tion of the system is larger than one Airy disk, as it is the case here, the two components can be independently analysed by, for instance, feeding the corrected image into a spectrograph.

5. Outlook

Considering these advantages, we have no doubts that Adaptive Optics is on the verge of becoming the most convenient way of first detecting, then studying, brown dwarfs in binary systems, even if speckle interferometry still provides a slightly higher angular resolution, in particular at 2.2 microns and below. The remaining question is how many such objects we can really observe with these techniques, knowing that only the youngest members of the class have not yet plunged behind the "invisibility barrier". The recent ups and downs of the hunting still prescribe a high level of caution when addressing this issue.

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Low-Resolution Spectroscopy of Southern Old Novae

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Current Views about Classical Novae at Minimum

Old novae, like dwarf novae, recurrent novae and nova-like variables, are Cataclysmic Variables (CVs). CVs are interpreted as interacting close binaries with a white dwarf primary and a red dwarf, or seldom a red giant secondary filling its Roche lobe. According to the current views, in many CVs matter from the secondary flowing through the inner Lagrangian point forms a hot viscous accretion disk around the white dwarf. Due to dissipation of angular momentum, this material moves inward across the disk until it is accreted by the white dwarf. The modes of accretion are different in CVs with strongly magnetized white dwarfs (their surface magnetic field is however only up to 10^8 Gauss, much less than the 10^{10} Gauss that isolated white dwarfs can reach).

In such objects accretion can occur without a disk, with flow of material to the polar caps as in AM Her systems, or a disk may exist but its inner part be disrupted, as in Intermediate Polars. Periodic thermonuclear runaways in the envelope accreted around the white dwarf are believed to produce the classical nova phenomenon (see Starfield, 1989 and references therein). Dwarf novae instead, show recurrent small amplitude outbursts which are believed to be caused by instabilities of the disk or of the mass transfer from the secondary. Old novae appear brighter and hotter than dwarf novae and this is thought to be due to larger mass transfer rates ($10^{-10} - 10^{-8}\ M_\odot yr^{-1}$ vs. $10^{-13} - 10^{-11}\ M_\odot yr^{-1}$). For accretion rates above $10^{-10}\ M_\odot yr^{-1}$ CV disks should be stable.

Current views of CVs, however, admit and suggest that secular changes of the mass accretion rates might cause an object to transit from one sub-class of CVs to another. To justify the space density of old novae, too low compared to the nova frequency, it has been hypothesized that most of the life of nova systems is spent in a state of "hibernation", with a very low mass transfer rate that makes most old novae faint and even undetectable (Livio et al., 1990). The nova phenomenon should then occur during the "high-state" of the mass transfer rate. Dwarf-nova like outbursts of three old classical novae have been observed and seem to confirm this theory (Vogt, 1986). Presently, however, the observational evidence for such an interpretation is still rather poor and modifications to the "hibernation" theory have already been suggested (Livio et al., 1990).

Some of the oldest recovered novae tend to become fainter, but their photometric behaviour can also be interpreted as very long term light oscillations, recently revealed for all CVs. The secondary components seem to have solar-type activity cycles which modulate the mass-transfer rate even long after the nova explosion (Bianchini, 1990, and references therein).

Many other features of the post-outburst behaviour of classical novae are

Table 1

Nova	Year	Mag (Dürbeck)	Mag (observed)
OY Ara	1910	17.5_p	19.5
CG CMa	1934	15.9_p	16.5
nova Car	1953	19.0_p	17.5
nova Cen	1986 N. 1	14.5_v	15.0
AR Cir	1906	15.0_p	14.2
BT Mon	1939	15.5 (var.)	17.3
GI Mon	1918	18.0_p	16.1
V616 Mon	1975 X-ray	20.2_B	18.2
RR Pic	1925	11.9_p	12.2
T Pyx	recurrent	15.3_p	15.5
CP Pup	1942	15.0_v	15.1
HS Pup	1963	20.5_p	18.1
HZ Pup	1963	17.0_p	17.4
nova Pup	1673	20.0_p	20.0
XX Tau	1927	18.5_p	20.0
CN Vel	1905	17.0_p	18.4–17.8

