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A NEW ECLIPSING BINARY STAR NEAR THE BL LAC OBJECT 1ES 1959+650

LEE, HYUN JU[1]; LEE, MYUNG GYOON[1]; KIM, SEUNG-LEE[2]

[1]Department of Astronomy, SEES, Seoul National University, Seoul, 151-742, Korea, email: hyun@astro.snu.ac.kr, mglee@astrog.snu.ac.kr

[2]Korea Astronomy Observatory, Taejon, 305-348, Korea, email: slkim@hanul.issa.re.kr

During our observational survey to investigate optical micro-variations of BL Lac type objects and quasars, we have discovered serendipitously a new variable star near the BL Lac object 1ES 1959+650 ($RA_{2000} = 19^h59^m59^s.85$, $DEC_{2000} = 65°08'54''.7$). This newly discovered variable star was catalogued as one of comparison stars for 1ES 1959+650 (♯5, $V = 14^m.54$, $V-R = 0^m.54$; Villata et al. 1998), and it is located at $RA_{2000} = 19^h59^m44^s.84$, $DEC_{2000} = 65°10'7''.4$. A finding chart for the new variable star is shown in Figure 1. The star numbers come from Villata et al. (1998).

We have obtained VR CCD photometry of this star using a 61cm optical telescope and PM512 CCD camera at the Sobaeksan Optical Astronomy Observatory (SOAO) in Korea for three nights (October 5th, November 5th and 6th, 1999). The field of view of the CCD image is $4'.3 \times 4'.3$ and its pixel scale is $0''.5$/pixel. CCD images were pre-processed with the IRAF/CCDRED package. We have performed simple aperture photometry to get instrumental magnitudes with $5''$ aperture radius using the IRAF/DAOPHOT package.

Figure 2 displays magnitude differences between the variable star and other two comparison stars (C1 = ♯2 and C2 = ♯4), and Table 1 lists differential magnitudes between the variable star and C1 star ($V = 12^m.86$, $V-R = 0^m.33$). It is obviously found that the brightness of the variable star changes by about 0.4 mag during the observations. Figure 3 illustrates a phase diagram for the variable star. The light curves of this variable star are similar to that of a W UMa type eclipsing binary (Hoffmeister et al. 1985) so that this variable star is classified as a W UMa type eclipsing binary. The period of the variable star is estimated to be about 0.2644 day (the epoch at primary minimum is HJD 2451457.04). Detailed analysis for this new eclipsing binary star will be given elsewhere.

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References:

Hoffmeister, C., Richter, G., Wenzel, W., 1985, in *Variable Stars*, p. 202
Villata, M., Raiteri, C.M., Lanteri, L., Sobrito, G., Cavallone, M., 1998, A&AS, **130**, 305

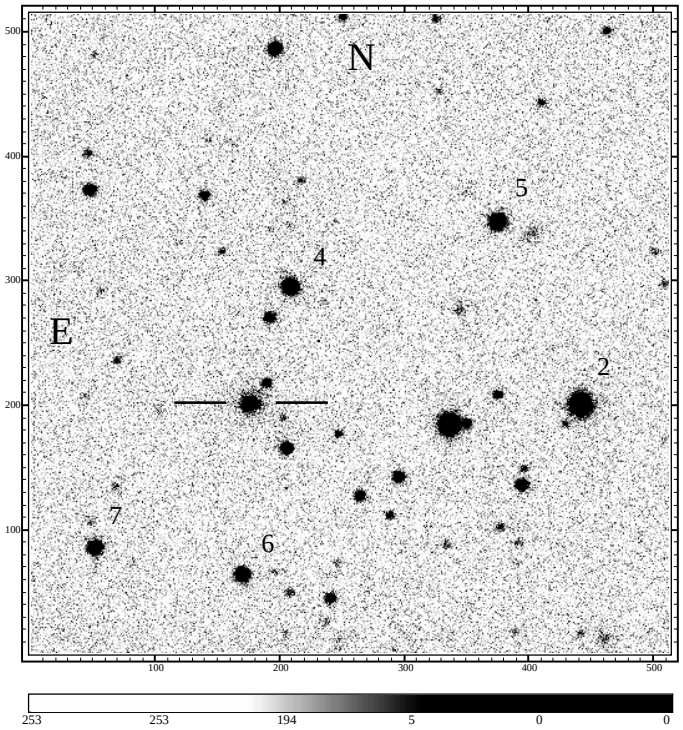

Figure 1. A greyscale map of the CCD image of the observed field (4′.3 × 4′.3) near the BL Lac object 1ES 1959+650 marked by the bars. The star numbers come from Villata *et al.* (1998). A new variable star discovered in this study is ♯5. We used ♯2 as a comparison star (C1) and ♯4 as a check star (C2).

