8 A Homogeneously Selected Sample of Cataclysmic Variable Stars

There is an enormous discrepancy of up to two orders of magnitude between the observed space density of cataclysmic variable stars (CVs), and population synthesis calculations. Patterson (1984) give an observed space density of $\sim 10^{-6}\,\mathrm{pc}^{-3}$, whereas Kolb (1993) predict $\sim 10^{-4}\,\mathrm{pc}^{-3}$ from theoretical calculations. This discrepancy has been attributed to a bias in the selection of CVs. Bright detection limits in surveys carried out so far may have led to preferential selection of *high* mass transfer systems (Patterson 1984; Shara 1986), whereas population studies indicate that the population of CVs is dominated by *low* mass transfer systems; i.e., mainly dwarf novae (DN). DNs show very infrequent outbursts, and are intrinsically faint, so that they may have been missed by surveys with bright detection limits. Patterson (1984) argue that this "hidden population" of CVs may amount to $\sim 99\,\%$ of all CVs.

The HES with its deep limiting magnitude, and high spectral resolution, making it possible to resolve the broad emission lines of CVs, offers the chance to look for this hidden population. Examples for HES spectra of CVs are shown in Fig. 54. The final aim of the project is to determine the scale height and space density of a well-defined sample of CVs.

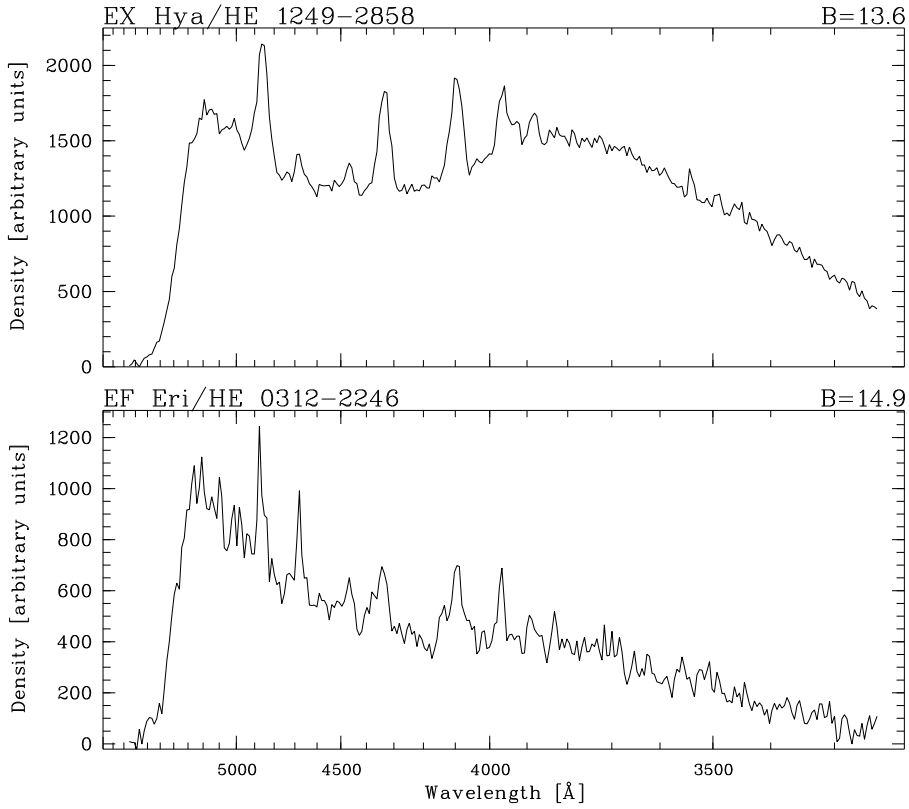

Figure 54: HES spectra of cataclysmic variable stars. Upper panel: the dwarf nova EX Hya; lower panel: EF Eri, a magnetic CV. In this type of object the formation of an accretion disc is prevented by strong magnetic fields. The absence of an accretion disc results in a less blue continuum.

We select CVs in the HES with the help of a feature detection algorithm similar to that described in Sect. 3.2. In the version adapted for CVs, the continuum is not determined by filtering, but is fitted simultaneously with the stellar lines under consideration. The selection criteria for CVs were:

(a) UV excess, i.e. dx_hpp1> 0, corresponding to $(U-B) \lesssim -0.18$

(b) Detection of Hβ in emission.

On an effective area of $\sim 1500\,\mathrm{deg}^2$ we identified 20 CV candidates. 6 of them could be identified as galaxies with the help of DSS-I images; another 5 were already known CVs. The remaining 9 candidates have been observed at the ESO-Danish 1.54 m-telescope in November 1997 with a resolution of $R = 1300$ (Grism #7 with $1''$ slit), which allows to resolve emission lines broader than 230 km/s. Since in CVs gas of the secondary is accreted onto the surface of a white dwarf, having a small radius, the velocity components of the gas along the line of sight in the inner part of the accretion disc are typically much higher than 230 km/s. This enables us to distinguish CVs from T Tauri stars, in which a much larger star sits in the middle of the accretion disc, so that lower velocities occur, and from dMe stars, with photospheric, unresolved lines.

Of the 9 stars observed, 6 have been confirmed as CVs; the remaining three are a dMe star, a T Tauri star, and a QSO, respectively. Hence, of the original set of 14 candidates, 11 (or 79 %) are CVs. This is the highest selection efficiency ever obtained in a survey for CVs. One of the CVs discovered in the HES, HE 0409-3029, turned out to be an eclipsing binary with a period of $\sim 3^h\,25^m$ (Augusteijn 1998, priv. comm.).

A first, rough estimate of the surface density of CVs based on our small sample indicates that in the HES, $\sim 3\times$ more CVs are found than in the Calán-Tololo Survey (CTS), when we apply the HES limiting magnitude to the CTS sample (Augusteijn 1998, priv. comm.). In the CTS, CVs are searched *by eye* on objective prism plates. The limiting magnitude of the CTS is $B_J = 18.5$. The above estimate is consistent with the fact that 5 of the 11 confirmed HES CVs *should* have been found in the CTS, since the survey areas overlap, but only 2 *have* been found. This suggests again, as in case of metal-poor stars, that quantitative selection criteria applied to digital data are superior to manual selection. However, our arguments are so far based on small numbers only.

Acknowledgements

The search for CVs was carried out in collaboration with T. Augusteijn and C. Tappert. Thomas carried out the follow-up observations of HES CVs.

References

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