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The Hamburg Quasar Survey[⋆,⋆⋆]

II. A first list of 121 quasars

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Abstract. The Hamburg Quasar Survey is a wide-angle objective prism survey for finding bright QSOs in the northern extragalactic sky ($|b| > 20°$; $\delta > 0°$). The taking of the prism plates for 567 fields covering this area was completed in 1997. Including direct plates for fields with $\delta > 20°$ the plate archive contains now 1871 plates. In this paper we present a first list of 121 quasars[1], which were verified by slit spectroscopy in the years 1986-1991, while experiments to develop efficient selection techniques were made. The sample contains objects with brightnesses $15 \leq B \leq 19.5$ and redshifts $z \leq 2.8$ collected over various parts of the sky, for which objective prism plates were available at that time.

Key words: surveys — quasars: general

1. Introduction

The Hamburg Quasar Survey (Hagen et al. 1995; hereafter Paper I) covers ≈13 600 deg^2 of the northern sky ($\delta > 0°$) at galactic latitudes $|b| > 20°$ with digitized objective prism plates. Given effective and robust search techniques the digitized database of objective prism spectra is well-suited to make searches for objects with low surface densities in the sky. The search technique currently used to select bright ($B \lesssim 17.5$) QSO candidates from the database has developed with growing experience. We present here a first list of 121 spectroscopically verified QSOs observed during 1986-1991, while experiments were made to optimize the selection technique over a wide range of optical brightnesses ($13 \lesssim B \lesssim 19.5$) corresponding to the full dynamical range of the Schmidt objective prism plates. For details on the Schmidt observations and the digitization method we refer to Paper I.

2. Schmidt observations and candidate selection

The survey plates were taken with the Schmidt telescope located at the German-Spanish Astronomical Center (DSAZ) on Calar Alto/Spain, using the 1.°7 objective prism. If the Milky Way region ($|b| < 20°$) is omitted, the complete northern sky can be covered by 567 fields. For all fields two objective prism plates are now available, with at least one plate having a quality grade of A or B. For the definition of the grades we refer to Paper I. Direct plates are available for all fields, except in the region $6 < \alpha < 18^{\rm h}$ and $\delta < 20°$. For this region the digitized POSS (Jenkner et al. 1990) is presently used for comparison with the prism plates. The complete plate archive now contains 1288 objective prism and 583 direct plates. A list of the plates is available from the www-page of the observatory.

The objective prism plates were scanned with the Hamburg PDS 1010G microdensitometer in a "low-resolution" mode (cf. Paper I). After on-line background reduction and object recognition, the low-resolution density spectra (≈15 independent pixels per spectrum) were used to search for QSO candidates. Different search techniques were applied taking advantage of typical spectral properties of QSOs, such as emission lines and blue continua. The selection technique currently applied to search for bright quasars will be described in a following paper (Hagen et al., in preparation).

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⋆ Based on observations obtained at the German-Spanish Astronomical Center, Calar Alto, Spain, operated by the Max-Planck-Institut für Astronomie, Heidelberg, jointly with the Spanish National Commission for Astronomy.

⋆⋆ Figures 4 to 14 are available with the electronic version of the paper at http://www.edpsciences.com

1 Tables 2-4 are also available in electronic form via anonymous ftp at cdsarc.u-strasbg.fr (130.79.128.5) or on the web via http://cdsweb.u-strasbg.fr/Abstract.html

3. Follow-up spectroscopy of QSO candidates

Follow-up spectroscopy of QSO candidates were carried out in several observing runs between 1986 and 1991 with the 3.5 m and 2.2 m telescopes at Calar Alto, Spain (Table 1), partially as backup programs for times of poor weather. Non-photometric weather conditions affected however all observing epochs. As the development of the search techniques used only few fields, and the behaviour of the techniques was studied with emphasis on faint density spectra, most of the candidates observed had brightnesses close to the limit of the plates, e.g. $17.5 \lesssim B \lesssim 19.0$. About half of the candidates were observed in only two fields located in the $\delta = 45 - 50^\circ$ strip centered at $\alpha = 9^{\rm h}53^{\rm m}$ and $12^{\rm h}42^{\rm m}$ (Epoch 2000). In these fields plates of excellent quality were obtained and they were selected therefore as primary test fields.

Most spectra were obtained with the Boller & Chivens-Cassegrain spectrographs equipped with an RCA CCD (624×1024 pixels with 15 μm pixel size) at a dispersion of 240 Å/mm, covering a spectral range from 3800 to 6800–7200 Å. On one single occasion (HS 0843+2533) only the red spectral region beyond 6300 Å was observed. The CCD was read out in binned mode (2×2 pixel), and the final resolution was ≈15 Å. In 1987, February a Reticon covering the wavelength range from 3800 to 6100 Å was used instead of the CCD detector. During two epochs the focal reducer with grisms and the RCA CCD was used, giving dispersions between 212 and 905 Å/mm, and resolutions of $10 - 50$ Å. The spectral coverage was $3900 - 8100$ Å. Exposure times were mostly 15 minutes but ranged from 10 to 45 minutes.

Table 1. Observing epochs. "Sp." denotes the spectrograph used and "Disp." the dispersion achieved. "CS" is the Cassegrain Spectrograph and "FR" the Focal Reducer

Epoch		Tel.	Sp.	Disp. [Å mm^{-1}]
Nov. 29 – Dec. 1	1986	3.5 m	CS	240
Feb. 5 – Feb. 8	1987	3.5 m	CS	240
May 26 – May 29	1987	3.5 m	CS	240
Jan. 8 – Jan. 12	1988	3.5 m	CS	240
Jun. 6 – Jun. 11	1988	3.5 m	CS	240
Jan. 9–14, 19–22	1989	3.5 m	CS	240
Jun. 13 – Jun. 19	1989	2.2 m	CS	240
Dec. 13 – Dec. 21	1989	3.5 m	CS	240
Jan. 19 – Jan. 25	1990	2.2 m	CS	240
Jun. 21 – Jun. 24	1990	3.5 m	FR	290
Jul. 23 – Jul. 30	1990	2.2 m	CS	240
Oct. 16 – Oct. 23	1990	2.2 m	CS	240
Jun. 26 – Jul. 2	1991	3.5 m	FR	212/905

The data reduction was carried out in Hamburg using the program package MIDAS. After standard bias- and flatfield-corrections the contribution of the night-sky was determined by fitting third order polynomials perpendicular to the dispersion for each pixel row in two windows outside the object spectrum. Cosmic ray hits were removed by median-filtering the rows, and the spectrum was extracted using an algorithm similar to the one described by Horne (1986). Wavelength scales were assigned by a linear fit to identified emission-lines in He-Ar comparison spectra. The flux calibration was done using observations of Feige 34, EG 247, BD+28°4211, HZ44 (Massey et al. 1988) and WD1736 (Greenstein 1984). For spectra taken during non-photometric weather conditions the flux calibration may have errors up to 40%. Corrections for atmospheric extinction or galactic reddening were not applied.

4. Results

The quasars confirmed by follow-up spectroscopy are listed in Tables 2 to 4, and their spectra are shown in the Appendix. The coordinates given in the table were determined on the digitized direct plates and are accurate to within $\pm 2''$. To avoid the publications of finding charts we verified that the application of these coordinates to *The Digitized Sky Survey*[2] leads to an unambiguous identification of the object. In a few cases slight adjustments of the coordinates were made to remove ambiguities. The redshifts were usually determined from two or more emission lines. In cases, in which only one emission line is seen in the spectrum, identification with Mg II was assumed. Only for HS 0843+2533 the line displayed is identified as Hα. The B-magnitudes were obtained from the objective prism plates as described in Paper I and have an accuracy of ±0.5 mag. New quasars reported here were already used for follow-up studies by Bade et al. (1995), Jaunsen et al. (1995), and Molthagen et al. (1997). Coordinates and magnitudes of HQS quasars in the two first papers were updated in this paper. HS 2250+1926 was previously identified as quasar by Wills & Wills (1979), but no redshift was given. Other objects were independently discovered by Stocke et al. (1991) (0840+2630, 1818+6740), Amirkhanyan (1993) (0404+0629), Schneider et al. (1994) (0955+4753), Moran et al. (1996) (0655+6940), and Wei et al. (1996) (0041+0117, 1706+6901), quoting similar redshifts and brightnesses.

