NEW RESULTS ON ETA CARINAE. EVIDENCE FOR AN ASYMMETRIC, INHOMOGENEOUS WIND.*

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The very peculiar object Eta Car is one of the best laboratory for the study of those physical processes - such as mass loss, superionization, dust condensation, wind interaction with the i.s. medium - that presently are of great astrophysical interest, especially for the study of the most luminous stars. For its light history and high luminosity Eta Car may also be considered as the galactic counterpart of the Hubble-Sandage variables. Eta Car is one of the rare astrophysical objects with evidence of dust condensation from ejected stellar matter (Andriesse et al.78) On the other side the star is also producing a strong, hard X-ray flux (Chlebowski et al. 1984), and the problem is whether there is any physical reason to have these two quite different processes in the same stellar environment. In any case rather extreme physical conditions are required which cannot be verified in a uniformly, spherically symmetric atmospheric enevelope. Andriesse et al. in fact suggested the presence of strong inhomogeneities, such as filaments, possibly related to the presence of a strong magnetic field. This may also explain the X-ray emission. In the following we shall present new optical and UV observations of Eta Car and its small nebula with the aim of clearfying the physical nature of its wind.

Very high spectral resolution ($\lambda/\Delta\lambda \simeq 10^5$) line profiles have been obtained in February 1984 at ESO with CAT-CES. The emission lines are characterized by a narrow component and asymmetric broad wings extending to ± 500 km/s. The NaI resonance doublet (Fig.1) only displays a very wide emission with broad, absorptions extending to -600 km/s. It is worth noting that during some epochs NaI was more intense than the nearby HeI line.

A large variety of line excitations and profiles is also shown by the UV spectrum (Fig.2). Viotti et al.(1981) have identified the NV doublet

* Based on data collected at ESO, La Silla, and with IUE at VILSPA.

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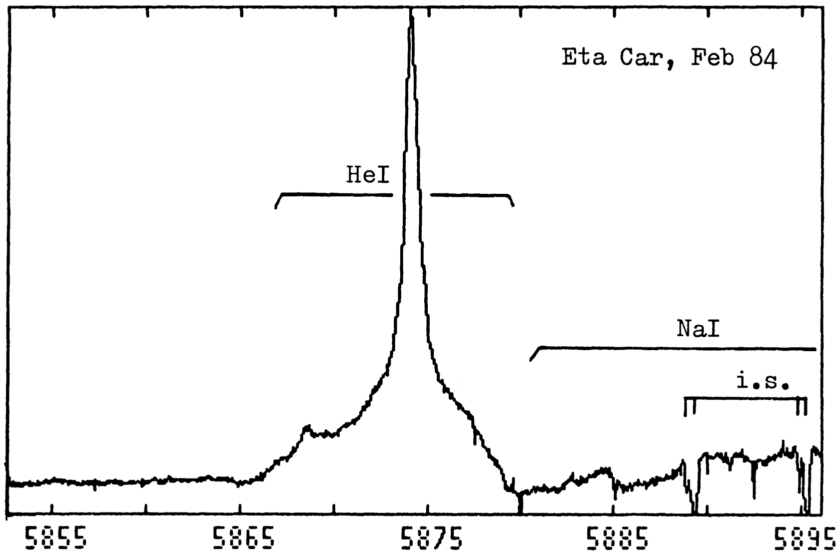

Figure 1. Very high resolution spectrum of Eta Car: line profiles of HeI 5875 A and of the NaI $D_{1,2}$ doublet (ESO: CAT-CES, February 1983).

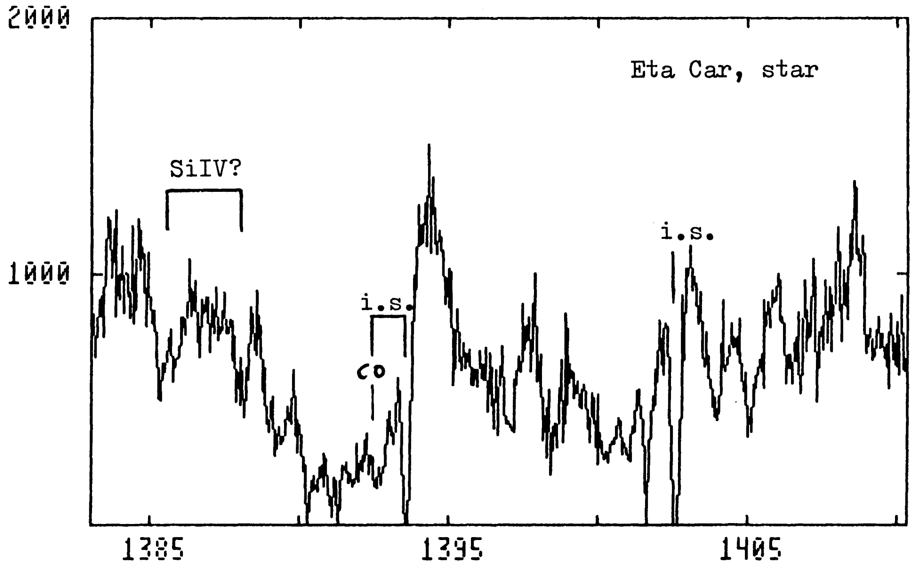

Figure 2. IUE high resolution spectrum of Eta Car near the SiIV resonan doublet, showing the i.s. lines and the broad absorption, with possible high radial velocity components.