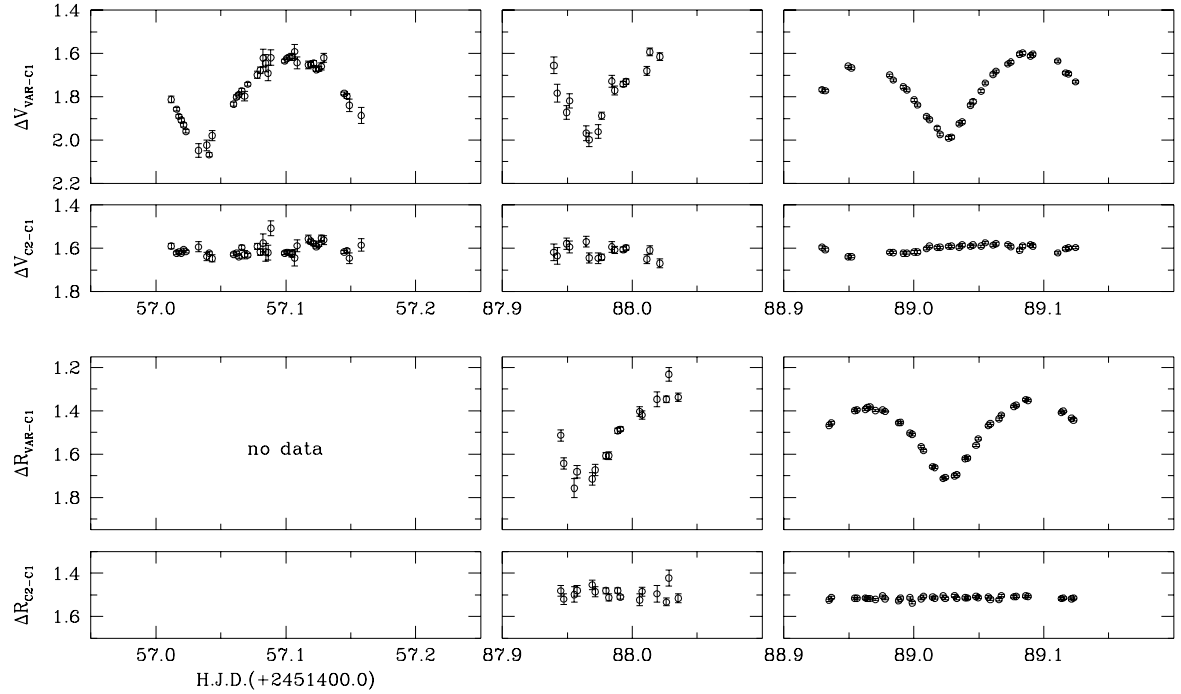

Figure 2. Light variations (V and R bands) of the new variable star with respect to the comparison star C1. Magnitude differences between C1 and C2 are also plotted for comparison in the lower panel.

