THE ASTRONOMICAL JOURNAL VOLUME 102, NUMBER 2 AUGUST 1991

THE LARGE, BRIGHT QSO SURVEY. IV. QSOs IN TWO EQUATORIAL FIELDS[1]

FREDERIC H. CHAFFEE[2] AND CRAIG B. FOLTZ
Multiple Mirror Telescope Observatory, University of Arizona, Tucson, Arizona 85721

PAUL C. HEWETT AND PAUL J. FRANCIS
Institute of Astronomy, Madingley Road, Cambridge CB3 0HA, England

RAY J. WEYMANN AND SIMON L. MORRIS
The Observatories of the Carnegie Institution of Washington, 813 Santa Barbara Street, Pasadena, California 91101

SCOTT F. ANDERSON
Department of Astronomy, FM-20, University of Washington, Seattle, Washington 98195

GORDON M. MACALPINE
Department of Astronomy, University of Michigan, Ann Arbor, Michigan 48109
Received 11 March 1991; revised 10 April 1991

ABSTRACT

This is the fourth paper in a series aimed at selecting ~ 1000 QSOs brighter than $B_J \simeq 18.7$ using machine-scanned direct and objective-prism plates from the UK Schmidt Telescope. The plate material is scanned at the Automated Plate Measuring facility. The candidate list is derived using a number of complementary selection algorithms ranging from "traditional" criteria, such as the presence of strong emission features, to criteria designed to select objects whose objective-prism spectra cannot be classified as normal stars, although they may possess no obvious QSO-like features. Follow-up spectroscopy at the Multiple Mirror Telescope is used to classify each candidate. In this paper we present results from the two final UK Schmidt Telescope equatorial fields in which 125 QSOs have been found as well as the detection of an additional 11 QSOs in the 0000 + 0000 field presented in the second paper in this series. We present coordinates, magnitudes, redshifts and spectra of moderate resolution, and signal-to-noise ratio for all 136 QSOs as well as for eight additional extragalactic objects which fail to meet our absolute magnitude criterion as QSOs.

1. INTRODUCTION

This is the penultimate paper in a series of five presenting the observational data for the Large, Bright QSO Survey (LBQS), which is aimed at providing a sample of ~ 1000 QSOs of a wide variety of types in the range $16.0 \leqslant B_J \lesssim 18.7$. Candidates are selected from machine-scanned UK Schmidt Telescope direct and objective-prism plates using well defined and consistently applied algorithms, and follow-up spectroscopy is obtained on the MMT. The reader is referred to the previous three papers in the series [Foltz *et al.* 1987 (Paper I); Foltz *et al.* 1989 (Paper II); Hewett *et al.* 1991 (Paper III)] for a description of the scientific objectives, candidate selection criteria, and observing procedures used for the LBQS.

This paper reports observations of QSO candidates in the final two equatorial fields of the LBQS, as well as those of a few remaining candidates in the 0000 + 0000 field (Paper II). Section 2 describes the observations and presents coordinates, magnitudes and spectra for each of the confirmed 136 QSOs and 8 AGNs. In Sec. 3 we compare our sample with all previously detected QSOs in the two fields and update the redshift distribution for the published LBQS.

[1] Observations reported here were obtained primarily with the Multiple Mirror Telescope, a facility operated jointly by the Smithsonian Institution and the University of Arizona.

[2] Senior Visiting Fellow, Institute of Astronomy, 1 July 1990–1 August 1991.

2. OBSERVATIONS

2.1 Plate Material and Candidate Selection

Two pairs of direct and objective-prism united Kingdom Schmidt Telescope (UKST) plates, whose characteristics are presented in Table 1, were searched for QSO candidates. The Automated Plate Measuring facility scans an area of $\sim 5.8° \times 5.8°$ on each plate, but the exclusion of areas around bright sources and near calibration wedges from further processing reduces the total analyzed area for the present fields to 64.2 square degrees. Furthermore, approximately 10% of the spectra cannot be processed because of plate flaws, satellite trails, or because they overlap with those of nearby sources. This results in an effective area of 57.8 square de-

TABLE 1. Plate data.[a]

Plate No.	R.A. (1950)	Dec.	Filter	Exp. Time[b]	Date	Grade[c]	Seeing	$B_{J_{lim}}$
J7915	01 00	+00 00	GG395	60	20 July 1982	B3	3.0	18.76
UJ12187P	01 00	+00 00	none	85	23 Sept. 1987	A1	2.0	
J8288	03 00	+00 00	GG395	60	09 Dec. 1982	BIE3	3.0	18.50
UJ12188P	03 00	+00 00	none	85	23 Sept. 1987	A1	2.0	

Notes to TABLE 1

[a] All plates are Kodak IIIa-J emulsion.

[b] All exposure times are in minutes.

[c] Details of the UKST grading system can be found in the UKST Handbook (1983).

0004-6256/91/020461-27$00.90

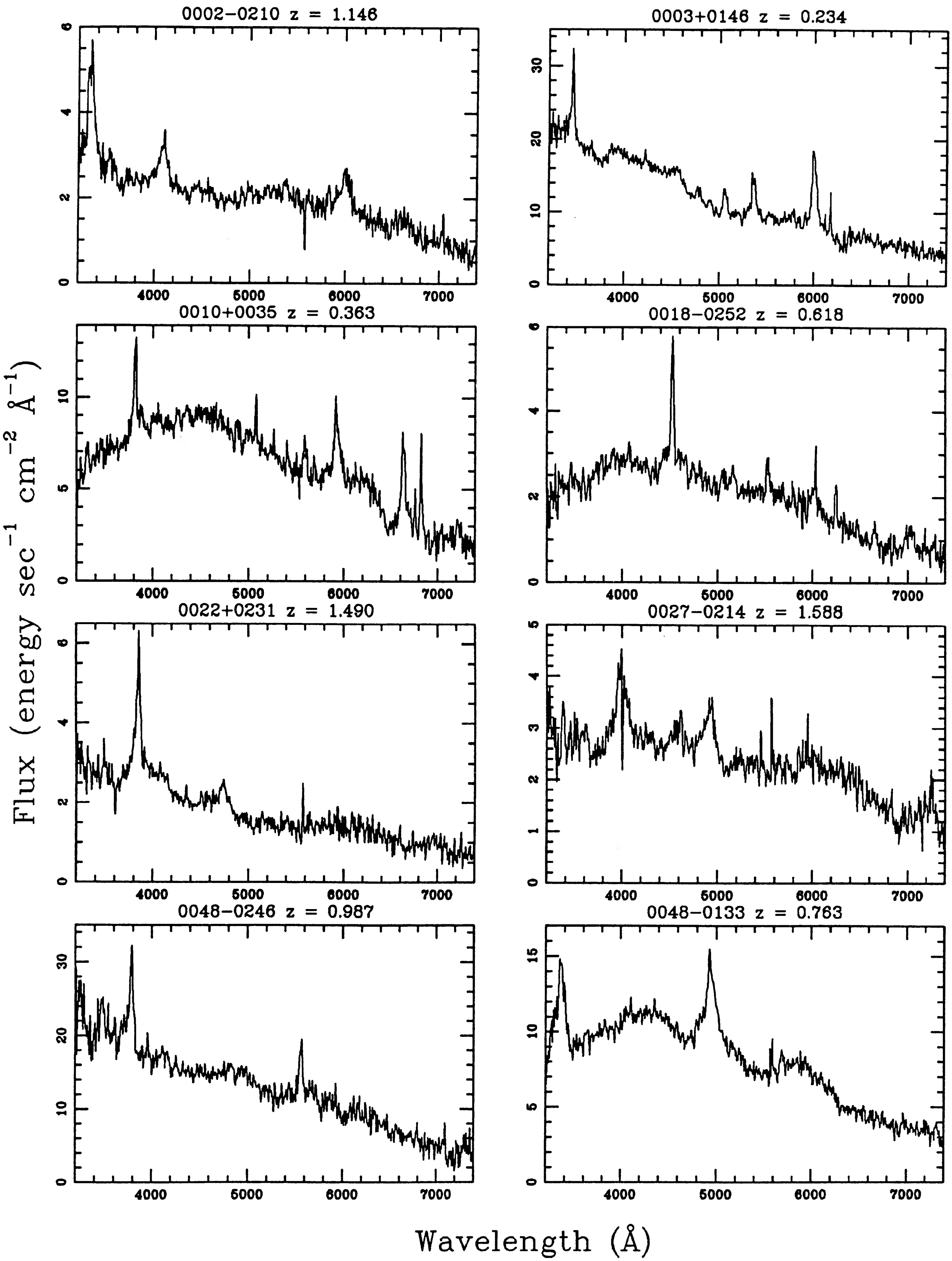

FIG. 1. 6 Å resolution spectra, in order of right ascension, of all confirmed QSOs. Absolute flux values should not be intercompared, and relative fluxes below λ 4000 are occasionally unreliable (see text).

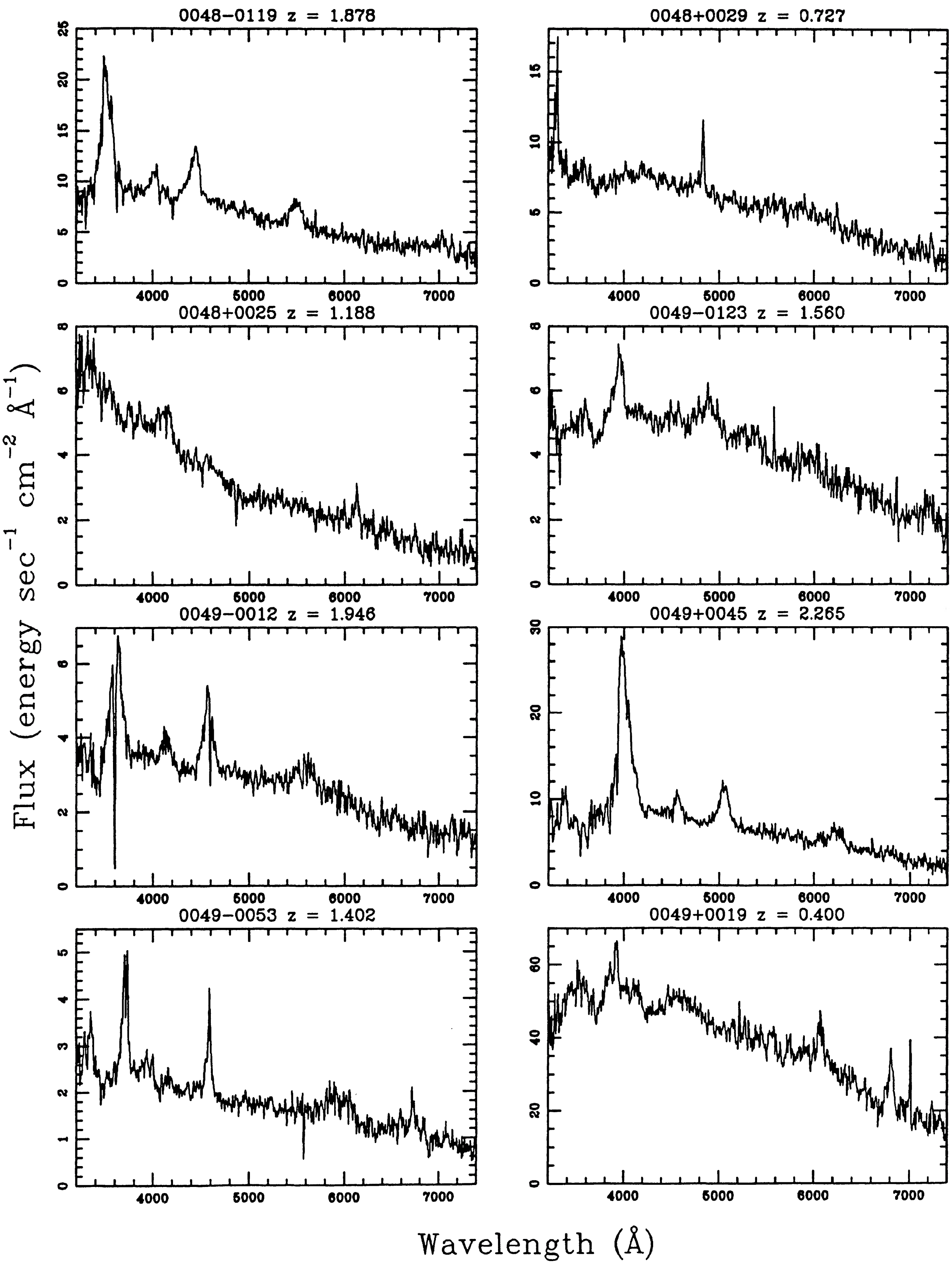

FIG. 1. (continued)

