

COMMISSIONS 27 AND 42 OF THE IAU
INFORMATION BULLETIN ON VARIABLE STARS

Number 4054

Konkoly Observatory
Budapest
28 July 1994

HU ISSN 0324 - 0676

PHOTOMETRY OF STARS IN THE FIELD OF S PERSEI

S Persei (BD+57°552 = HD 14528) is a member of the Perseus OB1 association, a suggestion first made by Bidelman (1947), and later confirmed via radial velocities by Humphreys (1970, 1975) and Gahm & Arkling (1971). It lies near the red, luminous limit of the MK classification system, with a mean spectral type of M4.5 Iab determined from eight-color photometry (White & Wing 1978). Slit and objective-prism classifications have ranged from M3 to M5, often showing hydrogen emission as far down as H δ (Bidelman 1947, Blanco 1955, Gahm & Hultqvist 1972). Few other stars are known to be both as luminous (Ia at maximum) and as cool; among MK standards, only EV Carinae is similar (Keenan & Yorka 1988). The star is also a well-studied OH, SiO, and H $_2$ O maser.

The star's variations have been followed visually almost continuously since they were discovered in 1872 by Krüger (1874). A summary of its early observational history is given by Campbell (1939). Even by the turn of the century, the unique nature of the light curve was evident (Turner 1904). The star exhibits long Mira-like cycles of large amplitude alternating with intervals of relative constancy. This behavior has consistently been interpreted as resulting from the beating of two interfering periods of about 810 and 950 days. The most useful analysis of this phenomenon is by Leung & Stothers (1977), which elaborates on theoretical results by Stothers & Leung (1971).

In the course of photoelectric monitoring of S Persei, in progress since October 1984, I have made a check on the existing magnitude sequence on the AAVSO (d) chart for the star. The chart magnitudes were last revised in 1952. I observed the stars using the Lowell 53cm photometric telescope. Strömgren y and b filters were used through a 29-arcsec diaphragm. Each observation consisted of at least four 10s integrations on 'star' and two 10s integrations on 'sky', with more integrations for stars fainter than about 9^m0. The stars were observed in two colors on 4 January or 9 December 1993 UT. Differential y observations made on two earlier occasions were reduced to V magnitudes using the results for HD 14415 and HD 14571 determined on the later nights.

Table 1 shows the adopted and observed mean V and $b - y$ for the standard stars, and the number of observations 'n'. The stars are sorted in RA order for equinox 2000. Primary Strömgren four-color standards are indicated with \star by the star name. The data in parentheses were omitted from the transformations. The mean deviations of the observed averages from the assumed values in this group of data are: $V = 0.000 \pm 0.005$; $b - y = 0.000 \pm 0.006$.

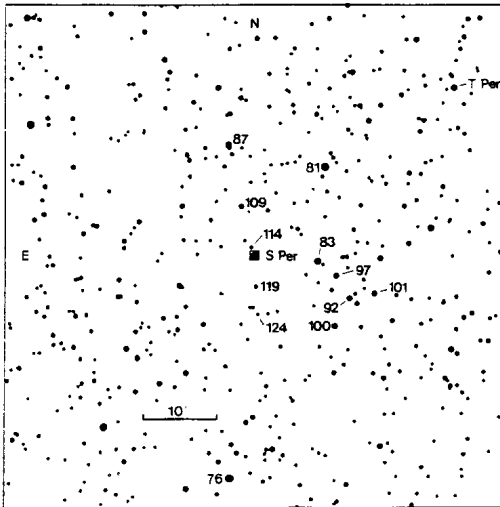


Figure 1. The field of S Persei showing stars from the GSC. V magnitudes are indicated to the nearest tenth with the decimal point omitted.

Table 1. Standard Star Observations

Name	V (std)	$b - y$ (std)	V (obs)	$b - y$ (obs)	n
HD 4790	6.624	0.862	6.628	0.863	1
HD 6479	6.361	0.257	6.361	0.260	1
HD 6480	7.266	0.325	7.266	0.324	1
HD 11577	7.707	0.112	7.714	(0.089)	1
HD 12642	5.619	0.996	5.622	(1.021)	1
HD 13421*	5.635	0.358	5.640	0.363	1
HD 16901	5.436	0.566	5.433	0.564	3
HD 22211*	6.487	0.408	6.489	0.406	1
HD 22695	6.194	0.597	6.187	0.583	1
HD 24357*	5.970	0.221	5.964	0.230	2
HD 24482	8.184	1.256	8.189	1.257	4
HD 26462*	5.707	0.231	5.714	0.237	1
HD 33021*	6.165	0.397	6.167	0.389	2
HD 42049	5.929	1.044	(5.906)	1.046	1
HD 42824	6.627	0.019	6.625	0.029	1
HD 43358*	6.363	0.296	6.369	0.292	1
HD 45433	5.540	0.858	5.532	0.860	2
HD 47420	6.118	0.910	6.107	0.917	1
HD 52533	7.702	0.006	7.708	0.002	1
HD 57006*	5.915	0.339	5.913	0.333	1
HD 76494	6.133	0.610	6.132	0.603	1

