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SPECTRAL TYPES FOR OBJECTS IN THE KISO SURVEY. IV. DATA FOR 81 STARS

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ABSTRACT

Spectroscopy and spectral types for 81 ultraviolet-excess objects found in the Kiso Schmidt-camera survey are reported. The data were secured with the McGraw–Hill 1.3 m telescope at 8 Å resolution covering the wavelength interval $\lambda\lambda$ 4000 – 7200 Å using the Mark II spectrograph. Descriptions of the spectra of some of the more peculiar objects found in this sample are given and include 14 subdwarfs, 23 definite DA white dwarfs, including a magnetic one, and one DQ white dwarf, eight quasars and emission-line objects, and a new composite DA + dM system. More spectroscopy of the new cataclysmic variable KUV 01584 – 0939 and a possibly related object, reported in Paper III, is also described.

I. INTRODUCTION

This is the fourth paper in an ongoing spectroscopic survey of the ultraviolet-excess objects found in the first Kiso Schmidt-camera survey list (Noguchi, Maehara, and Kondo 1980; Kondo *et al.* 1982; Kondo, Noguchi, and Maehara 1984), whence numerous white dwarfs and other peculiar objects were found. So far, spectral types for 184 of these objects have been published in Wegner and McMahan (1985, 1986) and Wegner, McMahan, and Boley (1987) (Papers I, II, and III, respectively), and some further details on the observations can be found in Wegner *et al.* (1987). In the meantime, additional spectroscopic lists of other stars of this type have continued to be published, e.g., by Wagner *et al.* (1986) and Zotov (1985). This paper reports further spectroscopy of an additional 81 of the ultraviolet-excess stars from the Kiso sample in Noguchi, Maehara, and Kondo (1980), observed in May and October 1986. As in Papers II and III, we concentrated primarily on sources brighter than $m_G = 17.0$ and bluer than $(U-B) = \mathrm{CI} = +0.5$, where M_G and CI refer, respectively, to the magnitude and color index of the photographic Kiso system.

II. OBSERVATIONS

All spectroscopic observations were obtained at the McGraw–Hill Observatory on Kitt Peak employing the Mark II spectrograph attached to the 1.3 m telescope. Each star was usually observed on one night only. The instrumentation and data-reduction procedures are identical to Papers I, II, and III, and since the first paper (Wegner and McMahan 1985) gives more detail, these will only be explained briefly. The Mark II spectrograph contains a self-scanning linear-diode-array detector system and a six-stage fiberoptically coupled electrostatic image tube (cf. Shectman and Hiltner 1976). For the present data, a 2.8 arcsec diam entrance hole and a 300 lines mm^{-1} grating were employed, giving about 8 Å resolution over the wavelength region $\lambda\lambda$ 4000–7200 Å. The data reductions were done at Dartmouth employing standard techniques that consisted of eliminating pixel-to-pixel variations in the Reticon detector by dividing the stellar spectra with those of a tungsten-filament lamp, wavelength calibration, atmospheric-extinction correction, calibration of the instrumental response with spectrophotometric standard stars, and smoothing of the data by convolving with a Gaussian function of the same halfwidth as the instrumental profile.

III. RESULTS OF THE SPECTROSCOPIC OBSERVATIONS

Table I summarizes the spectroscopic properties of the 81 newly observed Kiso stars. Columns I, II, and III give the name, the right ascension, and declination in 1950 coordinates, respectively. Columns IV and V contain the V and $(U-B)$ colors of each star, converted from the photographic m_G and CI photometry of Noguchi, Maehara, and Kondo (1980) employing the relations derived by Kondo *et al.* (1982) and listed in Paper II. Column VI tabulates our spectral type for each star. Nine of the stars in Table I appear in the PG survey of Green, Schmidt, and Liebert (1986), and are marked with an asterisk following column I. Additional cross references with published catalogs for these objects can be found in Noguchi, Maehara, and Kondo (1980).

Figures 1 and 2 are linear plots of the observed spectra of some of the more interesting white dwarfs in Table I, and Figs. 3 and 4 are the same kind of plots for some of the emission-line objects. Some spurious features due to problems with night-sky subtraction near λ 5577 and telluric absorptions for $\lambda > 6900$ can appear in these spectra. The following notes describe some of the more interesting objects in further detail.

