Mass Loss from Stars and the Evolution of Stellar Clusters
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The Early Mass Loss History of the Classical Nova V1974 Cyg 1992

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Abstract. The wind of the classical nova V1974 Cygni is studied by modeling the observed profiles of the most prominent ultraviolet doublets Mg II, C II, Al III, Si IV and C IV through the Sobolev Exact Integration (SEI) method by Lamers et al. (1997). Examples are shown for the Mg II 2800 Å doublet.

Accurate knowledge of the mass and chemical composition of matter ejected by novae in outburst is of crucial importance to gain insight on the enrichment of the interstellar medium in specific isotopes (Romano & Matteucci 2003), as well as to unveil the inner structure of the white dwarf and thus, indirectly, the nature of the progenitor star (see the case of O–Ne–Mg – novae, Livio & Truran 1994). The amount of mass lost also affects the further evolution of nova systems (see the evolutionary link between recurrent novae and type Ia supernovae proposed by Hachisu & Kato 2001).

In this paper we apply the Sobolev Exact Integration (SEI) method (Lamers, Cerruti–Sola and Perinotto 1997) to model the P Cygni profiles of the ultraviolet resonance doublets (Mg II, C II, Al III, Si IV and C IV) of the bright classical nova V1974 Cyg, whose 1992 outburst has been monitored in detail with IUE at high resolution (Cassatella et al. 2004).

Our purpose is to derive how mass loss and wind parameters vary with time during the outburst phase and to compare the results with the optically thick wind model of Hachisu & Kato (2005).

Following the notation in Groenewegen & Lamers (1989,1991), the mass loss rate $\dot{M}$ is proportional to $R_* v_\infty^2 \tau / q A_E$, where R_* is the photospheric radius, v_∞ the terminal velocity of the wind, τ the integrated optical depth in the line, q the mean ionization fraction of the ion considered, and A_E the abundance by number relative to H (we have omitted a normalization factor of τ – of the order of unity – and the atomic constants specific for the transition considered). Fitting the SEI model profile to the observed profile provides τ, v_∞ as well as the appropriate opacity and velocity laws of the wind.

For each doublet we have determined $q \times \dot{M}$ as a function of time assuming R_* as a function of time from Hachisu & Kato (2005), and the A_E values from Vanlandingham et al. (2005). Examples of model fitting of the Mg II profiles of V1974 Cygni on days 1, 12, 28 and 80 after outburst are given in Fig. 1.

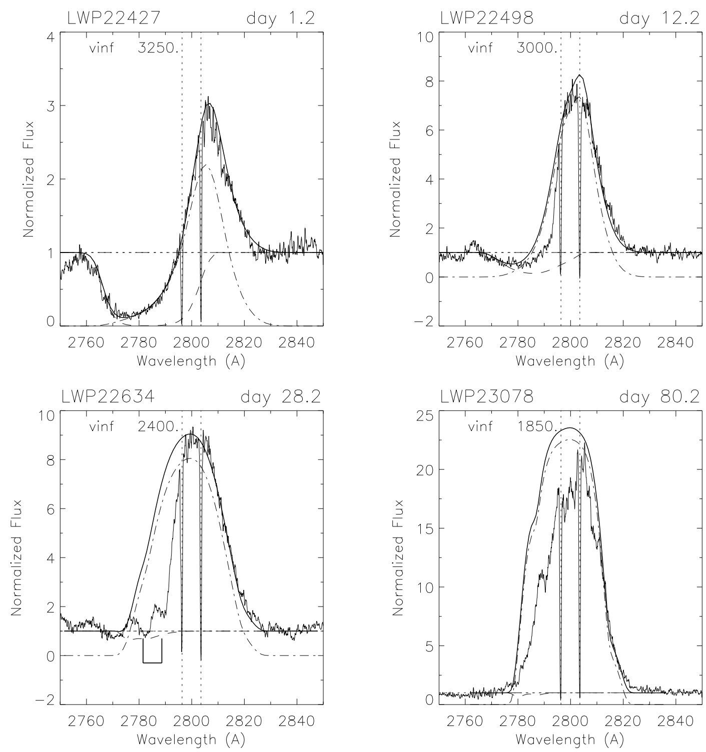

Figure 1. Observed and predicted profiles of the Mg II doublet at different dates. The continuous thick line, and the dashed and dot–dashed lines represent the P Cygni profile that best adjusts to the observations and the corresponding absorption and emission components, respectively. The position of the absorption lines from the "principal system" is indicated for day 28. Note the large decrease of v_∞ from 3250 km s^{-1} on day 1.2 to 1850 km s^{-1} on day 80.2. In the same period the opacity τ has decreased by about a factor of three.

A detailed analysis of the results obtained and of the implications for the nova wind model is in progress.

References

Cassatella, A., Lamers, H. J. G. L. M., Rossi, C., Altamore, A., & González–Riestra, R. 2004, A&A 420, 571
Groenewegen, M. A. T., Lamers, H. J. G. L. M., & Pauldrach, A.W.A. 1989, A&A, 221, 78
Groenewegen, M. A. T., & Lamers, H. J. G. L. M. 1991, A&A, 243, 429
Hachisu, I., & Kato, M. 2001, ApJ, 558, 323
Hachisu, I., & Kato, M. 2005, ApJ, 631, 1099
Lamers, H. J. G. L. M., Cerruti–Sola, M., & Perinotto, M. 1987, ApJ, 314, 726
Romano, D., & Matteucci, F. 2003, MNRAS, 342, 185
Vanlandingham, K. M., Schwarz, G. J., Shore, S. N., Starrfield, S., & Wagner, R. M. 2005, ApJ, 624, 914