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PHOTOELECTRIC PHOTOMETRY OF  $\rho$  CASSIOPEIAE

The peculiar variable star  $\rho$  Cassiopeiae ( $\rho$  Cas, HD 224014, = SAO 035879) was observed by four observatories using photoelectric photometers. Observations covered the period of time from September 18, 1986 to November 26, 1987. This represents a follow-up of data presented in an earlier bulletin (Leiker and Hoff, 1987). In that bulletin we reported on a substantial brightening of this star. That brightening epoch has now been confirmed by other observers, whose data is presented here. This note also contains data which suggests that the star has now begun to dim slightly.

$\rho$  Cas is a supergiant (F8pIA) star (Percy & Keith, 1985).  $\rho$  Cas was discovered to be a variable in 1900 by Louise D. Wells (Pickering, 1901). Much of the time this star was confined to a brightness between 4.1m and 5.1m (Bailey, 1978). Between August 1945 and June 1947  $\rho$  Cas decreased in brightness more than a magnitude (Gaposchkin, 1949). After it recovered from this minimum,  $\rho$  Cas continued its irregular variation in brightness of 4.1m and 5.1m (Leiker, 1987).

$\rho$  Cas was observed extensively from June 1986 to April 1987 by Leiker and Hoff (1987). A 0.4 meter Cassegrain telescope and a STARLIGHT-1 photon counting photometer at the University of Northern Iowa (UNI) Hillside Observatory using standard B and V filters was used to make the observations.  $\rho$  Cas was again observed by Leiker and Hoff from April 17, 1987 through August 19, 1987 using the same equipment. All of the  $\Delta m$  are made in the sense of  $\rho$  Cas - HD 223173. Table 1 lists the  $\Delta V$  magnitudes obtained from April 17, 1987 to August 19, 1987. Table 2 list the  $\Delta B-V$  magnitudes. Figures 1 and 2 are graphical representations of the data presented in Tables 1 and 2 respectively. Three observations were made to produce each of the delta magnitudes. Standard deviation and mean error were calculated according to Hall and Genet (1982).

Nesbella and Gainer observed  $\rho$  Cas from September 18, 1986 to October 19, 1987 using a 0.2 meter Schmidt-Cassegrain telescope and a solid state detector.  $\rho$  Cas was observed in both blue and visual light. Also listed are the number of observations made to produce each delta magnitude. Standard deviation and mean error was calculated according to Hall and Genet (1982). Table 3 lists the  $\Delta V$  magnitudes and Table 4 lists the  $\Delta B-V$  magnitudes (Leiker, 1987). Figures 3 and 4 are graphical representations of the data presented in table 3 and 4 respectively. All of the  $\Delta m$  are made in the the sense of  $\rho$  Cas - HD 223173.

Milton observed  $\rho$  Cas from December 8, 1986 to November 26, 1987. Milton used a 0.2 meter Schmidt-Cassegrain telescope, and a 1P21 photomultiplier tube with pulse counting electronics. The obtained  $\Delta m$  are in the sense of  $\rho$  Cas - HD 223173 (Leiker, 1987). Standard deviation and mean error were calculated by Milton. Table 5 list the  $\Delta$  magnitudes obtained. See figure 5.

Pray observed  $\rho$  Cas from September 10, 1986 to October 30, 1987. Mean error was calculated by Pray. Table 6 lists these data. The listed  $\Delta m$  are in the sense of  $\rho$  Cas - HD 223173 (Leiker, 1987). Figure 6 is a graphical representation of this data.