KUV 01509–1015. This 17.4 mag object (Fig. 3) shows broad Hβ and Hγ lines in emission near $\lambda\lambda$ 6605 and 5904 plus narrow [O III] near λ 6827, and thus has the appearance of a quasar with redshift $z = 0.30$.

KUV 01577–1221. This source appears to be a 17.6 mag quasar with a redshift of $z = 0.32$ as determined from broad Hβ and Hγ emissions near $\lambda\lambda$ 6750 and 6100 (Fig. 3).

KUV 03292+0035. This star appears to be a magnetic DA white dwarf with a mean surface field strength near 8 MG and has already been described in Wegner *et al.* (1987).

KUV 08387+4026. The spectrum of this object is nearly continuous, except for a possible emission feature near λ 4200, which is near the short-wavelength limit of our data.

KUV 13000+2908. The spectrum of this source and that of KUV 13011 + 3143, both shown in Fig. 4, exhibit strong narrow emission lines of Hα, Hβ, and [O III], and thus appear to be Seyfert II emission-line galaxies according to the

 0004-6256/88/061933-08$00.90

TABLE I. Summary of the spectroscopic properties of the Kiso objects.

KUV	R.A. (1950.0)	Dec. (1950.0)	V	(U-B)	Spectral type
01509-1015	01:50:56.0	-10:15:21	17.4	-1.0	QSO
01518-0928	01:51:45.2	-09:28:01	17.7	-1.0	DA
01577-1221	01:57:42.7	-12:20:38	17.6	-1.1	QSO
02075-0834	02:07:28.8	-08:34:07	15.8	-0.5	NHB
02510-0046	02:50:58.9	-00:45:57	16.7	-0.8	NHB
02579-0036	02:57:51.2	-00:35:34	17.3	-1.1	cont.?
03018+0234	03:01:48.4	+02:34:02	15.1	-0.1	NHB
03123+0155	03:12:16.6	+01:55:01	17.5	-1.0	DA
03195+0001	03:19:31.2	+00:01:21	16.6	-0.5	cont.
03292+0035	03:29:11.2	+00:35:08	16.7	-0.8	DAH
04239+1406	04:23:52.7	+14:05:33	16.7	-0.8	DA
04390+1631	04:39:02.1	+16:30:57	15.5	-0.9	NHB
05014+1225	05:01:23.1	+12:24:44	16.6	-0.8	cont.
05072+1249	05:07:14.1	+12:49:03	16.2	-1.0	sdB
05097+1649	05:09:40.0	+16:48:36	13.6	-0.1:	DA
05106+1625	05:10:36.2	+16:25:27	16.4	-0.8	NHB
05260+2711	05:25:58.7	+27:10:36	15.2	-0.8	DA
05286+2208	05:28:36.0	+22:07:46	14.4	-0.8	NHB
08100+3915	08:10:02.2	+39:14:40	16.6	-1.0	DA
08191+3951	08:19:07.0	+39:50:56	16.5	-0.9	sdO
08317+4117	08:31:43.3	+41:17:02	16.7	-1.0	DA
08368+4026	08:36:50.5	+40:25:43	15.5	-0.9	DA
08378+3934	08:37:48.0	+39:33:50	16.5	-0.9	DA
08381+3737	08:38:08.9	+37:37:03	17.0	-0.9	DA
08387+4026	08:38:39.6	+40:25:58	17.0	-0.9	cont.?