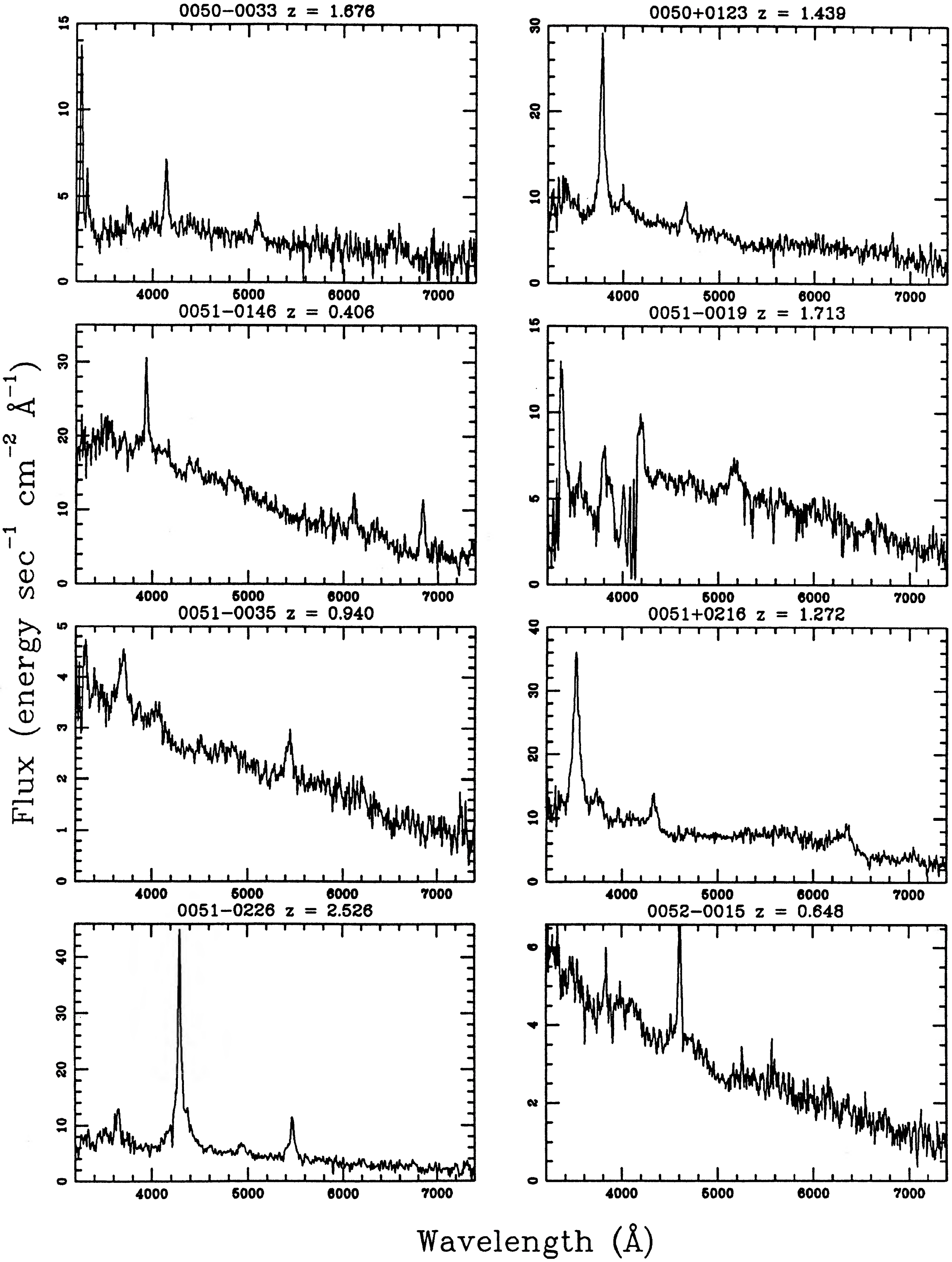

FIG. 1. (continued)

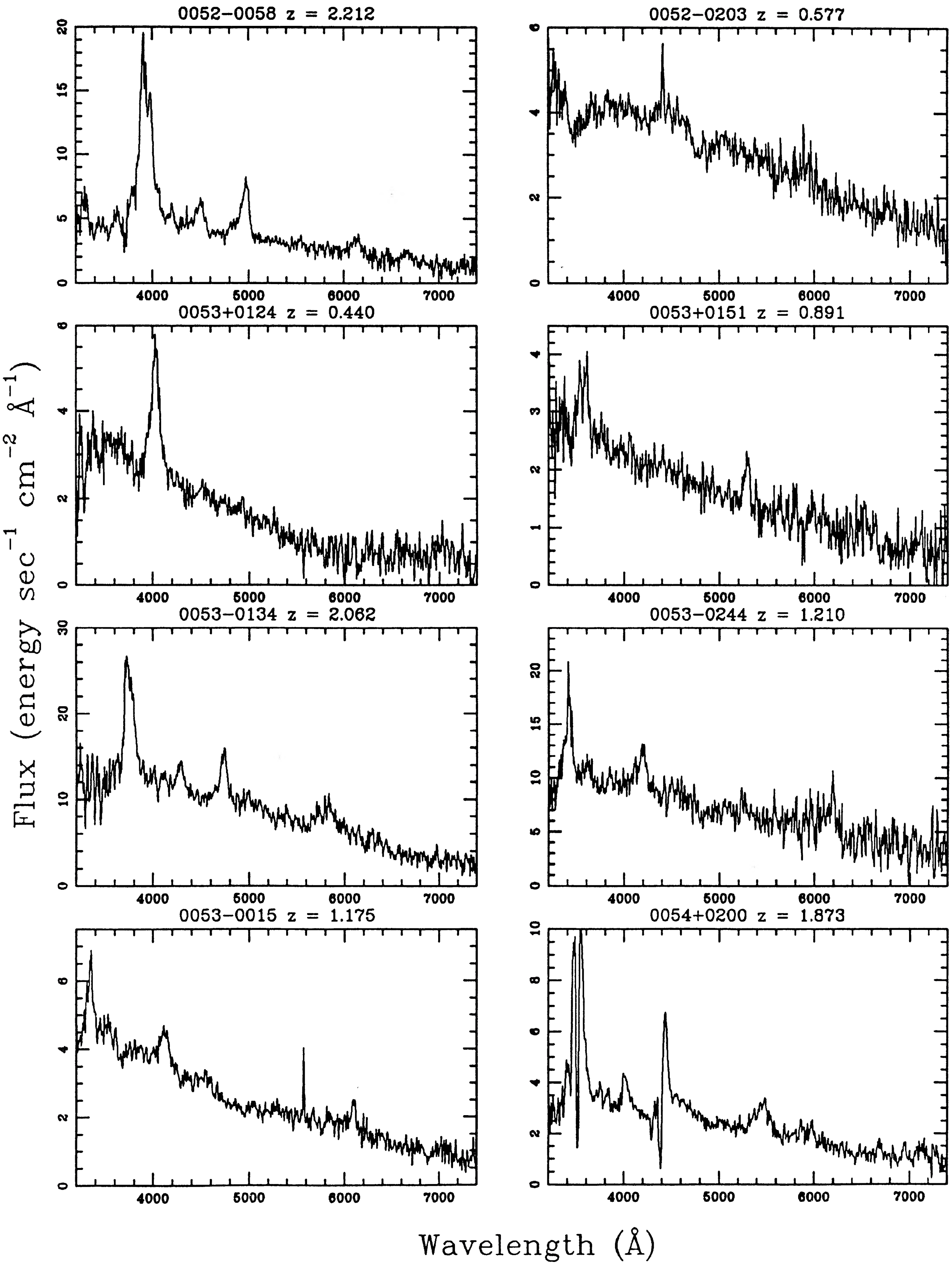

FIG. 1. (continued)

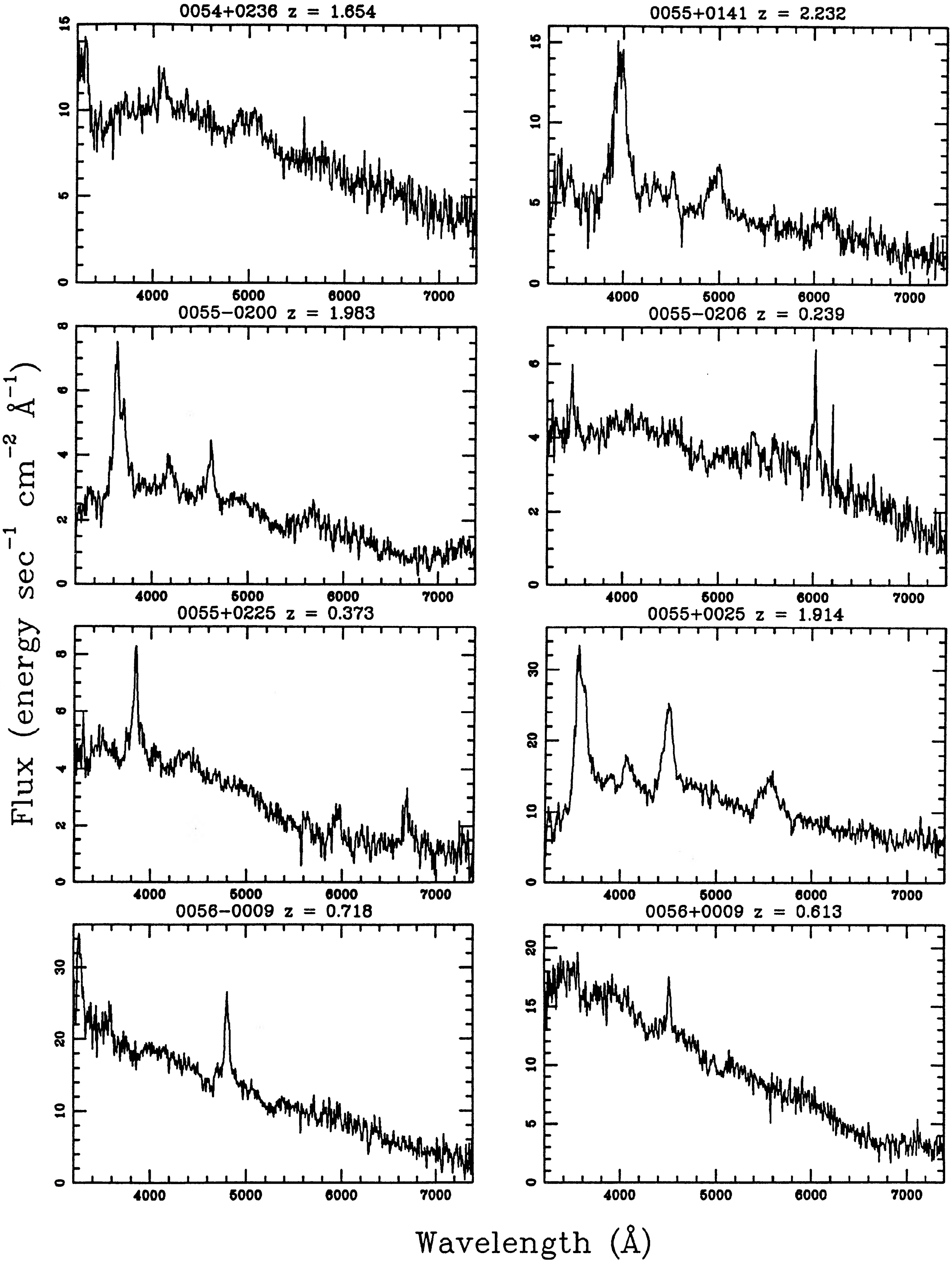

FIG. 1. (continued)