Table I.  $\Delta V$  magnitudes of  $\rho$  Cas obtained by Leiker and Hoff

HJD	$\Delta V$	$\sigma$	error
2446902.727	-1.085	0.044	0.025
2446930.853	-1.083	0.031	0.018
2446931.823	-1.029	0.015	0.009
2446932.821	-1.014	0.010	0.006
2446950.707	-0.983	0.020	0.012
2446951.691	-0.981	0.019	0.011
2446952.672	-0.952	0.022	0.013
2446953.697	-0.960	0.007	0.004
2446958.597	-0.970	0.018	0.011
2446958.741	-0.967	0.009	0.005
2446960.696	-1.007	0.023	0.013
2446961.709	-0.991	0.018	0.011
2446962.728	-1.006	0.003	0.001
2446972.734	-0.984	0.010	0.006
2446973.663	-0.970	0.007	0.004
2446978.680	-0.987	0.004	0.002
2446979.704	-0.990	0.045	0.026
2446979.713	-1.000	0.013	0.008
2446984.671	-1.009	0.018	0.010
2446990.654	-1.027	0.025	0.015
2446992.709	-1.038	0.006	0.003
2446993.676	-1.031	0.017	0.010
2446997.668	-1.060	0.042	0.024
2446998.708	-1.016	0.016	0.009
2447000.737	-1.046	0.041	0.024
2447002.656	-1.025	0.012	0.007
2447003.647	-1.015	0.007	0.004
2447005.697	-1.028	0.011	0.006
2447008.671	-1.036	0.004	0.002
2447010.661	-1.057	0.008	0.005
2447012.676	-1.047	0.005	0.003
2447024.597	-1.072	0.010	0.006
2447026.612	-1.083	0.013	0.007

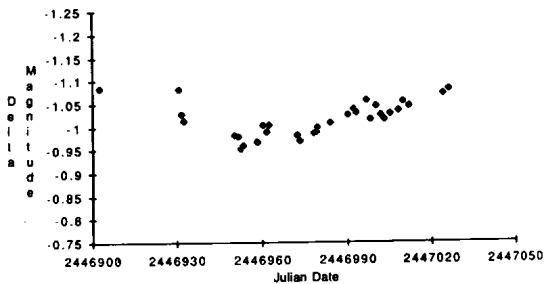
Figure 1.  $\Delta V$  magnitudes of  $\rho$  Cas obtained by Leiker and Hoff

Table II.  $\Delta(B-V)$  magnitudes obtained by Leiker and Hoff

HJD	$\Delta B-V$	$\sigma$	error
2446930.853	-0.205	0.044	0.031
2446931.823	-0.226	0.026	0.019
2446932.821	-0.228	0.022	0.016
2446950.707	-0.212	0.024	0.017
2446951.691	-0.197	0.022	0.015
2446952.672	-0.228	0.050	0.036
2446953.697	-0.206	0.026	0.018
2446958.597	-0.187	0.021	0.015
2446960.696	-0.170	0.032	0.022
2446961.709	-0.197	0.031	0.022
2446962.728	-0.172	0.003	0.002
2446972.734	-0.206	0.013	0.009
2446973.663	-0.210	0.029	0.020
2446979.713	-0.222	0.016	0.012
2446984.671	-0.192	0.024	0.017
2446990.654	-0.209	0.038	0.027
2446992.709	-0.173	0.006	0.004
2446993.676	-0.200	0.032	0.023
2446997.668	-0.170	0.047	0.033
2446998.708	-0.175	0.027	0.019
2447002.656	-0.199	0.016	0.011
2447003.647	-0.218	0.007	0.005
2447005.697	-0.206	0.014	0.010
2447008.671	-0.203	0.012	0.009
2447010.661	-0.202	0.009	0.007
2447012.676	-0.220	0.013	0.009
2447024.597	-0.220	0.015	0.011
2447026.612	-0.210	0.020	0.014

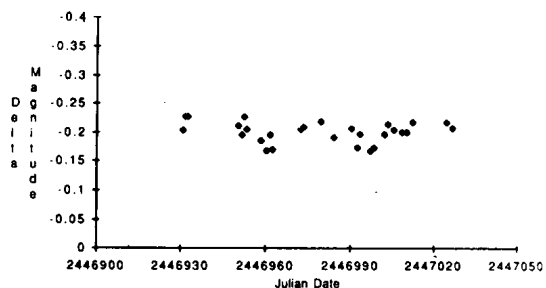
Figure 2.  $\Delta(B-V)$  magnitudes of  $\rho$  Cas obtained Leiker and Hoff