The sample contains four QSOs with broad absorption lines. The most remarkable is HS 0944+4836, in which three absorption lines dominate the spectrum (Fig. 1). The lines correspond to the ions Al III, C IV, and Si IV at a redshift of $z = 1.75 \pm 0.01$. We identify therefore the single weak emission at 5360 Å as C III] giving a redshift $z = 1.81$ for the QSO.

[2] The Digitized Sky Survey, 1994, CD-ROM Version, Space Telescope Science Institute.

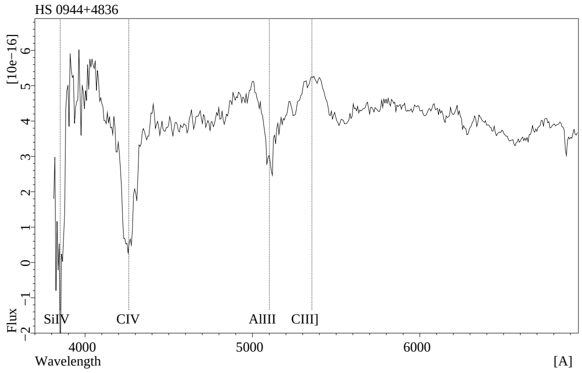

Fig. 1. BAL Quasar HS 0944+4836. The redshift of the absorption line system is $z = 1.75 \pm 0.01$. The emission line redwards of the Al III line is therefore C III] giving a redshift of $z = 1.81$ for the quasar

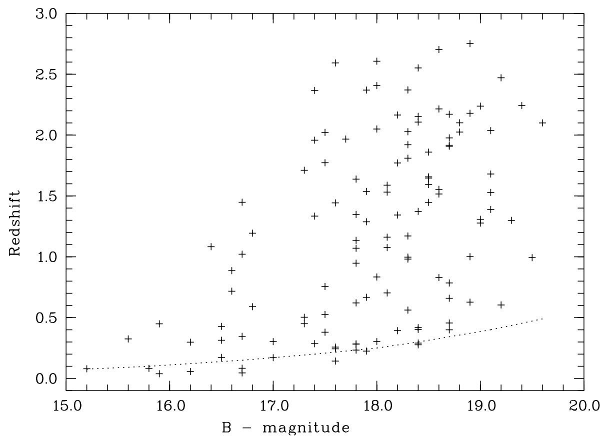

Fig. 2. Hubble diagram for the quasars in Tables 2 to 4. The dividing line separates QSOs (upper part) from Seyfert 1 Galaxies at $M_B = -23$ ($H_0 = 50$ km s^{-1}/Mpc and $q_0 = 0$)

In Fig. 2 we show a Hubble diagram of the sample displaying its brightness and redshift range. The majority of the objects have brightnesses close to the plate limits so that the maximum of the brightness distribution is in the range 17.5< B <19.0. Less than 15% have $M_B \leq -23$ and should be classified as Seyfert 1 galaxies. The redshift distribution (cf. Fig. 3) is almost flat between $z = 0.2$ and 2.2 and is decreasing gradually at larger redshift. For comparison the redshift distribution of the homogeneously selected quasar sample of the Large Bright Quasar Survey (Hewett et al. 1995) is overplotted in Fig. 3. Both distributions are grossly similar except for two peaks in the redshift distribution of our sample at redshifts of ≈0.3 and ≈2.1. They are due to the presence of emission lines (here Mg II and Lyα) in the blue part of the objective prism spectra at these redshifts and the preferred selection of very blue prism spectra for the follow-up observations.

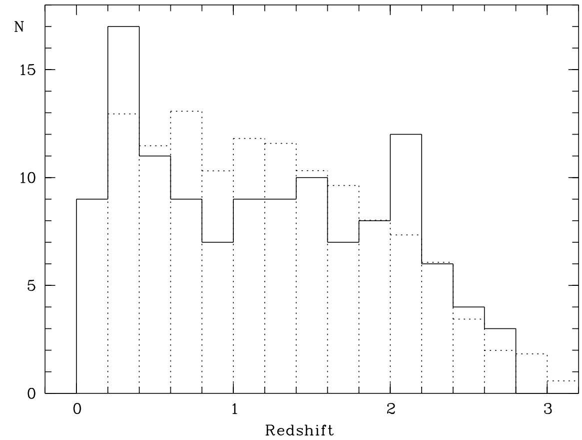

Fig. 3. Redshift distribution of the quasar sample (solid). Shown is also the redshift distribution of 1055 quasars with $z > 0.2$ of the Large Bright Quasar Survey (dotted) normalized to the number of objects of the present sample

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Table 2. New QSOs from the Hamburg quasar survey

Object	Coordinates (1950.0)		z	Obs. Date	B	Comments
HS 0041+0117	00 41 30.9	01 17 18	0.428	90/01/23	16.5	
HS 0043+0339	00 43 04.3	03 39 41	0.291	89/12/20	18.4	
HS 0131+0832	01 31 57.6	08 32 32	2.407	87/02/07	18.0	
HS 0135+0908	01 35 13.1	09 08 02	0.659	88/01/08	18.7	MgII
HS 0138+0802	01 38 01.3	08 02 14	1.171	88/01/10	18.3	
HS 0202+1848	02 02 42.0	18 48 11	2.703	89/12/14	18.6	
HS 0211+1858	02 11 43.3	18 58 40	2.471	89/12/15	19.2	
HS 0219+0309	02 19 56.8	03 09 06	1.021	89/12/20	16.7	
HS 0227+0558	02 27 42.1	05 58 29	2.050	89/01/13	18.0	
HS 0239+0732	02 39 34.7	07 32 09	0.450	89/01/21	17.3	
HS 0240+0840	02 40 58.3	08 40 06	1.070	89/01/21	17.8	
HS 0328+0528	03 28 13.3	05 28 15	0.046	89/01/09	16.7	
HS 0338+0443	03 38 35.9	04 43 50	0.084	89/12/13	16.7	
HS 0404+0629	04 04 57.3	06 29 56	0.346	89/12/17	16.7	
HS 0621+6738	06 21 38.5	67 38 37	1.588	88/01/08	18.1	
HS 0626+6745	06 26 55.3	67 45 52	0.225	88/01/09	17.9	
HS 0655+6940	06 55 38.7	69 40 41	1.967	89/12/15	17.7	
HS 0701+6405	07 01 30.3	64 05 45	1.921	89/12/17	18.3	
HS 0704+6335	07 04 46.2	63 35 30	1.194	89/12/15	16.8	
HS 0710+6024	07 10 23.4	60 24 41	1.773	89/12/14	17.5	
HS 0727+6342	07 27 46.2	63 42 18	2.371	89/12/14	18.3	
HS 0727+6205	07 27 48.7	62 05 27	0.325	89/12/14	15.6	
HS 0734+6226	07 34 13.0	62 26 58	1.076	89/12/19	18.1	
HS 0740+3222	07 40 22.1	32 22 19	1.531	87/02/07	18.1	
HS 0743+6059	07 43 24.9	60 59 25	0.277	89/12/20	18.4	
HS 0751+6107	07 51 58.9	61 07 47	2.607	89/12/13	18.0	
HS 0804+6218	08 04 01.7	62 18 26	1.135	89/12/19	17.8	
HS 0806+6212	08 06 34.4	62 12 10	0.173	89/12/15	16.5	
HS 0839+2858	08 39 29.3	28 58 11	1.343	89/12/20	18.2	
HS 0840+2630	08 40 50.8	26 30 03	0.258	89/12/19	17.6	
HS 0843+2734	08 43 33.1	27 34 44	2.028	89/12/20	18.3	
HS 0843+2533	08 43 56.5	25 33 15	0.057	90/01/22	16.2	Hα
HS 0844+2642	08 44 56.9	26 42 53	0.282	89/12/19	17.8	
HS 0845+2757	08 45 22.2	27 57 00	0.667	89/12/19	17.9	
HS 0852+2729	08 52 51.8	27 29 54	0.303	89/12/19	18.0	
HS 0856+2757	08 56 47.5	27 57 17	0.244	89/12/19	17.6	
HS 0936+4606	09 36 55.9	46 06 29	0.834	87/02/05	18.0	MgII
HS 0940+4820	09 40 48.3	48 20 34	0.393	89/01/22	18.2	
HS 0940+4806	09 40 55.2	48 06 34	2.243	89/01/21	19.4	
HS 0942+4622	09 42 44.1	46 22 49	1.447	89/01/12	18.5	
HS 0942+5008	09 42 49.1	50 08 05	0.756	89/12/21	17.5	MgII
HS 0942+4646	09 42 56.8	46 46 50	0.993	89/01/12	19.5	MgII
HS 0943+4725	09 43 07.1	47 25 24	0.233	89/01/12	17.8	
HS 0943+4849	09 43 20.7	48 49 03	1.308	89/01/12	19.0	
HS 0944+4836	09 44 09.5	48 36 10	1.81	89/12/20	18.3	BAL, CIII
HS 0944+4725	09 44 31.5	47 25 12	0.703	89/01/01	18.1	MgII
HS 0945+4630	09 45 36.1	46 30 29	1.001	89/02/08	18.9	
HS 0945+4646	09 45 55.0	46 46 14	1.908	89/01/09	18.7	
HS 0946+4845	09 46 45.6	48 45 31	0.590	88/01/13	16.8	MgII
HS 0947+4904	09 47 49.7	49 04 34	0.604	89/01/11	19.2	MgII
HS 0948+4631	09 48 14.6	46 31 54	1.771	89/01/12	18.2	
HS 0948+4735	09 48 44.7	47 35 10	1.594	88/01/08	18.5	
HS 0951+4642	09 51 01.3	46 42 17	0.997	89/01/09	18.3	MgII
HS 0952+5015	09 52 36.7	50 15 46	2.107	89/12/21	18.4	
HS 0954+4643	09 54 23.1	46 43 44	1.277	89/01/11	19.0	

