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OBSERVE ϑ^1 Ori A !*

Photometry in an instrumental UBVR-system of another minimum of ϑ^1 Ori A on 1975 December 05 was made at the Bochum 61-cm-telescope on La Silla (Chile) using the equivalent point method described by Hall and Garrison (1969). The observations confirm the preliminary period (Lohsen 1975) and, together with Strand's (1975) two estimates lead to an improved period of 196.297 ± 0.001 days. Since the minimum of 1974 April 25/26 depends only on one dubious estimate, only the double value, P_o= 392.594 d can be considered as the definite fundamental period. Because of the depth of the minima in 1975 (Walker 1976) and in 1973 and the symmetrical shape, the minimum on 1974 November 08 was certainly not a secondary, i.e. $P \neq 2P_o$. Visual estimates on 1976 March 12.75 preclude a period $P = P_o/4$ = 98.15 d, too.

Using P_o= 396.594 d the observed parts of minima of three consecutive years can be fitted together (Fig. 1) to estimate the total duration D = 20 + 2 h and the constant phase d = 2.5 ± 1 h. With the aid of the Russell-Merrill tables (1950) a ratio of the radii $k = r_s/r_g$ = 0.80 ± 0.05 (est.err.) and a central eclipse ($\cos i < (1-k)r_g$) was found. The low precision of the scanner observations in 1973 do not allow to decide whether primary minimum is a transit or an occulation. In both cases it seems to be difficult to explain the almost insignificant color dependence of the depth of minimum (Table 1). While the observations in 1973 might have been affected by systematic errors this explanation seems to be improbable for the photometry in 1975. A spectral type of B0 for the larger component is consistent with Petrie's (1965) classification B0.5 as well as Morton and Adams' (1968) color indices and an interstellar reddening of E(U-B)/E(B-V)= 0.72. If primary minimum is a transit, the type of the smaller component should be later than A5, in the occultation case it should be earlier than O5. The occultation case requires relatively small radii $R_g = 3R_\odot$ and $R_s = 2.4\ R_\odot$ in order to explain the total absolute magnitude

*Based on observations made at the European Southern Observatory.

$M_V = -2\overset{m}{.}2$ ($m_V = 6\overset{m}{.}7$; $A_V = 0\overset{m}{.}9$; $DM = 8\overset{m}{.}0$). A similar small radius of $R = 2.5R_\odot$ has been found (Hall 1971) for the brighter component of BM Ori = ϑ^1 Ori B, which is of spectral type B1-B3.

Taking the radius $R_g = 3.0R_\odot$ estimated from photometry in the occultation case, $k = 0.8$, and the total duration of primary minimum $D = 20$ h, we get a tangential relative velocity

$$v = 2R(1+k)/D = 105 \text{ km/s} = 22.15 \text{ au/y}.$$

With a circular orbit this yields a total mass

$M_1 + M_2 = r^3/P^2 = P(v/2\pi)^3 = 47\ M_\odot$ (assuming $P=P_O = 1.075$ y)

Considering all the uncertainties, this seems to be consistent with the spectral types. The transit case, however, taking $R_g=4R_\odot$ would yield a total mass of 112 $M_\odot$, i.e. an eccentric orbit must be assumed, which is quite common for widely separated pairs.

Feibelman (1975a) has found two secondary minima of $\Delta m = 0\overset{m}{.}8$ on old plates. The depth is inconsistent with the depth of primary minimum ($1\overset{m}{.}0$). Later (1975b) he corrected Δm to "considerable", which is more in accordance with the $0\overset{m}{.}3$ expected in the occultation case. A minimum of this depth should be detectable by visual estimates which were made at Hamburg Observatory throughout 1974, 1975 and 1976. They failed to show a secondary on 1975 February 23 and 1976 March 21, whereas around 1975 September there seem to have been a shallow dip. If these estimates and Feibelman's observations are real, the period is indeed 392.594 days and the orbit is considerably eccentric.

Taken altogether, the available observations are insufficient for a detailed planning of all further observations. As this system possibly allows us to measure accurately the mass and the radius of a young undisturbed BO type star, every effort should be made to observe at least the next primary minimum on 1977 January 01.1 since a similar oppurtunity may not occur before six or even twelve years. Spectroscopic observations are needed especially within some weeks before primary minimum. Apart from a desirable continuous survey, photometry is important near the expected secondary minima, i.e. 1976 September 25 to October 10 and 1977 April 11 to 25.

