# 051.03 Eta Carinae: Preparing for the Next Periastron & What We May Learn

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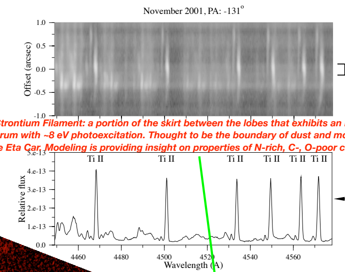
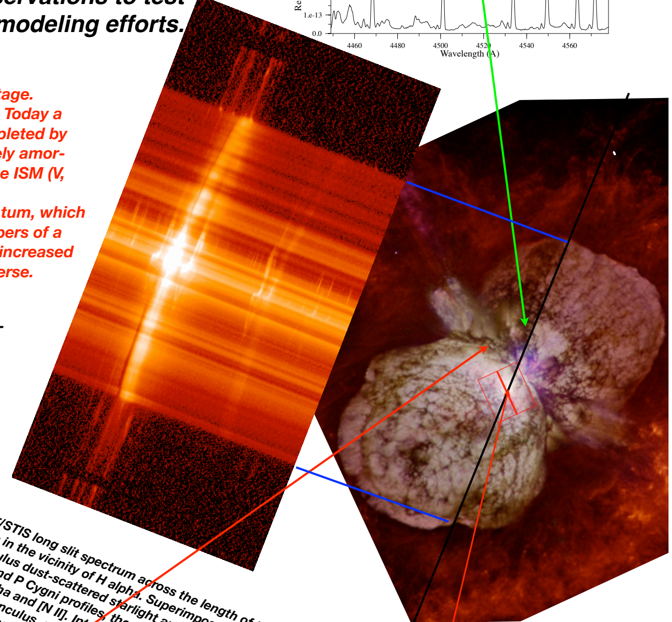
***Eta Carinae, with its historical ejection events of the 19th century and propinquity, provides an excellent test bed to study how massive stars transition to the presupernova stage. The next X-ray and visible/UV spectroscopic minimum, associated with the binary periastron, is predicted to be January 11, 2009 +/- 2 days. Observations are being prepared and proposed to test models of the binary system and response by the ejecta to changes in the photo-excitation. We are developing models and planning associated observations to test and further enhance these models. We solicit additional observational & modeling efforts.***




*The Strontium Filament: a portion of the skirt between the lobes that exhibits an ionized metal spectrum with ~8 eV photoexcitation. Thought to be the boundary of dust and molecule destruction by the Eta Car. Modeling is providing insight on properties of N-rich, C-, O-poor chemistry and dust.*

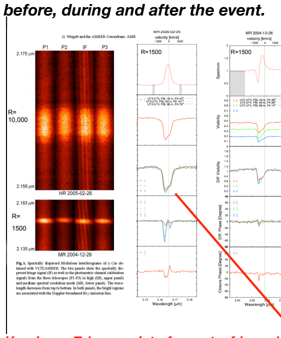


*HST/STIS long slit spectrum across the length of the Homunculus in the vicinity of H alpha. Superimposed upon the Homunculus dust-scattered starlight are the broad H alpha and He I wind P Cygni profiles; the exterior narrow line emission of H alpha and [N II]. Interior is emission from the ionized Little Homunculus, ejected in the 1890s and the peculiar Strontium Filament (see above).*

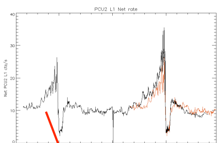
***The importance of Eta Car:***

***Our best understanding is that this is a massive binary system (>110 $M_\odot$) at the end of hydrogen-burning stage. Somehow at least 12 $M_\odot$ were ejected in the great eruption of the 1840s, and 0.5 $M_\odot$ came out in the 1890s. Today a massive wind ($10^{-3}$ $M_\odot$/yr at 600 km/s) enshrouds the binary. The ejecta is rich in N and He with C and O depleted by 100-fold. While H2, CH, CH+, OH, NH, NH3 have been detected, no CO is present. The dust is very grey, likely amorphous silicates and alumina. Thousands of emission and absorption lines of metals normally not seen in the ISM (V, Sc, Sr, Ti, Co, etc) are present due to no C or O that would lead to precipitation onto dust grains.***
***N-rich material is thought to originate in the very massive stars, especially those with high angular momentum, which can occur in binary systems. Long period Gamma Ray Bursters (GRBs) are thought to originate from members of a massive binary system, or the runaway companion from an evolved system. Studies of Eta Car will lead to increased insight of whether massive stars indeed could be GRB progenitors, at least in the early epochs of the Universe.***

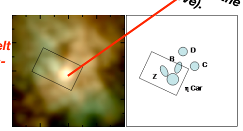
***Augusto Damineli et al (MNRAS submitted) have examined the considerable spectrophotometric observations along with Mike Corcoran's ongoing RXTE monitoring of Eta Car. They confirm the 2024-day periodicity, thought to be due to two massive stars in a highly elliptical orbit (e~0.9 to 0.95) and predict the next minimum associated with the periastron passage to occur in January 2009. Models of the binary wind-wind interaction and of the response of the massive ejecta are evolving leading to predictions on how the system will change across this spectacular event.***
***Observations are planned for X-ray, UV, visible, IR and radio portions of the spectrum. Proposals are being prepared to begin in fall, 2008 and to extend across to late 2009 with the intent of measuring the changes before, during and after the event.***



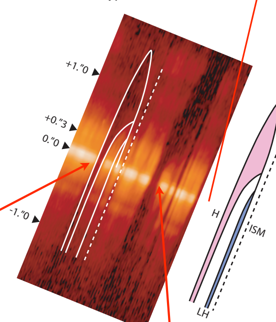

*Very Large Telescope Interferometry fringes have measured the size of the primary in continuum near 2 microns (4.3 mas), the H Br gamma line (9.6 mas) and the He I 2.06 micron line (6.5 mas). The latter appears to be photoexcited He+ region near the wind-wind interaction*



