The UV and optical properties of 20 old novae

Pierluigi Selvelli[1] and Roberto Gilmozzi[2]

[1]INAF-Astronomical Observatory of Trieste, Italy, [2]ESO-Garching. Germany.

Introduction

The IUE-based studies of old novae have been generally restricted to the individual behavior of the few brightest members of the class. Inspired by the obvious motivation of exploring the UV behavior of the *entire* sample, we have retrieved all of the IUE spectra of old novae available in the IUE-INES databank (20 objects), and added the recurrent nova T Pyx. For every object, when possible, SW and LW spectra have been averaged and merged. For GK Per, only the spectra taken when the star was in "low" state have been used. CK Vul has been disregarded because of its extreme weakness. We note that in most cases the observations are at the "limit": only 4 objects are "bright" (mv 12-13), the other have m$_V$ higher than 14, up to mv = 17.

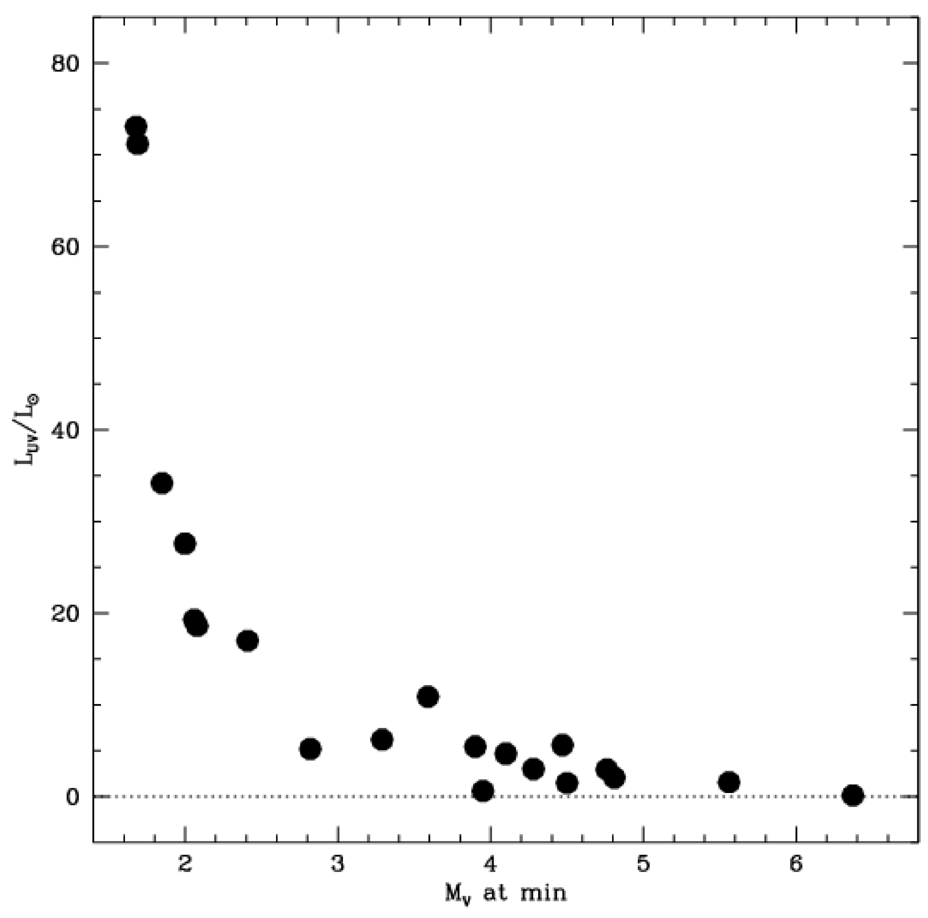

Figure 1: Periodogram of ...

The reddening and the distance

The "observed" UV spectra have been corrected for reddening by removing the broad interstellar absorption feature centered at λ 2175 Å, by applying the Savage and Mathis (1979) reddening law. The E_{B-V} values are quite clearly determined for most objects (see Table1), with the exceptions of X Ser and DK Lac (quite weak and noisy spectra) and GI Mon (bad overlap of the SW and LW regions).

For all old novae in the sample, a new estimates of the distance has been derived using the new extinction A_v=3.15×E_{B-V}, the value of m_V^{max}, and the M_V^{max} from the MMRD relations of Della Valle and Livio (1995) and Downes and Duerbeck (2000). The final value for the distance is the average.