Table 3. New QSOs from the Hamburg quasar survey

Object	Coordinates (1950.0)		z	Obs. Date	B	Comments
HS 0954+4815	09 54 26.2	48 15 41	0.829	89/01/09	18.6	MgII
HS 0955+4823	09 55 04.8	48 23 29	1.680	89/01/10	19.1	
HS 0955+4753	09 55 22.0	47 53 16	0.418	89/01/10	18.4	
HS 0955+4837	09 55 27.6	48 37 28	2.037	89/01/11	19.1	
HS 0955+4704	09 55 41.8	47 04 50	1.161	88/01/09	18.1	
HS 0956+4648	09 56 16.7	46 48 57	1.299	89/01/12	19.3	
HS 0956+4819	09 56 27.5	48 19 03	0.400	89/01/12	18.7	
HS 0957+4844	09 57 00.6	48 44 21	0.785	89/01/12	18.7	MgII
HS 0958+4716	09 58 04.4	47 16 59	2.165	89/01/13	18.2	
HS 0959+4944	09 59 00.9	49 44 04	0.403	87/02/07	18.4	
HS 1001+4840	10 01 03.0	48 40 40	0.562	89/12/21	18.3	
HS 1001+4940	10 01 49.5	49 40 16	2.025	89/01/21	18.8	
HS 1002+4820	10 02 05.9	48 20 09	2.370	89/01/21	17.9	
HS 1003+4733	10 03 25.0	47 33 45	0.981	87/02/08	18.3	
HS 1004+4515	10 04 31.4	45 15 31	1.288	89/01/21	17.9	
HS 1004+4543	10 04 49.4	45 43 06	1.657	87/02/07	18.5	
HS 1227+4641	12 27 13.5	46 41 05	2.154	88/06/10	18.4	
HS 1227+4537	12 27 55.3	45 37 23	2.101	88/06/11	18.8	
HS 1228+4654	12 28 24.5	46 54 10	1.516	88/06/08	18.6	
HS 1229+4807	12 29 14.1	48 07 26	1.373	88/06/11	18.4	
HS 1230+4741	12 30 38.1	47 41 28	1.529	88/06/11	19.1	
HS 1231+4528	12 31 01.7	45 28 56	1.958	88/06/08	17.4	
HS 1231+4814	12 31 11.8	48 14 32	0.380	88/06/10	17.5	
HS 1232+4811	12 32 01.9	48 11 27	1.916	88/06/10	18.7	
HS 1232+3410	12 32 11.5	34 10 19	0.526	87/02/06	17.5	MgII
HS 1232+4659	12 32 42.1	46 59 15	1.860	88/06/08	18.5	
HS 1232+4645	12 32 51.3	46 45 35	2.215	87/05/28	18.6	BAL
HS 1234+4550	12 34 28.1	45 50 05	2.552	88/06/07	18.4	BAL
HS 1234+4616	12 34 37.0	46 16 48	1.647	88/06/07	18.5	BAL
HS 1235+4919	12 35 37.4	49 19 27	2.179	88/06/08	18.9	
HS 1237+4756	12 37 45.4	47 56 31	1.554	88/06/10	18.6	
HS 1239+4633	12 39 16.9	46 33 43	2.752	88/06/06	18.9	
HS 1240+4706	12 40 07.8	47 06 58	2.100	88/06/11	19.6	
HS 1242+4920	12 42 28.8	49 20 55	1.977	88/06/06	18.7	
HS 1242+4925	12 42 32.0	49 25 24	1.389	88/06/06	19.1	
HS 1242+3412	12 42 46.1	34 12 33	0.717	87/02/06	16.6	
HS 1244+4750	12 44 24.0	47 50 20	0.627	88/06/08	18.9	MgII
HS 1245+4605	12 45 26.8	46 05 34	0.143	88/06/07	17.6	
HS 1248+4712	12 48 46.2	47 12 28	1.334	88/06/10	17.4	
HS 1249+4518	12 49 04.3	45 18 22	2.171	87/05/28	18.7	
HS 1250+4521	12 50 53.7	45 21 30	2.238	88/06/11	19.0	
HS 1251+4825	12 51 58.9	48 25 06	0.503	87/05/26	17.3	
HS 1616+6445	16 16 31.7	64 45 56	0.171	91/07/01	17.0	
HS 1623+7313	16 23 04.3	73 13 07	0.621	90/07/28	17.8	
HS 1638+6121	16 38 46.8	61 21 53	0.456	88/06/11	18.7	
HS 1703+5350	17 03 01.5	53 50 58	2.367	91/06/27	17.4	
HS 1706+6901	17 06 17.4	69 01 29	0.449	89/06/15	15.9	
HS 1707+6145	17 07 47.0	61 45 52	1.348	91/06/28	17.8	
HS 1709+6027	17 09 51.4	60 27 23	1.537	88/06/06	17.9	
HS 1714+6445	17 14 26.7	64 45 13	0.286	89/06/15	17.4	
HS 1714+5351	17 14 41.6	53 51 27	1.711	91/06/27	17.3	
HS 1723+6550	17 23 07.2	65 50 26	1.443	88/06/11	17.6	
HS 1728+6049	17 28 36.1	60 49 07	1.638	91/06/28	17.8	
HS 1803+7517	18 03 09.4	75 17 57	1.083	91/07/01	16.4	MgII
HS 1803+5425	18 03 37.0	54 25 23	1.448	89/06/15	16.7	

Table 4. New QSOs from the Hamburg quasar survey

Object	Coordinates (1950.0)		z	Obs. Date	B	Comments
HS 1811+5400	18 11 24.6	54 00 16	0.886	90/06/23	16.6	MgII
HS 1817+5342	18 17 07.3	53 42 29	0.080	91/06/30	15.2	
HS 1818+6740	18 18 37.1	67 40 04	0.314	88/06/06	16.5	
HS 1824+6507	18 24 35.9	65 07 37	0.303	88/06/11	17.0	
HS 1831+5338	18 31 45.7	53 38 01	0.039	90/06/23	15.9	
HS 1848+6705	18 48 26.3	67 05 07	2.022	88/06/06	17.5	
HS 1859+6909	18 59 37.1	69 09 54	0.298	90/07/27	16.2	
HS 2130+0839	21 30 59.4	08 39 45	0.947	91/06/30	17.8	MgII
HS 2247+1044	22 47 09.5	10 44 35	0.083	90/10/23	15.8	
HS 2250+1926	22 50 40.5	19 26 36	0.284	89/12/14	17.8	
HS 2348+0438	23 48 16.8	04 38 25	2.593	89/12/15	17.6	

