A MAGYAR
TUDOMÁNYOS AKADÉMIA
CSILLAGVIZSGÁLÓ
INTÉZETÉNEK
KÖZLEMÉNYEI

MITTEILUNGEN
DER
STERNWARTE
DER UNGARISCHEN AKADEMIE
DER WISSENSCHAFTEN

BUDAPEST-SZABADSÁGHEGY

Nr. 64.

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PHOTOELECTRIC OBSERVATIONS OF AN SERPENTIS

BUDAPEST, 1974

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SUMMARY

Three-colour photoelectric photometry of the RRab star AN Serpentis is presented.The period changes of the star is investigated.No light curve variation or non-repetitive behaviour were noted during the time interval covered by our observations.

INTRODUCTION

The light variation of AN Serpentis = 45.1935 was discovered by HOFFMEISTER (1935) and its type and period were first determined by SOLOVIEV (1935). Since the time of its discovery several observers have investigated the variable visually and photographically (SOLOVIEV 1936a, b, 1940a, b; PRAGER 1941; van SCHEWICK 1942; GAPOSCHKIN 1952; PAYNE-GAPOSCHKIN 1954; ALANIJA 1954; BATYREV 1957, 1964; TSESSEVICH 1966) and photoelectrically (SPINRAD 1959, 1961; FITCH et al. 1966; STURCH 1966; SZEIDL 1968; BASU 1968). JOY (1950) measured the radial velocity of the star and found a value of -60 km/sec for its normal radial velocity.

From his visual observations BATYREV (1957) came to the conclusion that the star had Blazhko-effect with a period of 22.94 days. His result was, however, uncertain because of the large scattering of the visual observations. Furthermore, it also seemed curious that an RRab star with high metal abundance like AN Serpentis (Δs=0, PRESTON 1959) had light curve variation. As can be seen from Table 1 the RR Lyrae stars with Blazhko-effect generally have a rather low metal abundance.(SW And is the only exception which is a very strangely behaving RRab star with temporary Blazhko-effect.) In order to disentangle this problem and to investigate the light curve variation suspected by BATYREV we commenced observing AN Serpentis in 1967.Since that time we have collected a large number of photoelectric observa-

Table 1

RR Lyrae stars with Blazhko-effect in case the secondary period and Δs are known

Star	Type	P_o	P_B	Δs
TV Boo	c	$0^d.313$	$33^d.5$	8
RS Boo	ab	0.377	537	2
RU Psc	c	0.390	28.8	7
RR Gem	ab	0.397	37	3
SW And	ab	0.442	36.8	0
RW Dra	ab	0.443	41.7	3
RV Cap	ab	0.448	225.5	6
XZ Cyg	ab	0.467	57.3	6.
RV UMa	ab	0.468	91	8
AR Her	ab	0.470	31.5	6
XZ Dra	ab	0.476	78	3
RZ Lyr	ab	0.511	116.7	9
SZ Hya	ab	0.537	25.8	6:
UV Oct	ab	0.543	80	9
TT Cnc	ab	0.563	89	7
RR Lyr	ab	0.567	40.8	6
AR Ser	ab	0.575	105	8:
DL Her	ab	0.592	33.6	6:
AT And	ab	0.617	82.7	3
Z CVn	ab	0.654	22.7	8:

tions in U, B and V which contradict BATYREV's result. AN Serpentis has not shown Blazhko-effect during the time interval of our observations at least.

OBSERVATIONS

Our photoelectric observations were made at both the Konkoly Observatory and the Catania Observatory.

1. At the Konkoly Observatory a total of 396 observations in yellow light, 390 observations in blue light and 193 observations in ultraviolet light were obtained during 17 nights in the years 1967, 1968 and 1971. These observations were made with the photoelectric photometer attached to the 24" reflector of the Konkoly Observatory. The photometer employed an unrefrigerated EMI 9502 B photomultiplier and the following Schott filters: 2mm UG 1 for ultraviolet light; 1 mm BG 12 plus 2 mm GG 13 for blue light and 2 mm GG 11 for yellow light.

A nearby comparison star was observed with AN Serpentis, and 3 nights this comparison star, (BD+13°3025 (9.5), was tied to the Johnson and Morgan UBV system by observations of standard stars. The results for BD+13°3025 are as follows:

$$V = 10.66 \quad B - V = +0.63 \quad U - B = +0.17$$

The U - B, B - V colours of the comparison star fit well the standard U - B, B - V relation for main sequence stars. According to the Sp, B - V relation the star is of spectral type G2V.

Very likely STURCH (1966) and BASU (1968) used the same comparison star since the photometric data of their comparison star agree very well with the data given above. They give the following photometric values for their comparison star:

	STURCH		BASU
V =	10.682	and	10.670
B - V =	+0.637	and	+0.625
U - B =	+0.187		

All the observations of the variable obtained at the Konkoly Observatory are reduced to the time of observations in yellow. Corrections for differential extinction were usually made with extinction coefficients determined for the particular night from the comparison star. On a few occasion a mean extinction coefficient was adopted. Observations of standard stars were used to transform the differential magnitudes and colours in instrumental system to the UBV system. These tie-in observations were made on several good and uniform nights and indicated that

$$\Delta V = \Delta y + \varepsilon\Delta(B - V)$$
$$\Delta(B - V) = \mu\Delta(b - y)$$
$$\Delta(U - B) = \psi\Delta(u - b)$$

where the small letters refer to instrumental quantities reduced to no atmosphere, and ε, μ and ψ are the scale factors.The scale coefficients derived on different nights of tie-in observations showed some small variations which probably resulted from instrumental and temperature effects, uncertain extinction terms and observational errors.

In Table 2 the observations of AN Serpentis on UBV system obtained at the Konkoly Observatory are listed.The magnitude differences are given as variable minus comparison (BD+13°3025).