The reddening-corrected UV continuum is well described by a power law $F_\lambda \sim \lambda^{-\alpha}$, where the spectral index α lies in the range $\sim$ 0.0 (GK Per in low state, DQ Her) to $\sim$ -2.6 (V841 Oph, T Aur). We note that there are remarkable differences (¡¡) in the slope alpha for all objects in common with the optical study by Ringwald et al (1996), probably because of the much higher E(B-V) values they have reported.

The UV luminosities

The UV luminosities L_{UV}, as determined from the reddening corrected UV-integrated flux and the new distances are in the range from 0.1 $L_\odot$ (DQ Her) to $\sim$ 40 $L_\odot$ (HR Del) and are reported in column x of Table 1. Table 1 gives also the absolute visual magnitude at minimum M_V^{min}, as estimated from the new distance and reddening and the m_V^{min} values from various sources in the literature. The adopted m_V^{min} value is quite uncertain in some objects (V446 Her, BT Mon, X Ser, V841 Oph) because of intrinsic variations, eclipsing effects, dwarf-nova-like behavior, etc..

We point out also that most of the reported mv values are not simultaneous with the IUE observations.

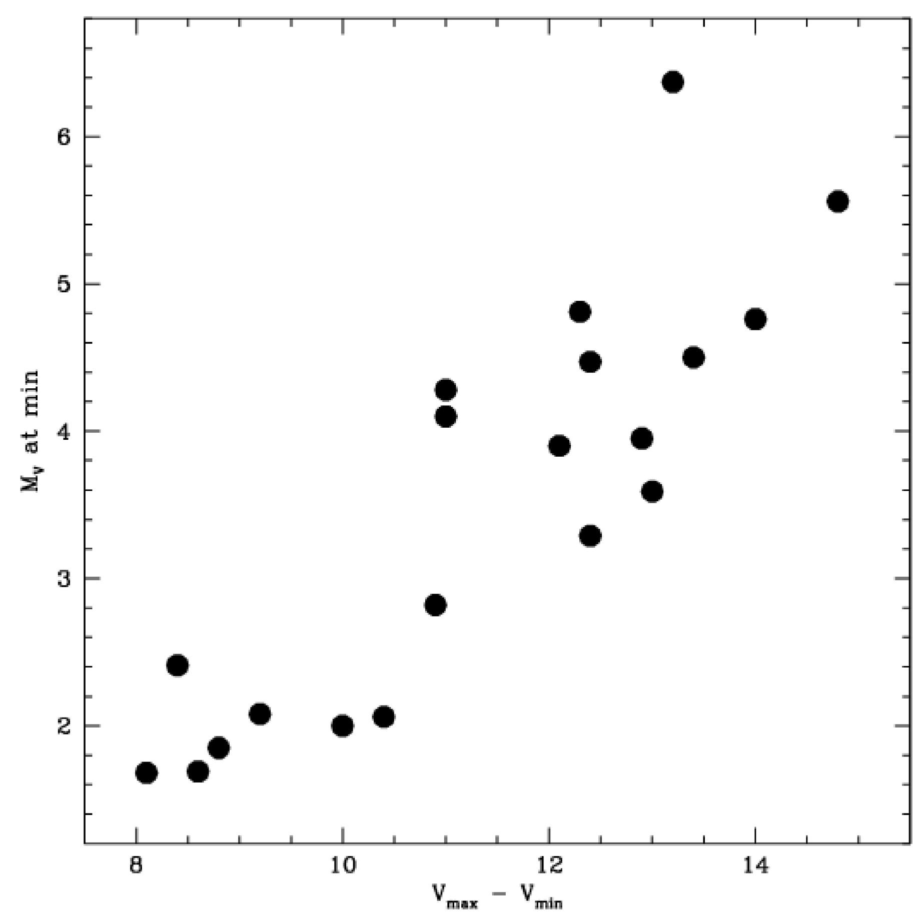

Figure 2: value maps

Searching for correlations

The data of Table 1 clearly indicate that a quite tight correlation exists between pairs of parameters such as L_{UV}-cos i, L_{UV}-M_V^{min}, and M_V^{min}-cos i, while a looser correlation exists between L_{UV}-α, L_{UV}-T, M_V^{min}-α, M_V^{min}-T, α-cos i, and T-cos i.

