

A SPECTROSCOPIC SURVEY OF SOME HIGH-LATITUDE BLUE VARIABLES*

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As part of a search for optically variable extragalactic objects, we obtained slit spectrograms of 32 high-galactic-latitude objects selected from the variable-star literature. One of the objects, V395 Her, is a distant galaxy, but we question its reported variability. The remaining objects are galactic variable stars; they include several eruptive variables, new RR Lyrae-type variables, and a variable white dwarf.

Key words: variable stars — stellar spectra — galaxies

In recent years, eight objects originally considered to be galactic variable stars have been found actually to be extragalactic objects. The eight objects, listed by Bond (1973) and Bond, Green, and Huchra (1974), include several members of the BL Lacertae class of optically variable galaxies (Strittmatter et al. 1972) and the Seyfert galaxy X Comae, which occasionally undergoes violent outbursts (Bond and Sargent 1973).

It seems likely that several additional variable extragalactic objects, probably of stellar appearance, await discovery in the *General Catalogue of Variable Stars* (GCVS) and its 1971 *First Supplement*. In fact, a survey of selected objects in the GCVS might be a relatively efficient means for discovering rare, nearby, bright quasi-stellar objects.

As a step toward such a survey, we obtained image-tube slit spectrograms on the night of 1974 March 31–April 1 for 32 variables listed in the GCVS. The Cassegrain spectrograph of the Steward Observatory 90-inch reflector was used at a dispersion of $238 \text{ \AA mm}^{-1}$. The variables selected were more than 10° from the galactic equator and located in unobscured regions of the sky, of irregular or unknown types of variation, and of unknown spectral type. In general,

the objects selected were neutral or blue in color on the *Palomar Sky Atlas* prints, although in a small number of cases redder variables were included if rapid light variations had been reported in the literature.

Table I lists the variables observed, their types of variation and photographic magnitude ranges as listed in the GCVS, and, for some of the stars, “revised” types of variation that we have deduced from their spectroscopic characteristics. The spectral types listed in the table were derived by one of us (H.E.B.) from the image-tube spectrograms. The low spectral resolution made the classification of the spectrograms somewhat difficult, but the wide range of wavelengths recorded (below $3200 \text{ \AA}$ to above $6500 \text{ \AA}$) compensated for this to a degree by providing criteria not generally seen on ordinary photographic spectrograms. It is believed that the spectral types are accurate to within several tenths of a spectral type for most of the variables. However, in most cases it was impossible to derive luminosity classes from these low-resolution spectra.

A conspicuous group of nine B8–F0 stars was found to show large Balmer discontinuities and, usually, very sharp hydrogen absorption lines. These objects appear to be horizontal-branch stars, and the symbol “hb” is used for them in Table I. It is likely that these variables are of the RR Lyrae type. Of particular interest are

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TABLE I
SPECTROSCOPIC OBSERVATIONS
OF HIGH-LATITUDE VARIABLES

Star	Type of Variation		Magnitude Range	Spectrum	Notes
	Original	Revised			
AI Boo	cst		14.8	G2	1,8
AQ Boo	cst		12.3	F8p	2,8
AV Boo	cst		15.7	K5	3,8
AT Cnc	Cep?	E?	12.3-14.6	DA	4
SV CMi	Z Cam?		13.0-16.3	Bp	5
RU Com	?		14.4-15.1	GO	
WY Com	cst		15.2	GO	6,8
XX Com	cst		12.1	F5	7,8
AM Her	Is	UG?	12.4- (14.2	Pec	9
V395 Her	Is?	cst?	16.1-17.7	Galaxy	10
V432 Her	Is?	RR?	16.2-17.4	B8 hb:	
V459 Her	Is	RR?	15.5-17.0	A0 hb	11
V473 Her	Is		14.3-14.7	G8 III:	
S10294 Her	E?		14.5-15	GO	12
UV Hya	?	RR?	13.3-14.0	A2 hb	
GY Hya	RR?	UG?	14-16	G2p?	13
TU Leo	UG?		11.7-14.9	GOp	14
AR Leo	E?		12.8-13.3	G5	
CQ Leo	L		14.6-15.0	K3	
TX Lib	?	RR?	12.4-13.2	F0 hb:	
VY Oph	?	RR?	12.5-14	F0 hb	
AL Oph	?		14.1-15.0	G5	
V680 Oph	L		13.5-14.1	G5p	15
AN UMa	N1		15.4-17.4	Pec	16
TU Vir	?	RR?	13.0-14.0	A7 hb	
TV Vir	?		14.5-15.2	F5	
VZ Vir	?	RR?	11.9-13.1	B8 hb	
WY Vir	?s	RR?	12.5-13.7	A2 hb	
ZZ Vir	?s	RR?	13.2-14.3	A5 hb	
DP Vir	RR?		14-15	A7 V:	
DR Vir	E?		14-14.5	G5	
DS Vir	RR?		15-15.5	A7 V:	

