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η Car RECOVERING FROM THE 2003.5 SPECTROSCOPIC EVENT

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The Luminous Blue Variable star Eta Carinae suffers spectroscopic events every 5.5 yr characterized by the fading of the high excitation lines of [Ar III], [Fe III], [Ne III], [N II] and [S III] (Damineli, 1996). The last of such events occurred around the end of June 2003 (Abraham et al., 2003). The line of highest excitation energy [Ne III] λ 3868 vanished on June 23th, followed by the others of decreasing energy. The narrow component of HeI λ 6678 vanished on June 29th, which implies a period of 2025 days, when comparing present data with previous observations. We adopt that date as the zero phase of cycle 11, in order that cycle 10 started in December 1997 and cycle 9 in June 1992. The ingress in the phase of totality for all lines occurred within days of the X-ray minimum (Corcoran, 2003).

As noted in previous spectroscopic events, different lines should recover from the minimum in different times, following a reverse sequence of excitation energy as during fading. Unfortunately, the star could not be observed from the ground through October–November, when the lower excitation lines like [N II] and [Fe III] were expected to be recovering. We succeeded to take spectra at the Observatório Pico dos Dias (LNA/Brazil) on 2003 December 12–14, corresponding to phase 0.08. We used the 1.6m telescope and Coudé focus to achieve spectral resolution of 0.6 Å and spectral coverage from 3800 Å to 11000 Å with S/N > 100 in the stellar continuum. Such observations proved to be crucial, since all the lines that have faded are showing up again, except for [Ne III] λ 3868. The line [Ar III] λ 7135 is faint but definitively present, as can be seen in the left panel of Figure 1. This figure displays the present spectrum and another taken on August 15th, when the spectroscopic event was near the mid phase.

In the December spectrum, the narrow components of He I lines start to rise again, and the broad components are much stronger than those in August. The lines [S III] λ 6312 and [Fe III] λ 4658–4701 are mildly intense as compared to [N II] λ 5755 that is almost half way of full recovery. HeI λ 10830 is much stronger than in the minimum. Another remarkable feature of our data is that [Ne III] remains absent from the spectrum along the last 22 weeks, almost twice the duration of totality in X-rays (Corcoran, 2003). [Ne III] is expected to reappear in the next weeks, indicating that the time delay between different lines to egress from the event is spread over a time interval of one month. These time delays could be related with the recombination times and the progress of the ionization front in the circumstellar envelope.

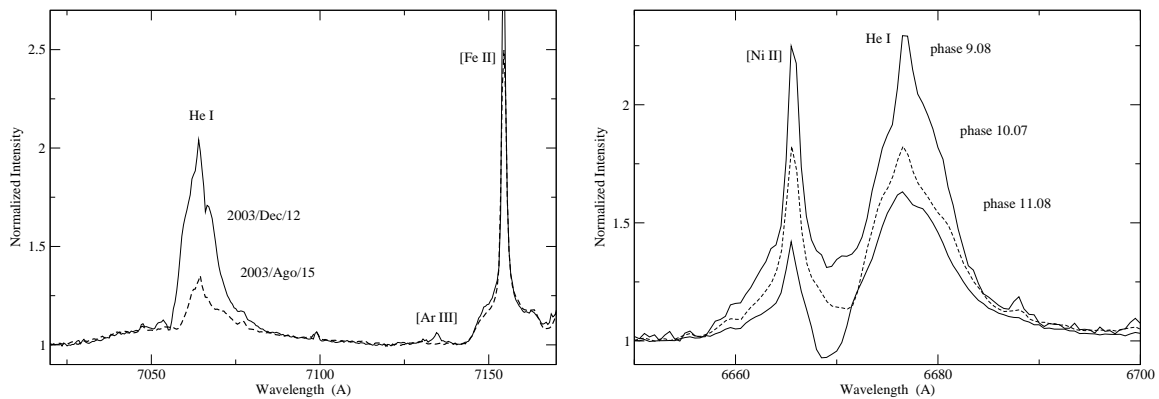


Figure 1. Left panel: He I, [Ar III] and [Fe II] lines near the center of the 2003.5 spectroscopic event (August 15th) and on December 12th, when it was ending. Right panel: comparison between line intensities in three subsequent cycles, around the same phase. We adopted the $P = 2025$ days and $T_0 = 2452820$ (June 29, 2003) as the starting point of cycle 11.

We have noticed previously that the spectrum is evolving secularly, in the sense that the high and intermediate excitation lines are becoming fainter and fainter from cycle to cycle (Damineli et al., 1999). In the right panel of Figure 1 we compare the lines of [Ni II] $\lambda 6666$ and He I $\lambda 6678$ around phase 0.08 in the last three cycles. It can be seen that the secular fading is continuing, but the step between the previous (10) and present cycle (11) was smaller than from cycle 9 to 10. It is seen also that the P Cygni profile in He I $\lambda 6678$ is deeper than previously. Other lines of He I and Si II show the same trend. Since the radial velocities of these P Cygni components are not changing, it seems that the stellar wind is becoming optically thicker.

References:

- Abraham, Z., Dominici, T. P., Damineli, A., et al., 2003, *IAUC*, **8162**, 4
 Corcoran, M. F., 2003, private communication, see
http://lheawww.gsfc.nasa.gov/users/corcoran/eta_car/etacar_rxte_lightcurve/
 Damineli, A., 1996, *ApJ*, **460**, L49
 Damineli, A., Stahl, O., Wolf, B., et al., 1999, in ASP Conf. Ser. 179, η Carinae at the Millenium, ed J. A. Morse et al. (San Francisco: ASP), 221