COMMISSION 27 OF THE I. A. U.
INFORMATION BULLETIN ON VARIABLE STARS
Number 3241

Konkoly Observatory
Budapest
23 September 1988
HU ISSN 0374 - 0676

ON THE ASSOCIATION MEMBERSHIP OF THE CEPHEID IR Cep

Although the Cepheid variable IR Cephei (HD 208 960 = BD + 60° 2321 = HBV 476) is rather bright (its mean brightness is $7^m.8$ in V), it has been neglected by the observers. The available observational material consists of three series: one set of photographic maxima (Klawitter, 1971), and two series of photoelectric UBV data (Wachmann, 1976; Szabados, 1977). No radial velocity or other detailed spectroscopic observation has been made as yet. This short period ($P = 2^d.114$) Cepheid variable, however, deserves special attention on account of two facts.

1. IR Cephei is located in the region of the Cepheus OB2 association, as was first pointed out by Antonello and Poretti (1986).

2. This star belongs to the group of the small amplitude Cepheids but unlike most s-Cepheids, IR Cep has a non-sinusoidal light curve. Its light curve resembles that of the normal (large amplitude) classical Cepheids but with a reduced amplitude. Such an effect can be expected if the variable star has a bright companion.

Since Antonello and Poretti (1986) did not perform the distance determination but only guessed the distance of IR Cep based on the possible reddening, it is worth calculating it.

The interstellar reddening in the region of IR Cep was studied by Kun (1982). A small subset of this absorption study is shown in Figure 1, where the colour excess is plotted against the distance modulus (uncorrected for reddening), taking into account the stars within one degree from IR Cep. It is clearly seen from this figure that all the stars in this direction farther away than 400 pc have nearly the same E_{B-V} colour excess, roughly $0^m.3 - 0^m.4$.

In order to estimate the distance of IR Cephei we used two widely accepted forms of the period - luminosity relationship:

$$\langle M_V \rangle = -3.80 \log P + 2.7(\langle B \rangle_o - \langle V \rangle_o) - 2.27 \qquad (1)$$

(Martin et al., 1979, with the zero-point taken from Feast and Walker, 1987), and

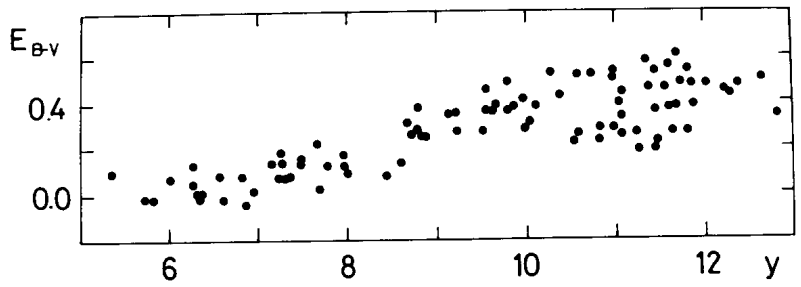

Figure 1. E_{B-V} colour excess vs. V-M_V distance modulus for the stars around IR Cep

$$\langle M_V \rangle = -3.53 \log P + 2.13(\langle B \rangle_o - \langle V \rangle_o) - 2.13 \qquad (2)$$

(Caldwell and Coulson, 1986, with the zero-point taken from Feast and Walker, 1987).

The following values could be determined from the observations:
mean visual brightness: $7\overset{m}{.}79$,
mean B-V colour index: $0\overset{m}{.}79$.
Assuming an E_{B-V} colour excess of $0\overset{m}{.}35$ (see above), the $\langle B-V \rangle_o$ colour index corrected for the reddening is $0\overset{m}{.}44$. The difference between this value and the value of $\langle B \rangle_o - \langle V \rangle_o$ is negligible as compared with the uncertainty of the colour excess. If we use R = 3.0 for the ratio of total to selective absorption, the distance of IR Cep is 630 and 650 pc when substituting into equations (1) and (2), respectively.

Recently Böhm-Vitense (1988) proposed that the short period Cepheids are all first overtone pulsators. Taking into account the difference $\log P_1 - \log P_o \approx -0.131$ (Iben and Tuggle, 1975), the distance of IR Cep would be 790 and 810 pc as derived from equations (1) and (2), respectively. Taking into account the $0\overset{m}{.}1$ uncertainty in the colour excess, and the possible deviation from the uniform R = 3.0 law, the estimated error of these distances is about ±40 pc.

The average distance of the Cep OB2 association was determined by Simonson (1968). He obtained about 800 pc for the distance of the centre of the association but the extent of the association is very large along the line of sight: the stars are spread over the range from 590 and 1100 pc.

In any case IR Cep is situated inside the boundary of Cep OB2 association. The apparent position in space, however, is not enough to make any statement whether IR Cep belongs to the association or not. Let us consider another criterion, viz. the age of the objects.

The age of the Cep OB2 association is in contradiction with the expected age of the Cepheid variables. Cep OB2 consists of two subgroups of different ages, and IR Cep is situated in the older subsystem which is about 6-7 million years old (Simonson, 1968), while according to the period - age relationship of the Cepheids (Kippenhahn and Smith, 1969) IR Cep is as old as about 90 million years. Based on this age criterion alone, it is impossible that IR Cephei is a physical member of Cep OB2.

Although, owing to this latter fact, it is improbable that IR Cep belongs to the Cep OB2 association, spectroscopic measurements are still necessary. There are only two rough estimations for the spectral type of IR Cep in the literature: Buscombe (1984) gives GOII with a comment that this value is somewhat uncertain, while Kun (1982) determined a spectral type of F8 from an objective prism spectroscopic survey. This latter value is in a better agreement with the spectral types of other low amplitude Cepheids than that of Buscombe. The spectroscopic data (including radial velocities) would give us important information about the possible companion to this variable that might cause the low-amplitude, non-sinusoidal light curve.

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