AAVSO and HST Observations of η Carinae

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Presented at the 93rd Spring Meeting of the AAVSO, July 23, 2004; received November 23, 2004; accepted November 23, 2004

Abstract Observations from the AAVSO and the Hubble Space Telescope (HST) of η Carinae are presented in comparison with other ground-based observations and in the context of the long-term brightening trend which started in the early 1900s. Our results are consistent with the idea put forth by others that there is a lowering of the continuous opacity in the dusty environment surrounding η Carinae which results in increased flux in optical wavelengths.

1. Introduction

η Carinae has been a captivating subject for astronomers for centuries (Humphreys 1999, also see http://etacar.umn.edu/). Beginning about 180 years ago η Car entered a period of remarkable variability culminating in its famous "Great Eruption" from 1837 to 1858, when it became one of the brightest stars in the sky.

John Herschel and several others recorded η Car's behavior during its eruption when for 20 years it oscillated between apparent magnitudes $m_v = 0$ and $m_v = 1.5$, briefly reaching $m_v = -1$. It then rapidly declined in about 10 years to below naked-eye visibility, eventually to about $m_v = 7–8$, due both to the cessation of the eruption and the formation of dust.

A second eruption began in 1887 and lasted seven years. It was then quiescent near $m_v = 8$ until the 1940's. In 1942 it began to brighten rapidly, and in less than 10 years was near naked-eye visibility again.

Figure 1, from Humphreys *et al.* (1999) shows the historical light curve of η Car.

Recently HST/STIS observations showed that the central star itself brightened significantly between 1997 and 2001 and is continuing to brighten after its recent (2003.5) "event."

2. AAVSO observations

In the AAVSO International Database there are over 8,400 observations of η Car made between 1911 and May 2004. Figure 2 shows all of these observations. A linear fit to the data shows steady brightening with a trend of $0.03 m/yr^{-1}$ or roughly 1

magnitude every 30 years. Figure 3 shows the visual observations binned into 90-day bins and includes photoelectric photometry from several AAVSO observers as well as the HST/STIS observations described in the next section.

3. HST observations

As described in great detail in Martin (2004), photometry was performed using images from the Hubble Space Telescope's Space Telescope Imaging Spectrograph (STIS) acquisition camera and the Advanced Camera for Surveys (ACS). This photometry measures the central star of the η Car system with a 0.3" aperture. This kind of resolution is not possible in ground-based photometry and gives unique insight into the behavior of the central star (Figure 4).

4. Secular brightening

The AAVSO and HST data presented here, along with ground-based data from other groups including specifically Whitelock (2004) and Fernandez Lajus (2003), show a secular brightening trend. Table 1 and Figure 5 show the trend in each of several bandpasses. The brightening trend is greatest in the J-band and almost non-existent in the L-band.

5. Why is it growing brighter?

It is obvious that η Car continues to grow in brightness. However, the reason for this brightening is unclear. The central star is near the Eddington Limit so an increase in its total luminosity would cause it to become unstable. Therefore, it seems more likely that the long-term secular brightening of η Car is due to the lowering of some continuous opacity source (i.e. dust clearing or destruction). Hopefully, continued study will yield a definitive answer.

References

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Humphreys, R., 1999, *Publ. Astron. Soc. Pacific*, **111**, 1124.
Martin, J., 2004, *Astron. J.*, **127**, 2352.
Whitelock, P., 2004, *Mon. Not. Roy. Astron. Soc.*, **352**, 447.

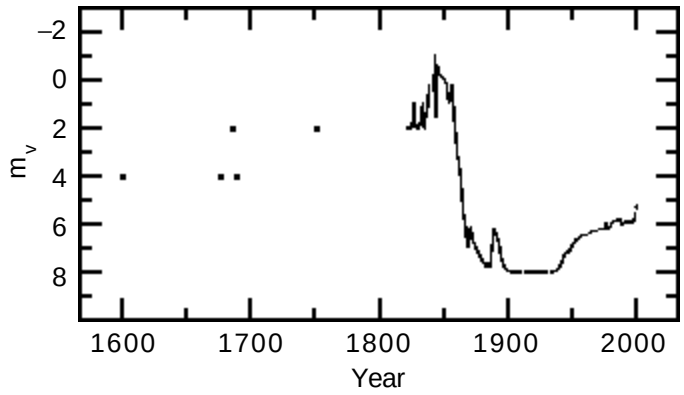

Figure 1. The Historical Light Curve of η Car from Humphreys *et al.* (1999).

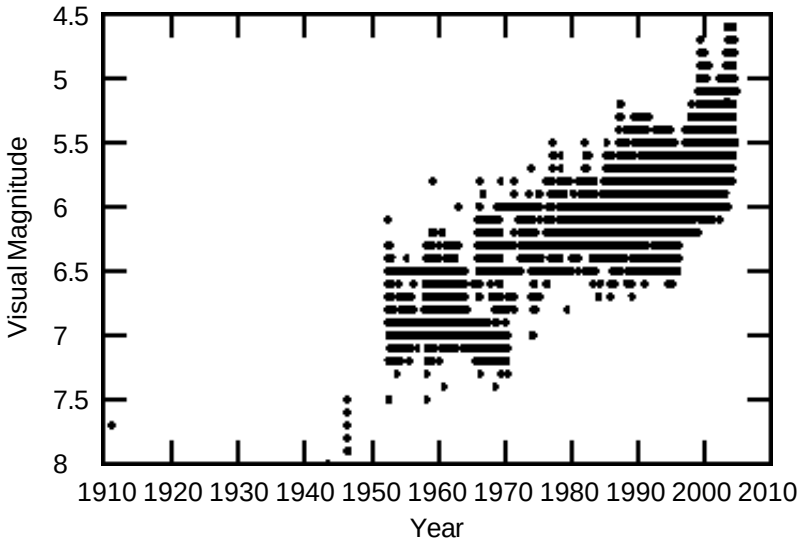

Figure 2. AAVSO visual observations of η Car, 1911–2004.