Table 1

Magnitude differences θ^1 Ori A minus C

Date	ΔV	Δ(U-B)	Δ(B-V)	Δ(V-R)
1975 Dec. 03/04	1.634±3	0.079±5	0.006±4	-0.009±3
1975 Dec. 05				
3.2 to 4.8 h UT	1.690	0.074 6	0.014 3	-0.014 3
4.9 to 6.8 h UT	1.865	0.092 3	0.010 3	-0.010 4
6.9 to 9.0 h UT	2.160	0.090 6	0.026 4	-0.003 5
1975 Dec. 05/06	1.632±4	0.074±6	0.010±4	-0.011±3
1975 Dec. 06/07	1.631 5	0.081 9	0.006 5	-0.010 4
1975 Dec. 07/08	1.629 3	0.080 4	0.010 7	-0.015 5

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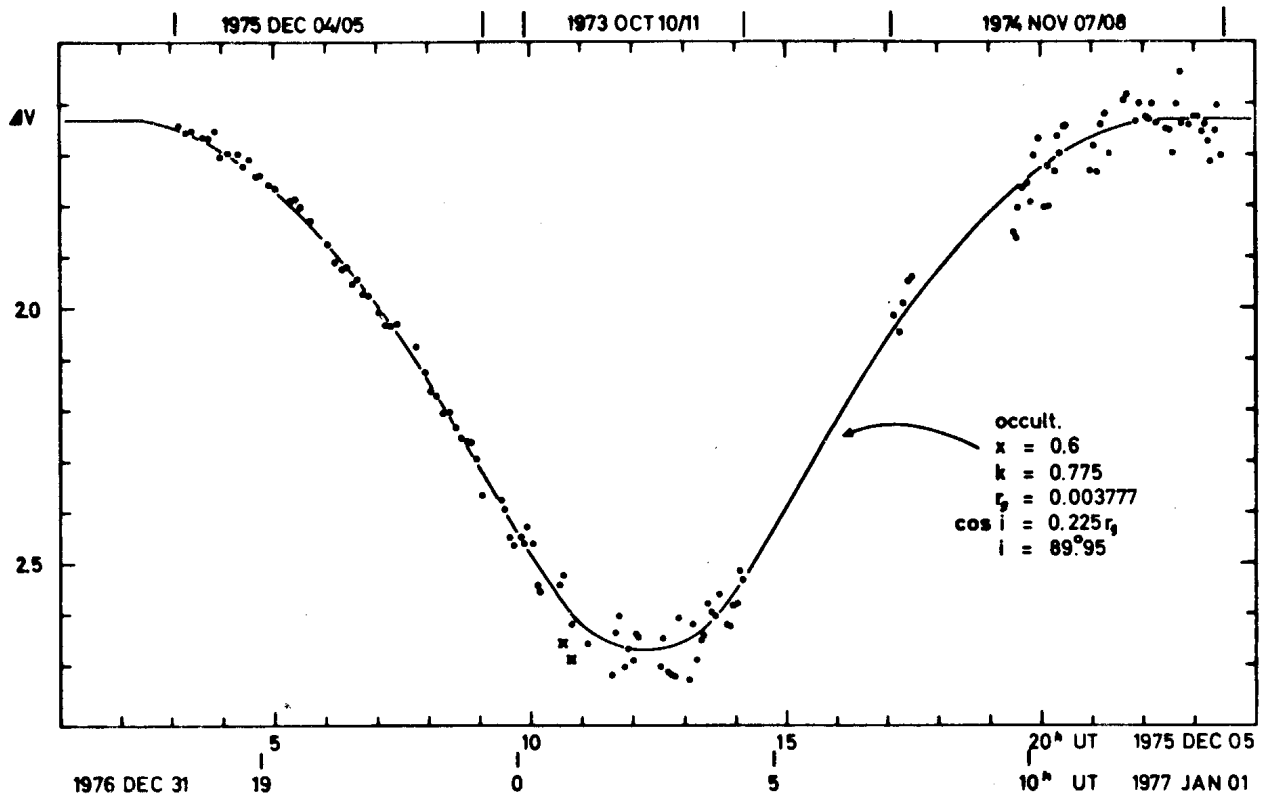

Fig.1: Magnitude differences δ^1 Ori A - C