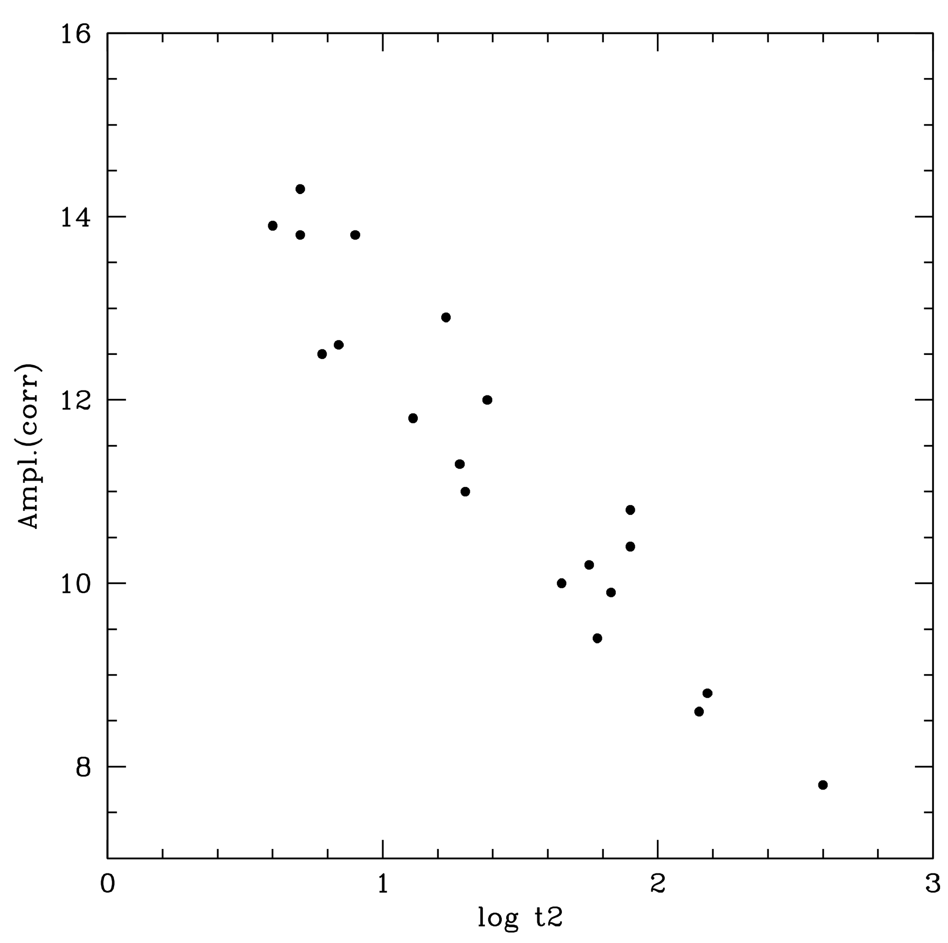

Figure 3: PP-plots for us

The definite correlation between L_{UV} and the system inclination angle is evident from Fig. 3: eclipsing objects (T Aur, BT Mon) have L_{UV}, close to 1$L_\odot$, while objects seen at low inclination or nearly pole-on (V 841 Oph) have L_{UV} on the order of 30 $L_\odot$. This behavior is in agreement with the conclusions reached by Warner (1987) that the "observed" M_V of old novae depends mainly on the system inclination angle, while the "reference" M_V (at i about 57^o for the V range) does not vary greatly from star to star. In particular it is found that objects seen at low $cos\ i$ values (e.g. BT Mon, GK Per, DQ Her) tend to have $\alpha \leq 1$, while objects seen at high $cos\ i$ values (e.g. V841 Oph, T Aur) have $\alpha \approx 2.5$.

Conclusions

The presence of a quite good correlation between L_{UV} and M_V^{min} (Fig. 4), indicates that the observed V magnitude is just the "tail" of the UV continuum distribution. Thus, the observed m_V has origin from the accretion disk itself, with a negligible contribution from other sources (the secondary).