2. At the Catania Observatory the observations were taken with the 61 cm Cassegrain reflector equipped with a standard three-colour photometer containing an unrefrigerated EMI 6256 photomultiplier tube.

In 1970 during two nights 97 observations of AN Serpentis were obtained, 40 in yellow, 40 in blue and 17 in ultraviolet light. As comparison star we used BD+13°3026 (9.5). According to our tie-in observations its brightness and colours are as follows:

V = 10.51 B - V = +0.94 U - B = +0.64

Table 2

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
39527.6413	.8687	+.679	-.067	
.6461	.8779	.652	.079	
.6475	.8805	.633	.092	
.6510	.8872	.632	.148	
.6524	.8899	.624	.155	
.6566	.8980	.571	.174	
.6580	.9006	.542	.193	
.6607	.9058	.475	.262	
.6621	.9085	.453	.232	
.6642	.9125	.409	.253	
.6656	.9152	.374	.246	
.6677	.9192	.351	.289	
.6691	.9219	.324	.253	
.6711	.9257	.246	.251	
.6725	.9284	.208	.245	
.6746	.9324	.173	.271	
.6760	.9351	.140	.282	
.6781	.9391	.110	.316	
.6795	.9419	.106	.320	
.6816	.9459	.095	.332	
.6829	.9483	.077	.318	
.6850	.9524	.058	.383	
.6864	.9550	+.028	.371	
.6885	.9591	-.036	.373	
.6899	.9618	.055	.377	
.6920	.9658	.091	.376	
.6934	.9685	.144	.338	
.6954	.9723	.163	.366	
.6968	.9750	.168	.401	
.6989	.9790	.186	4414	
.7003	.9817	-.219	-.395	
39537.6230	.9880	-.212	-.477	
.6244	.9907	.213	.497	
.6272	.9961	.247	.439	
.6286	.9987	.270	.437	
.6314	.0041	.239	.478	
.6356	.0122	.221	.465	
.6370	.0148	.259	.442	
.6397	.0200	.227	.433	
.6411	.0227	-.214	-.439	
39538.6095	.8776	+.645	-.098	-.052
.6116	.8816	.626	.110	.078
.6158	.8897	.618	.220	.017
.6179	.8937	.606	.253	.029
.6221	.9017	.554	.273	-.015
.6242	.9058	.481	.257	+.005
.6283	.9136	.397	.223	-.090
.6304	.9176	.358	.277	.130
.6345	.9255	.266	.290	.159
.6366	.9295	+.221	-.314	-.135
39538.6408	.9376	+.168	-.366	-.093
.6429	.9416	.143	.366	.081
.6471	.9496	.110	.367	.091
.6492	.9536	+.079	.375	-.039
.6533	.9615	-.003	.450	+.009
.6554	.9655	.068	.429	-.012
.6595	.9734	.163	.409	+.018
.6616	.9774	.192	.400	+.018
.6658	.9854	.223	.450	-.015
.6679	.9895	.239	.442	.061
.6721	.9975	.263	.459	.047
.6742	.0015	.273	.443	.038
.6783	.0094	.277	.400	.040
.6804	.0134	.261	.440	.001
.6845	.0213	.233	.470	.014
.6866	.0253	.234	.438	-.022
.6908	.0333	-.228	-.410	
39547.5203	.9457	+.107	-.342	
.5217	.9484	.059	.307	
.5245	.9538	+.003	.310	
.5286	.9616	-.031	.396	
.5300	.9643	.046	.447	
.5342	.9723	.095	.476	
.5369	.9775	.131	.470	
.5384	.9804	.154	.495	
.5412	.9858	.202	.479	
.5426	.9884	.231	.458	
.5453	.9936	.238	.479	
.5467	.9963	.243	.472	
.5495	.0016	.236	.483	
.5509	.0043	.236	.472	
.5536	.0095	.232	.476	
.5550	.0122	.239	.456	
.5578	.0175	.235	.418	
.5592	.0202	-.222	-.407	
39560.5605	.9235	+.301	-.260	
.5723	.9461	.080	.309	
.5737	.9487	+.047	.307	
.5946	.9888	-.246	.421	
.6015	.0020	.215	.476	
.6029	.0047	.246	.453	
.6057	.0100	.245	.436	
.6071	.0127	-.229	-.444	
39562.5232	.6829	+.643	-.083	-.061
.5253	.6869	.645	.083	.073
.5295	.6950	.635	.074	.049
.5316	.6990	.652	.046	.087
.5357	.7068	.638	.018	.081
.5378	.7109	+.644	-.022	-.013

