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Research Note

An additional note on the IR-excess of the helium-variable stars

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Summary. The infrared fluxes of two helium-variable stars in Orion (σ Ori E = HD 37479 and HD 37017) have been reobserved through 4.8 μm on 16 January 1982, at Steward Observatory. The *M*-band excesses previously reported are not confirmed by these observations.

Key words: IR-excess – He-stars

1. Introduction

Four previous papers have reported infrared excesses in intermediate helium-rich stars relative to normal B stars at the *M*-band (4.8 μm) wavelength. Groote et al. (1980) found excesses up to 150% in eleven helium stars; Groote and Kaufmann (1981) found an excess in σ Ori E of 284%, and 125% in HD 37017. Groote and Hunger (1982) claim a variable excess in σ Ori E which averages 270% which exhibits a periodicity of 1.19 days, the same as the H-alpha emission and magnetic field variation. However, Groote and Hunger find it impossible to explain this excess and its behavior in terms of any known IR-emitting model. Also, Groote and Kaufmann (1984) attempt to correlate the *M*-band excess with other stellar parameters and galactic distribution. A program was undertaken at Steward Observatory to confirm the *M*-band excess and to extend observations to longer wavelengths in order to identify the source of this radiation.

2. Observations

Infrared photometry was planned for three Orion helium-rich stars, σ Ori E, HD 37017, and HD 37776, during January 1982, using the 61-inch telescope at Catalina Station of Steward Observatory near Tucson, AZ. Due to lack of IR-excess, HD 37776 was too faint to observe, and all three stars were too faint to observe with the bolometer at wavelengths longer than 4.8 μm. Hence all observations reported here were done with an LN_2 cooled InSb detector and an 8 arcsecond aperture chopped with sky. The data was secured on 16 January, 1982, at about 6 hours U.T.

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The sky conditions were fine on the night the data was obtained, and no trouble was encountered with the instrument. Extinction was removed by the equal altitude transfer method – the standards were observed at the same airmass as the program stars, as described in Low and Rieke (1974). The primary standard, χ^2 Orionis, was measured just prior and after the helium-stars, and the secondary standard, η Tauri, was also measured several times. Both of our standards are B-stars (with χ^2 Ori somewhat reddened); their characteristics are given in Table 1a. The errors reported for the helium-star observations are the quadratic sum of the statistical errors in measuring the objects and the repeated measuring of the standards.

3. Results

The infrared continuum flux of a normal early B star is a negligible fraction of the star's flux and does not affect the temperature structure. High free–free opacity produces blackbody radiation at the boundary temperature of the photosphere, and so the IR colors are almost independent of spectral type (or temperature). In fact, all colors are defined to be 0.0 at A0 V, and the same value is expected throughout the hotter B stars. This is also stated by Bonsack and Dyck (1983), and confirmed by their observations of normal early B-stars (e.g. HR 801, an unreddened B3V star with $(K-M)=+0.01$), and by Gehrz et al. (1974). Table 1b shows the *K* magnitude and the IR colors we measured for σ Ori E and HD 37017. As can be seen, the colors, particularly the $(K-M)$, are all within 1 σ of 0.00, and so the maximum excess at *M* that we could allow is 10%. In contrast Groote and Hunger (1982) find for σ Ori E the $(K-M)$ color to be 1.00 ± 0.26.

Groote and Hunger also claim that the *M*-band excess of σ Ori E varies with a 1.19 day period (that being the same as the He I 4026 line strength variation). However the data base consists of 30 reliable measures taken over three years' time, and this is certainly not adequate to base a claim for a short period. We had originally intended to obtain a data set relatively free of aliasing. However, since no excess was found, we analyzed the data given in Groote and Hunger by Fourier methods. The power spectrum of their data is shown in Fig. 1 for frequencies near $\omega_0(=1/1.19$ cycles/day); it can be seen that there are many other peaks in the spectrum than the one with the known period. Thus

Table 1a. Infrared standard star characteristics

Star	*Sp. T.*	$(B-V)$	$(J-K)$	$(H-K)$	$(K-M)$
χ^2 (62) Ori	B2 Ia	+0.28	+0.06	−0.05	+0.05
η (25) Tau	B7 III	−0.09	0.00	0.00	+0.06

Table 1b. Infrared magnitude and colors

Star	K	$(J-K)$	$(H-K)$	$(K-M)$
σ Ori E (HD 37479)	6.96 ± 0.03	0.00 ± 0.04	0.00 ± 0.04	0.00 ± 0.06
HD 37017	6.92 ± 0.03	-0.10 ± 0.04	-0.06 ± 0.04	-0.08 ± 0.06

All data taken at J.D. 2444986.75; for σ Ori E, $\omega_0=0.16$ based on ephemeris given in Groote and Hunger (1982). The filter effective wavelengths are: $J=1.25$ μm, $H=1.6$ μm, $K=2.2$ μm, $M=4.8$ μm

any claim of reality of the IR excess based on the periodicity of variation is weak.

Bonsack and Dyck (1983) have observed the two B stars for which we have results, as well as 18 normal and 20 peculiar early A stars. They find also that HD 37017 and σ Ori E show marginal or no M-band excess, and we support their result. They suggest that for the stars observed by Groote et al., the excesses are much more common for the stars fainter than 5.0 visual magnitude, and that possibly the signal to noise is lower than reported there.

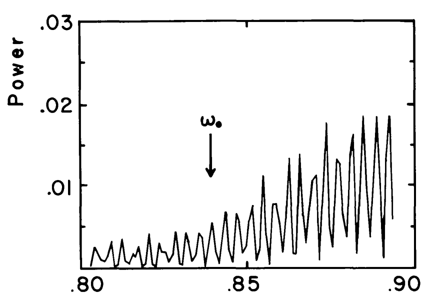

Fig. 1. The power spectrum of the M-band data given in Groote and Hunger (1982). The frequency of variation of the He I 4026 line strength, ω_0, is 0.84 cycles/day

4. Conclusions

Groote and Hunger (1982) give a comprehensive model for σ Ori E which cannot explain the large excess at 4.8 μm. The results presented here and in Bonsack and Dyck (1983) are that the excess is due to noise in the data, and is not real.

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