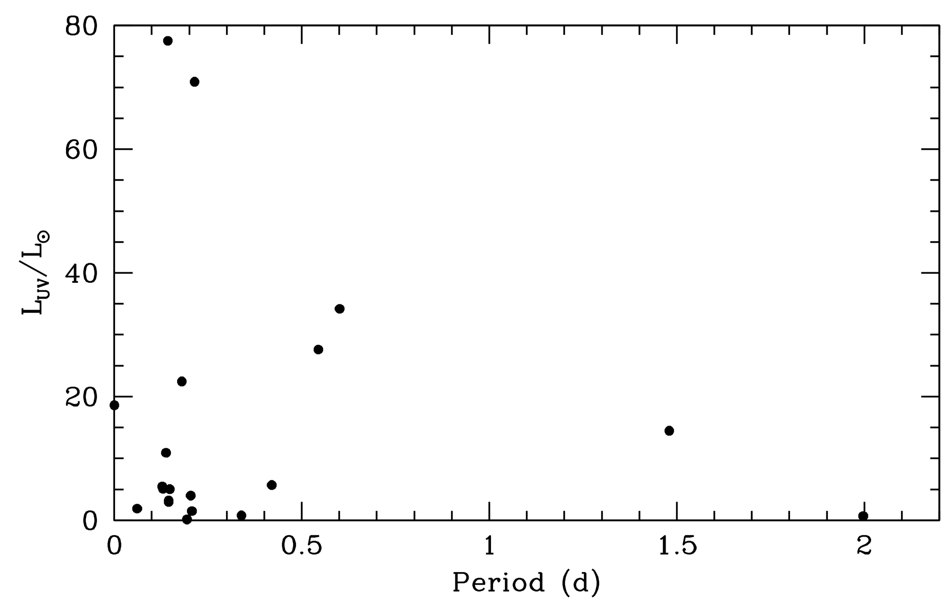

Figure 4: value maps

There are no additional clear correlations between pairs of the parameters listed in Table 1, but it is worth to mention that (with the exclusion of HR Del and T Pyx) a plot of L_{UV} versus ΔT shows some positive correlation !. BAD Luv -P : but lack of P values for five objects. P uncertain in X Ser. Patterson (1984) : relation M P**(3.3) forCVs

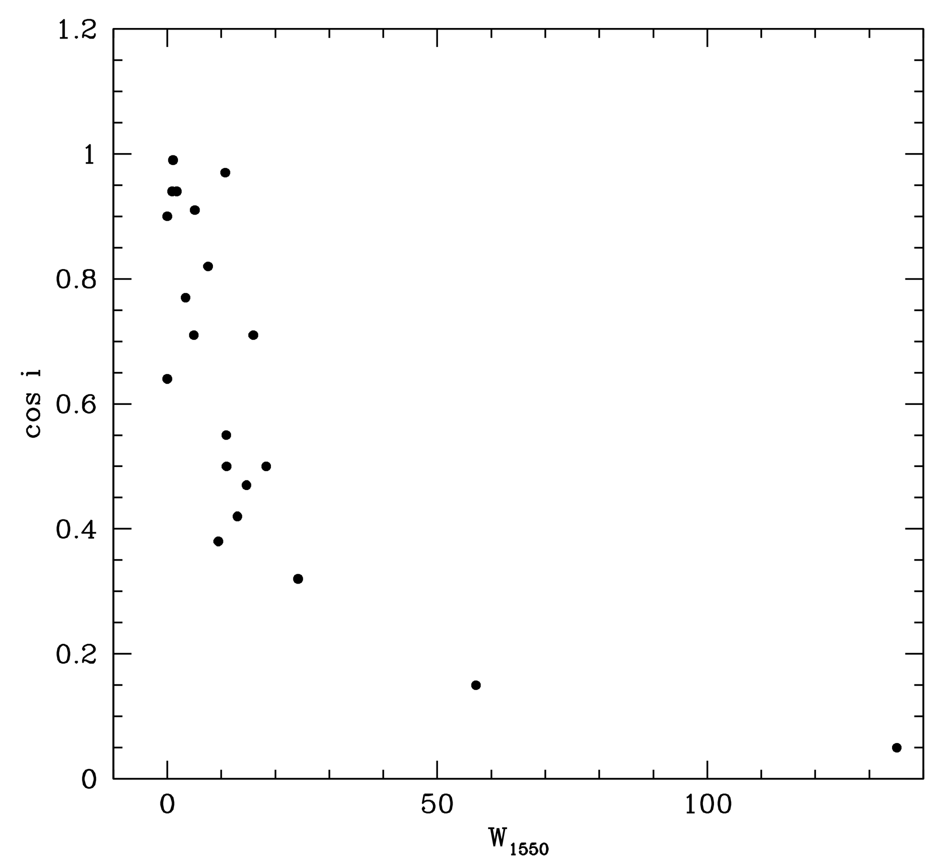

Figure 5: value maps

The equivalent width of the emission lines is strongly correlated with $cos\ i$, as it was the UV luminosity and the spectral index. In Fig. **??** we show, for example, the case of the CIV 1550 Å line

Most old novae show also the presence of some absorption features, likely identified as the resonance transitions of once-ionized metals (e.g, SiII 1260, CII 1335, etc). The origin (stellar, interstellar ?) of these absorption lines is not clear, since, apparently, no correlation between their equivalent widths and any of the system parameters (inclination angle, reddening, distance, etc.) has been found.

Final remark: how representative of the entire class of old novae the 20 objects under study are ? Selection effects may be present since only the brightest members of the class have been investigated.