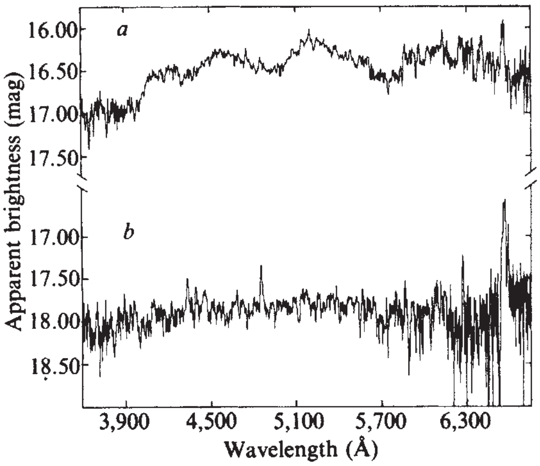

Fig. 2 IDS scans of VV Pup at 10 Å resolution on 2 February 1979 for *a*, the bright (11.48 UT to 11.58 UT) and *b*, the faint (12.27 UT to 13.10 UT) phases.

energy distribution at $\lambda \sim 4,100$ Å could then be interpreted as an optical depth effect.

Because X rays have hitherto not been detected in VV Puppis, there is no direct observational evidence, unlike AM Herculis, for the presence of a shock region. It is therefore possible that the features arise from a cooler region and that magnetic broadening effects are important. However, the eclipse data and luminosity criteria favour a high temperature ($\sim 10^8$ K) emitting region of small dimension[5,17].

The absorption features we have observed have not previously been detected in VV Pup. However, the long term variability of the light curve suggests that the height h of the optical column is variable. Values of $10^{-1} R$ and $10^{-2} R$ where R is the radius of the white dwarf, have been reported even at phases when the system had similar maximum brightness[5,6]. It is not clear how changes in the accretion rate are related to the height h, and width d, of the column. For a dipole field geometry and a cylindrical column at a pole a feature of half width $\Delta\lambda$ will survive magnetic broadening if $h/R \leqslant 1/3\ \Delta\lambda/\lambda$ and $d/R \leqslant 8/3\ \Delta\lambda/\lambda$. For the λ4,350 Å feature to be detectable we require $h/R < 0.02$ and $d/R \leqslant 0.16$. A large increase in h or d could easily result in the obliteration of the absorption features by magnetic broadening thus accounting for their non-detection by previous observers.

These spectra of VV Pup show hitherto unreported absorption features which are most probably high harmonic ($m = 6, 7, 8$) cyclotron absorption in the shock region near the surface of the white dwarf.

If this interpretation is correct, this would be the first determination of the magnetic field in the vicinity of a white dwarf in a close binary system. The analogy with Her X-1 where an X-ray cyclotron feature appropriate to the field of a neutron star has been detected is worth noting. Note also that the field strength deduced for VV Puppis lies in the range of field strengths deduced for isolated white dwarfs by the Zeeman effect[16,17].

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Optical counterpart of 2A0311−227

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The X-ray source 2A0311−227 was recently identified independently by Williams[1] and by Griffiths *et al.*[2]. Williams made a tentative identification from an inspection of low dispersion objective prism Schmidt plates taken at Cerro Tololo Inter-American Observatory for the discovery of active galaxies and quasars. The identifying characteristics were strong emission of H and He II. Griffiths *et al.* made the identification from an excellent HEAO-1 position followed by spectroscopic observations. The optical position of the object is $\alpha =$ 3 h 12 min 00.0 s, $\delta = -22°\,46'\,48''$ (1950). Figure 1 identifies the X-ray source among the neighbouring stars. It has a mag (variable) of about 15. Immediately after the tentative identification by Williams the 1.3-m telescope at McGraw-Hill Observatory on Kitt Peak was scheduled for spectrophotometric observations of the star in question, and we report the results here. A photon-counting spectral scanner was used. The instrument gives a dispersion of 1.15 Å per channel. Exposures of 5 and 10 min were made that covered the spectral region from 4,000 Å to 5,800 Å. A few scans were taken with lower dispersion and broader spectral coverage. The spectrum shows strong emission features, especially H I, He II λ4686 and the C III–N III blend at λ4640–4650 (ref. 2).

Analysis for radial velocities of the individual spectral scans obtained on the first night showed the star to be a spectroscopic binary of short period. Observations on subsequent nights established a period of 81.04±0.01 min (ref. 1).

The velocity curve for Hβ is shown in Fig. 2. The phase was computed from HJD 2,443,915.6300±0.0006+0.05628E. The semiamplitude is 355 km s^{-1}. The velocity curve for He II λ4686 is very similar. Any difference in either amplitude or phase is obscured by scatter in the observations. Both Hβ and He II λ4686 show a systemic velocity of $+130$ km s^{-1}. However, the projection of the solar motion at this galactic longitude and latitude ($l = 212.9$, $b = -57.4$) is 73 km s^{-1} which gives a galactic radial velocity of $+57$ km s^{-1}. The annual proper motion of $+0.147 \pm 0.013''$ and $-0.070 \pm 0.013''$ in right ascension and declination, respectively (W. J. Luyten, personal communication) indicates that the object is no more than a few hundred parsecs away.

The widths of emission lines are approximately 700 km s^{-1}. Their equivalent widths vary with phase. For example, Hβ changes by a factor of three. However, these equivalent widths must be corrected for variability of the underlying continuum. Preliminary data suggest that variations in the total flux will be small.