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)	J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
39562.5420	.7189	+.664	-.021	-.044	39611.4916	.4790	+.529	-.170	+.011
.5441	.7229	.667	.027	-.026	.4958	.4870	.519	.131	-.032
.5482	.7308	.669	.072	+.001	.4999	.4949	.523	.131	-.060
.5503	.7348	.667	.063	-.051	.5020	.4989	.525	.161	.000
.5545	.7428	.698	.094	.040	.5062	.5070	.527	.161	+.013
.5566	.7469	.707	.085	.011	.5083	.5110	.512	.142	-.011
.5607	.7547	.708	.094	.031	.5134	.5207	.511	.122	-.028
.5628	.7587	.692	.081	.003	.5249	.5428	.518	.086	
.5670	.7668	.704	.065	.015	.5305	.5535	.530	.111	+.003
.5732	.7787	.699	.037	.019	.5384	.5686	.509	.086	-.005
.5753	.7827	.708	.076	.012	.5437	.5788	.515	.066	+.016
.5795	.7907	.694	.048	-.008	.5458	.5828	.519	.071	-.022
.5816	.7948	.711	.067	.000	.5499	.5907	.531	.079	.025
.5857	.8026	.723	.059	-.007	.5520	.5947	.543	.094	.037
.5878	.8066	.708	.037	.015	.5562	.6027	.559	.105	.038
.5920	.8147	.710	.033	.007	.5583	.6067	.572	.096	-.044
.5941	.8187	.713	.031	.023	.5624	.6146	.602	.109	
.5982	.8266	.715	.046	.020	.5645	.6186	.569	.093	
.6003	.8306	.719	.057	-.039	.5687	.6267	.600	.102	
.6045	.8386	.722	.057	+.007	.5708	.6307	.610	.088	
.6066	.8426	.698	.021	-.054	.5749	.6385	.595	.091	-.009
.6107	.8505	.712	.040	.058	.5770	.6426	.601	.077	.056
.6128	.8545	.721	.040	.074	.5812	.6506	.603	.079	.014
.6177	.8639	.705	.033	.022	.5833	.6546	.621	.108	.020
.6198	.8679	.684	.035	.030	.5874	.6625	.595	.073	.020
.6281	.8838	+.646	-.142	-.034	.5895	.6665	+.610	-.064	-.059
39570.5390	.0367	-.178	-.479	+.011	39617.4375	.8680	+.724	-.087	
.5411	.0407	.175	.471	-.007	.4416	.8759	.662	.071	
.5464	.0509	.152	.453	.018	.4437	.8799	.646	.076	-.085
.5515	.0606	.134	.428	.038	.4479	.8879	.638	.179	-.040
.5536	.0647	.121	.439	.044	.4499	.8918	.620	.146	
.5578	.0727	.118	.397	.071	.4541	.8998	.539	.163	-.003
.5599	.0767	-.100	-.404	-.050	.4562	.9038	.518	.170	-.014
					.4604	.9119	.405	.235	
39600.4766	.3804	+.405	-.143	-.077	.4625	.9159	.353	.229	+.008
.4787	.3844	.407	.182	.035	.4666	.9238	.292	.314	-.074
.4829	.3925	.430	.189	.040	.4687	.9287	.238	.259	.099
.4850	.3965	.439	.171	.069	.4729	.9358	.161	.288	.124
.4891	.4043	.447	.184	.044	.4750	.9398	.120	.304	.174
.4912	.4084	.444	.190	.051	.4791	.9477	.074	.287	.166
.4954	.4164	.442	.183	-.026	.4812	.9517	.056	.320	.146
.4975	.4204	+.463	-.204	+.036	.4854	.9598	+.008	.379	.073
					.4874	.9636	-.022	.399	.071
39611.4385	.3773	+.381	-.140	-.084	.4916	.9716	.121	.390	.103
.4687	.4351	.479	.131	.076	.4937	.9757	.162	.383	.115
.4708	.4391	.466	.121	.037	.4979	.9837	.217	.431	.098
.4759	.4489	.480	.125	.028	.4999	.9875	.234	.439	.079
.4812	.4591	.508	.163	.032	.5041	.9956	.236	.448	.091
.4833	.4631	.515	.161	.030	.5062	.9996	.233	.444	.103
.4874	.4709	+.534	-.200	-.003	.5104	.0076	-.240	-.422	-.114

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	Δ(B−V)	Δ(U−B)	J.D. 2400000+	Phase	ΔV	Δ(B−V)	Δ(U−B)
39617.5124	.0115	−.235	−.437	−.084	39967.4402	.2776	+.251	−.271	
.5166	.0195	.220	.429	.068	.4423	.2817	.281	.265	
.5187	.0235	.215	.447	.043	.4465	.2897	.279	.226	−.035
.5229	.0316	.190	.462	.037	.4486	.2937	.265	−.182	−.028
.5249	.0354	.185	.445	.033	.4527	.3016	.280		
.5291	.0435	.189	.416	.062	.4548	.3056	.310	−.219	−.015
.5312	.0475	.169	.431	.066	.4590	.3137	.318	.249	−.009
.5354	.0555	.155	.411	.112	.4611	.3177	.326	.246	+.008
.5374	.0594	.157	.390	.084	.4652	.3255	.336	.262	
.5416	.0674	.130	.388	.087	.4673	.3295	.347	.251	−.031
.5437	.0714	.119	.366	.115	.4715	.3376	.373	.227	.054
.5479	.0795	.104	.373	.021	.4757	.3456	.419	.223	.059
.5499	.0833	.096	.368	.036	.4819	.3575	.417	.196	.017
.5541	.0914	.091	.339	.053	.4861	.3656	.401	.190	.046
.5562	.0954	.067	.342	.033	.4902	.3734	.387	.166	.031
.5604	.1034	.026	.370	−.018	.4923	.3774	.399	.188	.042
.5624	.1073	.015	.393	+.018	.4965	.3855	.433	.188	.061
.5666	.1153	−.007	.381	+.019	.4986	.3895	.444	.207	.002
.5687	.1193	+.006	.371	−.015	.5027	.3974	.425	.160	.029
.5729	.1274	.005	.312	−.027	.5048	.4014	.420	.145	−.020
.5749	.1312	.015	.331	+.009	.5090	.4094	.446	.179	
.5791	.1392	.037	.339	+.011	.5111	.4134	.461	.156	+.008
.5812	.1433	+.055	−.327	−.025	.5152	.4213	.470	.184	+.004
					.5173	.4253	.449	.151	−.032
39673.4461	.1492	+.049	−.300	−.071	.5236	.4374	.466	.110	−.043
.4482	.1532	.063	.305	.062	.5277	.4452	.490	.157	+.010
.4523	.1611	.069	.314	−.012	.5298	.4493	.484	.142	−.012
.4544	.1651	.083	.335	+.002	.5340	.4573	.483	.132	.038
.4593	.1745	.073	.312	−.006	.5361	.4613	.479	.104	.082
.4614	.1785	.075	.266	.040	.5402	.4692	.479	.127	.047
.4655	.1864	.122	.290	.046	.5423	.4732	.495	.146	.042
.4676	.1904	.142	.293	.052	.5465	.4813	.505	.142	.038
.4725	.1998	.165	.284	−.053	.5486	.4853	.507	.132	.015
.4787	.2116	.185	.331		.5527	.4931	.536	.179	.026
.4808	.2157	.171	.317		.5548	.4972	.510	.131	−.027
.4850	.2237	.180	.325		.5590	.5052	.478	.119	+.027
.4863	.2262	.196	−.320		.5611	.5092	.495	.141	+.024
.4891	.2316	.199			.5652	.5171	.492	.116	−.021
.4905	.2343	.203	−.310		.5673	.5211	.504	.128	+.002
.4933	.2396	.234	.283		.5715	.5291	.530	.160	+.011
.4947	.2423	.229	.297		.5736	.5332	.508	.151	−.009
.4989	.2503	.241	.296		.5777	.5410	.501	.110	.015
.5016	.2555	.220	−.246		.5798	.5450	.514	.109	.040
.5030	.2582	.223			.5840	.5531	.527	.132	.038
.5120	.2754	.227	−.235		.5861	.5571	+.523	−.128	−.023
.5148	.2808	.271	.233						
.5162	.2835	.275	.231		39996.4787	.8992	+.551	−.275	
.5190	.2888	.260	.239		.4801	.9019	.521	.277	
.5204	.2915	.275	.215		.4829	.9072	.494	.287	
.5231	.2967	.271	.214		.4843	.9099	.476	.282	
.5245	.2994	+.257	−.210		.4870	.9151	+.406	−.284	