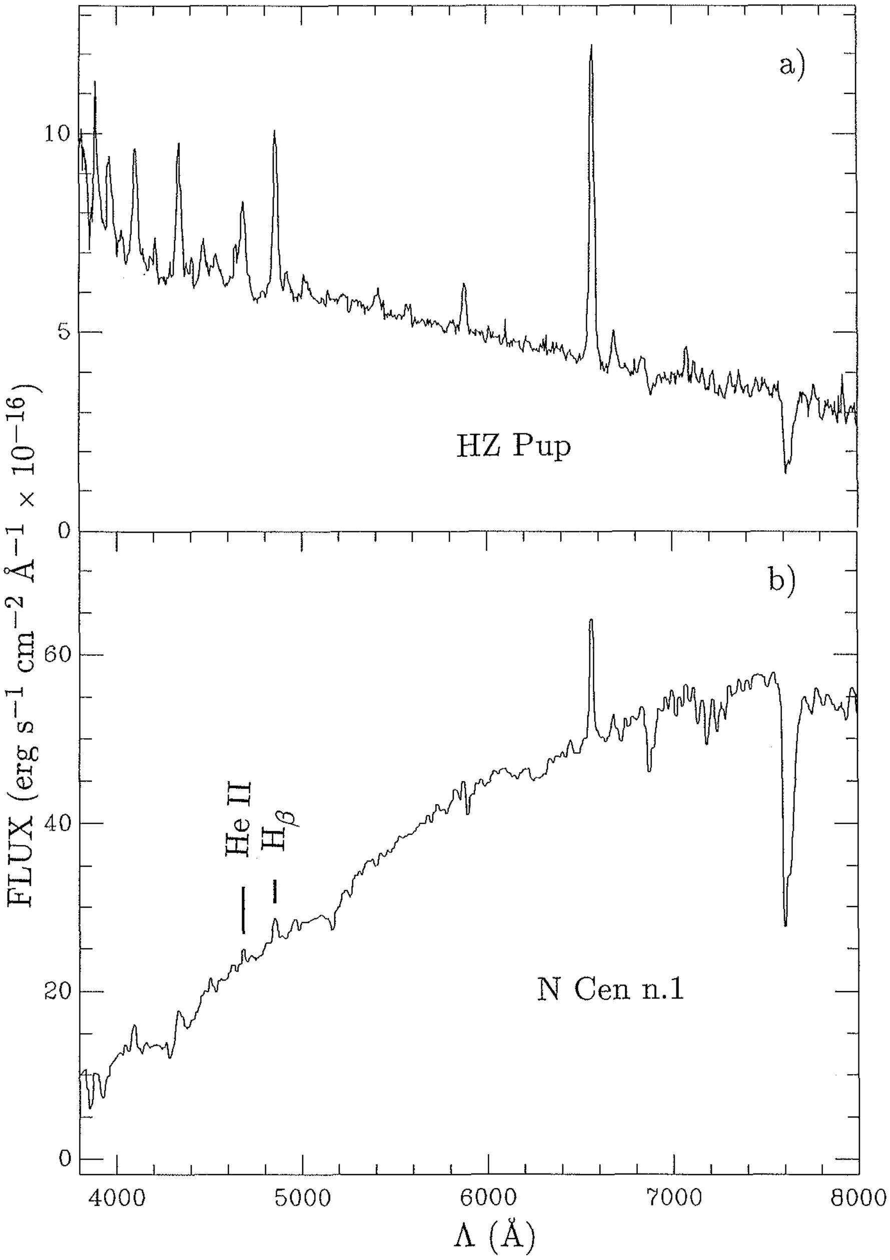

Figure 1: *The average spectrum of HZ Pup (Fig. 1a) compared with that of N Cen N. 1 1986 (Fig. 1b) that resulted much redder and symbiotic-like. The positions of H_β and He II 4686 are marked. Telluric absorptions are also visible.*

