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New UBV Light Curves of the Early-Type Eclipsing Binary V1331 Aql

New photoelectric UBV light curves and preliminary photometric solutions of the B-type eclipsing binary V1331 Aql (=HD 173198 = SAO 142563 = BD -01° 3553; sp=B1V, period = $1^{d}.364$, V=$7^{m}.7$ at maximum) are presented.

In the past, first photoelectric measurements of V1331 Aql were made by van Leeuwen (1975) with a five-colour Walraven photometer, but the light curves show a considerable scattering. De Freitas Pacheco et al. (1977) published UBV light curves based on a relatively small number of observations and solved it with the Russell-Merrill method and with Wood's WINK code. It is amazing that obviously no further investigations nor observations were dedicated to V1331 Aql until 1990.

Within the scope of a research program to determine absolute dimensions of OB-type eclipsing binaries we measured new photoelectric UBV light curves of V1331 Aql during 10 nights between June 15 and 29, 1990 with the single channel photometer at the ESO 0.5m telescope. An uncooled EMI 9789QB photomultiplier tube was attached. More than 500 individual measurements in each colour were achieved and are shown in Fig. 1. As a comparison star, HD 173003 (V=$7^{m}.7$, sp=B5) was used, which is similar to V1331 Aql in spectral type and magnitude; the non-variability of the comparison was checked with SAO 142571 (V=$9^{m}.8$, sp=B8). No significant variation in the intensity difference between the comparison and this star was found during the observation time.

The differential reduction of the data was made with our own computer code providing relative magnitudes (comparison - variable) and the heliocentric J.D. The transformation in the standard UBV system, which we carried out with a program by L. Kohoutek, yielded the following Johnson magnitudes for the comparison star: U = 7.773 $\pm$ 0.018, B = 8.160 $\pm$ 0.010, V = 7.699 $\pm$ 0.009.

Two primary minima and one secondary minimum of V1331 Aql were covered, what doubles the number of minima times published so far.

Table 1, Normal points for V1331 Aql. N means the number of individual measurements.

Phase	U (HD173003-V1331 Aql)	N	Phase	B (HD173003-V1331 Aql)	N	Phase	V (HD173003-V1331Aql)	N
.00318	-.04811	7	.00372	-.18700	7	.00345	-.32952	7
.00965	-.04242	13	.01020	-.18125	13	.00992	-.32123	13
.01655	-.02704	9	.01709	-.17062	9	.01682	-.31049	9
.02321	-.01395	10	.02375	-.15851	10	.02348	-.29479	10
.03181	.01691	12	.03235	-.12581	12	.03208	-.26649	12
.04565	.06506	9	.04619	-.08093	9	.04592	-.22629	9
.05980	.12074	6	.06034	-.02535	6	.06007	-.16968	6
.10693	.22640	8	.10747	.07096	8	.10720	-.07608	8
.14905	.25050	10	.14680	.09047	10	.14653	-.05361	10
.17372	.26808	12	.17160	.10973	12	.17133	-.03627	12
.19718	.27279	11	.19205	.11722	11	.19178	-.03024	11
.23045	.28697	8	.22172	.12562	8	.23180	-.01984	12
.26848	.29680	12	.26316	.13440	12	.27453	-.01473	14
.29588	.28071	12	.28999	.12566	12	.30539	-.02416	15
.31824	.28137	10	.31239	.11690	10	.33178	-.02890	12
.33987	.27353	11	.33328	.11412	11	.36282	-.04675	14
.36777	.25263	14	.36309	.09548	14	.38118	-.05596	8
.38861	.24944	8	.39195	.08714	8	.40396	-.06180	8
.41172	.23738	8	.41489	.07050	8	.42391	-.09075	9
.42823	.20254	9	.43007	.03994	9	.43874	-.12584	13
.44172	.17165	13	.44334	.00809	13	.45168	-.15794	15
.45407	.14327	15	.45546	-.02255	15	.46527	-.18588	17
.46756	.12090	17	.46898	-.04403	17	.47752	-.20579	10
.48001	.10789	10	.48192	-.06321	10	.48612	-.21717	7
.49114	.09628	7	.49855	-.07589	7	.50182	-.22225	8
.50862	.09746	8	.51638	-.06060	8	.52349	-.19866	10
.52947	.12883	10	.53532	-.02842	10	.53920	-.16946	8
.54422	.15511	8	.55016	.00575	8	.55722	-.12149	12
.56206	.19205	12	.56763	.04432	12	.57614	-.08751	12
.58065	.22161	12	.58724	.06850	12	.60689	-.05757	13
.61562	.25386	13	.62323	.09282	13	.63370	-.04515	12
.64372	.25878	12	.64271	.09678	12	.65601	-.04041	10
.69276	.27812	10	.68821	.11220	10	.71143	-.02377	13
.72628	.28733	13	.72458	.12395	13	.75039	-.01670	17
.76832	.28977	17	.76376	.12643	17	.81052	-.03262	14
.82725	.26559	14	.82367	.10870	14	.83981	-.04174	14
.84871	.24844	14	.84732	.09458	14	.86335	-.05891	15
.87418	.22823	15	.87291	.07889	15	.88652	-.07124	10
.89480	.21881	10	.89388	.06748	10	.90088	-.08103	9
.91082	.20467	9	.90985	.05402	9	.91526	-.09957	8
.92591	.16144	8	.92409	.01507	8	.92940	-.14066	7
.94470	.10074	7	.94276	-.03939	7	.94928	-.20704	9
.95987	.04404	9	.95874	-.09751	9	.96607	-.26456	10
.97510	-.00599	10	.97423	-.14646	10	.98118	-.30730	11
.98785	-.03601	11	.98738	-.17652	11	.99108	-.32200	7
.99662	-.04379	7	.99676	-.18782	8	.99736	-.32964	6