Table 2 (continued)

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
39996.4884	.9178	+.353	-.323	
.4912	.9231	.294	.299	
.4926	.9258	.258	.270	
.4982	.9365	.162	.345	
.4996	.9392	.109	.341	
.5023	.9444	.066	.315	
.5037	.9471	.050	.294	
.5065	.9524	.042	.299	
.5079	.9551	+.026	.310	
.5141	.9670	-.108	.353	
.5155	.9697	.121	.437	
.5183	.9750	.175	.388	
.5197	.9777	.198	.426	
.5225	.9831	.228	.431	
.5239	.9858	.231	.456	
.5266	.9909	.226	.472	
.5280	.9936	.233	.485	
.5308	.9990	.221	.514	
.5322	.0017	.223	.512	
.5357	.0084	.224	.488	
.5371	.0110	.226	.469	
.5398	.0162	.247	.451	
.5412	.0189	.230	.440	
.5440	.0243	.234	.426	
.5454	.0269	.226	.431	
.5482	.0323	.206	.463	
.5496	.0350	.194	.467	
.5523	.0402	-.202	-.451	
41095.5059	.0213	-.212	-.450	
.5080	.0253	.203	.453	
.5121	.0332	.200	.447	
.5142	.0372	.191	.426	
.5184	.0452	.196	.413	
.5212	.0506	.181	.398	
.5253	.0584	.152	.399	
.5274	.0625	.149	.381	
.5315	.0703	.126	.386	
.5336	.0743	-.114	-.356	
41096.4722	.8722	+.682	-.112	
.4736	.8749	.689	.122	
.4750	.8775	.690	.127	
.4764	.8802	.669	.123	
.4791	.8854	.652	.158	
.4805	.8881	.645	.201	
.4819	.8908	.620	.222	
.4833	.8934	.588	.183	
.4861	.8988	.549	.180	
.4875	.9015	.511	.189	
.4944	.9147	.383	.232	
.4958	.9174	+.366	-.235	

J.D. 2400000+	Phase	ΔV	Δ(B-V)	Δ(U-B)
41096.4972	.9201	+.341	-.237	
.5014	.9281	.270	.301	
.5028	.9308	.226	.288	
.5042	.9335	.216	.286	
.5069	.9386	.149	.319	
.5083	.9413	.125	.293	
.5097	.9440	.131	.310	
.5111	.9467	.122	.310	
.5159	.9559	.035	.294	
.5180	.9599	+.009	.308	
.5222	.9679	-.060	.346	
.5243	.9720	.076	.390	
.5284	.9798	.167	.367	
.5305	.9838	.220	.387	
.5347	.9919	.234	.427	
.5368	.9959	.223	-.440	
.5534	.0277	.236		
.5555	.0317	-.221		
41117.3824	.9244	+.285	-.233	
.3845	.9285	.204	.264	
.3970	.9524	.035	.387	
.3984	.9551	+.011	.397	
.4011	.9603	-.063	.359	
.4025	.9629	.088	.378	
.4039	.9656	.130	.392	
.4074	.9723	.146	.395	
.4088	.9750	.167	.433	
.4102	.9777	.168	.454	
.4136	.9842	.207	.422	
.4150	.9869	.219	.448	
.4164	.9896	.226	.441	
.4254	.0068	.226	.470	
.4268	.0095	.240	.472	
.4331	.0215	.243	.449	
.4345	.0242	.215	.474	
.4359	.0269	.212	.477	
.4386	.0321	-.173	-.454	
41119.4846	.9511	+.071	-.371	
.4860	.9538	.045	.364	
.4874	.9564	+.003	.329	
.4888	.9591	-.029	.356	
.4923	.9658	.094	.340	
.4937	.9685	.118	.340	
.4951	.9712	.141	.382	
.4965	.9739	.154	.383	
.5041	.9884	.192	.424	
.5055	.9911	.201	.451	
.5068	.9936	.222	-.418	
.5082	.9963	-.235		