still very puzzling. It is not even clear when the white dwarf returns, after the explosion, to a true quiescent state. During the outburst, a fraction of the accreted envelope works its way back on the white dwarf, producing a long phase of constant bolometric luminosity. While the theory foresees a length of ≥ 100 years for this phase unless the white dwarf is rather close to the Chandrasekhar mass, UV observations (Gallagher and Code, 1974) and X-ray observations of nova remnants (Ögelman et al., 1987), suggest a turn-off time of only a few years.

A systematic study of novae at minimum is very promising not only for understanding the correlations between the properties of the binary systems (periods, masses, mass-transfer rates, etc.) and the characteristics of the explosion, including the chemical composition of the ejected material, but also as a test of the "hibernation" scenario sketched above.

The spectra emitted by old novae may be rather complicated: different parts of the binary system radiate in infrared, optical, ultraviolet and X-rays through a variety of thermal and non-thermal physical mechanisms. Most old novae are rather faint and although more than 200 galactic novae have been hitherto discovered, the spectra of only a very small fraction of them has been studied at quiescence, despite the importance of the post-outburst stage for the models. Only systematic spectrophotometric surveys including a large sample of objects allow a systematical approach to the problem, but there are only few and incomplete CV surveys with general results for novae for the northern hemisphere and none for the southern (see Shara et al., 1986, Williams, 1983).

The Programme

The aim of this spectroscopic survey is to study the continuum energy distribution at very low resolution and the intensities of low and high excitation lines in the spectral range 3000–9000 Å of the largest possible number of objects at different evolutionary stages. The survey of southern old novae has recently been started with the 1.5-metre ESO telescope, equipped with the B & C spectrograph, a 150 groves/mm grating and the CCD detector. The resolution is about 25 Å.

Old novae in the northern hemisphere are observed with the 1.8-m telescope of the Asiago Observatory, with equivalent equipment. In the first run at ESO in February 1991, 22 objects have been pointed and 16 spectra have been obtained. Exposure times ranged from 20 to 60 minutes. Our survey is part of a more general programme of multiwavelength study of post-outburst novae, that we are also pursuing with other means in other energy ranges: a selected number of post-outburst objects is being monitored with IUE in the UV range and with Rosat in soft X rays; significant results are expected also from the Rosat all sky survey.

First Results

Table 1 gives for each one of the observed objects the year of the outburst, the magnitude given in Dürbeck's catalogue (1987) and a rough estimate of the visual magnitude observed by us. For 10 of these objects the spectra at quiescence were obtained for the first time. The faintest object we were able to detect is N Pup 1673, the oldest of our sample, that has V ≃ 20. The signal-to-noise ratio in this case is only ≃ 3, but it is sufficient to measure at least the continuum level which seems to have a maximum around 5000 Å. No emission lines could be detected above the noise. HZ Pup (1963) is a classical example of a quiescent nova, with a very blue continuum, strong emission of H I, He I and He II (Fig. 1a). The identification of the quiescent OY Ara, that had an outburst in 1910, is classified as ambiguous in the Dürbeck catalogue (Dürbeck, 1987), but the strong and broad H emission lines, even if on an unusually red continuum, seem to confirm the previous identification beyond doubt. CG CMa