TABLE I. (continued)

KUV	R.A. (1950.0)	Dec. (1950.0)	V	(U-B)	Spectral type
08388+4029	08:38:46.5	+40:29:17	16.4	-0.5	sdB
08391+3800	08:39:05.3	+37:59:46	16.0	-0.9	DA
08418+3814	08:41:50.0	+38:14:26	15.8	-0.5	NHB
08422+3813	08:42:11.0	+38:12:57	15.9	-0.8	NHB
08473+3838	08:47:20.5	+38:38:30	17.0	-0.9	DA
08547+3830*	08:54:42.8	+38:30:28	15.6	-1.1	sdB
09008+3752	09:00:49.6	+37:52:13	17.2	-1.0	sdO?
09469+3813	09:46:56.6	+38:13:21	16.8	-0.5	NHB
10003+3732*	10:00:19.2	+37:31:39	15.0	-1.5	NHB
11230+4240	11:22:58.9	+42:40:03	17.0	-1.0	DA
11294+3725	11:29:25.3	+37:25:21	17.3	-0.9	NHB
11390+4225*	11:38:57.5	+42:25:20	15.5	-0.9	DA
11472+3858	11:47:13.5	+38:57:35	17.1	-0.8	DA
12532+2819	12:53:14.2	+28:19:17	15.3	-0.5	NHB
12540+2759*	12:54:02.0	+27:58:44	15.5	-0.9	NHB
12562+2839	12:56:09.6	+28:38:57	15.8	-0.5	DA?
12572+2811	12:57:09.8	+28:11:02	16.7	-0.8	sdO
13000+2908	13:00:01.6	+29:07:35	16.8	-0.5	em.
13008+2827	13:00:48.8	+28:27:11	15.9	-0.8	em.
13011+3143	13:01:03.4	+31:43:26	17.4	-0.8	em.
13023+3145	13:02:17.0	+31:45:08	16.0	-0.9	sdB
13037+2751	13:03:41.8	+27:51:30	15.8	-0.5	NHB
13066+2800	13:06:36.2	+28:00:18	16.0	+0.2	cont?
13077+3208	13:07:39.3	+32:07:37	15.5	+0.2	NHB
13079+3213	13:07:52.1	+32:13:18	14.8	-0.5	NHB
13088+3139	13:08:47.4	+31:38:48	16.4	-0.8	DA
13091+3122	13:09:06.8	+31:21:46	17.5	-0.9	em.

TABLE I. (continued)

KUV	R.A. (1950.0)	Dec. (1950.0)	V	(U-B)	Spectral type
13096+3008	13:09:37.8	+30:07:53	17.5	-0.9	sdOB
13126+3229	13:12:34.3	+32:28:46	16.4	-0.8	NHB
16303+3744*	16:30:15.5	+37:44:08	16.4	-0.8	QSO
16491+3539*	16:49:06.5	+35:38:43	14.7	-1.0	sdB
16501+3404	16:50:05.3	+34:04:25	14.3	-0.5	NHB
16507+3635	16:50:43.7	+36:35:10	14.0	-0.5	NHB
18020+6639	18:02:02.2	+66:39:11	17.1	-0.8	NHB
18046+6436	18:04:38.1	+64:35:36	15.9	-0.8	NHB
18126+6704	18:12:35.3	+67:03:51	15.5	-0.8	sdB
18169+6643	18:16:52.2	+66:42:59	16.3	-1.1	sdOB
18186+6740	18:18:37.0	+67:40:04	16.5	-0.9	QSO
18189+6501	18:18:53.2	+65:00:44	16.0	-1.0	sdB
18246+6508	18:24:36.0	+65:07:37	16.1	-0.5	NHB
18284+6650	18:28:24.2	+66:50:23	15.8	-0.5	DA
18312+6431	18:31:14.6	+64:31:30	17.0	-0.9	sdB
18332+6429	18:33:14.0	+64:29:27	16.9	-0.8	DA+dM
20432+7457	20:43:13.0	+74:57:09	15.1	-0.1	sd?
20573+7233	20:57:19.0	+72:32:50	15.0	-0.9	NHB
23032+1254	23:03:09.6	+12:53:48	16.1	-0.1	NHB
23061+1229*	23:06:04.6	+12:29:24	14.8	-0.9	DA
23139+1129	23:13:56.7	+11:29:20	16.9	-0.8	DQ
23141+1057	23:14:05.0	+10:56:51	16.6	-0.1	cont.?
23147+1104	23:14:41.4	+11:03:48	16.8	-0.5	cont.?
23165+1005	23:16:32.1	+10:04:47	16.6	-0.5	cont.
23180+1242	12:18:00.0	+12:41:46	16.6	-1.5	DA
23182+1007	23:18:12.6	+10:07:25	16.6	-0.5	em.
23189+0901	23:18:54.9	+09:01:01	17.0	-0.9	DA
23224+1151*	23:22:26.5	+11:51:14	16.0	-0.8	DC?
23282+1046*	23:28:09.7	+10:45:34	15.3	-0.9	DA

