Non-LTE Modeling of Nova Cygni 1992

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Abstract. We present a set of atmospheric models that are fit to the observed early time development of the UV spectrum of Nova Cyg 92. The models have an unprecedented number of species and spectral lines treated in direct multi-level NLTE.

1. Introduction

The early phases of nova explosions are dramatic, and challenging to model, because, among other things, the early UV light curve is dependent upon the rapid time development of massive line blanketing opacity as the expanding atmosphere heats up. Because nova atmospheres are translucent to large physical depth, and have steep radial density and temperature gradients, their UV spectra are heavily blanketed with many absorption lines that arise from many ionization stages. Therefore, detailed NLTE modeling with many species treated in NLTE is necessary to accurately model the spectrum and the light curve (Hauschildt et al. 1994). Nova Cyg 92 is the most extensively observed nova in the UV.

2. Modeling

As a result of recent improvements (Short, Hauschildt, & Baron 1999), the model atmosphere code PHOENIX can now self-consistently treat 103096 overlapping bound-bound transitions among 10991 energy levels among 93 ionization stages among 23 chemical elements in direct multi-level NLTE in the calculation of both the equilibrium structure of the atmosphere and the emergent spectrum. Fig. 1 shows the comparison of the IUE spectra in the IUE SWP and LWP bands and the synthetic spectra as a function of time. The spectra are best fit by a sequence of models that heat up from $T_{\text{eff}} = 12$ kK to 17 kK over the first two weeks of the optically thick wind phase. At each time, the best fit $T_{\text{eff}}$ was
Figure 1. Comparison of observed and synthesized spectral time sequence. Dark lines: IUE LWP and SWP band spectra; light lines: synthetic spectra. Each time is labeled with the observed UV color, $T_{UV}$ (see text), and the $T_{\text{eff}}$ of the best fit model. The first spectrum is during the fireball phase.

found by comparing the synthetic and observed IUE "color", which is formed by calculating the value of $\log(\int d\lambda F_{\text{LWP}} / \int d\lambda F_{\text{SWP}})$. There is good agreement with the overall shape of the pseudo-continuum at all times, which is significant because this $\lambda$ range is very temperature sensitive at these temperatures.

References