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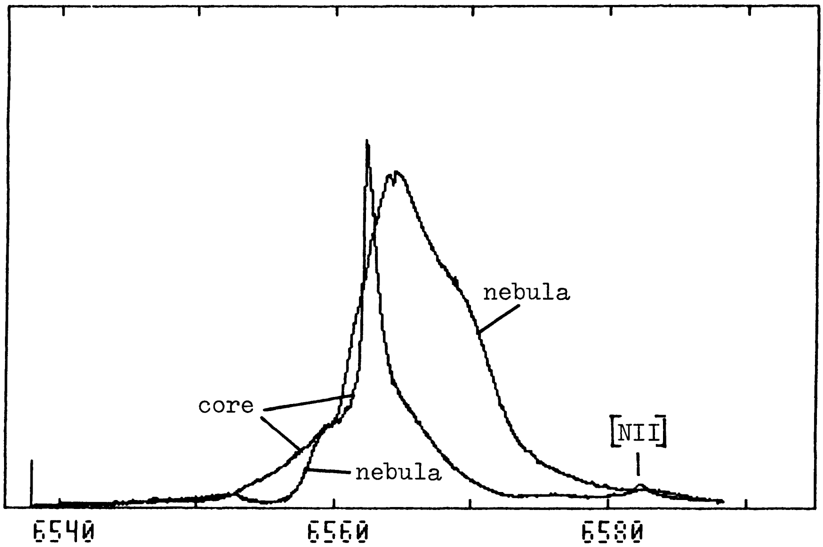

Figure 3. Very high resolution Hα profile in the stellar core and of the nebula 3"-5" South of Eta Car (ESO: CAT-CES, February 1984, April 1985).

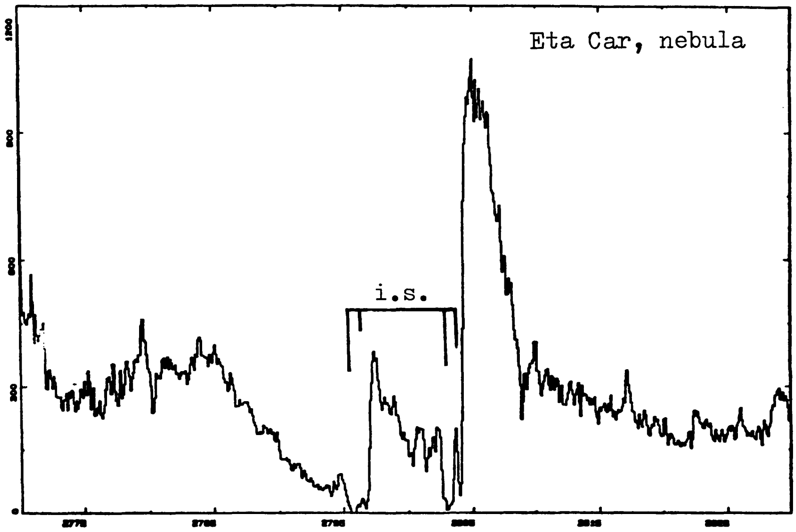

Figure 4. The high resolution UV spectrum of the Eta Car nebula near the MgII doublet (IUE, December 1980).

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with a very broad P Cygni profile extending to -600 km/s, the same velocity observed in the low ionization lines of NaI (Fig.1), CaII and MgII (Cassatella et al.1979). This indicates that both high and low ionization lines are present in the whole velocity range of the stellar wind.

Additional information about the process of mass ejection from Eta Car can be derived from the observation of the nebular halo. The spatial structure of the halo is very complex with condensations, shells and diffuse matter all expanding with velocities of up to 800 km/s. High spatial resolution IR imagery of Eta Car by Bensammar et al.(1985) has recently determined a size of about 0''.2 for the central core, which is the inner diameter of the dusty nebula where the grains start to condense.
We have observed the high resolution H_α profile 3"-5" South of the star in April 1985 (ESO: CAT-CES). The profile appears broad and asymmetric, shifted by +100 km/s with respect to the stellar velocity (Fig.3). The line width is in agreement with the general expansion of the halo, while the shift suggests this part of the halo to be receding from us. The P Cygni absorption is quite strong with respect to the star, but the main difference is the absence of the central narrow peak seen in the stellar line. Since this peak is normally observed in the higher ionization lines (Fig.1) we conclude that there exists a hot stationary region near the stellar core with a low (projected) expansion velocity.
More informations may be obtained from the IUE high resolution spectroscopy of the nebula. Our observations show that the emission appear broader than in the core spectrum, with less prominent absorptions (compare the MgII profile in Fig.4 with Cassatella et al.1979).

In conclusion these results suggest that in the case of the EtaCar wind we are not dealing with a spherically symmetric structure, with a monotonic density and temperature law. The hot, low radial velocity region may be either matter ejected at right angles with respect to the line of sight or, more probably, a stationary cloud or disk around the stellar core. In any case the expanding envelope of Eta Car is highly asymmetric. High spatial and spectral resolution observations with the Faint Object Camera onboard of the Hubble Space Telescope will be crucial for the understanding of the mass loss, dust formation and X-ray emission process in this unique Hubble-Sandage variable.

REFERENCES

Andriesse C.D., Donn B.D., Viotti R. 1978, Mon. Not. R. A. S. 185, 771.
Bensammar S. et al. 1985, Astronomy Astrophysics 146, L1.
Cassatella A., Giangrande A., Viotti R. 1979, Astron. Astrophys. 71, L9.
Chlebowski T. et al. 1984, Astrophys. J. 281, 665.
Viotti R. et al. 1981, Space Science Reviews 30, 235.

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