Appendix

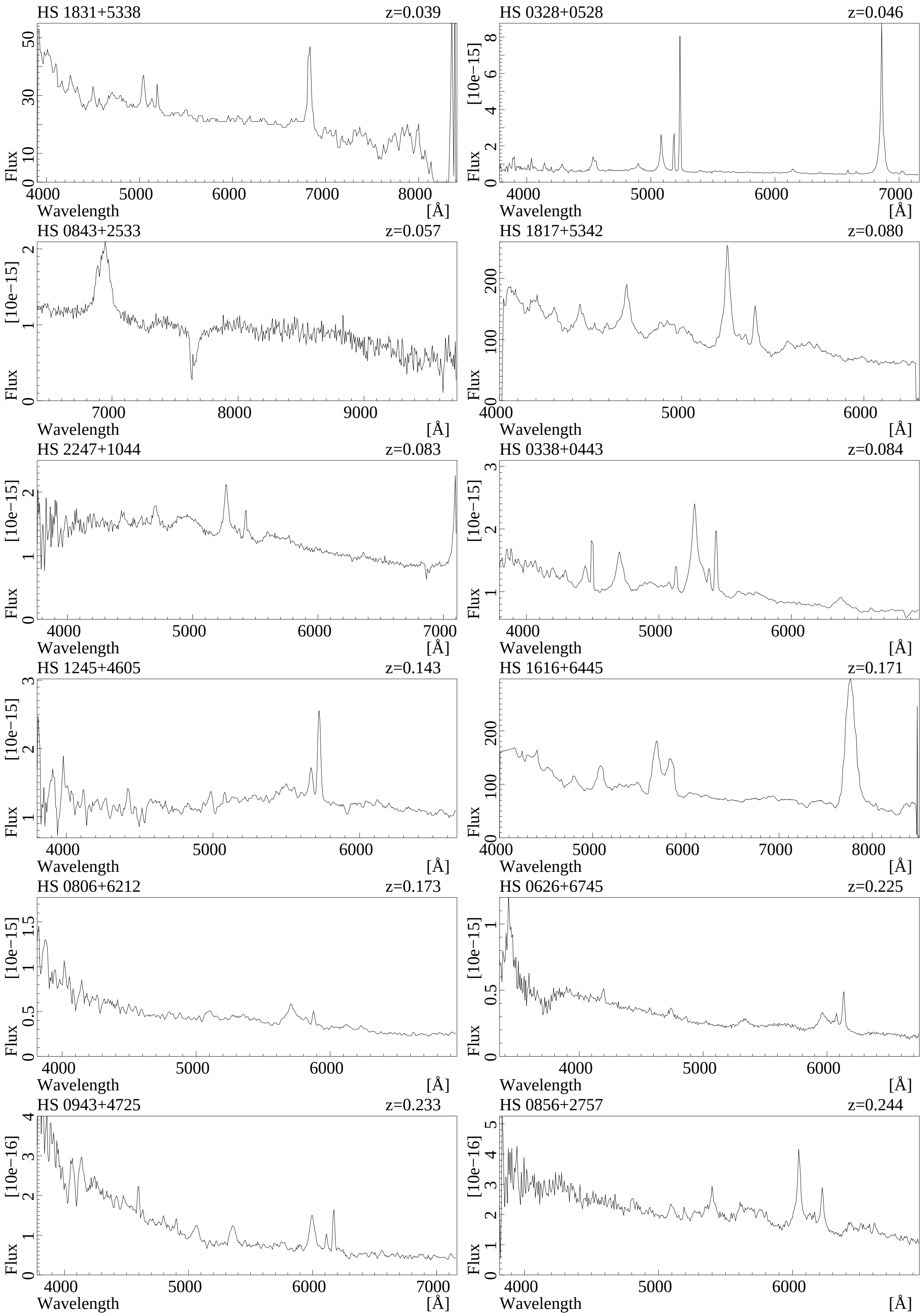

Fig. 4. Spectra of new HQS quasars

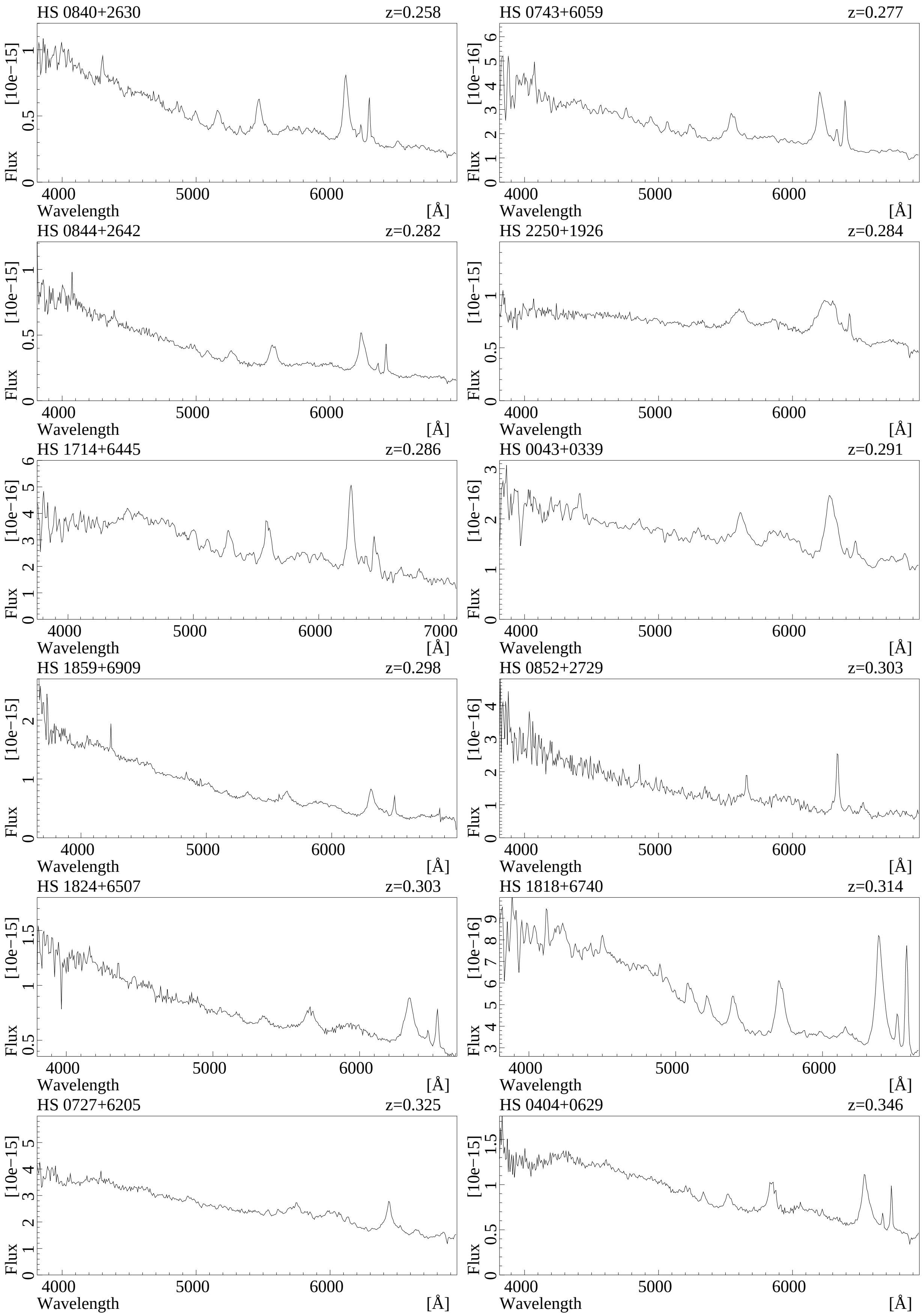

Fig. 5. Spectra of new HQS quasars (continued)

