IUE AND OTHER NEW OBSERVATIONS OF THE SLOW NOVA RR TEL

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ABSTRACT

Ultraviolet spectra of RR Tel made with the International Ultraviolet Explorer satellite are reported. These cover the range 1150-3200 Å at both high and low dispersion through both large and small apertures. A range of exposure times yields a dynamic range of 1000 in line intensities. A line list of 431 lines is presented giving measured wavelength, intensity and full width at half maximum. Over three quarters of the lines are identified. There is a correlation of line width with ionization energy. Lines identified include common species from once to four times ionized. Lines seen are generally resonance, semi-forbidden or forbidden lines but some recombination lines are also seen for C, O and Ne. Many Fe II lines are seen - most are from odd levels near 5 ev to even low - lying levels but decays from even 10 ev levels are also seen. One third of the decays from the 5 ev levels are part of a cascade from higher levels. Population of the 10 ev levels may be due to Lα fluorescence. Diagnosis of densities and temperatures suggests stratification. Forbidden line wavelengths are used to refine intersystem separation of energy levels in some species.

Low dispersion data yield a continuum energy distribution. The strength of the $\lambda 2175$ feature and the He II Paschen line intensities yield $E_{B-V} = 0.10$ magnitude. The continuum energy distribution is not due to a simple combination of gaseous emission processes and a hot star or accretion disk but the very high ratio of the energy in the lines to that in the continuum of 3.3 argues such a source must be present.

New ground-based photometry finds variations of order 0.03 magnitudes r.m.s. from night to night and within a night. If due to the lines this, in combination with the emission measure, would interestingly constrain the distance but it is more likely the variation is seated in the continuum.

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The full text of this paper will shortly be submitted to Monthly Notices of the Royal Astronomical Society. The line list is available on request from the authors.

ON THE NATURE OF THE NOVA-LIKE VARIABLE CD-42°14462

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ABSTRACT

Low-dispersion long and short wavelength IUE spectra of the nova-like system CD-42°14462 were obtained on August 24 U. T. 1979. The short wave spectrum exhibits absorption features due to C III (λ1175), Lα (λ1216), N V (λ1240), He II (λ1640), Si IV (λ1394), N IV (λ1785) with C IV (λ1550) as a P Cygni feature with blue-shifted absorption suggesting the presence of material leaving the system. Possible interpretations of this object are discussed.

INTRODUCTION

Nova-like variables seem to be related to cataclysmic variables but are not known to have suffered major outbursts such as those of dwarf novae, recurrent novae, classical novae or symbiotic variables.

The system CD-42°14462 (V3885 Sgr) (refs. 1, 2, 3, 4) is one such system which, optically, exhibits broad Balmer absorptions, weak He I absorption and Ca II with possible weak central emission in the H lines. Rapid flickering with periodicities near 30 seconds is presumably associated with a hot spot at the impact region of material with an accretion disk (refs. 5, 6).

Cowley et. al. noted its spectroscopic similarity with the nova-like system BD-7°3007. If one is viewing a single white dwarf, it is particularly puzzling to have the simultaneous presence of H, He I and Ca II. In normal white dwarf stars, Balmer H and He I lines are rarely observed together and when Ca II is present with only Balmer lines, the Balmer lines are usually narrower.

CD-42°14462 has recently been observed as an X-ray source by the Einstein satellite over the energy range 0.15 to 4.5 Kev (ref. 7). We report below on IUE observations of CD-42°14462 as part of a survey of nova-like variables at ultraviolet wavelengths.

OBSERVATIONS

We have obtained IUE low dispersion short (SWP 6280) and long (LWR 5450) wavelength spectra of the nova-like variable CD-42°14462. The exposure times with the large aperture were 8 minutes for both spectra. The short-wavelength spectrum was overexposed from 1250Å to approximately 1330Å and the long-wave spectrum was

overexposed in the interval 2450Å to 3000Å. The times of mid-exposure were August 24.7180 U.T. and August 24.7275 U.T. 1979 for the short- and long-wavelength spectra, respectively. In addition, using the Fine Error Sensor (FES) of the satellite, apparent magnitudes of $+10^{m}.35$ and $+10^{m}.34$ were measured. These apparent visual magnitudes are consistent with the measures of other investigators summarized in reference 2, and indicates a reasonably constant light level for the object. We display the short wave ($\lambda\lambda$1150Å - 1900Å) spectrum in figure 1.