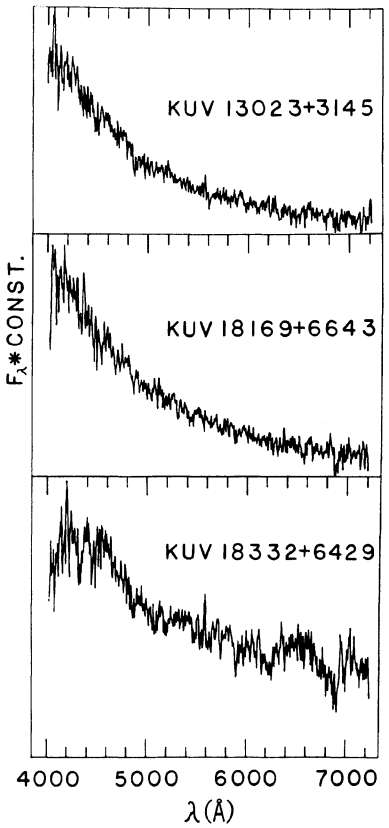

FIG. 1. Relative linear-intensity plots of three of the objects listed in Table I. Zero intensity lies at the bottom of each panel and all data were obtained with the Mark II spectrograph attached to the McGraw–Hill 1.3 m telescope on Kitt Peak.

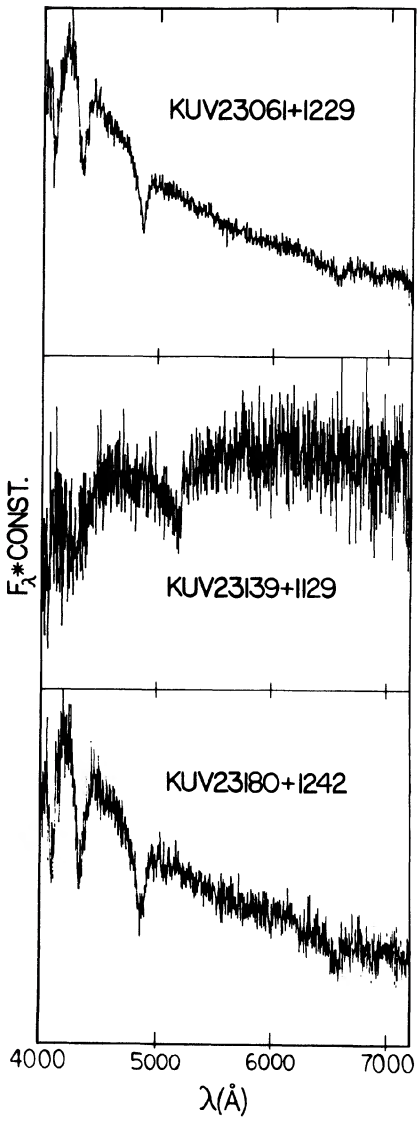

FIG. 2. The same as Fig. 1, except for four additional white dwarfs.

criteria of Osterbrock and Dahari (1983). Their redshifts are nearly identical at $z = 0.02$, but on the Palomar Sky Survey prints the former object has a definitely elongated image, while the latter appears stellar.

KUV 13023+3145. This hot object (Fig. 1) has weak Balmer lines and λ 4472 in absorption.

KUV 13091+3122. This 17.5 mag star seems to have an emission feature near λ 5100 in its spectrum near λ 4450.

KUV 13096+3008. This star (Fig. 4) seems to show a broad emission feature near λ 5100 in addition to possible hydrogen Balmer lines in absorption.

KUV 16303+3744. This object (Fig. 4) is listed as a QSO in the PG survey with redshift $z = 1.471$. It shows a broad emission feature near λ 4700.

KUV 18169+6643. The spectrum of this hot star shown in Fig. 1 shows weak lines of both H and He.