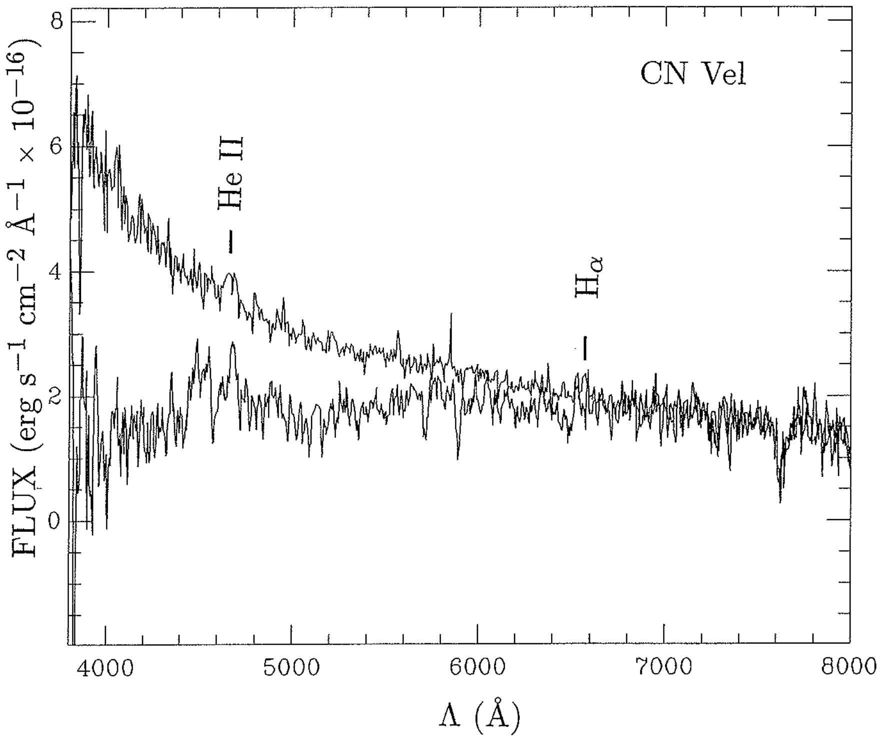

Figure 2: *The "blue flare" of CN Vel. The spectrum taken on February 21, compared to the average of the spectra of February 18 and 19, when the nova was at quiescence.*

(1934) does not appear as a classical nova, and even the suggested dwarf nova nature is extremely unlikely: the characteristic features of its spectrum are a hot continuum and H lines in absorption like a B star. An interesting possibility could be that of an X-ray source that bursted also in the optical range. Also the spectrum of N Car 1953 is not nova-like, but a late-type star absorption spectrum, casting doubts either on the classification as a nova or on the position recorded. An even later-type spectrum is that of AR Cir (1906), previously classified as a very slow nova, but probably a symbiotic star. GI Mon (1918) shows a blue continuum with weak H and HeII emission lines. The spectrum of HS Pup (1963) has an F-type continuum, very strong Hα emission and a strong Balmer decrement ($\geq$ 4) that could be ascribed to interstellar material. XX Tau (1927) shows a blue continuum and strong Balmer emissions.

Among the novae for which the spectrum at quiescence is already known, there are BT Mon (1939), with a flat continuum with strong emission lines and HeII fainter than Hβ; T Pyx (recurrent), whose continuum is very blue; RR Pic (1925), which is very blue and has very strong lines of HeII and λ4650 (CIII); CP Pup (1942) with a blue continuum and equally strong Hβ and HeII; the optical and X-ray nova V616 Mon (A0620-00) (1975), black hole candidate (Mc Clintock and Remillard, 1986). We also observed N Cen 1986, that has Hα in emission and weak HeII overimposed on a very red spectrum that resembles a symbiotic star rather than a classical nova (Fig. 1b).

The most interesting finding is a flare of the very slow nova CN Vel (1905). The nova was observed for 3 nights and in the 3rd the continuum seemed to flare in the blue region, as it is shown in Figure 2. More observations of this interesting object are undoubtedly needed.

The variety of the observed spectra, noted also in the pioneering survey of Williams (1983) is very interesting and confirms that the nova phenomenon is still poorly understood, so that systematic studies of the old nova population are requested.

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