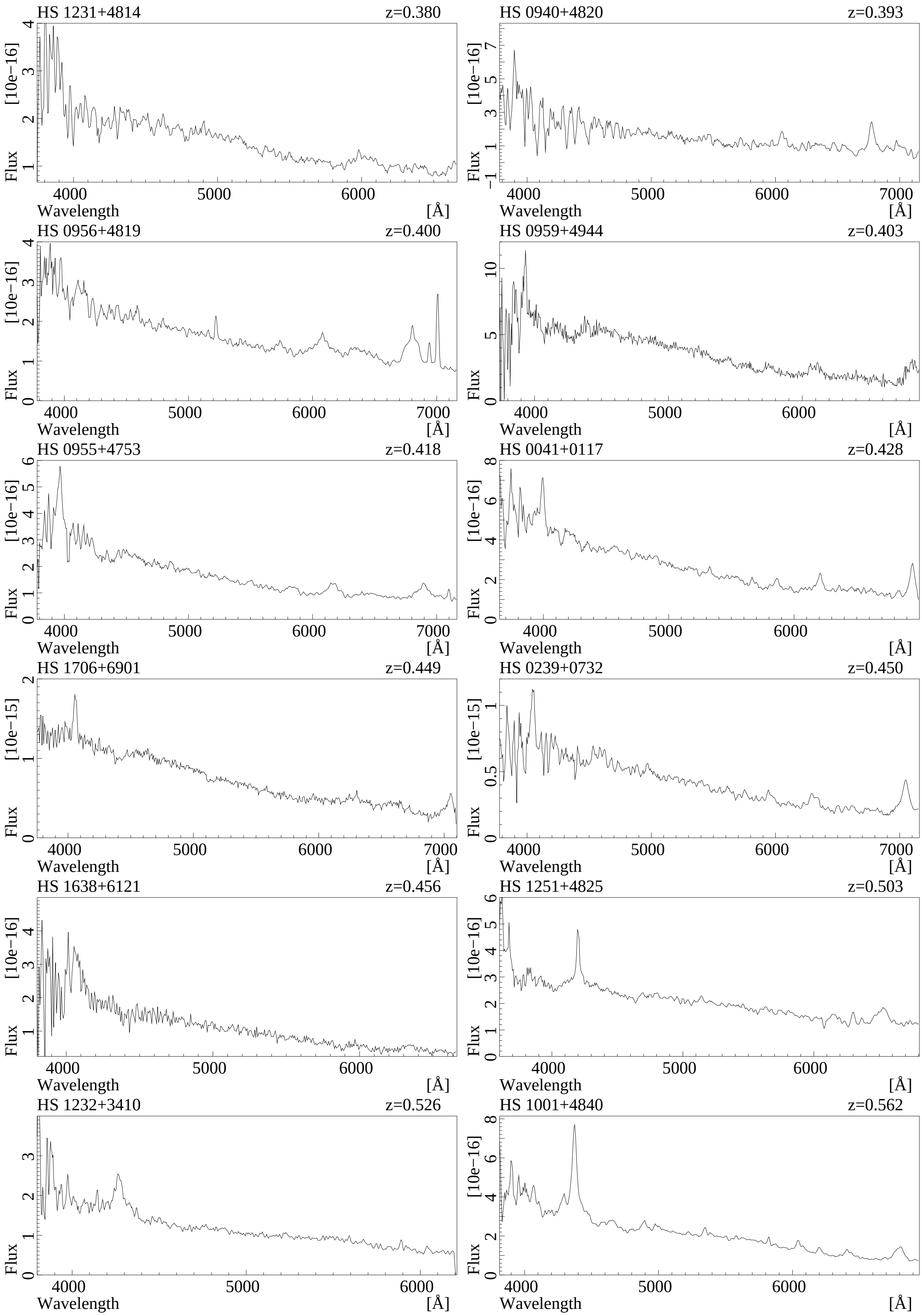

Fig. 6. Spectra of new HQS quasars (continued)

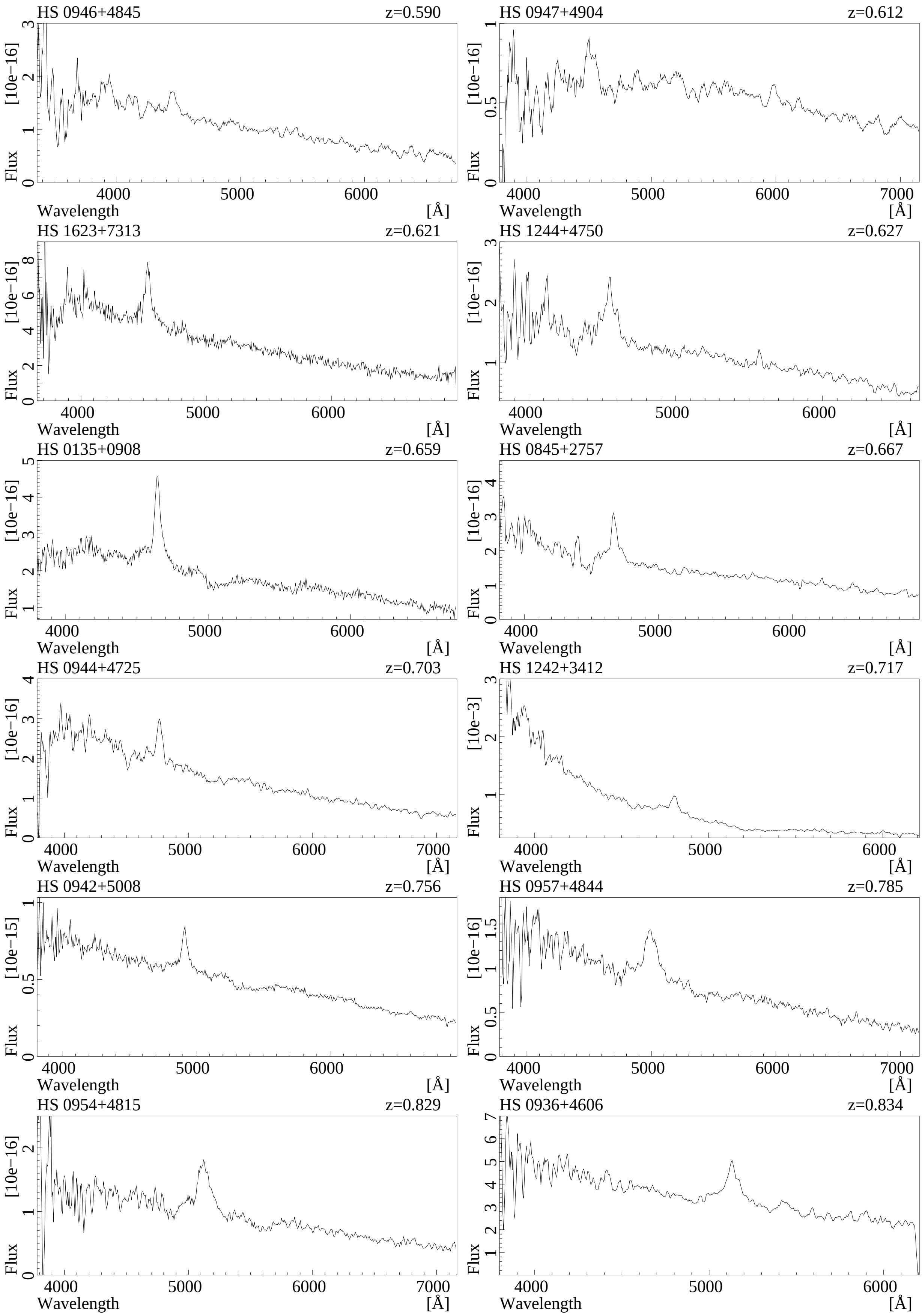

Fig. 7. Spectra of new HQS quasars (continued)