Blue and yellow light curves for this object were obtained at Carnegie Southern Observatory (data not shown). There are two maxima and two minima in visual light (5,300 Å); the two minima are of nearly equal depth, but the two maxima differ by 0.4 mag. The total variation is near 1.2 mag, at $V = 13.8$–15.0. A characteristic of the visual light curve seems to be a three-peaked structure at the primary maximum. The separation of the peaks is approximately 6 min and the drop in brightness between peaks is typically 0.3 mag. The central peak, which is also the brightest, occurs at phase 0.775. The maximum is in phase with the maximum velocity of approach. In the blue (4,300 Å) only one maximum is present, which again

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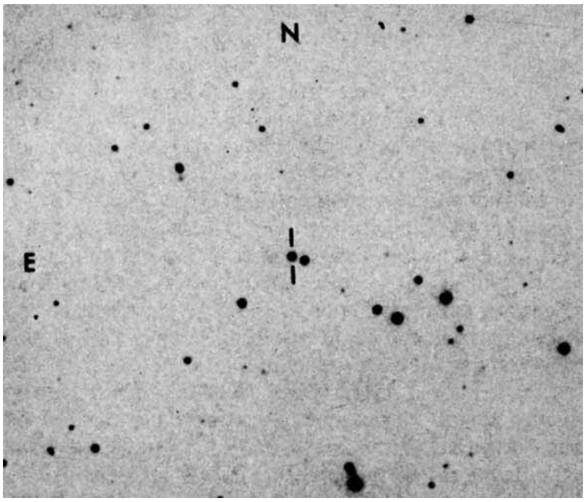

Fig. 1 Identification chart for 2A0311 − 227.

corresponds in phase to the primary maximum of the visual light curve. The total variation in the blue is about 0.6 mag. During one cycle of the blue light curve a large dip of 0.6 mag was observed during the maximum. This dip, which occurred at phase 0.712, had a width at half-minimum of about 2 min compared with 20–25 min for the maximum on which it occurred. One cycle later the dip was again present, although less pronounced. There is a colour variation, as one would expect from the differences in the blue and yellow light curves, with the star reddest at the two maxima of the yellow light curve.

This system has many characteristics in common with AM Herculis. The period is short (81 compared with 186 min), the spectral characteristics are similar (strong H and He II emission), the light curves for both systems are radically different in blue and yellow radiation[3], the two stars show considerable flickering[3] and both stars show variable circular and plane polarisation[4,5]. Each shows a short polarisation pulse that corresponds to maximum light[4,5]. In this system the polarisation pulse occurs at phase 0.742. Interestingly, this agrees very well with the dip in the visual light curve which precedes the central peak of the primary maximum. Finally, both objects have variable X-ray radiation[6,7].

The model for this X-ray source is therefore probably similar to that of AM Her—a white dwarf and a low mass main sequence companion[8]. We suggest a model with a white dwarf of 1.2 solar masses and a companion with 0.2 solar masses. This model follows from the work of Warner who has found that the masses of white dwarfs in cataclysmic variables are typically 1.2 solar masses[9]. He has also found that there is a relationship between the mass ratio and the orbital period. Using this relationship we find a mass of 0.2 solar masses for the secondary. In this model the separation of the two components is 0.7 $R_\odot$ and the main sequence component will just fill its Roche lobe. The collapsed star is most probably a white dwarf, as circular polarisation is observed[5]. Also, this model is compatible with the estimated distance from the proper motion.

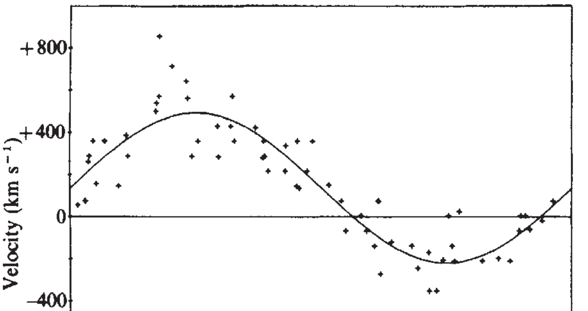

Fig. 2 The Hβ velocity curve for 2A0311 − 227.

The origin of the emission lines is unclear, but, as in other similar systems, they probably arise from the gas flow from the companion to the white dwarf. Further analysis of observational data may assist in establishing a more critical working model for this unique system.

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Atomic resolution with a 600-kV electron microscope

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The resolution that may be achieved with an electron microscope can be improved by increasing the accelerating voltage, provided that the electrical and mechanical design is of a sufficiently high standard to realise the theoretical performance[1,2]. Several such microscopes have been constructed in recent years[3–5] and have produced images containing information which can be interpreted directly to a higher resolution than any yet obtained at 100 kV (refs 6, 7). The Cambridge University 600-kV high resolution electron microscope is now yielding high quality micrographs with directly interpretable resolution approaching 0.2 nm. We describe here some of the novel features of this microscope and give some measurements which establish its electron-optical performance. We also show some examples of recent observations which demonstrate the benefits of its atomic resolving power. A more detailed description of the instrument and more references are given elsewhere[2,8].

The electron gun incorporates a lanthanum hexaboride thermionic cathode, in the indirectly-heated rod configuration[9,10]. For operation with a brightness 10 times greater than is normally obtained from a tungsten filament the cathode lifetime is regularly more than 100 h. Such brightness allows observation of images on the fluorescent viewing screen at electron-optical magnifications > ×500,000, and hence permits direct and accurate correction of astigmatism and choice of objective lens defocus without recourse to lengthy trial and error procedures (compare Krivanek *et al.*[11]). Fringes of 0.27 nm spacing from a

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