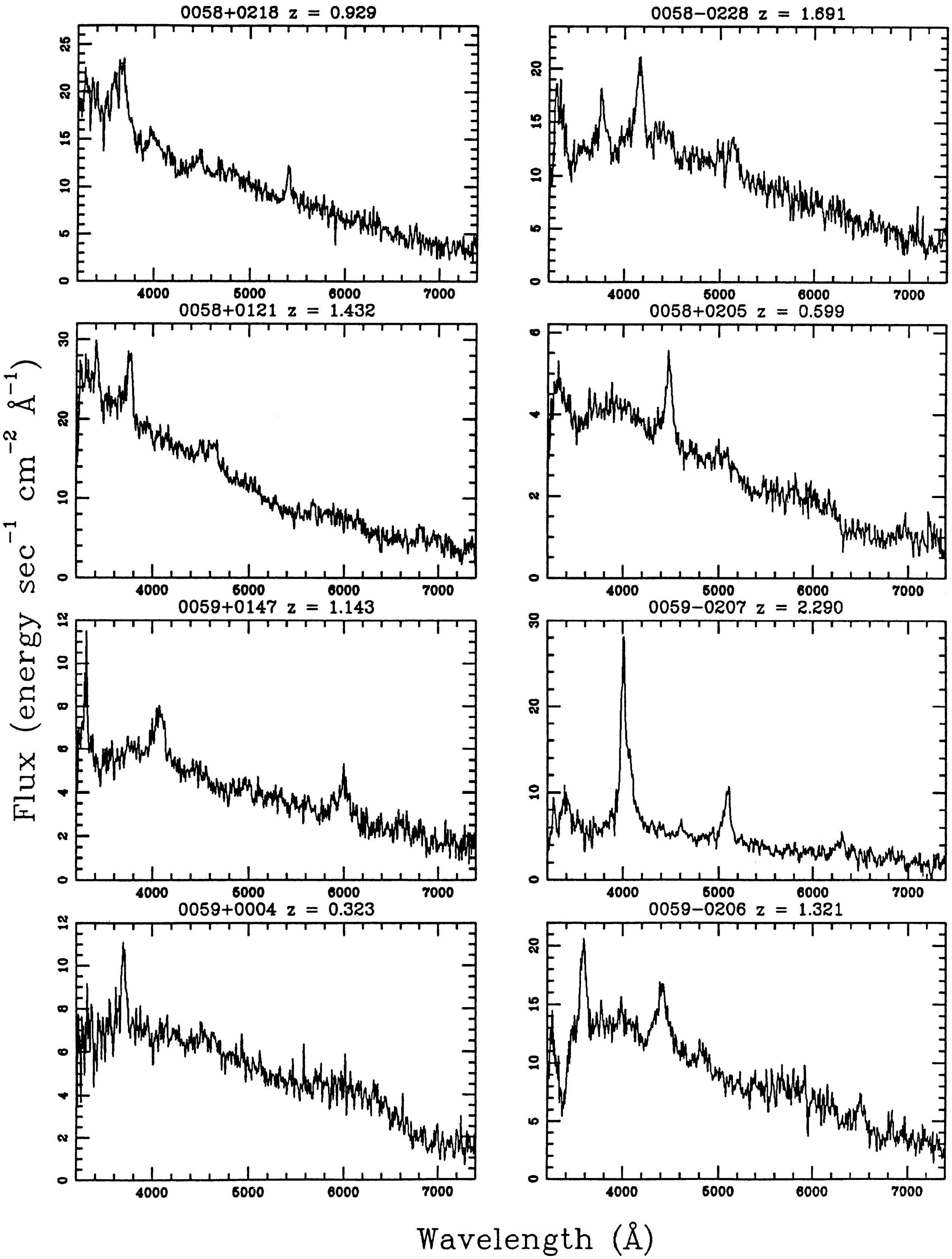

FIG. 1. (continued)

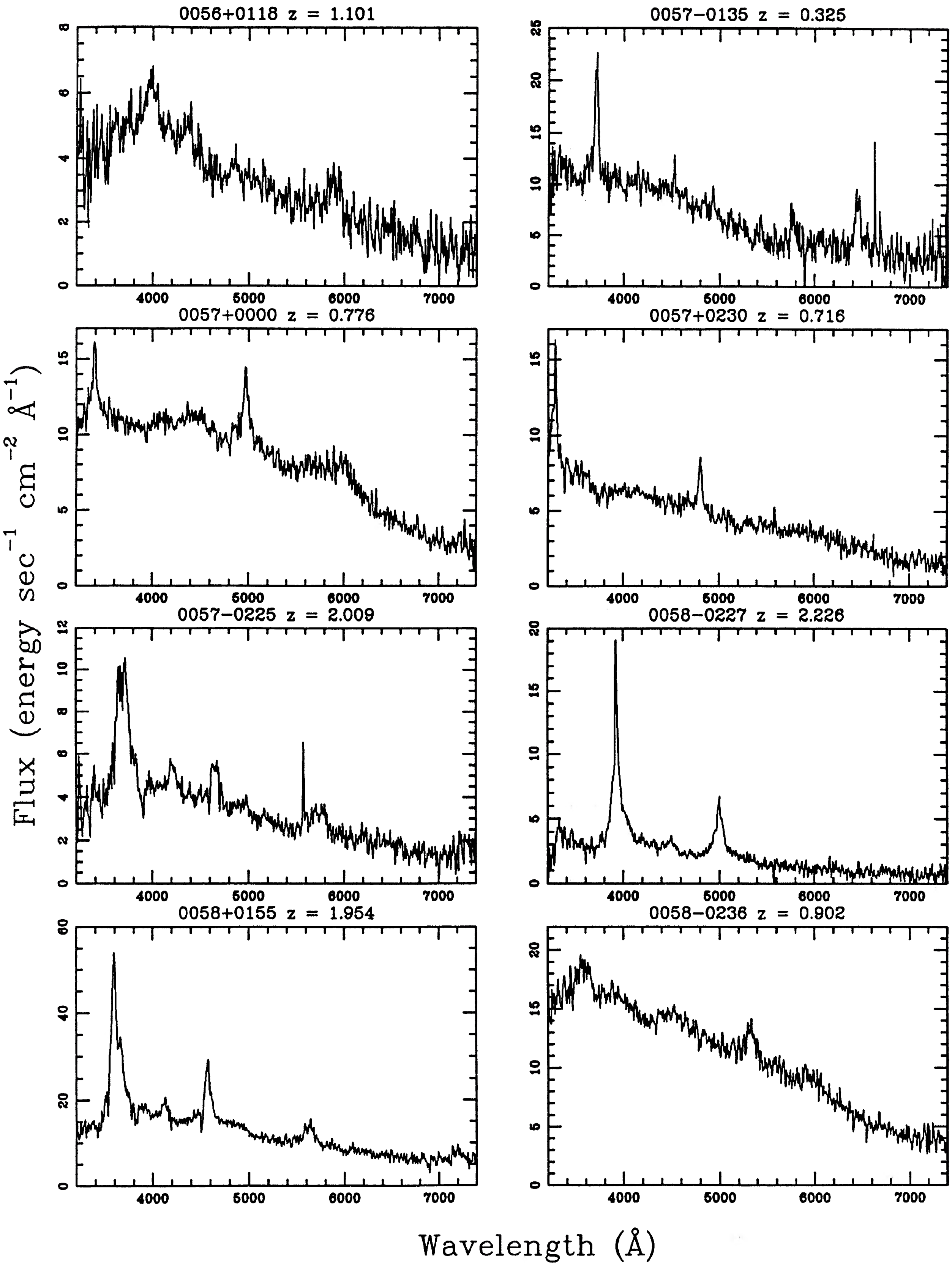

FIG. 1. (continued)

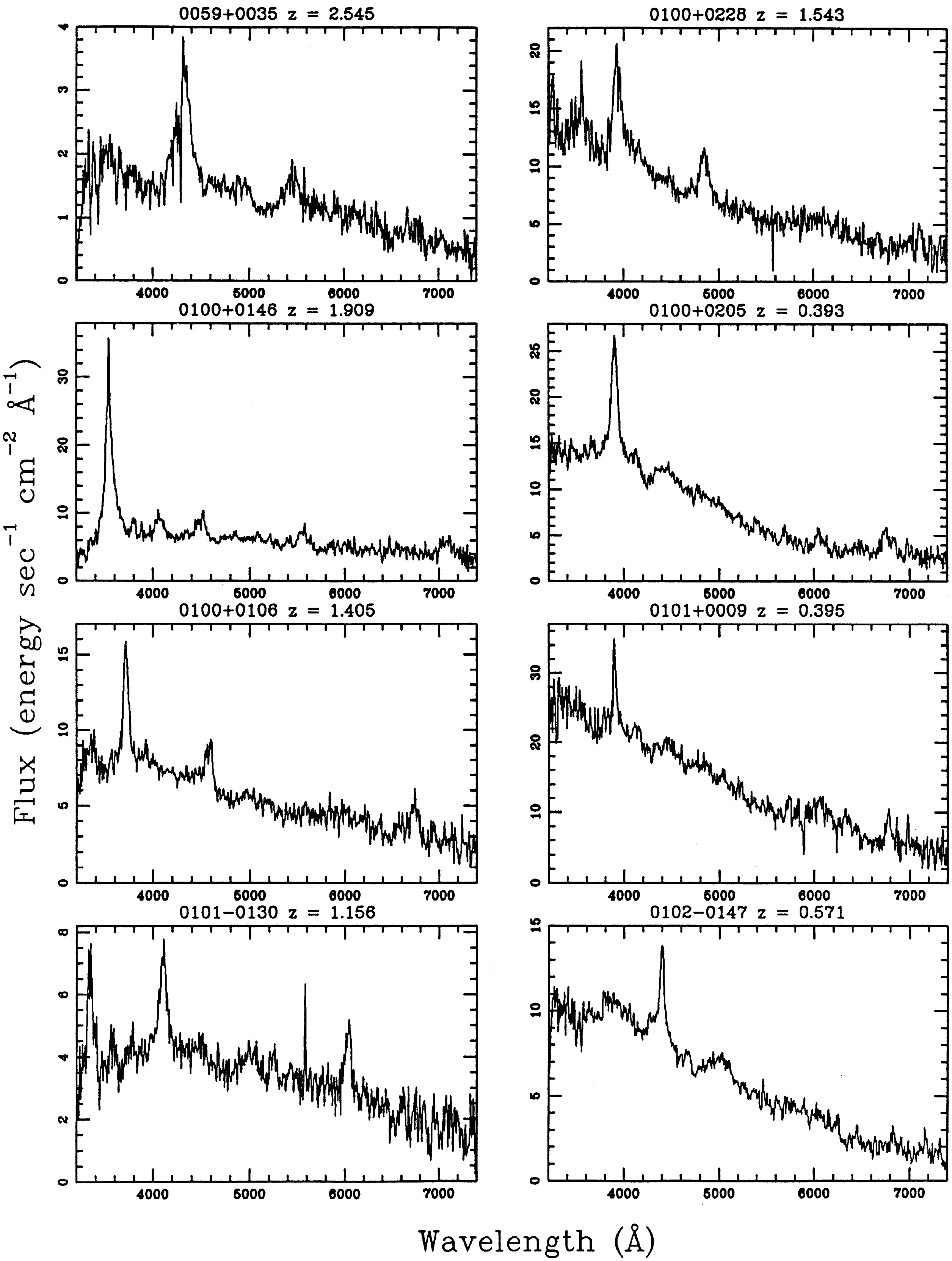

FIG. 1. (continued)