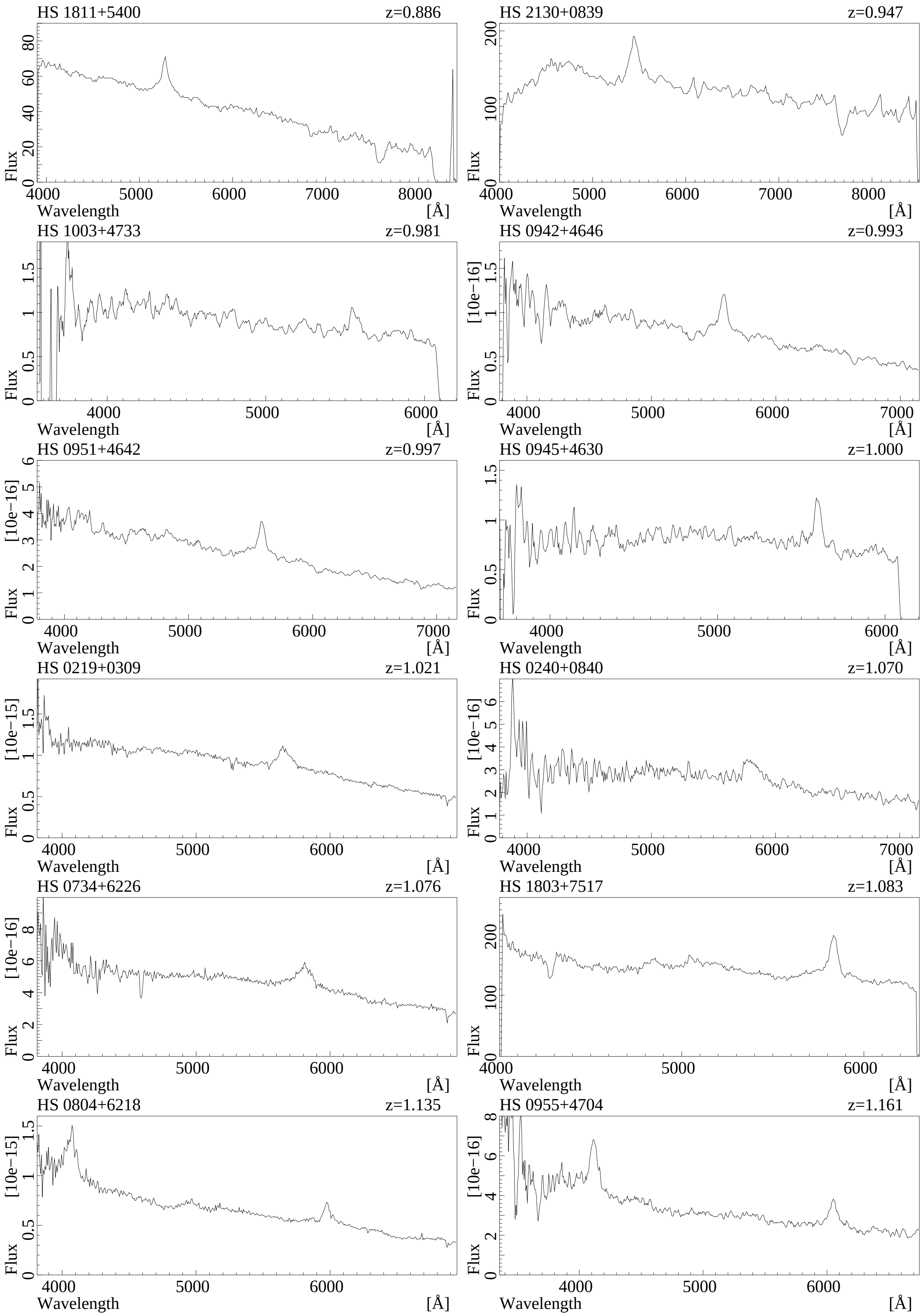

Fig. 8. Spectra of new HQS quasars (continued)

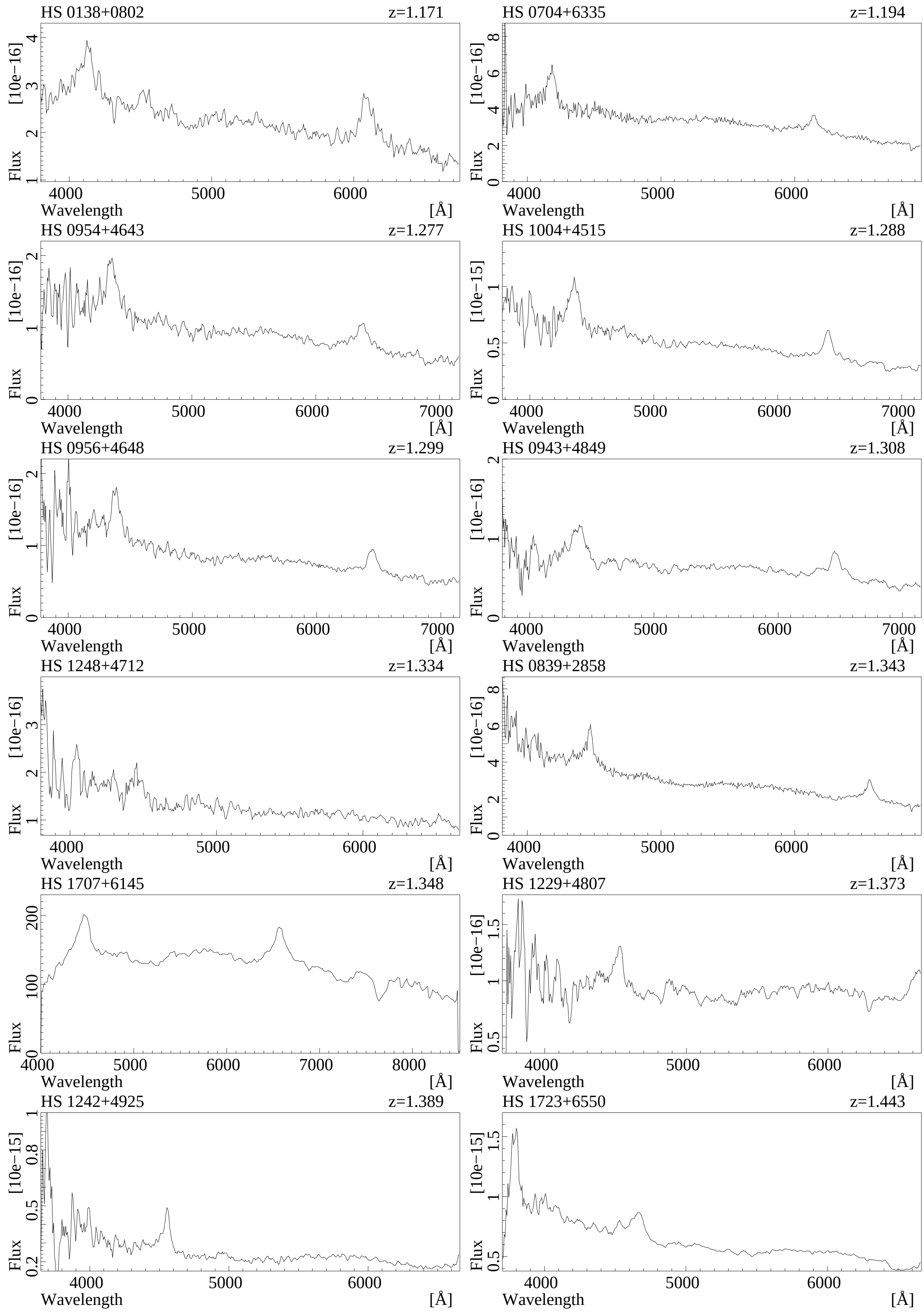

Fig. 9. Spectra of new HQS quasars (continued)

