Atti Accademia Nazionale dei Lincei

Classe Scienze Fisiche Matematiche Naturali

Rendiconti

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Radial velocities of Omicron Andromedae from 1961 to 1966

Atti della Accademia Nazionale dei Lincei. Classe di Scienze Fisiche, Matematiche e Naturali. Rendiconti, Serie 8, Vol. **45** (1968), n.1-2, p. 39–44.

Accademia Nazionale dei Lincei

<http://www.bdim.eu/item?id=RLINA_1968_8_45_1-2_39_0>

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Astrofisica. — *Radial velocities of Omicron Andromedae from 1961 to 1966.* Nota [(*)] di PIERO GALEOTTI e LAURA E. PASINETTI, presentata dal Socio F. ZAGAR.

RIASSUNTO. — Si riportano le misure delle velocità radiali di Omicron Andromedae per il periodo 1961–1966 durante il quale è apparsa come una normale stella B.

Nessun andamento caratteristico delle variabili ad eclisse si presenta nei nostri grafici di velocità radiali. I valori dedotti dalle prime righe dell'idrogeno variano da —20 a —50 km/sec per gli anni successivi al 1961; questa dispersione è probabilmente reale essendo molto superiore agli errori quadratici medi. Invece nel 1961, le velocità sono assai più alte a causa della presenza di intensi nuclei nelle righe di Balmer, che alterano le misure.

Le velocità degli altri elementi mostrano una dispersione maggiore essendo le righe misurabili poche e molto allargate; tali velocità risultano in certi casi molto più alte di quelle dell'idrogeno; in particolare per il silicio, sono per la maggior parte positive. Si potrebbe pertanto avanzare l'ipotesi di una stratificazione degli elementi; tuttavia essendo gli errori di queste misure alquanto elevati, tale conclusione è piuttosto incerta.

INTRODUCTION.

In two preceding papers (Pasinetti 1967, 1968) we have noticed that it is very interesting to observe the variable star Omicron Andromedae also in the period in which it appears as a normal B–type star.

Furthermore the type of variability of Omicron Andromedae has not been well ascertained: it is considered by several Authors a photometric double star showing, sometimes, a shell-spectrum; other AA., on the contrary, have not found eclipsing type variations but only variations of some hundredths of magnitude, characteristic of a shell star.

In 1961 at the Merate Observatory we began making spectrographic observations of this star, still continuing. Our results for the period 1961–1966 and 1967 are reported respectively by the two papers above mentioned, with the complete bibliography.

Radial velocity measurements have been taken by the following AA.:

– Campbell (1902) gives the results obtained by H_γ line from five plates taken in the years 1900 and 1901; the velocities range from —11 to — 20 km/sec. We believe that in such period the star must be without shell but no information is reported about the aspect of the Balmer lines; but the eventual presence of cores in the Balmer lines may influence the measurements.

– Plaskett and Pearce (1935) give a mean velocity of — 13.8 km/sec but the epochs of observation are not specified; moreover they report the

(*) Pervenuta all'Accademia il 26 agosto 1968.

Wright's opinion according to which the velocity of this star is probably variable but " the evidence is considered insufficient to establish its variability ".

– Slettebak (1954) reports the results of five observations performed in the years 1949, 1950, 1951, during the shell-period, and 1952, 1953 when the shell had just disappeared and therefore the cores must still be very strong in the Balmer lines; in view of the small number of plates and measurable lines per plate, no attempt was made to interpret the radial velocities.

Since the measurements so far performed are insufficient and the variability of the radial velocities has not been well ascertained, we have measured all the plates taken during the period 1961–1966 in which Omicron Andromedae has appeared as a normal B–type star.

Results.

The observations have been performed with the Zeiss telescope of the Merate Observatory; all the data regarding the observations and the plates used in our measurements are reported by Pasinetti 1968 in Table I not containing five spectra, which it was not possible to use in the preceding work; for these we give the following data:

Table I.

Sp. No.	Date	J. D. 2430000 +	Phase	Spectral Range
1250	1962–12 Aug.	7888.621	0.477	3500–4400 III order
1251	12 Aug.	7888.630	.482	3500–4400 III order
1506	20 Oct.	7958.397	.091	3300–4600 II order
1515	15 Nov.	7984.376	.330	3300–4600 II order
1520	16 Nov.	7985.403	.971	3300–4600 II order

We have measured all the possible lines considering that the results reported by the preceding AA. are not decisive and that it is often difficult to measure accurately the spectral lines of this star. In fact the lines are much broadened by the high rotational velocity (350 km/sec); furthermore some lines are well observable on some plates but weak or not measurable on others.

The utilised lines, besides all the visible hydrogen ones are reported in the following list in which we have marked with an asterisk those of

Petrie's list (1953); some are not contained in the spectral range considered by this A.:

He I	3819.8	He I	4921.9
He I	3867.5	He I	5875.7
He I	3871.8	Ca II	3933.7*
He I	3926.5	Ca II	4267.2*
He I	4009.3	Si II	3853.7
He I	4026.2*	Si II	3867.5
He I	4121.0*	Si II	4128.1*
He I	4143.8	Si II	4130.9*
He I	4387.9*	Mg II	4481.2*
He I	4471.5*		

We have measured also the lines of hydrogen following H_8, although they are not usually utilised in these studies. We have taken such measurements because the first lines of the Balmer series show in some years cores more or less evident which could alter the observed radial velocities; furthermore the graph of the radial velocities deduced from the last lines of the Balmer series is in good agreement with that obtained from the standard lines only. Our results are reported in Table II.