Table 3
Observations at Catania

J.D. 2440000+	Phase	Δm	J.D. 2440000+	Phase	Δm	J.D. 2440000+	Phase	Δm
			in yellow					
707.5424	.9000	+.655	707.5897	.9906	-.148	718.5095	.9068	+.580
.5477	.9101	.565	.5949	.0005	.178	.5134	.9143	.475
.5508	.9161	.478	.5970	.0046	.183	.5195	.9260	.340
.5550	.9241	.360	.6011	.0124	.185	.5224	.9315	.275
.5569	.9277	.303	.6036	.0172	.173	.5285	.9432	.218
.5611	.9358	.233	.6078	.0252	.185	.5329	.9516	+.153
.5632	.9398	.200	.6118	.0329	.153	.5412	.9675	-.001
.5673	.9477	.173	.6150	.0390	-.113	.5530	.9901	.165
.5696	.9521	.148				.5599	.0033	.178
.5738	.9601	.078	718.4799	.8501	+.860	.5632	.0097	.170
.5761	.9645	+.048	.4874	.8645	.875	.5702	.0231	.160
.5804	.9728	-.040	.4909	.8712	.815	.5737	.0298	.148
.5824	.9766	.060	.4992	.8871	.768	.5799	.0417	-.120
.5873	.9860	-.113	.5030	.8944	+.688			
			in blue					
707.5468	.9084	-.010	707.5939	.9986	-.938	718.5084	.9047	+.048
.5490	.9126	.035	.5960	.0026	.958	.5124	.9124	-.095
.5541	.9224	.198	.6001	.0105	.923	.5186	.9242	.255
.5561	.9262	.290	.6022	.0145	.923	.5215	.9298	.353
.5600	.9337	.410	.6067	.0231	.930	.5274	.9411	.460
.5620	.9375	.443	.6089	.0273	.890	.5311	.9482	.520
.5661	.9454	.473	.6126	.0344	.868	.5403	.9658	.720
.5687	.9503	.535	.6188	.0463	-.825	.5519	.9880	.913
.5728	.9582	.608				.5588	.0012	.935
.5750	.9624	.665	718.4809	.8520	+.428	.5621	.0076	.935
.5789	.9699	.740	.4866	.8629	.373	.5690	.0208	.928
.5815	.9749	.800	.4899	.8693	.368	.5728	.0281	.920
.5859	.9833	.888	.4982	.8852	.293	.5789	.0397	-.888
.5888	.9888	-.883	.5019	.8922	+.210			
			in ultraviolet					
718.4857	.8612	-.105	718.5174	.9219	-.780	718.5574	.9986	-1.645
.4887	.8670	.123	.5204	.9277	.915	.5610	.0055	1.650
.4968	.8825	.233	.5259	.9382	1.100	.5677	.0183	1.600
.5005	.8896	.288	.5301	.9463	1.098	.5714	.0254	1.615
.5072	.9024	.433	.5377	.9608	1.248	.5777	.0374	-1.583
.5107	.9091	-.573	.5484	.9813	-1.488			

colour photometer containing an unrefrigerated EMI 6256 photomultiplier tube.

In 1970 during two nights 97 observations of AN Serpentis were obtained, 40 in yellow, 40 in blue and 17 in ultraviolet light. As comparison star we used BD+13°3026(9.5). According to our tie-in observations its brightness and colours are as follows:

$$V = 10.51 \quad B - V = +0.94 \quad U - B = +0.64$$

The individual observations in instrumental system are given in Table 3 in the sense variable minus comparison (BD+13°3026). The phases of observations obtained at both the Catania Observatory and the Konkoly Observatory have been calculated by using the formula:

$$\text{phase} = \frac{\text{J.D.} - 2439538.6734}{0.5220729}$$

LIGHT AND COLOUR CURVES

Composite light curve in V is shown in Figure 1. In order to make a more precise analysis of the light and colour curves possible 44 normal points were obtained in V and in both colours which are tabulated in Table 4. Since most of the observations were collected on

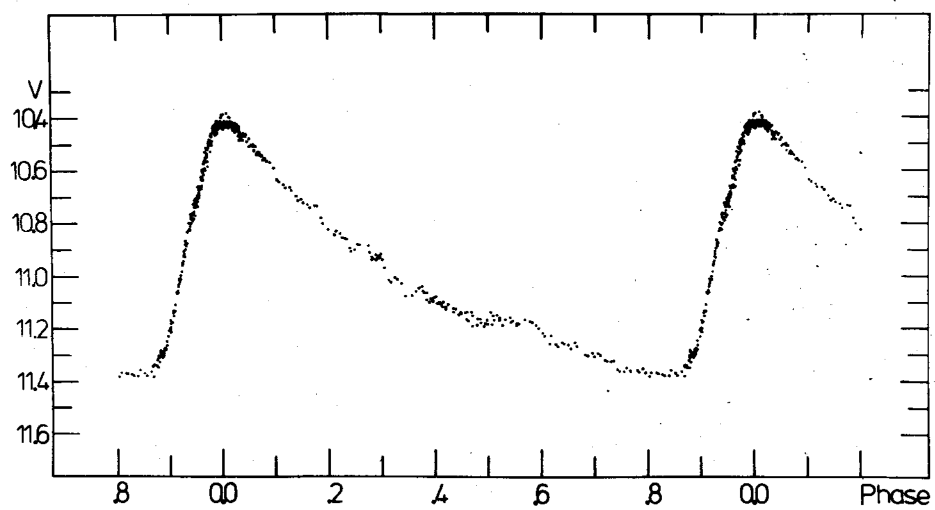

Figure 1. Light curve of AN Serpentis

the ascending branch and near the maxima of the variable, the light curve was not uniformly covered, Therefore, the normal points are not chosen at equal intervals but rather as determined by groups of yellow observations of equal number. Each normal point was formed from nine yellow observations and the colours belonging to these yellow observations. The normal points are plotted against phase in Figure 2. The light and colour curves are very regular and typical of the class of variables which AN Serpentis belongs to.

Figure 3 shows the observations at Catania Observatory plotted against phase.