Table 2. Photometry of Stars in the Field of S Persei

Name	RA (2000)	Dec (2000)	V	$b - y$	n	spec	Remarks
HD 4528	2 ^h 22 ^m 51 ^s .7	+58°35'12"	9.632	2.073	1,1	M4.5Iab	(1)
HD 14571	2 23 15.9	+58 05 18	7.616 .004	0.874 .010	4,2	K IIII	
HD 14403	2 21 38.1	+58 47 03	8.140	0.724	1,1	G8III	(2)
HD 14415	2 21 45.9	+58 34 24	8.302 .002	0.684 .001	4,2	G5II	(3)
HD 14559	2 23 18.5	+58 50 04	8.705 .008	0.134	2,1	A0V	(4)
HD 14356	2 21 12.3	+58 29 27	9.212 .001	0.352	2,1	F0V	
HD 14383	2 21 26.4	+58 32 26	9.713	0.365	1,1	F5V	(5)
BD+57°548	2 21 27.8	+58 25 43	9.994 .045	0.359	2,1		
HD 14300	2 20 46.5	+58 30 03	10.095 .001	0.200	2,1	A3V	
GSC 3698-0184	2 23 05.0	+58 41 46	10.941 .002	0.289	2,1		
AG+58°256	2 22 54.8	+58 36 16	11.383 .002	0.444	2,1	A0	(6)
GSC 3698-1822	2 22 49.9	+58 30 59	11.949 .007	0.379	2,1		
GSC 3698-1966	2 22 48.1	+58 27 17	12.541 .032	0.514	2,1		

Remarks:

- (1) - = S Persei, measured 4 Jan 1993 UT.
(2) - = NSV 793. $b - y = 0.728$ (Olsen 1993).
(3) - $b - y = 0.693$ (Olsen 1993).
(4) - $V = 8.68$, $b - y = 0.12$ (Pesch & McCuskey 1974).
(5) - = NSV 791. includes mag. ~ 13 companion.
(6) - = BD+57°552b.

The results for the stars near S Persei are shown in Table 2, listed in order of decreasing brightness. A single measurement on S Per itself is given as the first entry. The star positions come from the PPM and Carlsberg Meridian Circle astrometric catalogues or the GSC; spectral types were retrieved from the literature via SIMBAD. Column 'n' shows the number of measurements in V and $b - y$, respectively. For values determined on two or more nights, the standard deviation of the mean is given in the second line of each entry.

The color of S Persei lies far outside the range of the standard stars, and so the magnitude and color are subject to substantial 'reduction errors' (cf. Manfroid & Sterken 1992) as a result of extrapolating the color system defined by the standards ($0.01 < b - y < 1.26$). Previous experience on other very red stars suggests the night-to-night jitter from extrapolating varying sets of standards to this extent results in scatter of about $0.03 - 0.05$ in $b - y$, but more consistent values in V.

HD 14383 = NSV 791 was suspected of variability from visual observations by Hallows, reported by de Roy (1935), but Hallows notes from his series of follow-up observations that "variation must presently be considered as rather doubtful." Thus the star is not likely to be a large-amplitude variable.

Finally, I will note that the two stars used as comparisons for the differential photoelectric measurements, HD 14415 and HD 14571, appear to be constant at the few-millimag level over the ten years I have used them.

For the convenience of observers, a chart derived from the GSC is shown in Figure 1. The comparison stars are indicated by their V magnitudes rounded to the nearest tenth (decimal point omitted) in the style of visual variable- star charts.

Preparation of this report was facilitated by the use of SIMBAD, maintained by the Centre de Données astronomiques, Strasbourg, France.

Brian A. SKIFF
 Lowell Observatory
 1400 West Mars Hill Road
 Flagstaff AZ 86001-4499
 Internet: bas@lowell.edu

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