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HR 2557: A LUMINOUS δ SCUTI STAR

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HR 2557 is shown to be light variable. It is suggested that this star is one of the most luminous δ Scuti stars known.

Key words: stars, δ Scuti—stars, photometry

Introduction

HR 2557 was noted to have an unusual spectrum by Cowley and Crawford (1971) who classified it as a δ Delphini star. Morgan and Abt (1972), however, considered it to have a normal spectrum and they defined it as an A9 III standard star on the MKA system. In her reclassification of the bright F stars, Cowley (1976) also used HR 2557 as an A9 III standard star.

In the analysis of the δ Del stars, Kurtz (1976) did a fine abundance analysis of HR 2557 but the results of that analysis were inconclusive. The derived abundances appeared to be marginally abnormal in the manner of the anomalous abundance δ Del stars, but the errors were sufficiently large that normal abundances could not be ruled out.

As part of an ongoing program to determine the relationship between pulsation and metallicism, HR 2557 was monitored photoelectrically and found to be variable.

Data Acquisition

Observations were made on seven nights in 1975 and 1976 using the University of Texas Volksphotometer attached to the McDonald Observatory 92-cm and 76-cm reflectors. Integration times of 90 sec in Strömgren y were used and two comparison stars were observed in the cycle C1VC2. Table I gives the dates of the observations, the number of comparison-star observations made on each night, and the computed internal standard deviations of the comparison-star magnitudes with respect to their mean. Table II lists the observations giving the heliocentric Julian Date and the y apparent magnitude. The external accuracy of the y-magnitude scale has an estimated error of ±0.05 magnitude since it was fixed with respect to the Johnson V magnitude of HR 2568 given in the *Catalogue of Bright Stars* (Hoffleit 1964). Figure 1 is a plot of the observed magnitudes showing the light variability of HR 2557.

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Discussion

Periodicities were searched for in the light variations of HR 2557 by applying a discrete Fourier transform to the data as developed by Deeming (1975). When the entire data set in Table II is analyzed, several peaks appear in the power spectrum, but they are poorly defined. Analysis of the data on a night-by-night basis yields periods on the order of four hours. This can be just as easily derived from a visual inspection of the light curves shown in Figure 1 since at most one cycle of data is available on a given night. The very low amplitude of the light variations coupled with at least one period of the order of four hours makes an accurate determination of the periodicities present in this star impossible with the present data.

From the Strömgren indices of HR 2557 (Lindemann and Hauck 1973), and Crawford's (1970) calibration of the ZAMS in terms of those indices, we calculate an absolute magnitude for HR 2557 of $M_v = 0.0$ from $M_v = M_v(\text{ZAMS}) - 8\delta c_1(\beta)$, and $M_v = -0.2$ from $M_v = M_v\,(\text{ZAMS}) - 9\Delta c_1(b-y)$. Eggen (1976) computes the

TABLE I

Computed Internal Standard Deviations

V = HR 2557	C1 = HR 2568	C2 = HR 2585
UT Date	N	σ (mag)
1975 Oct 27	52	0.0006
1975 Nov 22	50	0.0015
1975 Nov 23	*	*
1975 Nov 25	83	0.0010
1975 Nov 27	52	0.0008
		C2 = HR 2645
1976 Feb 12	94	0.0016
1976 Feb 16	79	0.0013

*C1 only used in the data reduction. C2 was possibly variable.

