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α SCULPTORIS - A LONG PERIOD BINARY

This prototype (HD 5737, B8III, V = 4.30) of the α Scl-subgroup of weak helium line stars has been investigated e.g. by Jugaku and Sargent (1961), Guthrie (1965), Norris (1971), Vilhu (1972) and Schmitt (1973). Bernacca and Molnar (1972) found it to be a photometric variable on the basis of UV-observations (2 observations). According to Bernacca and Molnar the strengthening of TiII, CrII and SrII lines around 2400 Å appears to redistribute flux longwards of the Balmer discontinuity. It is not known whether this strengthening is periodic or accidental, and what is its reason.

Figure 1 shows radial velocity variations of α Scl. Old Lick Observatory measurements (Campbell and Moore, 1928) were supplemented by new measurements of four Mt. Wilson plates from years 1944 and 1955 (Ce 3656, 10092, 10097, 10161, 2.8 Å/mm). These same spectrograms have previously been analysed for abundances (Vilhu, 1972). Radial velocities were measured from several lines of HeI, MgII, SiII and FeII with accuracy ±2 km/s.

One point obtained from ultraviolet observations with Copernicus-satellite (Upson and Vilhu, 1975) is included. This point represents the mean value of several lines in regions 1046-1051 Å, 1154-1166 Å and 1300-1305 Å (ArI, CI, OI, FeII, FeIII, CrIII). The known interstellar line ArI 1048 seems to follow the velocity variation. Thus it probably originates from a circumstellar cloud participating in orbital motion.

Due to the apparent long period, the variability cannot be related with the rotation of the star as is the case in many Ap stars (for α Scl V sin i =15 km/sec, Vilhu (1972)).The binary

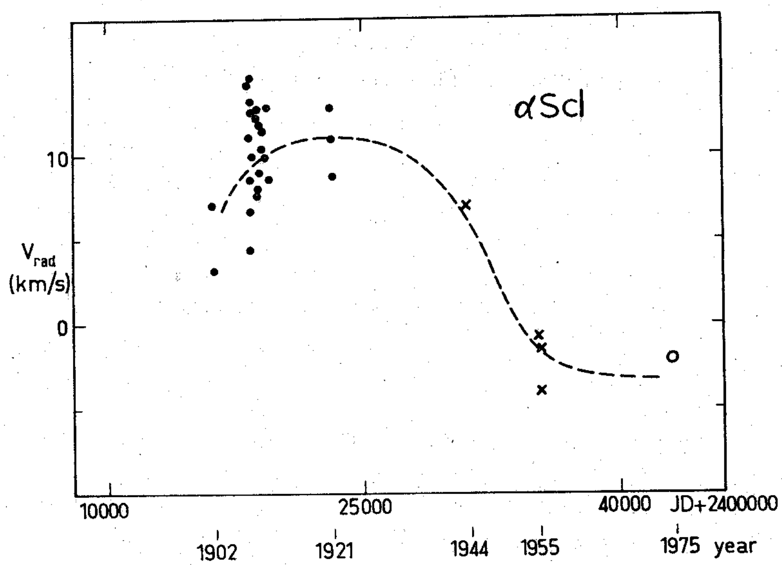

Fig. 1. Radial velocity variations of α Scl. Points: old Lick Observatory measurements (Campbell and Moore, 1928). Crosses: new measurements of Mt. Wilson plates (this paper). Circle: a value from UV-region (see text, Upson and Vilhu, 1975).

motion is then the most probable reason for the variability. From the radial velocities of Fig. 1 it is rather difficult to derive the period and amplitude. Estimating $P = 100$ years and $K_1 = 6$ km/s, a value 0.8 for the mass function f(M) can be calculated (assuming $e = 0$). If the mass of α Scl is about 7 $M_\odot$ (Norris, 1971), this gives a minimum mass 4 $M_\odot$ for the companion (if $i = 90^{o}$). If the eccentricity is different from zero, smaller companion masses will result. The 4 $M_\odot$ companion would thus be a B9 star having 7 times smaller luminosity than α Scl (assuming main-sequence). With these values it is quite reasonable that the companion is not seen in the spectrum.

Further, using the above values for P and K_1 we obtain for the semi-major axis $a_1 \sin i$ a value of 4000 $R_\odot$. This means that the system is very wide. Even for the so called case C evolution of close binaries the system is rather wide, if the orbit is not eccentric. It is not, of course, precluded that the period and separation may have increased (for instance mass and angular momentum loss and kick from the companion by supernova-explosion). If the secondary is more massive than 4 $M_\odot$, it should then be a black hole.

More radial velocity measurements are clearly needed to get better estimates for the orbital parameters and for the companion mass.

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References:

Bernacca, P.L., Molnar, M.R. 1972, Astrophys.J. 178, 189

Campbell, W.W., Moore, J.H. 1928, Lick Obs. Publ. XVI, p.12

Guthrie, B.N.G. 1965, Publ.Roy.Obs. Edinburgh 3, 264

Jugaku, J., Sargent, W.L.W. 1961, P.A.S.P. 73,249

Norris, J. 1971, Astrophys. J. Suppl. 23, 213

Schmitt, A. 1973, Astron. Astrophys. Suppl. 9, 427

Upson, W.L., Vilhu, O. 1975, as guest investigators using the Princeton telescope on the satellite Copernicus (unpublished observations)

Vilhu, O. 1972, Ann.Acad.Sci. Fennicae,Ser. A VI Physica, No.394