Table III.  $\Delta V$  magnitudes of  $\rho$  Cas by Nesbella and Gainer

JD	$\Delta m$	$\sigma$	error	#
2446691.516	0.921	0.011	0.008	2
2446732.686	1.037	0.005	0.002	8
2446735.541	1.037	0.008	0.002	16
2446748.695	1.086	0.009	0.003	12
2446812.688	1.239	0.027	0.012	5
2446822.573	1.247	0.009	0.002	14
2446829.542	1.253	0.015	0.004	12
2446837.535	1.256	0.009	0.003	10
2446845.512	1.254	0.009	0.003	9
2446871.521	1.219	0.017	0.007	7
2446872.517	1.212	0.011	0.006	4
2446874.523	1.210	0.023	0.010	5
2446877.524	1.217	0.011	0.006	3
2446895.869	1.121	0.010	0.004	8
2446906.799	1.086	0.033	0.007	22
2446964.757	0.986	0.012	0.007	3
2446970.757	0.999	0.008	0.003	5
2446971.696	0.963	0.025	0.015	3
2447029.773	1.083	0.009	0.004	6
2447039.628	1.103	0.024	0.017	2
2447042.641	1.186	0.284	0.107	7
2447053.688	1.078	0.008	0.003	6
2447067.613	1.112	0.006	0.003	5
2447073.623	1.130	0.008	0.004	5
2447082.609	1.120	0.005	0.002	5
2447083.597	1.129	0.008	0.004	5
2447087.562	1.128	0.006	0.003	5

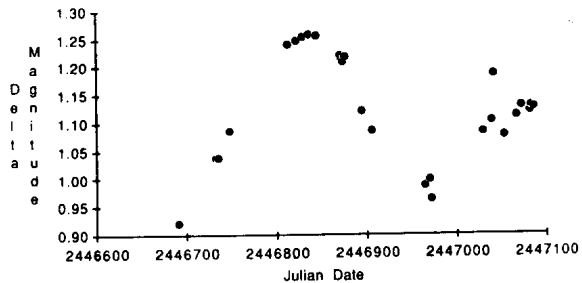
Figure 3.  $\Delta V$  magnitudes of  $\rho$  Cas by Nesbella and Gainer

Table IV.  $\Delta(B-V)$  magnitudes of  $\rho$  Cas by Nesbella and Gainer

JD	B-V	$\sigma$	error
2446691.516	0.108	0.023	0.017
2446732.686	0.168	0.034	0.024
2446735.541	0.251	0.033	0.024
2446748.695	0.406	0.071	0.050
2446812.688	0.300	0.049	0.035
2446822.573	0.316	0.034	0.024
2446829.542	0.381	0.043	0.030
2446837.535	0.319	0.033	0.023
2446845.512	0.242	0.018	0.013
2446871.521	0.293	0.038	0.027
2446872.517	0.276	0.018	0.013
2446874.523	0.273	0.038	0.027
2446877.524	0.145	0.036	0.025
2446895.869	0.185	0.039	0.027
2446906.799	0.094	0.037	0.026
2446964.757	0.192	0.031	0.022
2446970.757	0.132	0.024	0.017
2446971.696	0.332	0.035	0.024
2447029.773	0.242	0.043	0.030
2447039.628	0.196	0.029	0.021
2447042.641	0.123	0.284	0.201
2447053.688	0.261	0.021	0.015
2447067.613	0.287	0.015	0.010
2447073.623	0.282	0.012	0.008
2447082.609	0.284	0.014	0.010
2447083.597	0.276	0.015	0.011
2447087.562	0.278	0.018	0.012