TABLE II

Photometry of HR2557

HJD 2442000.000+	y (mag)	HJD 2442000.000+	y (mag)	HJD 2442000.000+	y (mag)
712.850	6.045	738.934	6.041	741.840	6.036
712.856	6.044	738.940	6.040	741.846	6.035
712.861	6.044	738.948	6.038	741.852	6.033
712.865	6.044	738.955	6.041	741.858	6.034
712.871	6.046	738.960	6.040	741.863	6.033
712.876	6.046	739.816	6.044	741.876	6.036
712.880	6.047	739.823	6.046	741.882	6.035
712.885	6.049	739.828	6.043	741.887	6.033
712.890	6.049	739.834	6.044	741.893	6.034
712.894	6.048	739.839	6.042	741.899	6.035
712.899	6.050	739.845	6.041	741.905	6.036
712.904	6.050	739.851	6.040	741.912	6.036
712.909	6.054	739.856	6.041	741.918	6.037
712.913	6.053	739.861	6.039	741.924	6.037
712.918	6.053	739.869	6.036	741.930	6.039
712.923	6.055	739.875	6.035	741.935	6.040
712.927	6.054	739.880	6.035	741.941	6.036
712.932	6.053	739.886	6.034	741.946	6.039
712.937	6.050	739.896	6.032	741.951	6.036
712.942	6.052	739.903	6.029	741.958	6.038
712.946	6.052	739.909	6.033	741.963	6.036
712.952	6.054	739.916	6.031	741.968	6.039
712.956	6.053	739.923	6.031	741.974	6.037
712.960	6.050	739.929	6.031	741.979	6.038
712.965	6.050	739.934	6.031	741.985	6.035
712.970	6.050	739.941	6.032	741.991	6.034
712.975	6.049	739.946	6.030	741.996	6.036
712.980	6.048	739.958	6.033	742.003	6.034
712.985	6.047	739.964	6.035	742.008	6.036
738.794	6.045	739.970	6.041	743.863	6.031
738.801	6.043	739.977	6.037	743.869	6.033
738.807	6.044	739.982	6.038	743.875	6.030
738.813	6.043	739.988	6.041	743.881	6.030
738.818	6.048	739.995	6.042	743.886	6.033
738.825	6.047	740.002	6.040	743.893	6.033
738.830	6.047	740.008	6.039	743.898	6.035
738.836	6.047	740.013	6.038	743.905	6.035
738.842	6.047	740.020	6.042	743.911	6.036
738.848	6.047	741.763	6.037	743.918	6.035
738.853	6.045	741.770	6.035	743.925	6.037
738.859	6.045	741.777	6.038	743.930	6.033
738.864	6.043	741.783	6.038	743.936	6.034
738.870	6.044	741.788	6.036	743.941	6.032
738.876	6.044	741.794	6.036	743.948	6.032
738.887	6.044	741.799	6.037	743.953	6.035
738.895	6.043	741.804	6.037	743.958	6.035
738.901	6.042	741.811	6.039	743.964	6.033
738.908	6.040	741.816	6.039	743.969	6.036
738.915	6.045	741.828	6.039	743.975	6.039
738.925	6.041	741.834	6.038	743.982	6.040
743.988	6.040	820.715	6.038	824.631	6.046
743.994	6.038	820.720	6.037	824.636	6.044
744.001	6.041	820.725	6.037	824.640	6.040

TABLE II (Continued)

HJD 2442000.000+	y (mag)	HJD 2442000.000+	y (mag)	HJD 2442000.000+	y (mag)
744.007	6.039	820.730	6.037	824.645	6.039
744.013	6.040	820.735	6.036	824.650	6.040
820.578	6.038	820.740	6.038	824.654	6.038
820.582	6.040	820.745	6.037	824.659	6.038
820.587	6.040	820.749	6.040	824.664	6.041
820.593	6.040	820.755	6.039	824.668	6.040
820.598	6.043	820.760	6.042	824.673	6.038
820.604	6.043	820.765	6.041	824.678	6.038
820.609	6.045	820.770	6.041	824.682	6.038
820.615	6.045	820.775	6.043	824.687	6.036
820.620	6.046	820.790	6.044	824.692	6.036
820.625	6.046	820.795	6.047	824.697	6.037
820.630	6.048	820.800	6.047	824.702	6.036
820.635	6.047	820.805	6.047	824.707	6.037
820.640	6.048	820.810	6.047	824.711	6.036
820.646	6.046	820.815	6.047	824.716	6.039
820.650	6.046	820.820	6.046	824.722	6.038
820.655	6.044	824.572	6.038	824.726	6.038
820.660	6.044	824.578	6.038	824.730	6.041
820.665	6.043	824.583	6.040	824.735	6.039
820.670	6.043	824.588	6.041	824.742	6.041
820.675	6.041	824.593	6.042	824.747	6.042
820.680	6.041	824.597	6.044	824.751	6.046
820.685	6.037	829.603	6.045	824.757	6.043
820.690	6.039	824.607	6.045	824.762	6.042
820.695	6.037	824.612	6.044	824.767	6.042
820.700	6.037	824.617	6.043		
820.705	6.037	824.622	6.047		
820.710	6.036	824.627	6.046		

absolute magnitude to be $M_v = 0.3$ from the reddening-free formula $\Delta M_v = 7.5(\delta[m_1] + \Delta[c_1])$, but he feels this may be a slight underestimate. We estimate the external error in M_v may be as large as ± 0.5 magnitude since HR 2557 is more luminous than any of the stars Crawford used in determining the above calibrations.