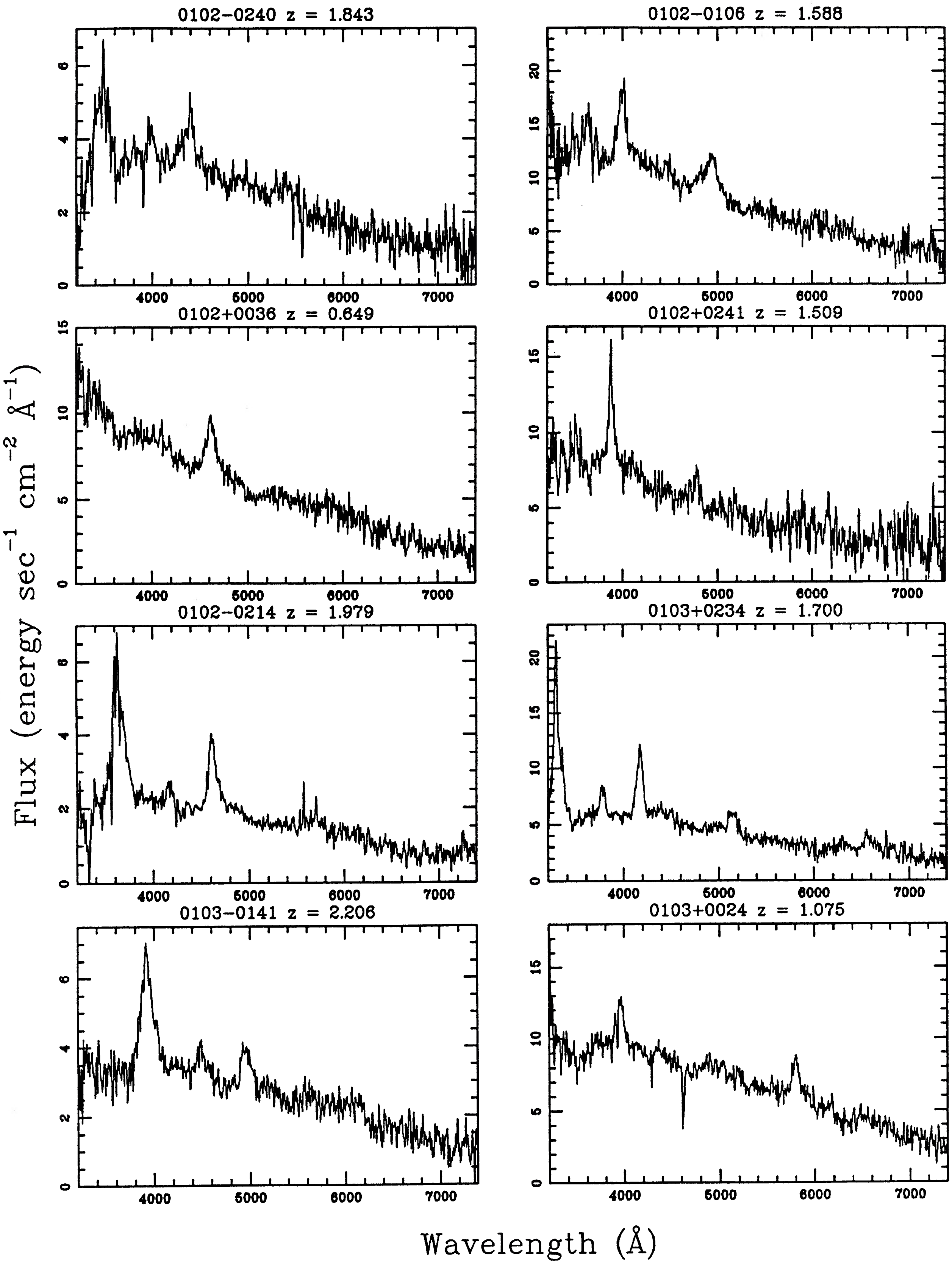

FIG. 1. (continued)

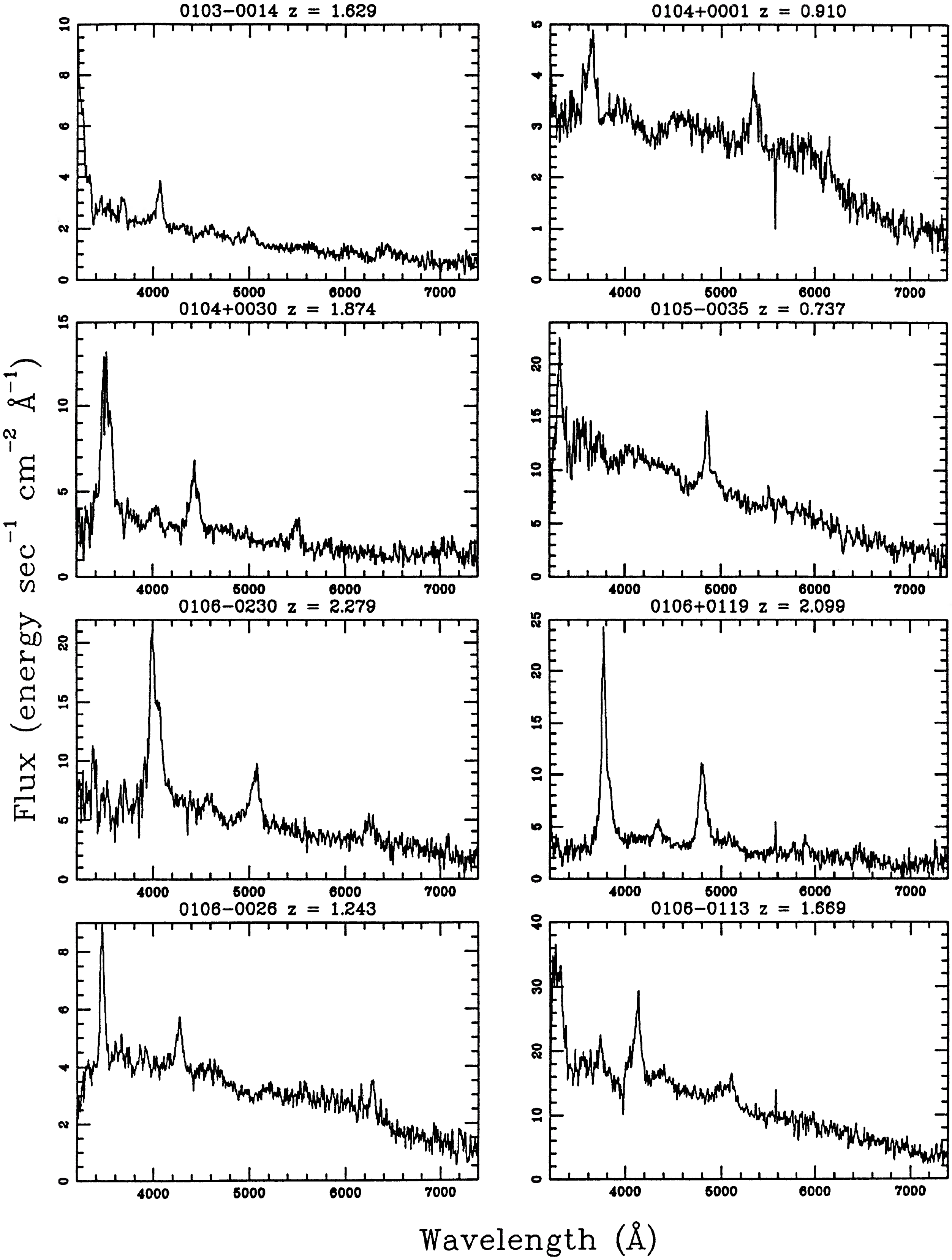

FIG. 1. (continued)

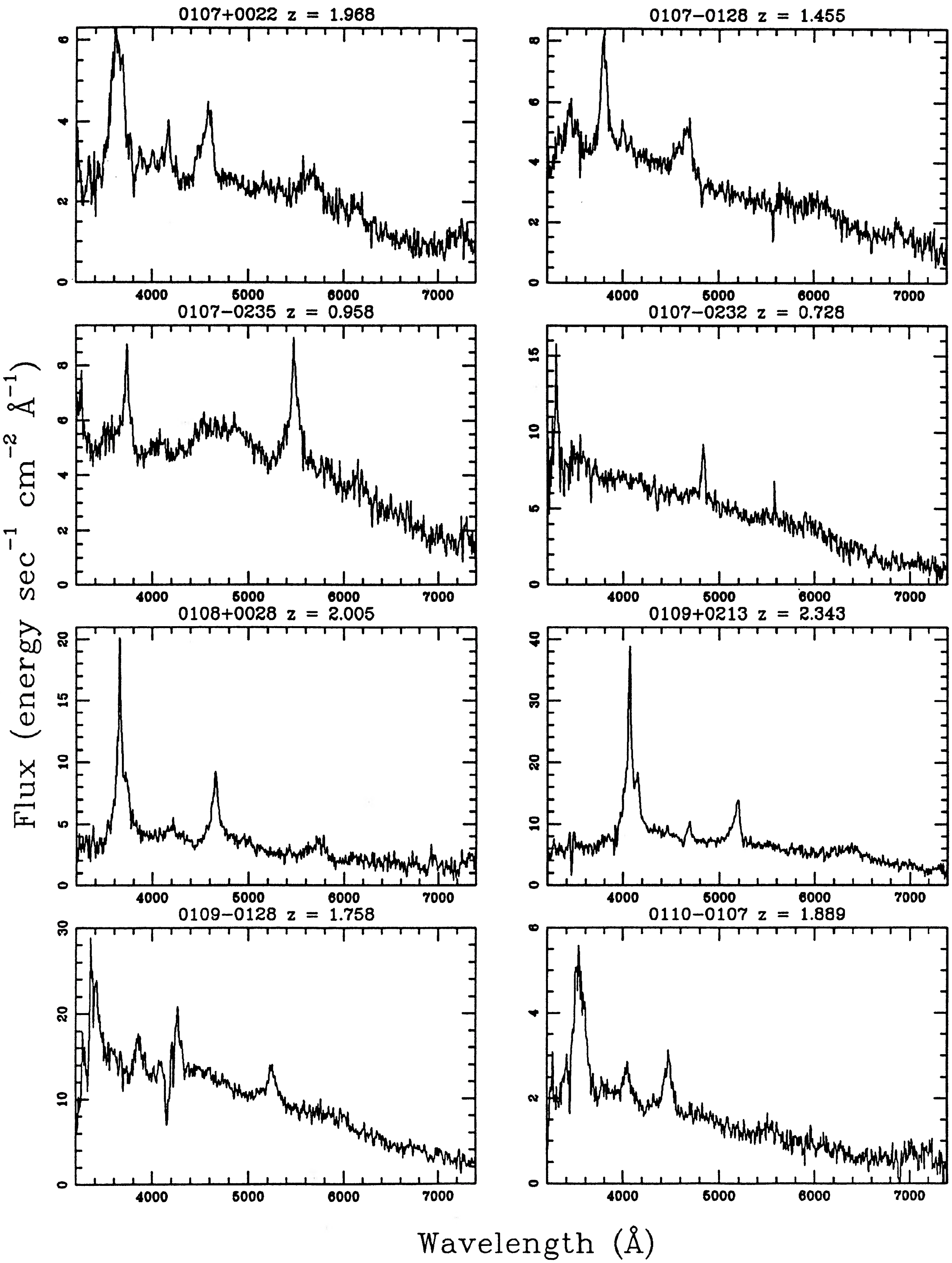

FIG. 1. (continued)