Both Figure 1 and Figure 3 clearly indicate that no irregularities or non-repetitive behaviour as reported by BATYREV (1957) could

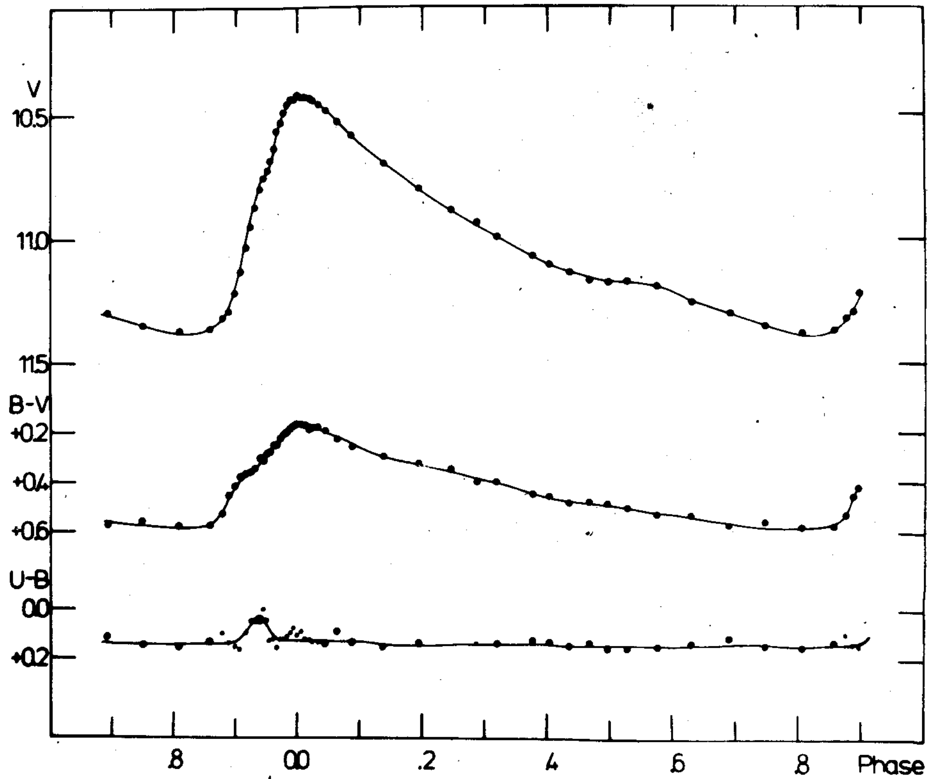

Figure 2. Normal points as function of phase

be detected during the time interval covered by our observations. Nevertheless, it is possible that the star might have had Blazhko-effect and then it disappeared. At present there is no doubt about the stable character of AN Serpentis.

The hump on the ascending branch of AN Ser is conspicuous in both Figure 2 and Figure 3. The duration of the hump fits well into the relation found by DETRE (1959) between the duration of the hump and the visual light amplitude of different RR Lyrae stars.

SPINRAD (1959) observed an unusual hump on the declining branch of the variable. BASU (1968), however, showed that the suspected hump was unreal. Our light curves also confirm BASU's result, there is no unusual hump on the declining branch of AN Serpentis in the phase region $0^{P}.20 < \phi > 0^{P}.40$

The two-colour diagram of AN Serpentis is shown in Figure 4. The dashed line represents the main sequence. The phases of AN Ser are shown as numbers on the loop, with zero phase being that of maximum in

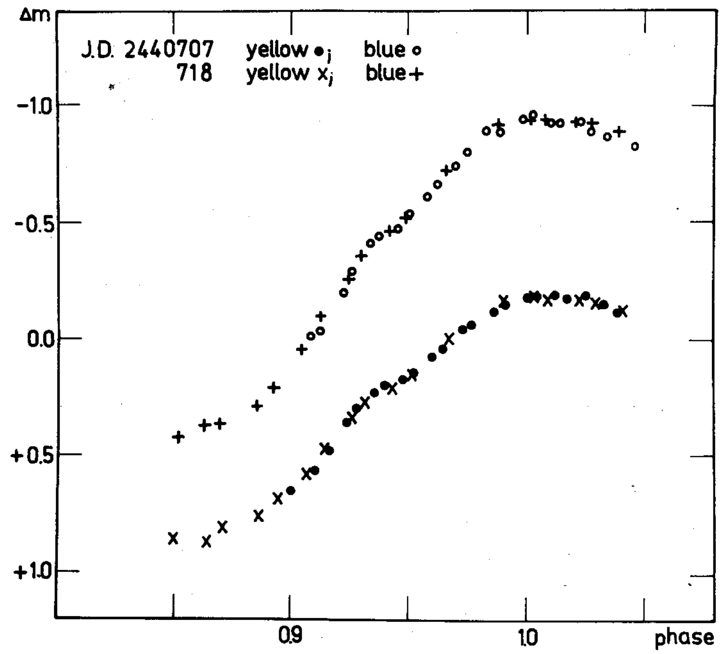

Figure 3. Observations obtained at the Catania Observatory

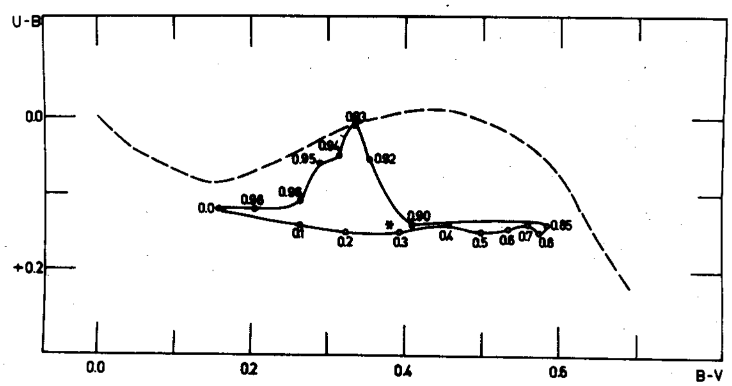

Figure 4. Two-colour diagram for AN Serpentis. Phases are shown as numbers on the loop, with zero phase being that of maximum light.