***RXTE light curve demonstrating the X-ray drop predicted to occur mid-January 2009 (M. Corcoran)***

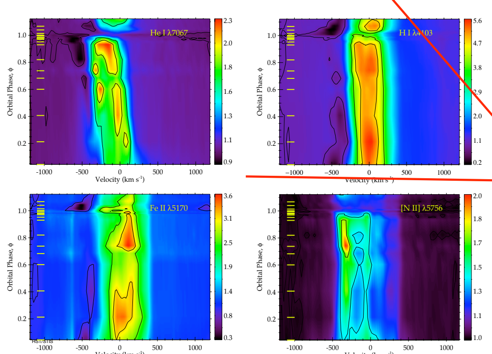



*HST image of central 1". The core is Eta Carinae. B, C and D are the Weigelt Blobs, intensely bright emission structures photoexcited by the FUV of the hot secondary.*

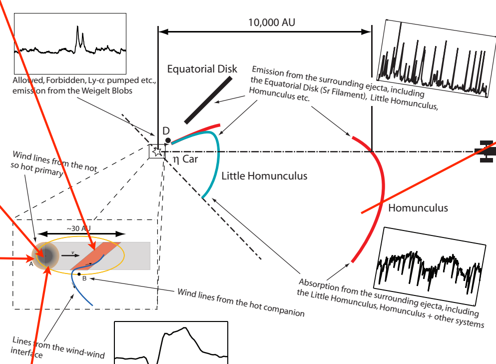



***Studies of the ejecta lead to improved understanding of the ejection mechanism, the excitation mechanisms, the abundances, and the chemistry in this N-rich, C-,O-depleted system, quite unlike the ISM or highly evolved stellar systems. We may gain insight on how the first stars enriched the ISM.***

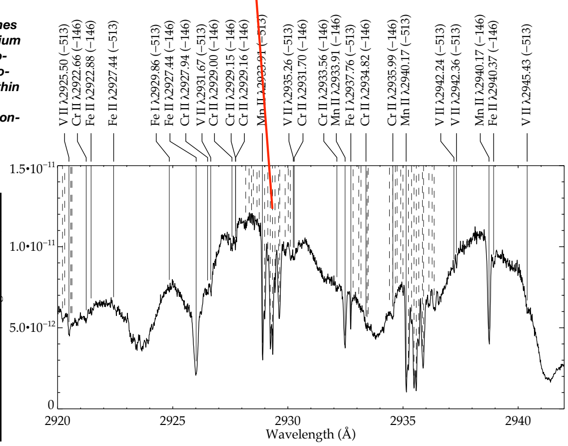
***In line of sight, the HST/STIS longslit NUV spectra demonstrate the curvature of the absorbing Homunculus shell and the HST/STIS high dispersion echelle brings out the narrow line absorptions of metals such as Fe II, Cr II, V II. VLT/UVES adds detection of Sc II, Sr II, Na I, Ca II.***

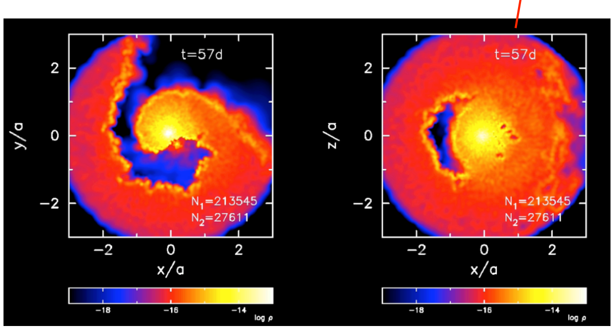



***P Cygni line variations over a 6.3 year interval bracketing two minima, 1998.0 and 2003.5. The H I and Fe II follow the wind of the massive primary. The He I traces a portion of the primary wind and the wind-wind structure photoionized by the hot secondary. The geometry of this concept is illustrated to right. We are currently unable to obtain a mass ratio, but hope to do such with an appropriate 3-D model.***

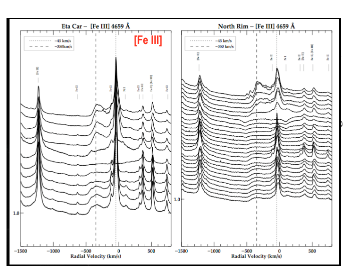



***Schematic of the ejecta surrounding Eta Car. We see emission lines from the ionized Little Homunculus and the metal-ionized Strontium Filament in the skirt. We see dust-scattered starlight from the Homunculus. Absorptions originate in line of sight from the Little Homunculus (-146 km/s) and the Homunculus (-513 km/s). Deep within is Eta Car, a massive binary consisting of a more massive, cooler primary with massive, dense wind and a less massive, hotter secondary in a highly elliptical orbit.***




*Example of a 3-D model (courtesy of A. Okazaki). We are building P Cygni line profiles using this model to predict the observed profiles of H I, Fe II, and He I with orbital phase.*




*Can we build a 3-D model of Eta Car in our direction? Profiles of the scattered light off the Northern rim of the foreground lobe are quite different from those seen in line of sight. Integral field spectroscopy may enable such a map. See Poster 051.21*

***Example of the HST/STIS NUV echelle spectra. Thousands of nebular absorption lines appear primarily in the Homunculus (-513 km/s) and the Little Homunculus (-146 km/s). As we analyze these spectra and the spectra of the Strontium Filament with the goal of abundance and chemistry, modeling of atomic transitions and laboratory measurements are essential. See Poster 051.09 for evidence of other shells.***

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