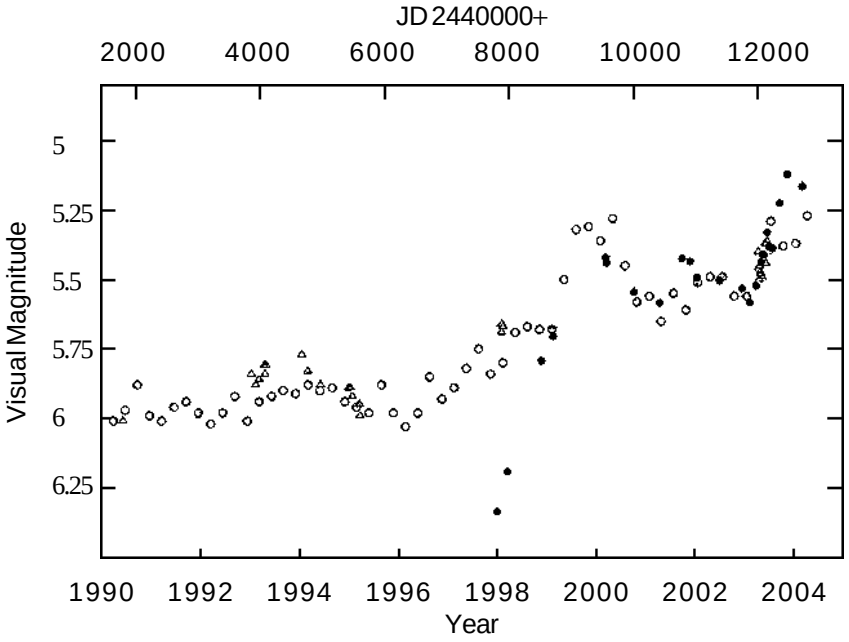

Figure 3. AAVSO visual (90-day bins) and photoelectric photometry observations of η Car, 1990–2004, and HST/STIS observations shown in Figure 4. Symbols: AAVSO visual, open circle; AAVSO PEP and constant, open triangle; HST/STIS and constant, solid circle.

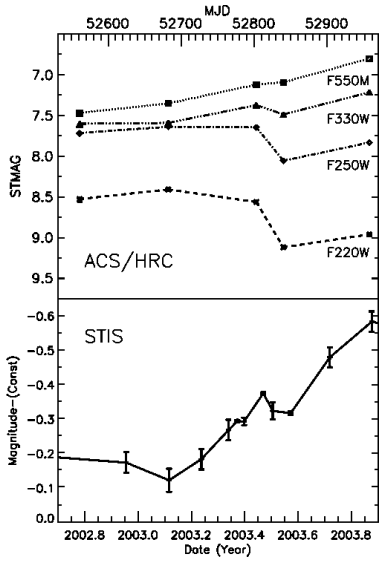

Figure 4. HST photometry of η Car from STIS and ACS.

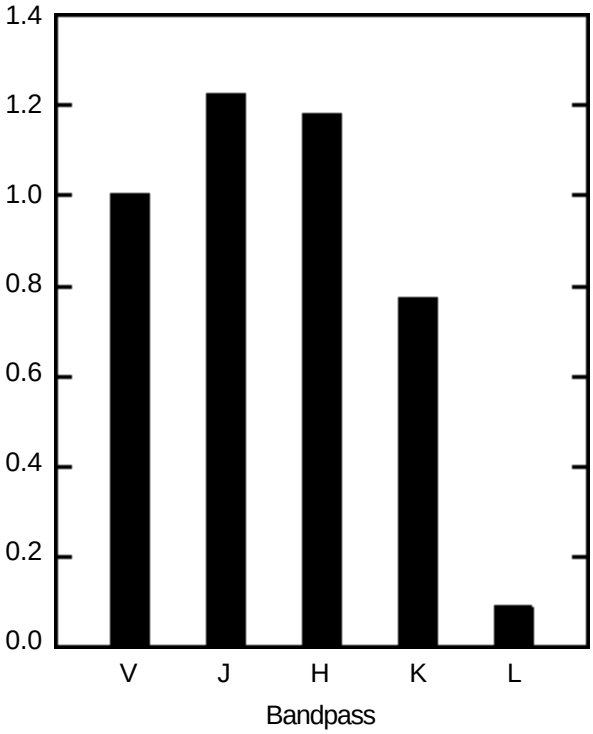

Figure 5. η Car 30-year brightening trend. JHKL photometry from Whitelock *et al.* (2004).

Table 1. η Car 30-year brightening trend. JHKL photometry from Whitelock *et al.* (2004).

Band	*m/30yrs*
Visual	1.0
J	1.22
H	1.18
K	0.77
L	0.09