Table 4

Normal points

Phase	ΔV	n	Δ (B-V)	n	Δ (U-B)	n
$0^{p}.0054$	-0.236	9	-0.463	9	-0.077	2
.0113	.236	9	.455	9	.043	2
.0189	.232	9	.438	9	.041	2
.0245	.222	9	.448	9	.033	2
.0325	.204	9	.450	7	.035	2
.0436	.181	9	.438	9	.028	5
.0634	.138	9	.399	9	.080	6
.0870	-0.081	9	.371	9	.033	8
.1377	+0.032	9	.331	9	.017	9
.1940	.133	9	.306	9	-0.032	6
.2459	.219	9	.284	7		0
.2871	.270	9	.231	9	-0.031	2
.3196	.330	9	.236	8	.027	6
.3768	.408	9	.178	9	.044	9
.4044	.439	9	.173	9	.034	8
.4358	.472	9	.147	9	.020	9
.4683	.503	9	.149	9	.033	9
.4975	.513	9	.143	9	.011	9
.5290	.510	9	.125	9	.014	8
.5758	.528	9	.097	9	.019	9
.6315	.597	9	.094	9	.029	5
.6922	.636	9	.054	9	.054	9
.7486	.690	9	.069	9	.022	9
.8076	.711	9	.050	9	.015	9
.8585	.703	9	.055	9	.038	6
.8784	.657	9	.100	9	.072	3
.8883	.633	9	.175	9	.030	3
.8985	.557	9	.209	9	.016	3
.9075	.470	9	.251	9	.005	2
.9163	.371	9	.260	9	.071	3
.9238	.290	9	.267	9	.117	2
.9306	.211	9	.279	9	.117	2
.9388	.139	9	.326	9	.118	4
.9455	.092	9	.313	9	.166	1
.9506	.062	9	.340	9	.118	2
.9553	+0.022	9	.347	9	.039	1
.9612	-0.030	9	.377	9	.045	3
.9665	.095	9	.373	9	.012	1
.9721	.131	9	.403	9	.042	2
.9767	.172	9	.419	9	.048	2
.9831	.204	9	.429	9	.056	2
.9881	.226	9	.445	9	.070	2
.9930	.225	9	.457	9	.091	1
0.9985	-0.247	9	-0.461	8	-0.063	3

V light. The loop for the variable lies below the luminosity class V line at all phases. This depression of the loop below the main sequence has already been noted by SPINRAD (1959) who attributes the effect to absorption-line blanketing in the ultraviolet as the high galactic latitude of the variable ($b^{II} = 45^{\circ}.2$) makes any large amount of interstellar reddening very unlikely.

Table 5 summarizes the most important photometric data for AN Serpentis.

Table 5

	V	B	U	B - V	U - B
maximum	10.42	10.57	10.69	+0.15	+0.12
mean	10.97	11.35	11.49	+0.38	+0.14
minimum	11.38	11.97	12.11	+0.59	+0.14
amplitude	0.96	1.40	1.42	0.44	-

The mean values of the colour indices are $\langle B - V \rangle = +0.41$ and $\langle U - B \rangle = +0.14$, while PRESTON's quantities for the U - B excess on the rising branch: $\delta_1 = 0.13$ and $\delta_2 = 0.13$. The interval between minimum and maximum, divided by the period is $\varepsilon = 0^P.16$, while the time from hump to maximum expressed in period is $\varepsilon^* = 0^P.06$.

PERIOD CHANGES AND O - C DIAGRAM

All the maxima published and known to us are listed in Table 6. In addition to the reference where the maxima observed were published we denoted the kind of observations: vis=visual, pg=photographic, and pe=photoelectric.

The O - C values have been calculated by using the formula:

$$C = J.D.\ 2414708.9500 + 0^d.52207162 \cdot E$$

Having scrutinized our photoelectric blue and yellow light curves we have not found any measurable phase leg between them. Therefore we have not applied any corrections to the visual or photographic maxima.

For all the photoelectric observations do not exhibit any sign of light curve variation we have formed a mean value of O - C's for each year. These average O - C values are plotted against Julian Days in Figure 5. If we do not question the very uncertain observation at J.D.2426122 we can conclude from the O - C diagram that the period of AN Serpentis decreased by 0.00001 day around J.D.2428000. A slight increase of the period might take place in the last 20 years.