The short-wavelength spectrum reveals the presence of the following absorption features: C III (λ1175), Lyα (λ1216), N V (λ1240), Si III (λ1300), Si IV (λ1393, 1402), He II (λ1640), N IV (λ1785) and possibly Al III (λ1850). In addition, a relatively strong C IV (λ1550) feature is observed in P Cygni profile with blue shifted absorption and essentially rest-frequency emission. The long-wave spectrum reveals the possible presence of N IV (λ2478), C IV (λ2493) and O V (λ2786) absorption features but otherwise appears featureless.

ANALYSIS AND DISCUSSION

Our continuum fluxes, plotted on a log F_ν vs. $1/\lambda$ (μ-1), are shown in figure 2, together with fluxes provided by J. L. Greenstein for a similar nova-like variable, BD-7°3007. On the same plot, fluxes from broad band photoelectric U, B, V, R, I photometry are shown from the observations of Wegner and Eggen for CD-42°14462 and multi-channel ground-based measurements of BD-7°3007 made by Greenstein (ref. 8). The absolute calibration of the U, B, V, R and I photometry was based upon the work of Hayes (ref. 9).

The spectrum of CD-42°14462 in figure 2 seems to be essentially flat from the far UV out to 5500Å but seems to turn downward longward of V with the lowest flux values being an I measurement near 0.9μ. Shown for comparison is a $F_\nu \alpha \nu 1/3$ flux distribution derived under local Black Body behavior for a viscous, steady state optically thick disk (ref. 10), a model stellar atmosphere (T_{eff} = 16,000°K; log g = 4.5) from Kurucz (ref. 11), and a steady state optically thick model accretion disk from the grid of Herter et al. (ref. 12), corresponding to a mass transfer rate $\dot{M} = 10^{-7} M_\odot$/yr and inclination i = 30°. The X-ray flux points log $F_\nu \simeq$ -30.1 ergs s^{-1} Hz^{-1} and log $F_\nu \simeq$ -28.4 ergs s^{-1} Hz^{-1} centered on ~5Å and 35Å, respectively due to Cordova (ref. 7) are off the scale of figure 2. The accretion disk model of Herter et al. (ref. 12) for the case shown in the figure predicts an X-ray flux of log F_ν = -25.6 ergs $cm^{-2}s^{-1}Hz^{-1}$ at 30Å.

The model accretion disk spectra shown in figure 2 are clearly discordant with overall observed fluxes. The $\nu^{1/3}$ distribution gives far better agreement than the models of Herter et al. (ref. 10) in the UV, but remarkably good agreement with the observed fluxes are achieved with the Kurucz stellar atmosphere at relatively low gravity. While we cannot completely rule out the presence of an accretion disk given the theoretical uncertainties in the models, the present data are best fitted with the Kurucz model atmosphere.

The hot components of other nova-like binaries have been fitted with hot stellar atmosphere models as reported by Slovak and Lambert for the old slow nova V603 Aquillae, and several symbiotic variables thought to have accretion disks but viewed at low inclination so that the disk is tilted out of the line of sight. Patterson* reported a cataclysmic variable, HT Cas, in which a white dwarf appears to dominate the light and seems to be responsible for the observed flickering.

Based upon our present data we cannot rule out any of the following three explanations of our overall continuum fluxes: (1) a hot optically thick accretion disk; (2) a cooler accretion disk ($T_{eff} \lesssim 25,000°K$) which mimics a stellar photospheric continuum; (3) a hot single star (no accretion disk) of uncertain surface gravity. A successful model of this system must account for the 0.2 day periodicity in the radial velocities found by Cowley et al. (ref. 4), the high-frequency oscillations reported in (ref. 5) and the X-ray fluxes reported by Cordova. A further constraint is imposed by the presence of the C IV P Cygni feature which almost certainly indicates systemic mass outflow of some type.

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