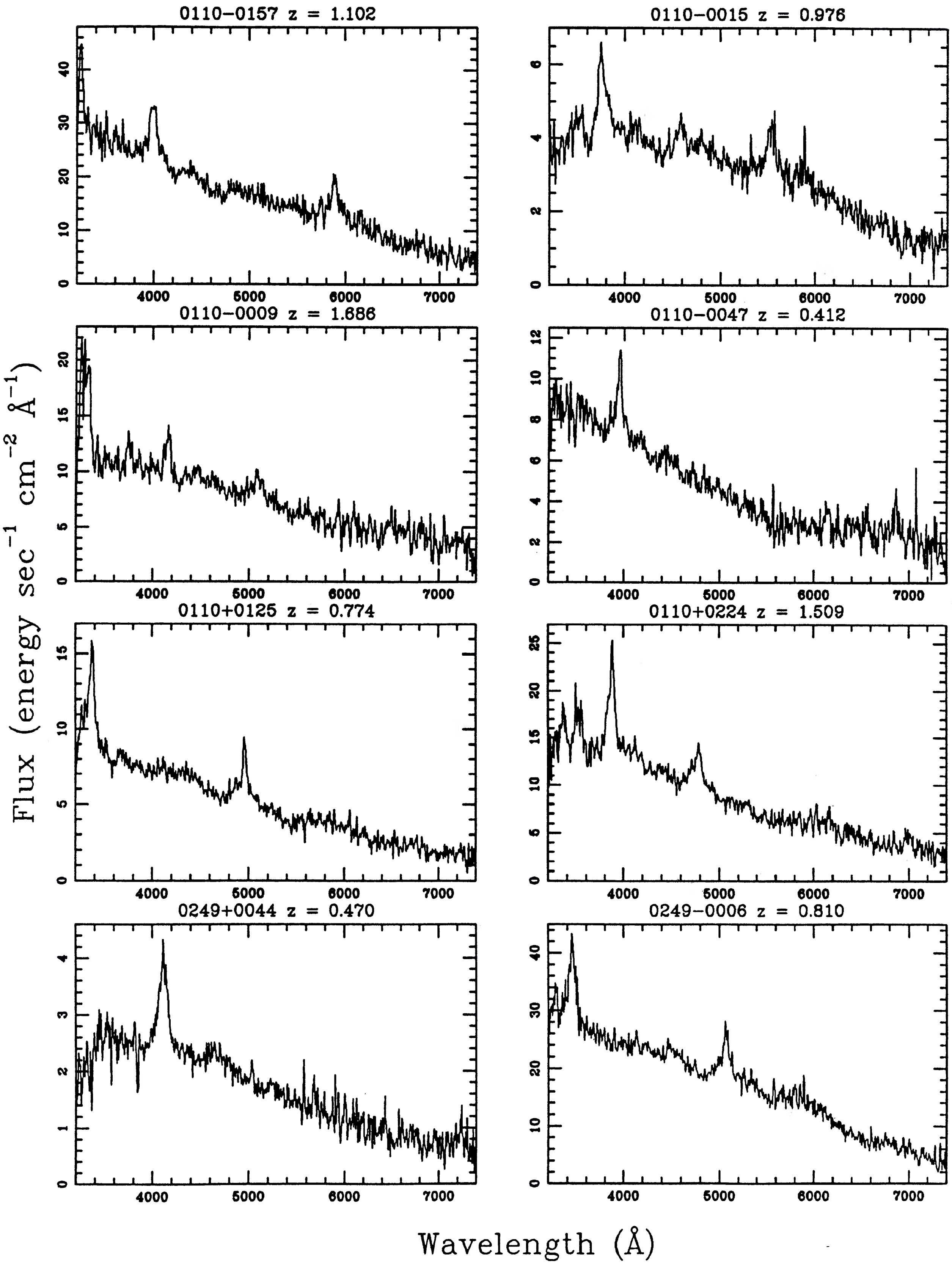

FIG. 1. (continued)

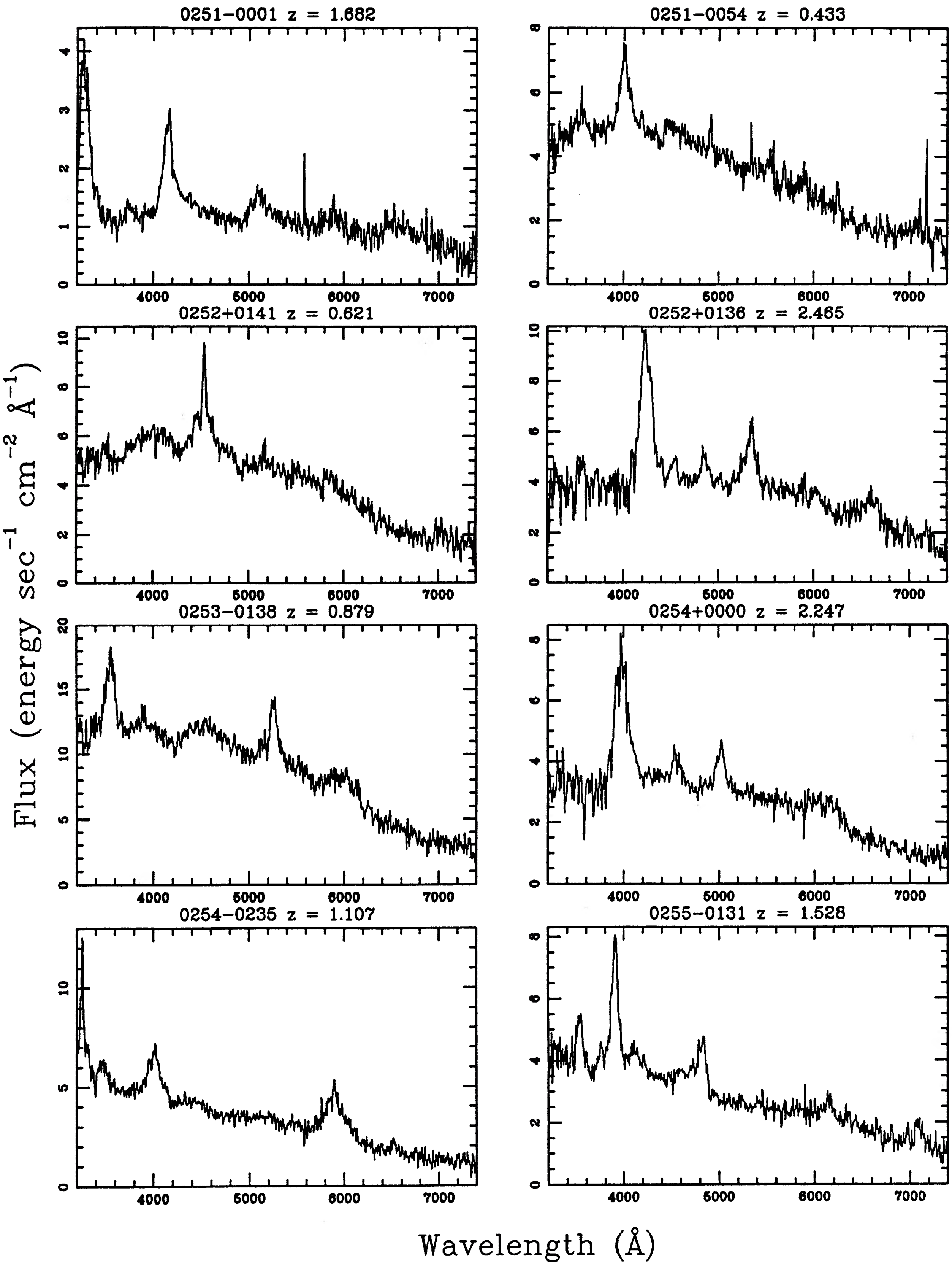

FIG. 1. (continued)

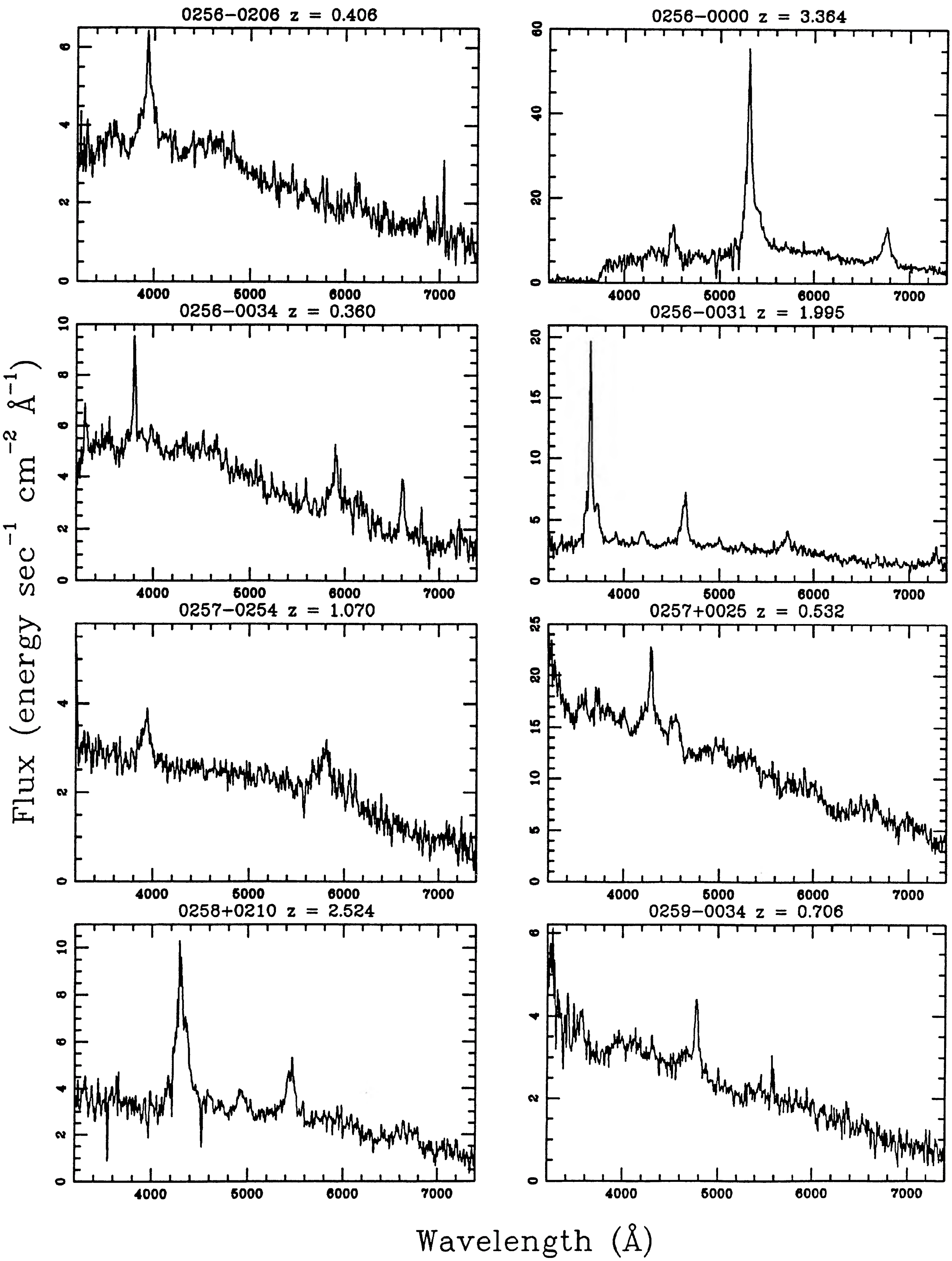

FIG. 1. (continued)