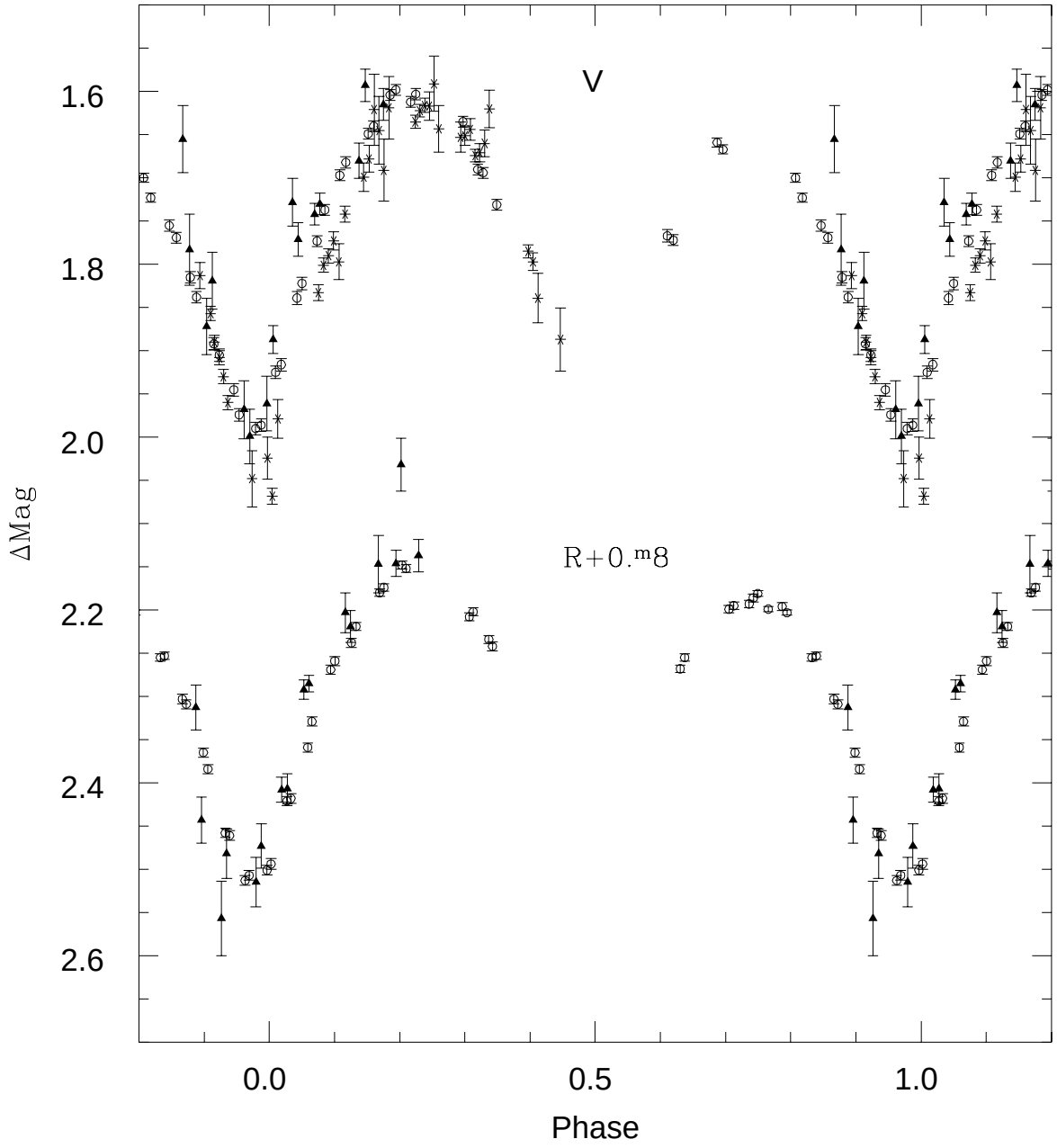

Figure 3. Phase diagram of the new eclipsing binary star. R magnitudes of the variable star were arbitrarily increased by +0.8 mag. Asterisks, filled triangles, and open circles represent, respectively, the data for October 5th, November 5th and 6th.

Table 1: Differential V and R magnitudes of the new eclipsing binary with respect to the comparison star C1

HJD 2451400 +	ΔV	HJD 2451400 +	ΔV	HJD 2451400 +	ΔV	HJD 2451400 +	ΔV
57.0118	1.813	57.0992	1.635	87.9668	1.999	89.0179	1.945
57.0161	1.857	57.1011	1.622	87.9738	1.961	89.0201	1.974
57.0177	1.890	57.1030	1.616	87.9763	1.887	89.0269	1.990
57.0197	1.908	57.1049	1.617	87.9843	1.728	89.0291	1.986
57.0214	1.930	57.1068	1.591	87.9865	1.771	89.0349	1.925
57.0232	1.960	57.1088	1.643	87.9932	1.742	89.0372	1.916
57.0330	2.048	57.1176	1.653	87.9954	1.730	89.0436	1.839
57.0392	2.024	57.1194	1.651	88.0112	1.680	89.0457	1.822
57.0411	2.068	57.1215	1.644	88.0137	1.593	89.0518	1.773
57.0435	1.979	57.1235	1.674	88.0211	1.615	89.0549	1.737
57.0599	1.833	57.1254	1.671	88.9294	1.767	89.0610	1.697
57.0620	1.801	57.1273	1.660	88.9319	1.772	89.0634	1.682
57.0640	1.790	57.1293	1.620	88.9496	1.659	89.0725	1.649
57.0660	1.773	57.1450	1.785	88.9520	1.667	89.0747	1.640
57.0682	1.797	57.1470	1.797	88.9814	1.700	89.0814	1.604
57.0707	1.742	57.1489	1.839	88.9843	1.723	89.0837	1.598
57.0782	1.699	57.1581	1.887	88.9918	1.755	89.0897	1.612
57.0804	1.678	87.9397	1.655	88.9946	1.769	89.0918	1.603
57.0825	1.621	87.9424	1.783	89.0004	1.815	89.1110	1.635
57.0845	1.645	87.9493	1.872	89.0028	1.838	89.1169	1.690
57.0864	1.691	87.9517	1.819	89.0099	1.892	89.1191	1.694
57.0885	1.619	87.9645	1.968	89.0121	1.905	89.1246	1.731

HJD 2451400 +	ΔR	HJD 2451400 +	ΔR	HJD 2451400 +	ΔR	HJD 2451400 +	ΔR
87.9451	1.513	88.0282	1.232	88.9971	1.503	89.0573	1.469
87.9473	1.643	88.0353	1.337	88.9987	1.509	89.0590	1.459
87.9553	1.757	88.9347	1.468	89.0056	1.565	89.0657	1.438
87.9575	1.682	88.9365	1.455	89.0074	1.584	89.0675	1.419
87.9694	1.715	88.9545	1.399	89.0145	1.658	89.0771	1.380
87.9716	1.673	88.9564	1.395	89.0162	1.661	89.0789	1.374
87.9797	1.608	88.9626	1.393	89.0226	1.713	89.0862	1.348
87.9821	1.607	88.9644	1.386	89.0242	1.707	89.0879	1.352
87.9888	1.492	88.9662	1.381	89.0315	1.701	89.1135	1.408
87.9908	1.485	88.9705	1.399	89.0331	1.694	89.1151	1.402
88.0056	1.403	88.9761	1.396	89.0396	1.621	89.1215	1.434
88.0077	1.419	88.9780	1.403	89.0411	1.618	89.1229	1.442
88.0190	1.347	88.9882	1.455	89.0480	1.559		
88.0262	1.346	88.9899	1.453	89.0497	1.529		