TABLE II.

Sp. No.	Phase	H before H_8	H after H_8	He I	Si II	Ca II	Mg II
				1961			
858	0.80	—19.0±2.6	—42.8±8.2	+ 3.0±10.0	+20.4	+56.9	— 16.6
859	.83	+ 9.7±7 4	—30.3 —	— 3 2±16.7	— 8.1	—35.9	+ 71.8
861	.41	— 6.7±1.3	—12.1±8.0	+34.0±23.9	+94.1	—27.9	— 22.0
862	.44	+15.5±6.8	+ 5.4 —	+ 6.9±17.6	—10.8	+11.6	+ 16.9
864	.03	+ 9.2±6.1	—21.8 —	+23.9±23.5	+65.6	— 3.8	—
865	.05	— 6.0±2.9	— —	+22.1±15.0	+33.3	+18.8	— 5.1
867	.66	+29.1 —	— —	+16.2±20.7	+50.9	+13.8	+ 83.5
868	.67	+12.0 —	— —	—10.6±11.7	—16.6	+52.1	— 1.8
870	.29	+ 2.7±4.5	— —	—20.0±22.3	+20.2	+21.1	— 8.7
871	.31	+26.4±8.3	— —	+64.4±12.8	—60.1	+25.6	+104.5
P14	.33	—28.5±3.3	—32.0±5.2	+ 5.4±12.2	—10.0	—38.6	— 48.7
P15	.33	—31.2±3.0	—39.3±4.7	—32.6±13.5	—55.9	—10.2	— 26.3
880	.43	—16.2±3.3	—28.5±6.5	—30.8±19.8	—69.0	—13.8	+ 83.8
881	.45	—11.7±2.7	—25.1±7.2	— 0.7± 7.3	+ 4.8	+20.2	— 20.9

TABLE II (*continued*).

Sp. No.	Phase	H before H_8	H after H_8	He I	Si II	Ca II	Mg II
			1962				
1231	0.19	—31.7±1.2	—34.6±4.4	—30.4±16.9	+ 3.8	— 3.7	—
1250	.48	—24.3±5.5	—20.6±6.1	+37.3±20.8	— 3.8	+ 7.8	—
1251	.48	—28.6±7.1	—30.4±4.1	+35.4±15.7	—	+21.8	—
1299	.80	—27.8±5.5	—21.2±5.1	+45.8±11.9	+19.1	+16.6	—
1322	.73	—28.5±0.3	—42.8±5.9	—42.3± 8.1	—12.5	—12.0	—
1323	.73	—39.6±5.5	—56.2±6.1	—22.0±17.9	+ 0.7	—24.1	—
1329	.36	—18.1±6.2	—47.5±4.1	—34.7± 6.1	+30.1	— 3.0	—
1330	.37	—24.6±9.4	—17.8±5.3	+11.4±15.5	+10.9	— 4.1	—
1440	.59	—28.4±3.8	—39.6±2.6	— 0.7±13.3	+51.4	—10.8	—
1506	.09	—34.6±6.5	—39.3±3.9	—46.3±14.1	— 4.0	+81.5	+ 3.1
1507	.10	—35.3 —	— —	— —	—	—	—
1515	.33	—31.1±4.3	—44.1±5.5	—34.7±18.0	+ 6.3	— 6.2	—109.9
1520	.97	—44.4±8.1	—43.6±4.6	—15.6±18.5	+32.9	+33.1	— 2.6
			1963				
1603	0.39	—42.9 —	— —	— —	—	—	—
1604	.41	—33.7 —	— —	— —	—	—	—
1608	.00	—61.9 —	— —	— —	—	—	—
			1964				
2037	0.74	—47.8±7.2	—40.0±5.3	—46.1±10.5	+37.1	—66.4	+ 34.1
2053	.00	—44.8±5.4	—31.6±6.8	—35.8± 4.2	+ 8.4	—74.4	+ 60.7
			1965				
2243	0.37	—40.6±2.4	—30.4±3.7	—41.7±21.9	+49.9	— 6.2	+ 51.4
2248	.82	—15.3 —	— —	— —	—	—	—
			1966				
2316	0.13	—39.9± 3.9	—47.8±7.8	—36.1± 8.9	+21.1	+34.1	+ 10.5
2318	.77	—49.6 —	— —	— —	—	—	—
2384	.74	—38.1±10.2	—48.3±3.0	—43.2±12.6	—43.0	—12.2	+ 13.0
2385	.76	—33.4± 6.6	—24.3±4.8	—51.8±11.3	+ 3.9	—16.8	+ 61.5
2390	.33	—38.5± 4.4	—36.3±4.4	—46.3± 6.2	—17.9	+20.5	— 0.8
2391	.34	—52.1± 5.5	—63.6±8.4	—43.6±14.5	+14.8	—21.9	— 43.0

Explanation for the columns: 1–number of the spectrum, 2–phase, 3–heliocentric radial velocity deduced from the Balmer lines before H_8 and mean square error, 4–ibidem for the Balmer lines after H_8, 5–8 ibidem for the other elements.