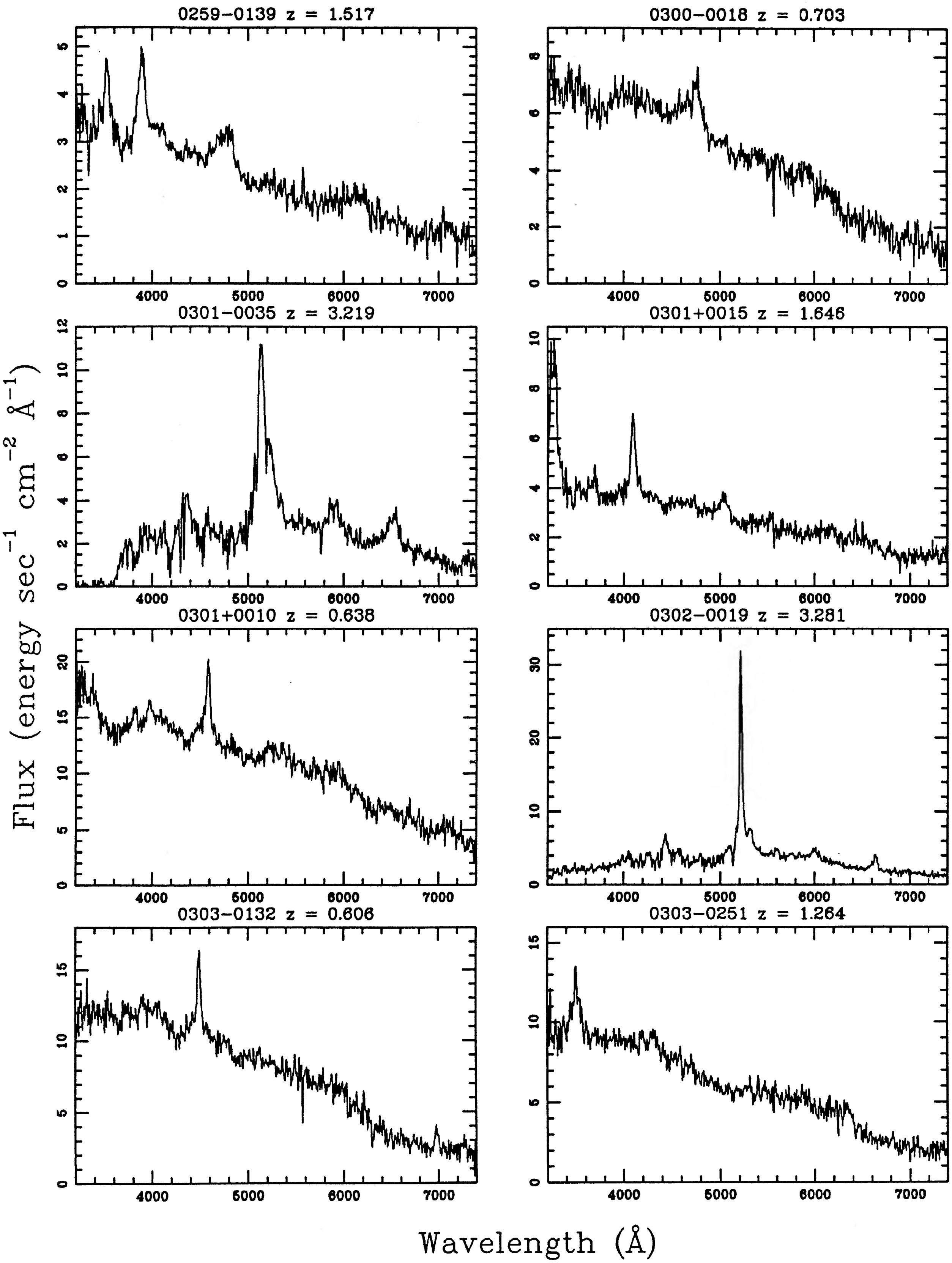

FIG. 1. (continued)

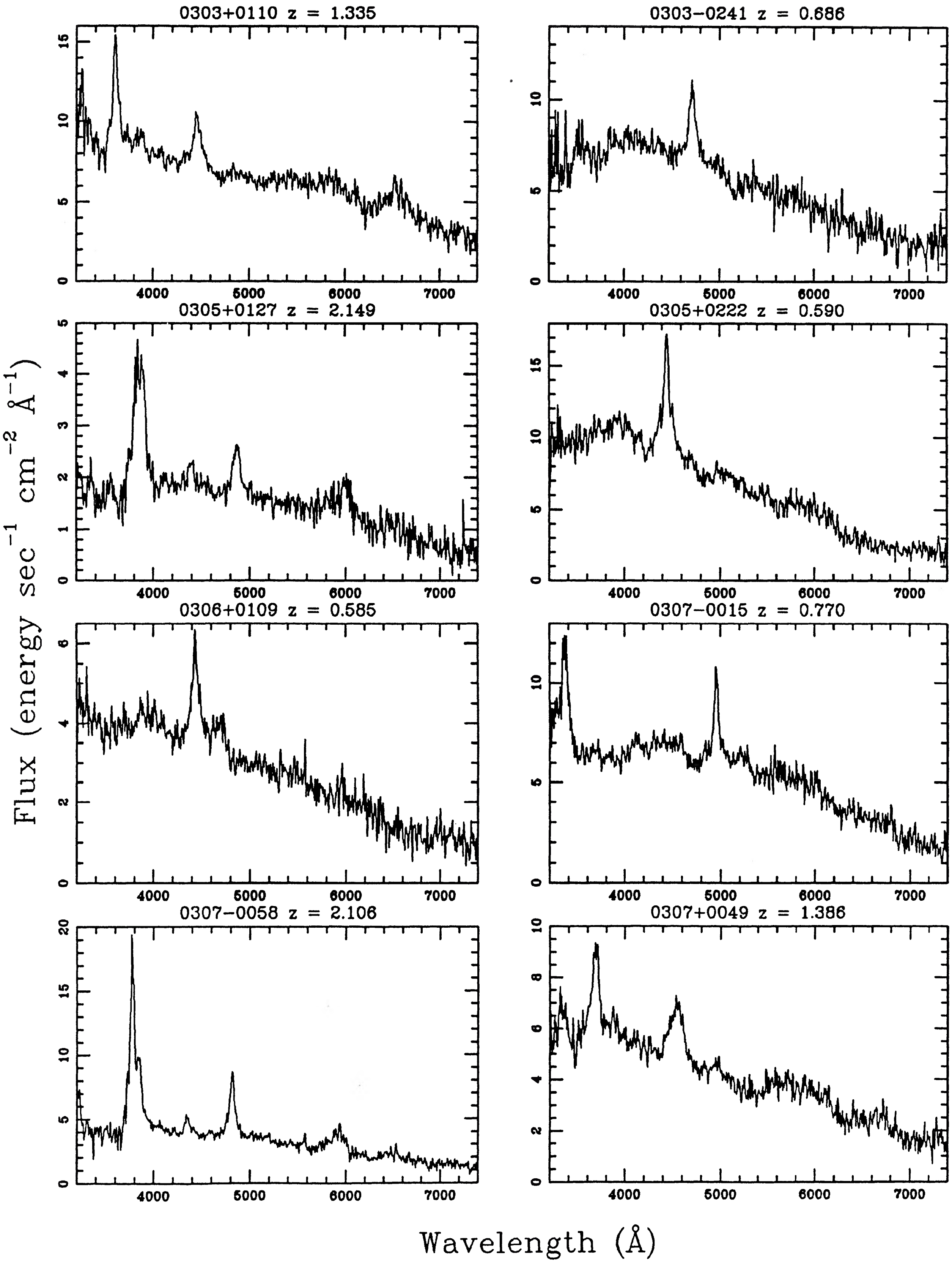

FIG. 1. (continued)

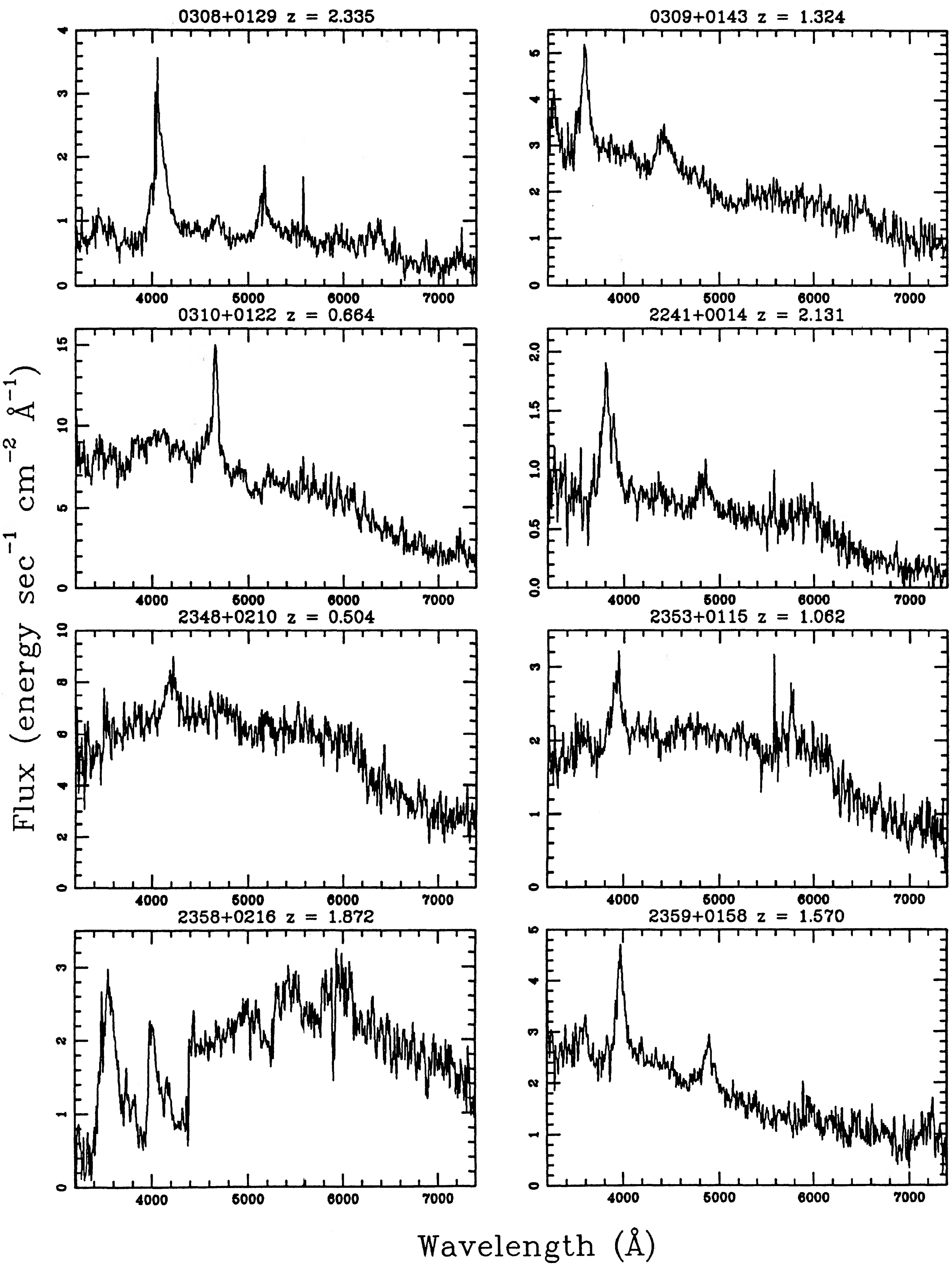

FIG. 1. (continued)

TABLE 2. Confirmed QSOs.