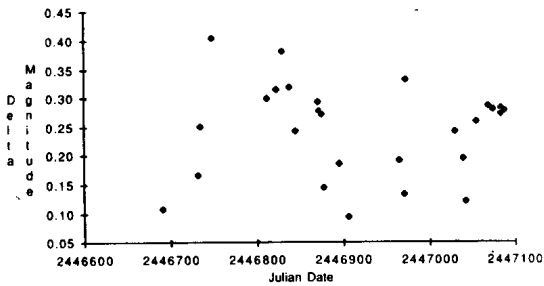
Figure 4.  $\Delta(B-V)$  magnitudes of  $\rho$  Cas by Nesbella and Gainer

Table V.  $\Delta V$  magnitudes of  $\rho$  Cas by Milton

HJD	$\Delta V$	$\sigma$	error	#
2446772.692	-1.126	0.005	0.003	3
2446792.792	-1.243	0.028	0.016	3
2446803.680	-1.247	0.004	0.002	3
2446811.637	-1.238	0.009	0.005	3
2446832.669	-1.263	0.013	0.008	3
2446845.681	-1.256	0.012	0.007	3
2446851.664	-1.253	0.010	0.006	3
2446987.880	-1.046	0.008	0.004	3
2447001.810	-1.044	0.007	0.004	3
2447015.735	-1.074	0.007	0.004	3
2447030.879	-1.102	0.004	0.002	3
2447037.782	-1.097	0.011	0.006	3
2447071.695	-1.138	0.007	0.004	3
2447085.689	-1.152	0.022	0.013	3
2447094.649	-1.148	0.004	0.002	3
2447102.690	-1.157	0.003	0.002	3
2447125.627	-1.118	0.002	0.001	3

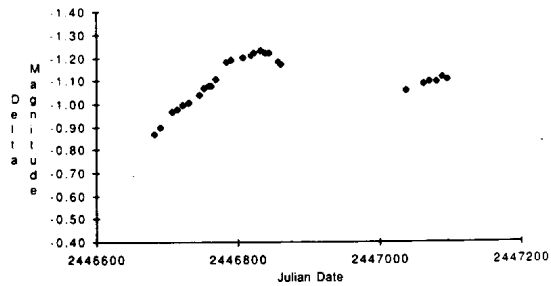
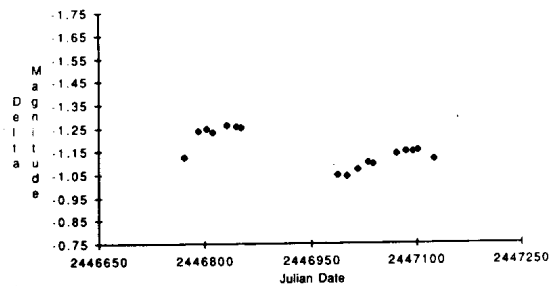
Figure 5.  $\Delta V$  magnitudes of  $\rho$  Cas by MiltonFigure 6.  $\Delta V$  magnitudes of  $\rho$  Cas by Pray

Table VI.  $\Delta V$  magnitudes of  $\rho$  Cas by Pray

JD	$\Delta V$	error	JD	$\Delta V$	error
2446683.5	-0.87	0.006	2446820.5	-1.21	0.006
2446691.5	-0.90	0.006	2446824.5	-1.22	0.006
2446709.5	-0.97	0.006	2446834.61	-1.23	0.006
2446715.5	-0.98	0.006	2446841.53	-1.22	0.006
2446723.5	-1.00	0.006	2446846.51	-1.22	0.006
2446732.5	-1.01	0.006	2446859.52	-1.18	0.006
2446747.5	-1.04	0.006	2446862.53	-1.17	0.006
2446754.5	-1.07	0.006	2447040.558	-1.06	0.002
2446760.5	-1.08	0.006	2447065.535	-1.09	0.002
2446764.5	-1.08	0.006	2447074.493	-1.10	0.002
2446770.5	-1.11	0.006	2447083.493	-1.10	0.002
2446786.5	-1.18	0.006	2447091.536	-1.12	0.002
2446792.5	-1.19	0.006	2447098.53	-1.11	0.002
2446809.5	-1.20	0.006			

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