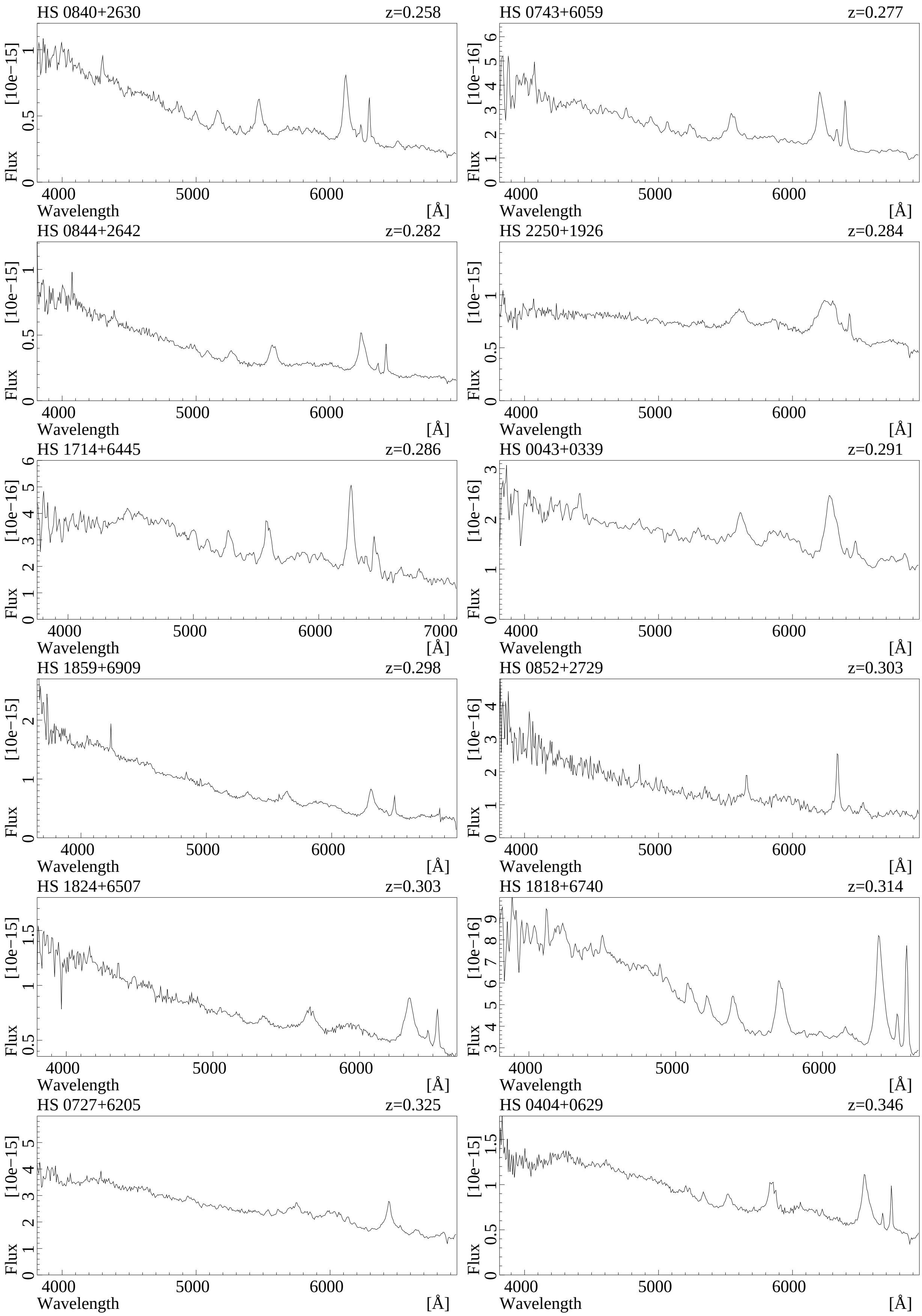

Fig. 10. Spectra of new HQS quasars (continued)

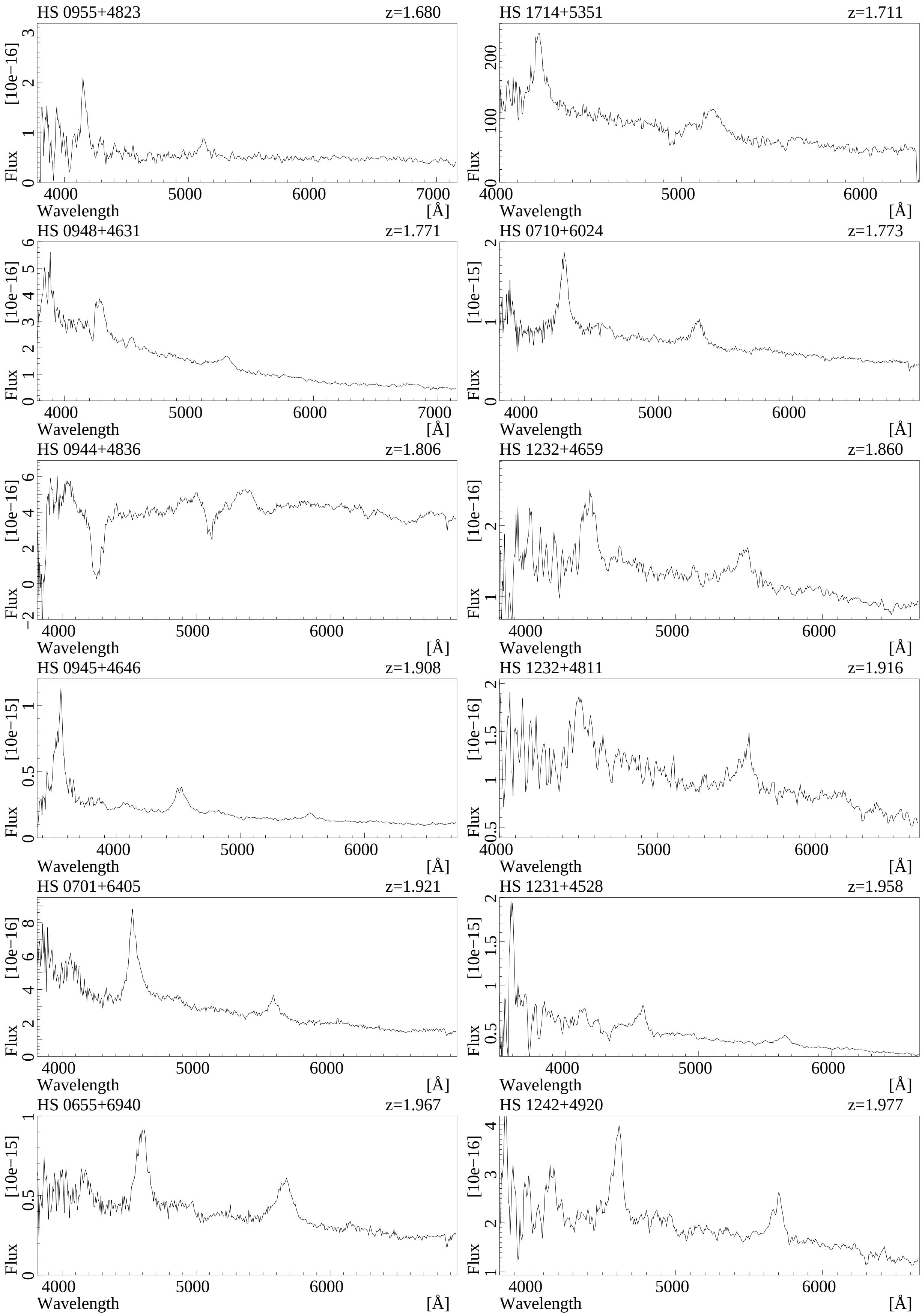

Fig. 11. Spectra of new HQS quasars (continued)