Figure 2 is a color-magnitude diagram for the δ Scuti stars listed by Baglin et al. (1973) with HR 2557 plotted with an adopted absolute magnitude of $M_v = 0.0$. The temperature indices $(b-y)$ and β, the computed absolute magnitude, and the spectral type of HR 2557 all place it within the observed δ Sct instability strip. The light variation shown in Figure 1 and a possible periodicity of the order of four hours is also consistent with δ Sct pulsation. It is therefore suggested that HR 2557 is among the most luminous of the known δ Sct stars.

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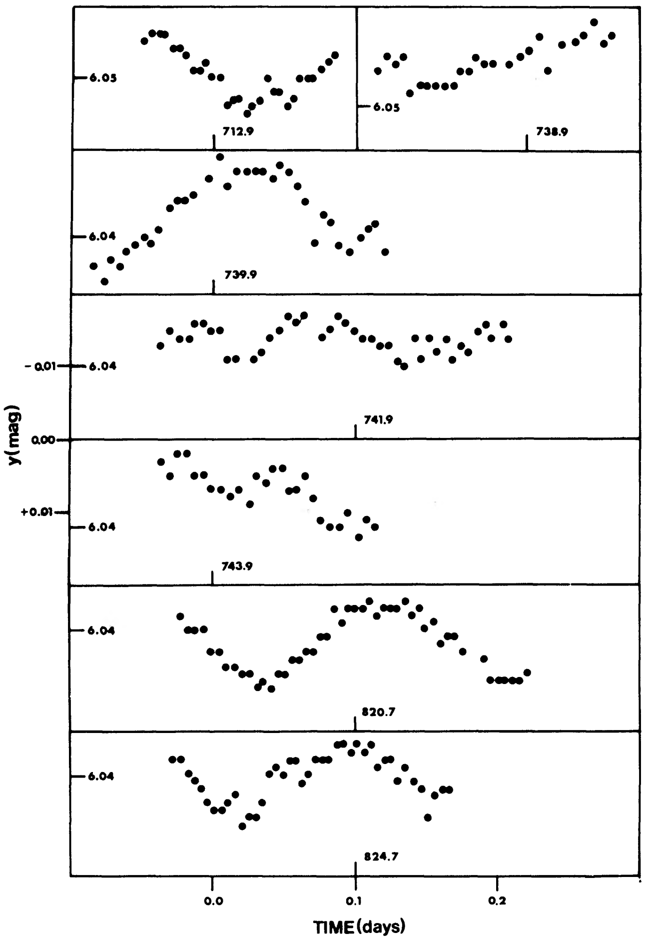

FIG. 1—The observed y magnitudes for HR 2557. The abscissa is the heliocentric Julian Date − 2442000.000. The ordinate is the apparent y magnitude.

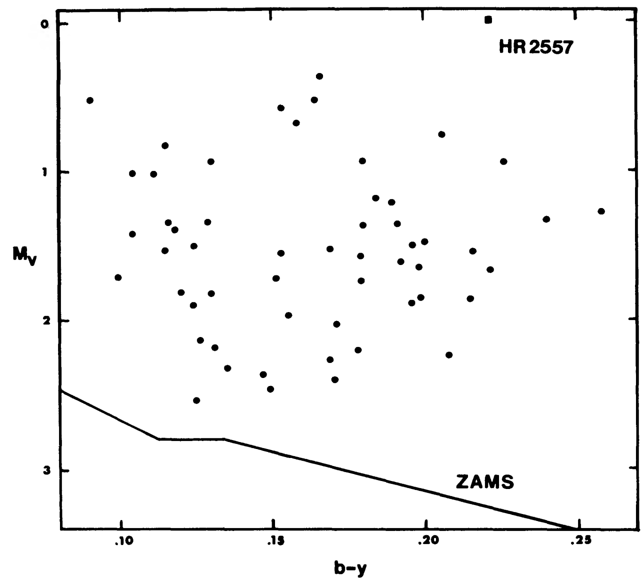

FIG. 2—A color-magnitude diagram for the δ Sct stars listed by Baglin et al. (1973). Absolute magnitudes have been calculated from $M_v = M_v$ (ZAMS) $- 9\Delta c_1(b-y)$. HR 2557 is the square plotted at an adopted absolute magnitude of $M_v = 0.0$.