23:07	00:10:54	0.671	870.48	ESD/EC	10.65	10.41	10.33	0.86	1.1	1.18	0.24	0.08	0.32

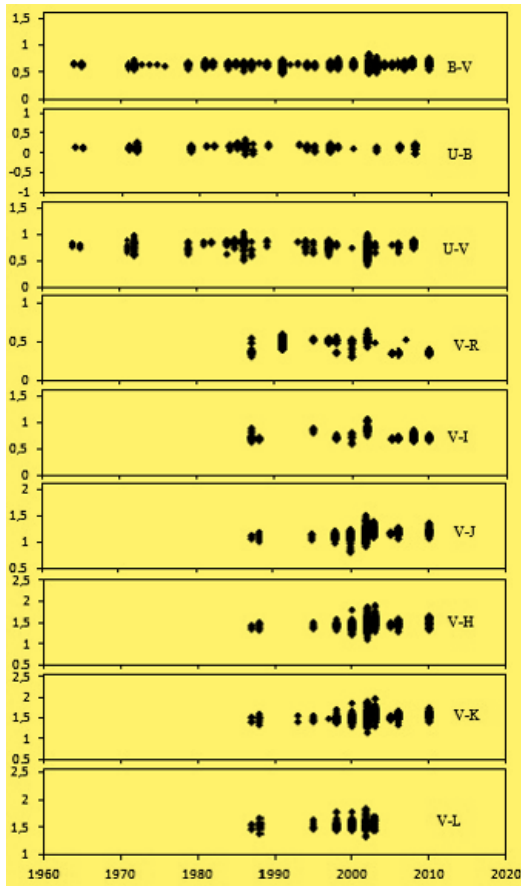


Figure 1: Produced colour indexes from the solar analogs and solar twins in the literature.

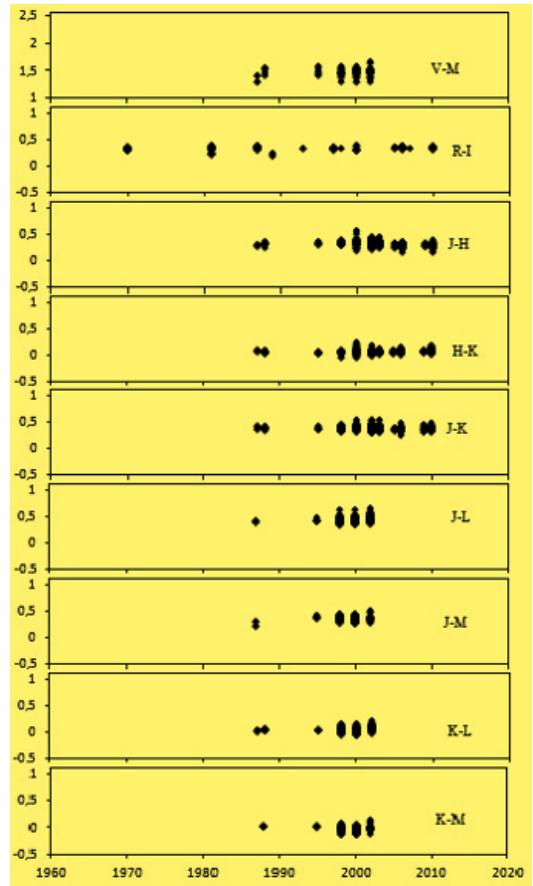


Figure 2: Produced colour indexes from the solar analogs and solar twins in the literature.

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Table 3: The Solar twin stars that are compatible with our results in the literature.

16 Cyg A	HD 10307	HD 25680
HD 89010	HD 84737	GSC 3493- 432
HD 213575	l Aur	GSC 4413- 304
HD 44594	18 Sco	HD 141004
HD 159222	HIP 78399	HD 11131
16 Cyg B	HD 98618	HD 86728
HD 146233	HD 1835	HD 187923A
HD 28099	HD 20630	HD 109358
HD 76151	HD 20766	HD 1581