Notes to Table I--

1. Eclipsing binary of small amplitude according to Hoffmeister (1964).
2. Diffuse spectral lines. Algol-type eclipsing binary according to Hoffmeister (1964).

TABLE I (*Continued*)

3. Eclipsing or rapid variable according to Hoffmeister (1964).
4. The presence of broad, shallow hydrogen absorption lines leads to the DA classification. The Na I D lines may be present in absorption. The white-dwarf spectrum rules out the suspicion of its discoverers (Romano and Perissinotto 1968) that AT Cnc is a Cepheid. The possible presence of the D lines in absorption suggests instead an eclipsing binary system composed of the DA star and a faint red-dwarf companion. Further observations would be of great interest.
5. The spectrum shows broad hydrogen absorption lines, a strong ultraviolet continuum, and no emission lines. Several He I lines are present in absorption, ruling out a DA classification. The star was near the bright end of its reported magnitude range at the time of observation. The lack of emission lines is not inconsistent with the spectroscopic behavior of other U Gem and Z Cam variables near maximum light (Joy 1960).
6. RR Lyrae variable according to Hoffmeister (1964).
7. Algol-type eclipsing binary according to Hoffmeister (1964).
8. Considered constant by Meinunger and Wenzel (1968).
9. Hydrogen and Ca II K emission lines are present, superposed on a blue continuum. The spectrum is very similar to those of several U Gem variables at minimum light (Kraft 1962).
10. Found to be a galaxy on the Palomar Sky Atlas prints by one of us (Bond 1972). V395 Her shows a normal absorption-line spectrum with a redshift of $+19111 \text{ km sec}^{-1}$ relative to the Sun. The normal spectrum leads us to question the reality of the light variations reported by Hoffmeister (1960) for this non-stellar object.
11. Very large Balmer jump and sharp hydrogen absorption lines.
12. Possible small-amplitude, short-period eclipsing binary according to Hoffmeister (1968).
13. RR Lyrae or U Geminorum variable according to Hoffmeister (1963a). The spectrum rules out an RR Lyrae type. A slight ultraviolet excess may be present, although strong night-sky emission lines make it difficult to be certain of this. The U Gem classification is probably correct.
14. Spectrum very strong in the ultraviolet. The GO star is either extremely weak-lined, or, more likely, has a faint, hot companion.
15. In spite of the G5 spectral type, the star is very red; the spectrum drops off rapidly near 4000 Å and could not be detected below about 3900 Å. Some RV Tauri variables have somewhat similar spectra (Joy 1952).
16. Strong emission lines of hydrogen, He I, and He II ($\lambda\lambda 4541, 4686$) superposed on a very blue continuum. Called an RR Lyrae variable by Hoffmeister

TABLE I (*Continued*)

(1963b), but found instead to show repeated, rapid, nova-like outbursts by Meinunger and Wenzel (1968). The spectrum bears a close resemblance to that of the photometrically similar star V Sge (Herbig et al. 1965).

stars like TU Virginis; this star is not particularly weak-lined (that is, Preston's 1959) index ΔS is small), in spite of its location at a distance of about 3 kpc above the galactic plane.

We call attention to several other objects of special interest in Table I. These include three hot, eruptive variables (SV Canis Minoris, AM Herculis, and AN Ursae Majoris), two possible U Geminorum-type variables (GY Hydrae and TU Leonis), and a variable, possibly eclipsing, white dwarf (AT Cancri). Further details are given in the notes to Table I.

All of the variables observed appear to be galactic stars, with the exception of V395 Herculis, which, as explained in the notes to Table I, was already known to be a galaxy. This result, although disappointing, was not surprising in view of the small number of objects observed. We still believe that this technique, which will be continued with both slit and slitless spectrographs, eventually will yield several new, relatively bright QSOs as well as new information on variable stars at high latitudes.

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