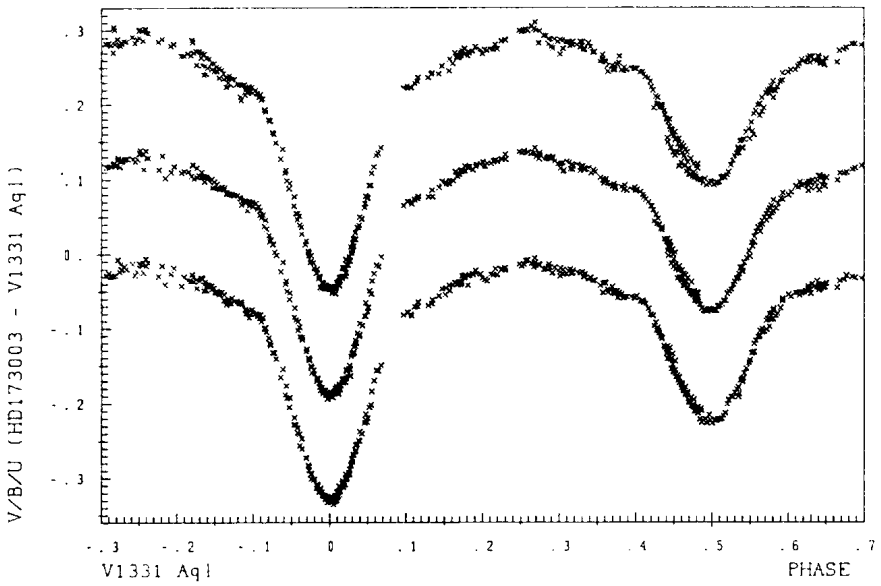

Fig. 1: UBV light curves of V1331 Aql; individual measurements (U top, B middle, V bottom) are differential magnitudes in the sense comparison (HD173003) minus V1331 Aql.

Table 2. Typical light curve solution (l_3 means third light contribution)

i(°)	q(=M_2/M_1)	T_2(K)	L_2/L_1	l_3(%)	r_1 (mean Roche radii)	r_2 (mean Roche radii)
70.259	0.632	19130	U: 0.313 B: 0.340 V: 0.363	U: 0.00 B: 1.41 V: 0.06	0.370	0.283

Fixed parameters:

T_1 = 25400 K	x_1(U) = 0.315	x_2(U) = 0.340
$g_{1,2} = A_{1,2}$ = 1.0	x_1(B) = 0.300	x_2(B) = 0.320
	x_1(V) = 0.245	x_2(V) = 0.262

Taking all these data into account we calculated a new period giving the improved ephemeris:

$$\text{Pri.Min.} = \text{hel.J.D. } 2442610.0581 + 1^{d}.3641953\ E \pm 1$$

Our 1990 light curves of V1331 Aql were solved using the Wilson-Devinney approach combined with the Simplex parameter optimization procedure (c.f. Kallrath and Linnell, 1987), which is, according to our experiences, superior to the conventional differential corrections method, especially with respect to the convergence behaviour. As input data we used 46 normal points in each colour, formed from 6 to 17 individual measurements each. These normal points are listed in Table 1.

We obtained convergent solutions for several values of q ($=M_2/M_1$) ranging from about 0.6 to 0.8 with nearly equal fit quality. In all cases the system configuration appears to be detached. As the luminosity ratio L_1/L_2 is always about 0.3 and the temperature of the secondary turns out to be around 19000 K (assuming 25400 K for the primary), the most probable model of V1331 Aql is a detached system with both components not too far from ZAMS. Hence, the spectral type of the secondary should be B2.8, and masses of the primary and secondary amount to 13 and 8 $M_\odot$, respectively. Then the mass ratio should be about 0.6, a value which is very close to the one we achieved in several light curve solutions (Lorenz et al., 1991). One typical solution is given in Table 2.

The final decision about the mass ratio must be delayed until an independent spectroscopic determination will be available. A radial velocity curve of V1331 Aql will be measured by the authors in July 1991 at the ESO 1.52m spectroscopic telescope.

REINALD LORENZ
HORST DRECHSEL
Dr. Remeis-Sternwarte
Sternwartstr. 7
D-8600 Bamberg, Germany

PAVEL MAYER
Dept. of Astronomy and Astrophysics
Charles University Prague
Svedska 8
CS-150 00 Praha 5 CSFR

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