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Comment
0002−0210	00 02 44.2	−02 10 28	1.146	17.4	09/29/89	
0003+0146	00 03 13.8	+01 46 19	0.234	16.6	09/29/89	
0010+0035	00 10 53.6	+00 35 49	0.363	17.8	09/29/89	
0018−0252	00 18 52.3	−02 52 20	0.618	18.4	09/29/89	n
0022+0231	00 22 24.3	+02 31 33	1.490	18.8	09/29/89	
0027−0214	00 27 27.7	−02 14 18	1.588	18.8	09/29/89	a?
0048−0246	00 48 16.4	−02 46 45	0.987	17.6	10/08/88	
0048−0133	00 48 18.1	−01 33 56	0.763	17.2	09/29/89	f
0048−0119	00 48 28.9	−01 19 04	1.878	17.6	09/09/88	HB
0048+0029	00 48 47.3	+00 29 04	0.727	18.6	09/29/89	n
0048+0025	00 48 56.5	+00 25 32	1.188	18.2	09/29/89	
0049−0123	00 49 01.8	−01 23 28	1.560	17.8	09/29/89	b??
0049−0012	00 49 23.4	−00 12 23	1.946	18.4	09/29/89	HB,a?,d?
0049+0045	00 49 28.4	+00 45 12	2.265	17.5	09/09/88	HB
0049−0053	00 49 51.6	−00 53 22	1.402	18.7	09/29/89	n
0049+0019	00 49 52.9	+00 19 22	0.400	18.7	09/29/89	f
0050−0033	00 50 23.2	−00 33 26	1.676	18.8	11/02/88	n
0050+0123	00 50 43.5	+01 23 43	1.439	18.4	10/08/88	C
0051−0146	00 51 16.6	−01 46 47	0.406	17.7	10/08/88	
0051−0019	00 51 21.4	−00 19 25	1.713	18.7	09/29/89	b
0051−0035	00 51 35.3	−00 35 25	0.940	18.7	09/29/89	
0051+0216	00 51 41.0	+02 16 39	1.272	18.4	10/13/88	C
0051−0226	00 51 51.3	−02 26 55	2.526	18.6	10/08/88	n*
0052−0015	00 52 07.5	−00 15 05	0.648	17.7	10/14/88	n,c
0052−0058	00 52 21.3	−00 58 59	2.212	17.9	09/09/88	HB
0052−0203	00 52 43.1	−02 03 19	0.577	18.5	09/29/89	o,c,f?
0053+0124	00 53 00.9	+01 24 22	0.440	17.8	10/14/88	o
0053+0151	00 53 39.3	+01 51 22	0.891	18.6	10/13/88	
0053−0134	00 53 41.2	−01 34 42	2.062	18.3	10/08/88	
0053−0244	00 53 42.7	−02 44 53	1.210	17.9	11/02/88	
0053−0015	00 53 55.6	−00 15 04	1.175	18.7	09/29/89	
0054+0200	00 54 10.3	+02 00 18	1.873	18.4	09/29/89	a?,b?
0054+0236	00 54 36.4	+02 36 15	1.654	17.6	11/01/89	u,s
0055+0141	00 55 02.8	+01 41 41	2.232	18.6	10/08/88	
0055−0200	00 55 15.3	−02 00 36	1.983	18.6	10/08/88	
0055−0206	00 55 31.7	−02 06 28	0.239	17.5	09/29/89	
0055+0225	00 55 35.3	+02 25 44	0.373	18.6	11/01/89	
0055+0025	00 55 50.8	+00 25 02	1.914	17.5	09/09/88	
0056−0009	00 56 31.7	−00 09 19	0.718	17.7	10/08/88	HB
0056+0009	00 56 44.4	+00 09 09	0.613	18.0	09/29/89	o,c

TABLE 2. (continued)

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Comment
0056+0118	00 56 54.5	+01 18 22	1.101	18.1	10/13/88	
0057−0135	00 57 15.5	−01 35 16	0.325	17.9	11/02/88	
0057+0000	00 57 28.5	+00 00 33	0.776	17.2	09/29/89	
0057+0230	00 57 37.1	+02 30 47	0.716	18.3	09/29/89	
0057−0225	00 57 43.3	−02 25 23	2.009	18.6	10/13/88	
0058−0227	00 58 11.6	−02 27 26	2.226	18.6	10/13/88	n*
0058+0155	00 58 19.7	+01 55 29	1.954	17.2	09/09/88	HB
0058−0236	00 58 34.7	−02 36 49	0.902	18.3	09/29/89	
0058+0218	00 58 45.6	+02 18 22	0.929	17.7	10/13/88	
0058−0228	00 58 49.8	−02 28 56	1.691	18.2	10/13/88	
0058+0121	00 58 54.6	+01 21 37	1.432	17.6	10/08/88	
0058+0205	00 58 59.7	+02 05 47	0.599	18.5	10/16/90	
0059+0147	00 59 02.2	+01 47 04	1.143	18.0	09/09/88	
0059−0207	00 59 09.1	−02 07 59	2.290	18.4	10/08/88	
0059+0004	00 59 17.3	+00 04 21	0.323	18.6	09/29/89	o
0059−0206	00 59 32.4	−02 06 46	1.321	18.0	11/02/88	b
0059+0035	00 59 53.5	+00 35 31	2.545	18.5	09/29/89	
0100+0228	01 00 30.9	+02 28 06	1.543	18.4	10/13/88	
0100+0146	01 00 34.0	+01 46 14	1.909	18.5	10/08/88	
0100+0205	01 00 38.5	+02 05 05	0.393	17.5	09/09/88	HB
0100+0106	01 00 49.7	+01 06 07	1.405	18.5	11/01/89	
0101+0009	01 01 08.9	+00 09 32	0.395	17.4	10/08/88	
0101−0130	01 01 57.2	−01 30 35	1.156	18.5	10/13/88	
0102−0147	01 02 20.9	−01 47 35	0.571	17.4	11/01/89	f
0102−0240	01 02 21.2	−02 40 11	1.843	18.6	10/13/88	
0102−0106	01 02 34.7	−01 06 45	1.588	17.8	10/14/88	
0102+0036	01 02 35.3	+00 36 55	0.649	18.4	09/29/89	o,c
0102+0241	01 02 35.5	+02 41 03	1.509	18.6	11/02/88	
0102−0214	01 02 44.0	−02 14 31	1.979	18.6	09/29/89	d?
0103+0234	01 03 03.3	+02 34 56	1.700	18.0	09/09/88	
0103−0141	01 03 07.0	−01 41 00	2.206	18.5	11/07/88	
0103+0024	01 03 09.6	+00 24 01	1.075	17.4	09/09/88	
0103−0014	01 03 55.9	−00 14 40	1.629	18.5	09/29/89	
0104+0001	01 04 02.8	+00 01 12	0.910	18.3	09/29/89	
0104+0030	01 04 14.1	+00 30 26	1.874	18.5	10/13/88	
0105−0035	01 05 03.4	−00 35 13	0.737	18.1	10/14/88	
0106−0230	01 06 03.2	−02 30 32	2.279	18.5	10/08/88	
0106+0119	01 06 04.5	+01 19 01	2.099	18.3	10/08/88	HBr
0106−0026	01 06 07.8	−00 26 03	1.243	18.5	09/29/89	u?
0106−0113	01 06 21.6	−01 13 47	1.669	18.1	10/14/88	b??

TABLE 2. (continued)

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Comment
0107+0022	01 07 20.5	+00 22 15	1.968	18.5	09/29/89	
0107−0128	01 07 21.6	−01 28 45	1.455	18.4	09/29/89	
0107−0235	01 07 40.3	−02 35 51	0.958	18.1	09/29/89	HB,f
0107−0232	01 07 41.5	−02 32 55	0.728	18.4	09/29/89	
0108+0028	01 08 04.1	+00 28 57	2.005	18.3	10/13/88	
0109+0213	01 09 42.4	+02 13 53	2.343	17.6	09/09/88	HB*
0109−0128	01 09 54.3	−01 28 17	1.758	18.3	09/29/89	b?
0110−0107	01 10 06.8	−01 07 58	1.889	18.6	10/16/90	
0110−0157	01 10 08.1	−01 57 48	1.102	17.2	10/08/88	
0110−0015	01 10 28.1	−00 15 58	0.976	18.4	09/19/89	
0110−0009	01 10 28.1	−00 09 21	1.686	17.8	11/02/88	
0110−0047	01 10 36.9	−00 47 27	0.412	18.7	11/01/89	
0110+0125	01 10 50.0	+01 25 57	0.774	17.8	10/08/88	
0110+0224	01 10 56.4	+02 24 59	1.509	18.1	10/13/88	
0249+0044	02 49 21.8	+00 44 50	0.470	18.5	09/29/89	C3,o,c
0249−0006	02 49 47.2	−00 06 17	0.810	17.2	09/29/89	C3
0251−0001	02 51 07.1	−00 01 02	1.682	18.4	09/29/89	C3
0251−0054	02 51 59.4	−00 54 30	0.433	17.8	09/29/89	C3
0252+0141	02 52 08.1	+01 41 09	0.621	17.7	09/29/89	C3,o,c
0252+0136	02 52 40.1	+01 36 21	2.465	17.9	09/29/89	HB
0253−0138	02 53 44.0	−01 38 43	0.879	16.8	09/29/89	C4,f?
0254+0000	02 54 10.8	+00 00 43	2.247	18.2	09/29/89	HB*
0254−0235	02 54 26.9	−02 35 26	1.107	17.9	09/29/89	Cp
0255−0131	02 55 13.6	−01 31 47	1.528	18.3	09/29/89	HB
0256−0206	02 56 05.9	−02 06 08	0.406	18.5	09/29/89	C4
0256−0000	02 56 31.8	−00 00 34	3.364	18.2	09/29/89	HB,L,s
0256−0034	02 56 37.0	−00 34 35	0.360	18.0	09/29/89	C3,n
0256−0031	02 56 55.1	−00 31 55	1.995	17.6	09/29/89	HBr,n
0257−0254	02 57 01.1	−02 54 06	1.070	17.6	09/29/89	
0257+0025	02 57 03.3	+00 25 42	0.532	16.8	09/29/89	HB,o,c,f
0258+0210	02 58 10.4	+02 10 55	2.524	18.0	09/29/89	C4
0259−0034	02 59 46.9	−00 34 09	0.706	18.4	09/29/89	
0259−0139	02 59 58.1	−01 39 33	1.517	18.4	09/29/89	HB
0300−0018	03 00 42.1	−00 18 45	0.703	18.3	09/29/89	o,c
0301−0035	03 01 07.7	−00 35 04	3.219	18.4	09/29/89	HB,L,d
0301+0015	03 01 08.7	+00 15 19	1.646	18.3	09/29/89	Cp
0301+0010	03 01 48.4	+00 10 52	0.638	17.2	09/29/89	HB,o,c,f
0302−0019	03 02 16.3	−00 19 52	3.281	17.8	09/29/89	HB,n
0303−0132	03 03 10.0	−01 32 05	0.606	18.2	09/29/89	
0303−0251	03 03 17.5	−02 51 48	1.264	18.5	09/29/89	