KUV 18186+6740. This object (Fig. 4) resembles KUV 01509 − 1015 described above by showing strong emission features near $\lambda\lambda$ 6400, 5710, and 6570, and thus appears to be a quasar of redshift $z = 0.27$.

KUV 18332+6429. This star (Fig. 1) appears to be a composite object. The short-wavelength portion of its observed spectrum is dominated by the spectrum of a hot component showing Hβ and Hγ, while the long-wavelength portion shows features characteristic of a dM star, whence we conclude that this is a DA + dM system.

KUV 23139+1129. The spectrum of this object shown in Fig. 2 shows the strong (0,0) bandhead of the C_2 molecule near λ 5165 and thus appears to be a DQ white dwarf.

KUV 23182+1007. The spectrum of this star is shown in Fig. 3, where it shows an emission line near λ 4686.

IV. KUV 01584 − 0939 AND KUV 23061 + 1229: TWO NEW SPECTRUM VARIABLE CATACLYSMIC STARS

KUV 01584−0939. One spectrogram of this object, obtained 3 November 1985, showing strong emission lines, was described in Wegner, McMahan, and Boley (1987). During October 1986, an additional time series of nightly spectra was obtained to monitor this object for spectroscopic variations. The resulting spectra obtained on six nights are shown in Figs.5(a) and 5(b). The visible spectrum of these objects was dominated by the strong narrow emission of He II

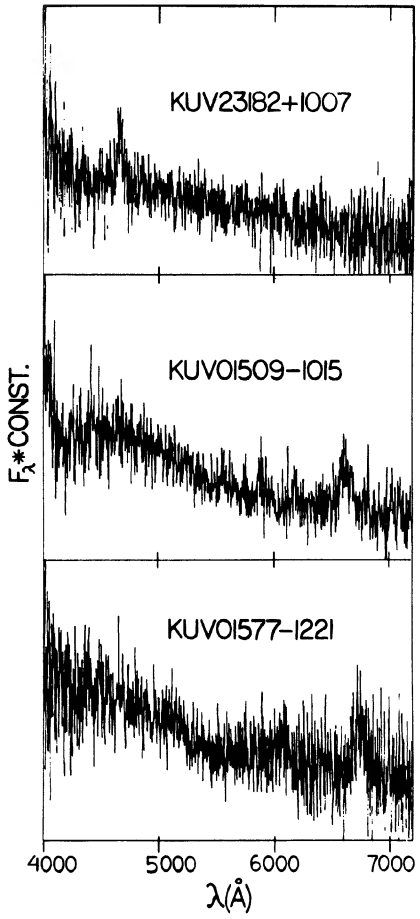

FIG. 3. Relative linear-intensity plots of three of the emission-line objects reported in Table I. Zero intensity lies at the bottom of each panel.