The obtained radial velocities have been plotted against the phases computed by means of the data of Schmidt (1959); from the inspection of these graphs it follows that the radial velocities do not show the trend charac-

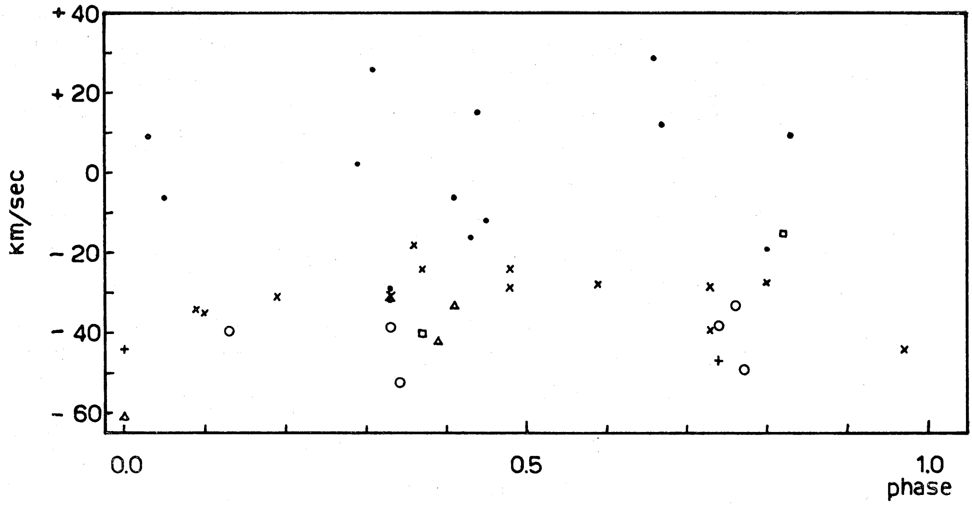

Fig. 1. – Radial velocities of the Balmer lines before H_8.
• 1961, × 1962, △ 1963, + 1964, □ 1965, ○ 1966.

teristic of the eclipsing variables. In fig. 1 the results relative to the first Balmer lines are plotted; from this we can deduce the following considerations:

I) The values of 1961 are sistematically higher than those of other years. This fact is caused by the presence of intense cores in the Balmer lines up to H_8; instead, in the successive years such cores were scarcely visible or vanished completely, as we remarked in our preceding works. Therefore the velocities for 1961 are relative to the thin shell which appears around the system also in the phase of normality in some years. The values obtained from the lines later than H_8 show a pattern like that of the earlier Balmer lines for the years after 1961.

II) The velocities for the years successive to 1961 are always negative in agreement with the data of Campbell, Plaskett and Pearce. Most of the values range from — 20 to — 50 km/sec; the dispersion of the velocities is probably real being higher than the mean square errors.

Regarding the velocities of the other elements, the graphs show a larger dispersion of dots; the velocities are sometimes much higher than those of hydrogen; moreover most values of Si are positive. These differences may be caused partly by the large errors of measurement owing to the few and very broadened lines of each element, partly may be eventually real and therefore indicate a possible stratification of the elements. We have included in Table II the velocities of these elements also, because they may be of some interest in future investigations of this star.

Owing to these variations from element to element we could not average all the lines of each plate.

We have also plotted such velocities against the phases computed with the data corrected by Jackisch (1963): the results are nearly the same.

We conclude that a curve of velocity characteristic of the eclipsing variables does not result from our measurements, but it is not possible to exclude that Omicron Andromedae is an eclipsing binary because, according to Schmidt (1959), this close binary system would have components very deformed; moreover gaseous masses would also be present so that radial velocities may be considerably altered.

It would be interesting to re-examine the measurements reported by Plaskett and Pearce taken at Ottawa Observatory on fifty plates; these AA. give only a mean value of the velocity, —13.1 km/sec, but it would be very useful, in our opinion, to consider these measurements taking in account the year of observation, the eventual presence of cores in the Balmer lines, and the phase according to the data of Schmidt.

References.

Campbell W. W., « Lick Obs. Bull. », *1*, 159 (1902).
Jackisch G., « Mitt. veränd. Sterne », *2*, 13 (1963).
Pasinetti L. E., « Mem. Soc. astr. It. », *39*, 73 (1968).
Pasinetti L. E., « Atti XI Riunione Soc. astr. It. », Padova, Ottobre 1967.
Petrie R. M., « Publ. Dominion astrophys. Obs. Victoria », *9*, 297 (1953).
Plaskett J. S. and Pearce J. A., « Publ. Dominion astrophys. Obs. Victoria », *5*, 158 (1935).
Schmidt H., « Z. Astrophys. », *48*, 249 (1959).
Slettebak A., « Astrophys. J. », *119*, 460 (1954).