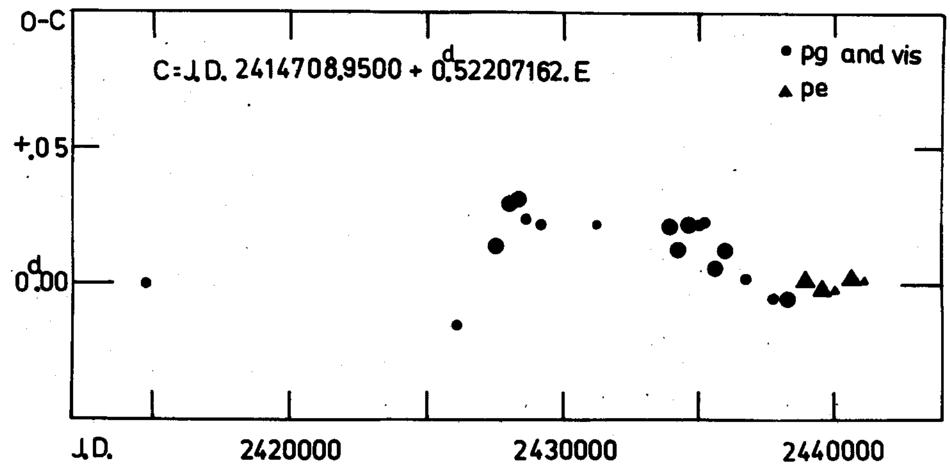

Figure 5. O - C diagram for AN Serpentis

Table 6

Year	J.D.24...	Reference		O - C	E	$\overline{O - C}$	$\overline{E}$
1899	14708.950	Payne-G. (1954)	pg	.0000	0	.0000	0
1930	26122.464	Soloviev (1936a)	"	-.0158	21862	-.0158	21862
1934	27462.673	v.Schewick (1942)	"	+.0354	24429	+.0141	24580
	463.686	"	"	+.0043	24431		(6)
	521.635	"	"	+.0033	24542		
	543.546	"	"	-.0127	24584		
	599.461	"	"	+.0406	24691		
	657.384	"	"	+.0137	24802		
1935	874.620	"	"	+.0679	25218	+.0294	25471
	931.487	"	"	+.0291	25327		(13)
	953.453	"	"	+.0681	25369		
	955.488	"	"	+.0148	25373		
	28007.193	Soloviev (1935)	v"s	+.0347	25472		
	010.311	Soloviev (1936a)	"	+.0203	25478		
	011.346	"	"	+.0111	25480		
	021.266	"	"	+.0118	25499		
	033.263	"	"	+.0011	25522		
	043.208	"	"	+.0268	25541		
	045.337	v.Schewick (1942)	pg	+.0675	25545		
	046.331	"	"	+.0173	25547		
	155.438	Soloviev (1936b)	vis	+.0114	25756		
1936	219.688	v.Schewick (1942)	pg	+.0465	25879	+.0309	26095
	245.265	Soloviev (1936a)	vis	+.0420	25928		(12)
	256.227	"	"	+.0505	25949		
	280.219	"	"	+.0172	25995		
	308.430	v.Schewick (1942)	"	+.0364	26049		
	332.444:	"	"	+.0351	26095		
	333.472	"	"	+.0189	26097		
	369.513	"	"	+.0370	26166		
	391.433	"	"	+.0300	26208		
	403.423:	"	"	+.0123	26231		

Table 6 (continued)

Year	J.D.24...	Reference		O - C	E	$\overline{O - C}$	$\overline{E}$
1936	28424.326	v.Schewick (1942)	vis	+.0325	26271		
	425.360	"	"	+.0223	26273		
1937	609.131	Soloviev (1940b)	"	+.0241	26625	+.0241	26625
1938	29156.260	Soloviev (1940a)	"	+.0221	27673	+.0221	27673
1944	31235.149	Tsessevich (1966)	"	+.0219	31655	+.0219	31655
1951	33876.303	Batyrev (1957)	"	+.0155	36714	+.0209	36750
	886.233	"	"	+.0262	36733		(7)
	887.271	"	"	+.0200	36735		
	898.235	"	"	+.0205	36756		
	899.283	"	"	+.0244	36758		
	909.202	"	"	+.0240	36777		
	910.238	"	"	+.0159	36779		
1952	34128.466	"	"	+.0180	37197	+.0131	37316
	149.344	"	"	+.0131	37237		(6)
	174.410	"	"	+.0196	37285		
	184.331	"	"	+.0213	37304		
	242.265	"	"	+.0053	37415		
	265.232	"	"	+.0012	37459		
1953	515.341	"	"	+.0379	37938	+.0214	38051
	540.403	Alanija (1954)	pg	+.0404	37986		(5)
	562.305	Batyrev (1957)	vis	+.0154	38028		
	621.288	"	"	+.0043	38141		
	632.256	"	"	+.0088	38162		
1954	986.234	"	"	+.0223	38840	+.0223	38840
1955	35248.312	"	"	+.0203	39342	+.0225	39367
	274.420	"	"	+.0247	39392		(2)
1956	606.445	Batyrev (1964)	"	+.0122	40028	+.0060	40065
	628.359	"	"	-.0008	40070		(4)
	629.397	"	"	-.0070	40072		
	639.343	"	"	+.0197	40091		
1957	928.552	"	"	+.0010	40645	+.0126	40745
	993.339	"	"	+.0511	40769		(4)
	995.373	"	"	-.0032	40773		
	36005.297	"	"	+.0015	40792		
1959	660.497	Tsessevich (1966)	pg	+.0016	42047	+.0016	42047
1962	37817.400	"	"	-.0061	44263	-.0061	44263
1963	38205.308	"	vis	+.0027	45006	-.0055	45068
	229.314	"	"	-.0066	45052		(4)
	252.281	"	"	-.0108	45096		
	264.292	"	"	-.0074	45119		
1965	845.891	Fitch et al. (1966)	pe	+.0038	46233	+.0015	46336
	846.933	"	"	+.0016	46235		(3)
	39006.6845	Basu (1968)	"	-.0008	46541		
1967	537.631:	present paper	"	-.0011	47558	-.0022	47601
	538.6745	"	"	-.0017	47560		(5)
	547.5485	"	"	-.0030	47577		
	560.601	"	"	-.0023	47602		
	617.5060	"	"	-.0031	47711		
1968	996.5310	"	"	-.0021	48437	-.0021	48437
1970	40707.5971	"	"	+.0025	49799	+.0022	49810
	718.5600	"	"	+.0019	49820		(2)
1971	41117.4220	"	"	+.0012	50584	+.0012	50584

We are indebted to Prof. L. DETRE for drawing our attention to this star and for useful discussions. One of us (S.K.) is grateful to Prof. G. GODOLI for providing opportunity to observe this star at the Catania Observatory. Our thanks are also due to Miss A. FARÁDI and Mrs. I. KÁLMÁN for preparing the manuscript.

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