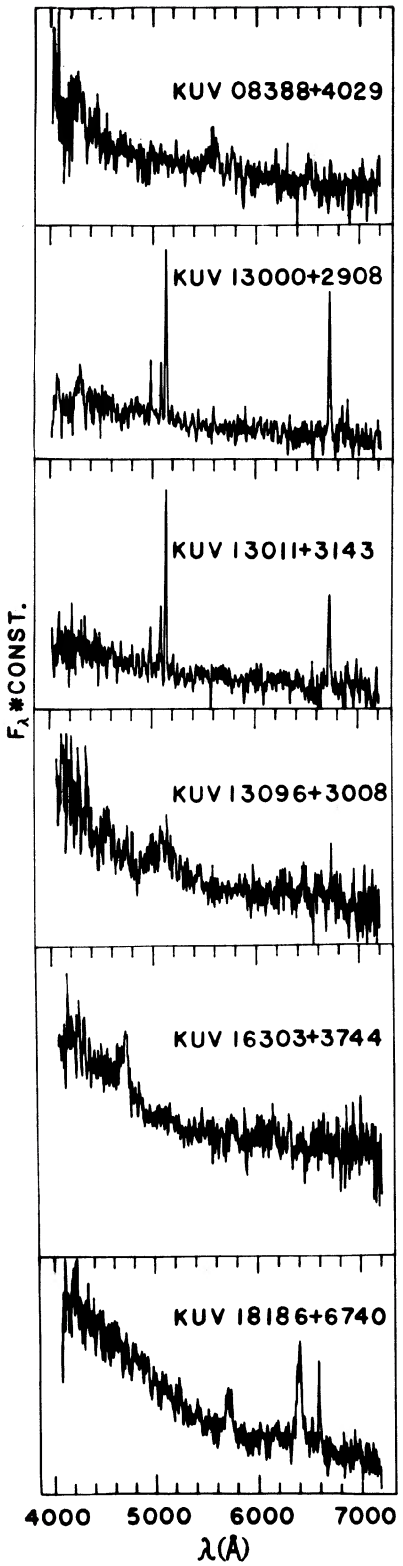

FIG. 4. The same as Fig. 3, except for six additional emission-line objects.