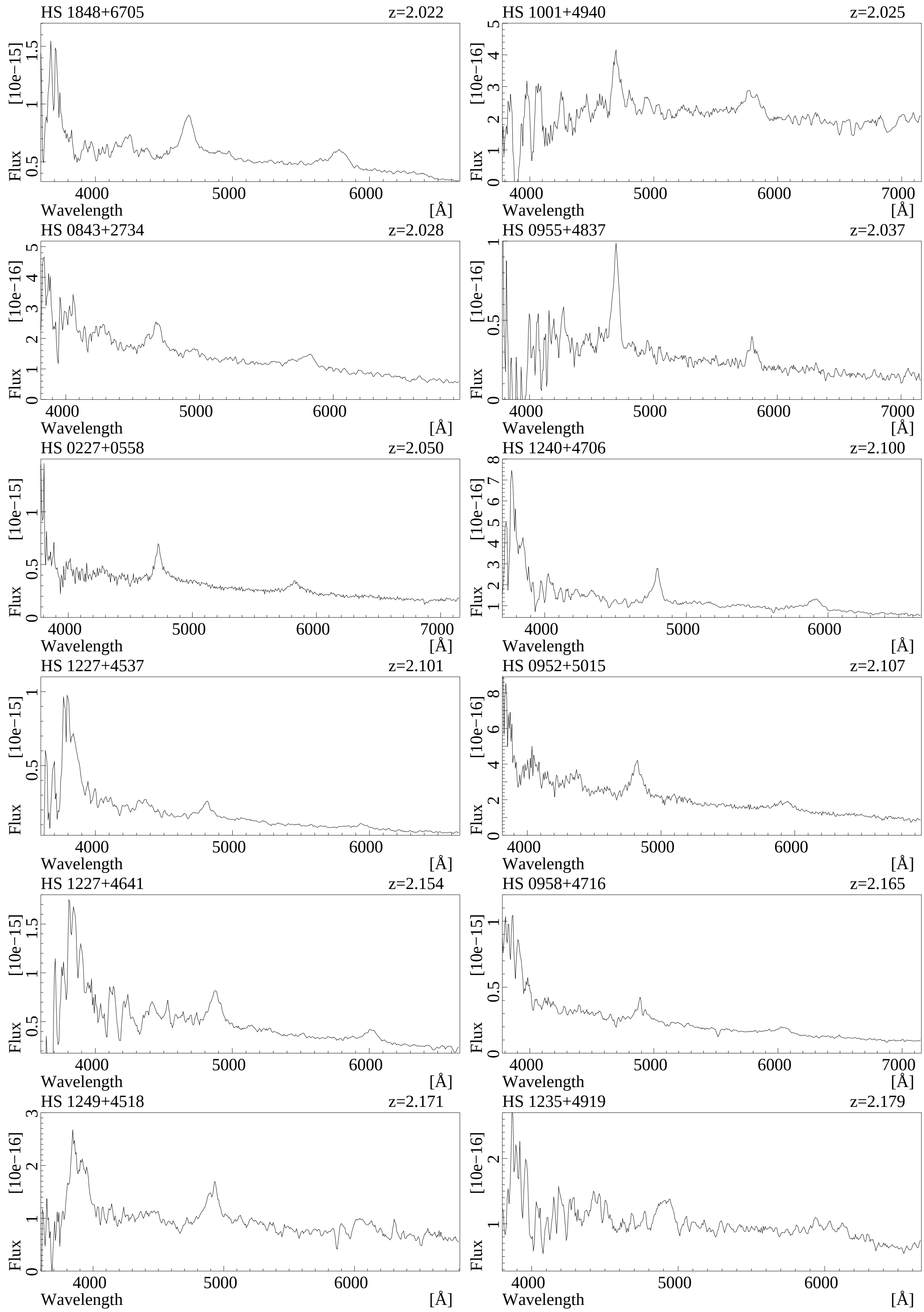

Fig. 12. Spectra of new HQS quasars (continued)

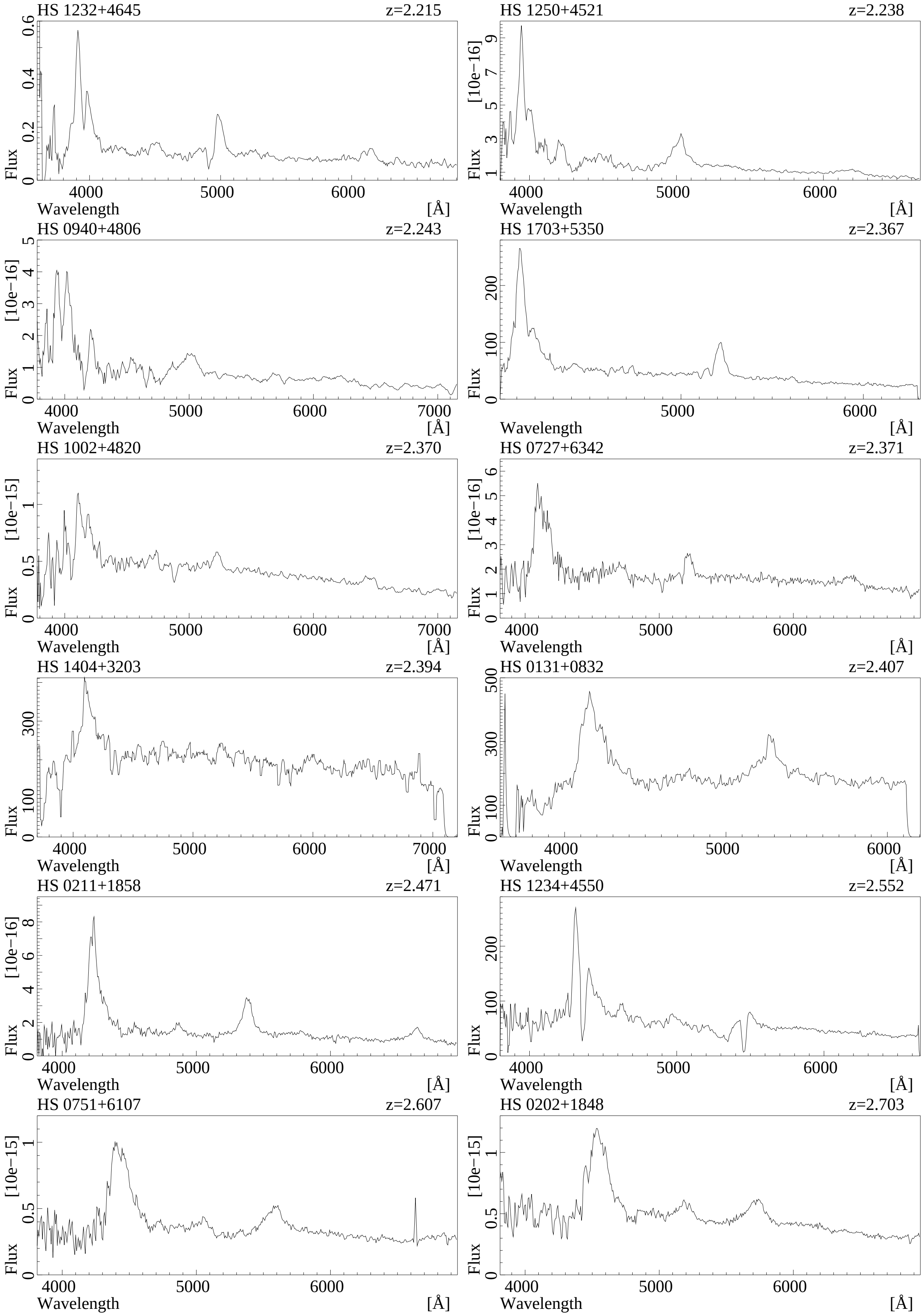

Fig. 13. Spectra of new HQS quasars (continued)

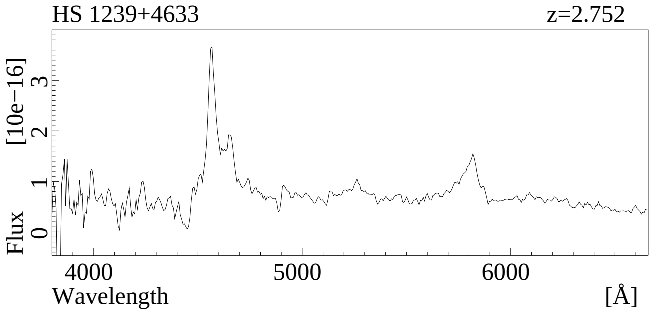

Fig. 14. Spectra of new HQS quasars (continued)