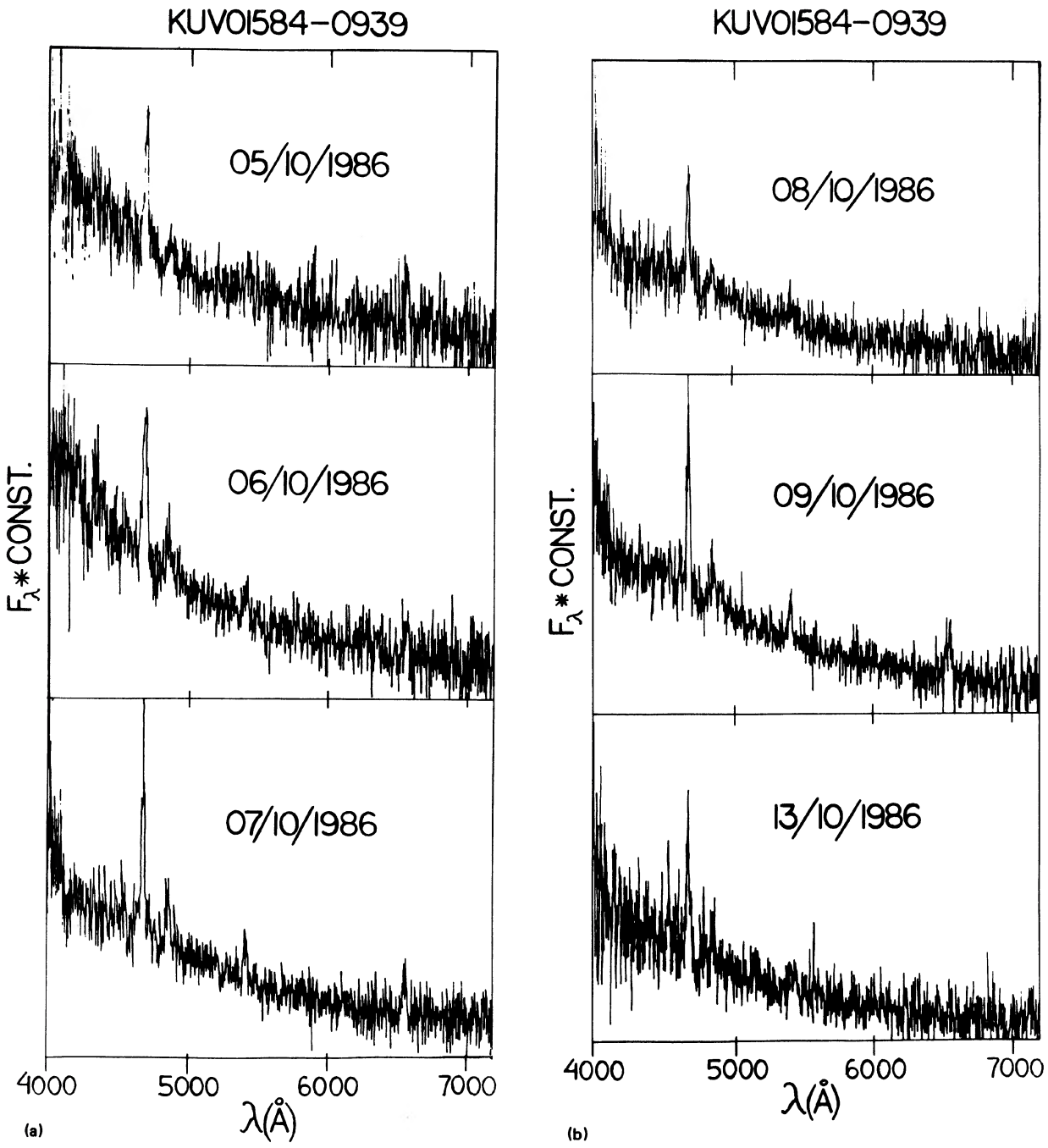

FIG. 5. (a and b) Time series of spectra of KUV 01584 − 0939 showing spectroscopic variations. These spectra are in relative linear-intensity units and zero intensity lies at the bottom of each panel.

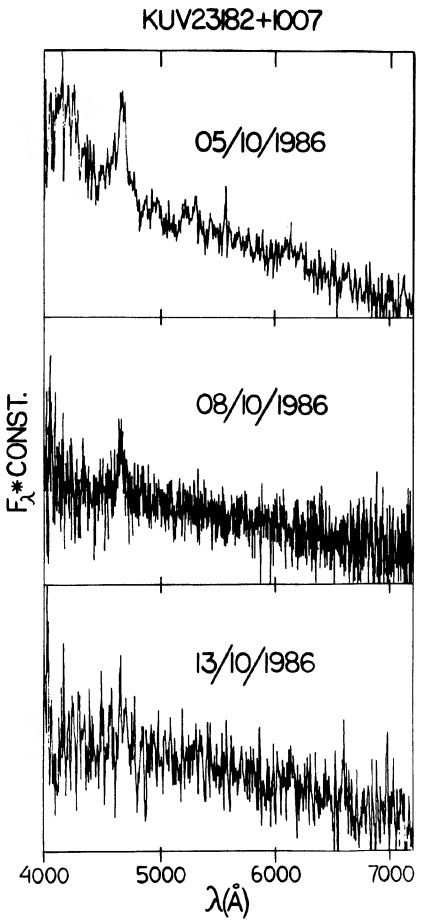

FIG. 6. The same as Fig. 5, but for KUV 23061 + 1229.

λ 4686, which is unresolved in our spectra. On some of the nights, other emission features are prominent, notably λ 5411 of He II and lines near $\lambda\lambda$ 6562 and 4861.

In addition to the visible-wavelength spectra, one ultraviolet spectrum of KUV 0159 − 0939 was secured 4 January 1987 with the SWP camera of the *International Ultraviolet Explorer* (*IUE*) satellite in the low-resolution (approximately 7 Å) mode. This was described in Wegner *et al.* (1987) and, although the integration time of 60 min was too short to obtain a well-exposed continuum, it can be seen that the object's energy distribution is very blue and that relatively strong emission features near $\lambda\lambda$ 1640 and 1243 appear in the spectrum.

KUV 23061 + 1229. Three spectra of this object are shown in Fig. 6. On the first two nights, a broad emission feature is definitely seen at λ 4686 of He II, while the last one shows that it is either weak or absent.

V. CONCLUSIONS

We have given spectral types for 81 of the ultraviolet-excess objects in the Kiso survey list of Noguchi, Maehara, and Kondo (1980). This makes a total of 265 stars that have published spectroscopy found in this survey and observed with the McGraw–Hill 1.3 m telescope.

The detailed spectroscopic composition of the Kiso objects observed to date in this study has been discussed in Wegner *et al.* (1987), where it was found to be virtually identical to that of the Palomar–Green survey (Green, Schmidt, and Liebert 1986). Of the objects reported in this paper, there seem to be several worthy of further study.

Systematic spectroscopic observations of the Kiso ultraviolet stars are continuing and in the future it is planned to present spectroscopic data for the remaining objects in sets of about one hundred objects each.

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Note added in proof: S. R. Swanson at Dartmouth has pointed out to us that KUV 23139 + 1129 is DA and that the star we describe as DQ lies approximately 1'.7 south and 0'.9 west of the correct star.

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