TABLE 2. (continued)

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Comment
0303+0110	03 03 37.9	+01 10 23	1.335	17.4	09/29/89	HB
0303−0241	03 03 51.9	−02 41 27	0.686	18.5	09/29/89	o,c
0305+0127	03 05 28.3	+01 27 52	2.149	18.4	09/29/89	
0305+0222	03 05 38.3	+02 22 56	0.590	17.9	09/29/89	o,c
0306+0109	03 06 20.7	+01 09 48	0.585	18.3	09/29/89	o,c
0307−0015	03 07 05.8	−00 15 03	0.770	17.4	09/29/89	
0307−0058	03 07 30.0	−00 58 08	2.106	17.9	09/29/89	
0307+0049	03 07 45.4	+00 49 50	1.386	18.0	09/29/89	
0308+0129	03 08 50.7	+01 29 43	2.335	18.5	09/29/89	
0309+0143	03 09 14.6	+01 43 54	1.324	18.3	09/29/89	
0310+0122	03 10 08.6	+01 22 04	0.664	18.2	09/29/89	HBr*,o,c
2241+0014	22 41 21.2	+00 14 19	2.131	17.6	09/29/89	
2348+0210	23 48 23.9	+02 10 59	0.504	18.4	09/29/89	
2353+0115	23 53 36.6	+01 15 41	1.062	18.5	09/29/89	
2358+0216	23 58 48.0	+02 16 22	1.872	18.6	09/29/89	b
2359+0158	23 59 41.9	+01 58 35	1.570	18.7	11/01/89	

Notes to TABLE 2

a — 'Associated' absorption present, namely strong non-BAL absorption within 5000 kms^{-1} of the corresponding emission line.

b — BAL QSO; b? — probable BAL QSO; b?? — possible BAL QSO.

C — Unusually strong CIV/CIII] ratio.

c — If single line were CIII] λ1909, C IV λ1550 would be observable.

d — Damped Lyman α candidate.

f — Strong UV Fe II emission.

L — Lyman limit absorption.

l — Weak Lyman α + N V λ1240 emission.

n — Narrow emission lines; n* — narrow lines with broad component visible.

o — One-line redshift.

s — Weak Si IV λ1397 emission.

u — Droop in UV may be due to atmospheric dispersion losses at large airmass.

HB — Tabulated in Hewitt and Burbidge (1987)

HB* — HB coordinates in error by more than 10 arcsec.

HBr — radio-selected

C3 — Tabulated in Cristiani *et al.* (1989).

C4 — Tabulated in Cristiani *et al.* (1991).

Cp — S. Cristiani, private communication.

Notes on Individual Objects

0027−0214 — Unusually strong broad feature near λ1780 (rest).

0048+0025 — Unusually blue, weak lines.

0054+0236 — Unusually strong AlIII λ1858 emission.

0100+0146 — Unusually large Ly α/CIV ratio.

0110+0224 — Strong CII λ1334 emission?

0252+0136 — Strong OI λ1302 emission?

0302−0019 — Very strong, narrow Ly α emission.

2358+0216 — Probable AlIII BAL, therefore, probable Mg II BAL.

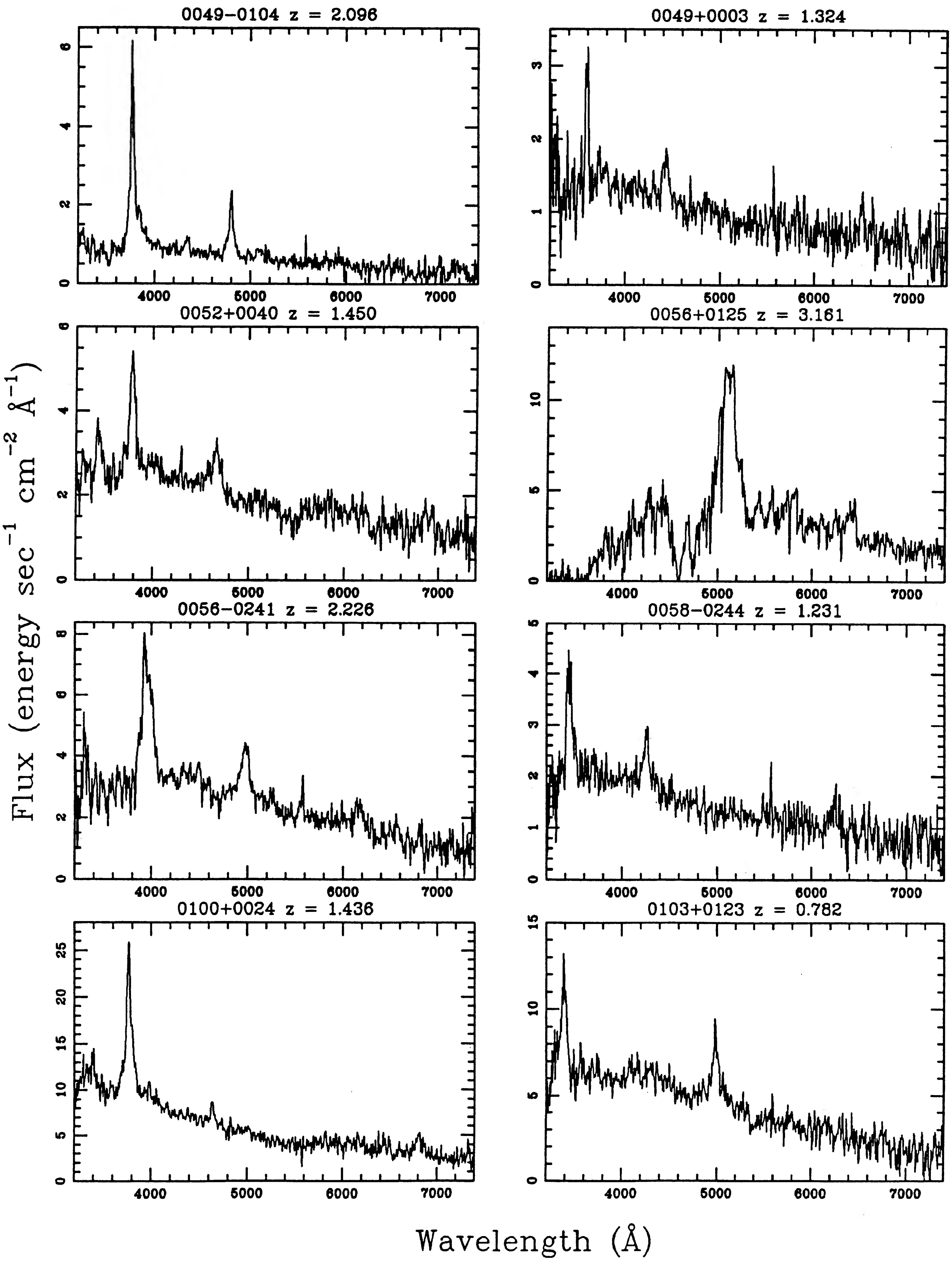

FIG. 2. Spectra of QSOs fainter than LBQS magnitude limit.

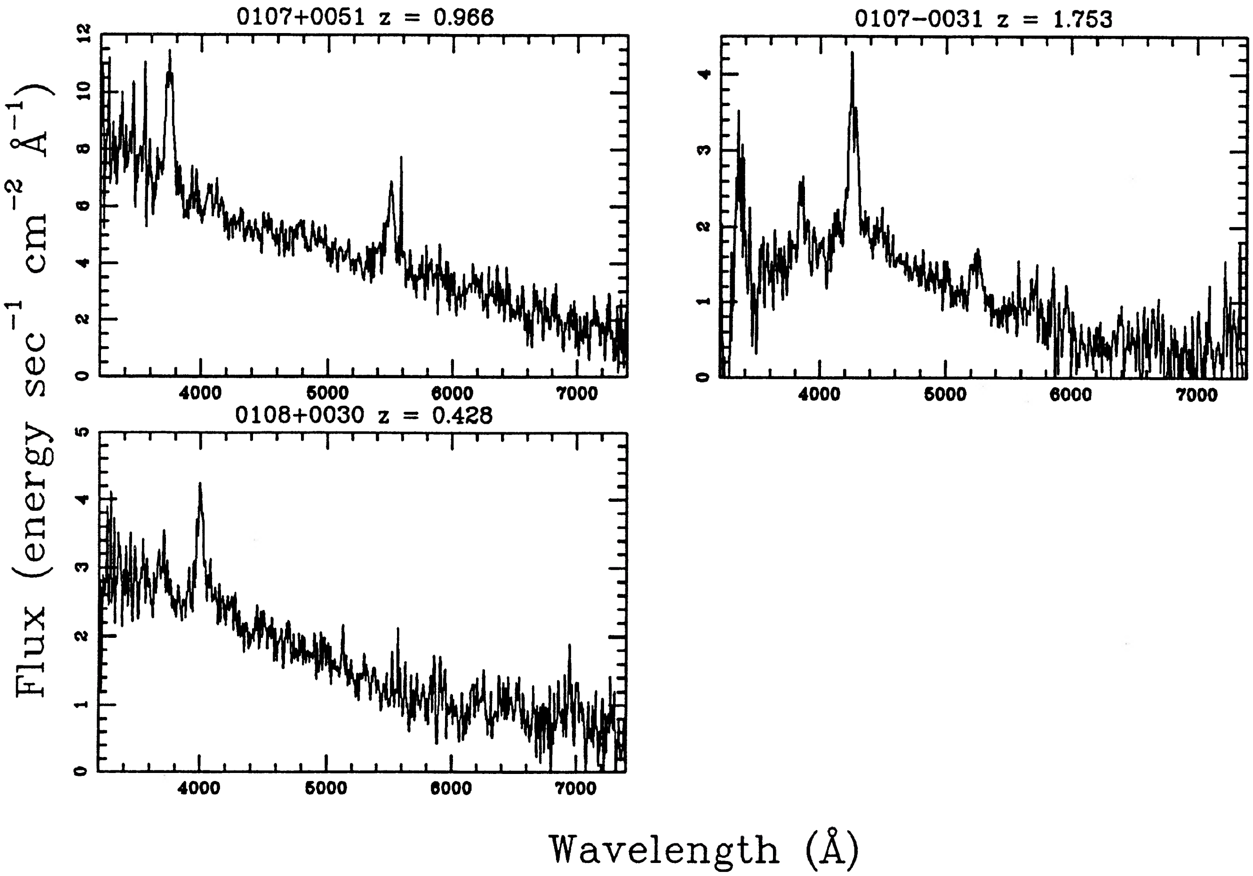

FIG. 2. (continued)

TABLE 3. QSOs Fainter than magnitude limit.

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Comment
0049−0104	00 49 04.7	−01 04 28	2.096	18.9	11/07/88	n
0049+0003	00 49 51.5	+00 03 50	1.324	19.4	10/16/88	
0052+0040	00 52 26.4	+00 40 23	1.450	19.0	11/07/88	
0056+0125	00 56 43.4	+01 25 56	3.161	18.8	10/08/88	HB,d,L
0056−0241	00 56 47.3	−02 41 51	2.226	18.9	10/13/88	
0058−0244	00 58 31.2	−02 44 03	1.231	19.1	10/13/88	
0100+0024	01 00 55.5	+00 24 49	1.436	18.9	10/13/88	C
0103+0123	01 03 30.4	+01 23 06	0.782	18.8	10/08/88	
0107+0051	01 07 13.4	+00 51 53	0.966	19.0	10/13/88	u?
0107−0031	01 07 50.9	−00 31 40	1.753	18.8	10/14/88	
0108+0030	01 08 18.9	+00 30 52	0.428	19.0	10/13/88	

Notes to TABLE 3

See Notes to Table 2

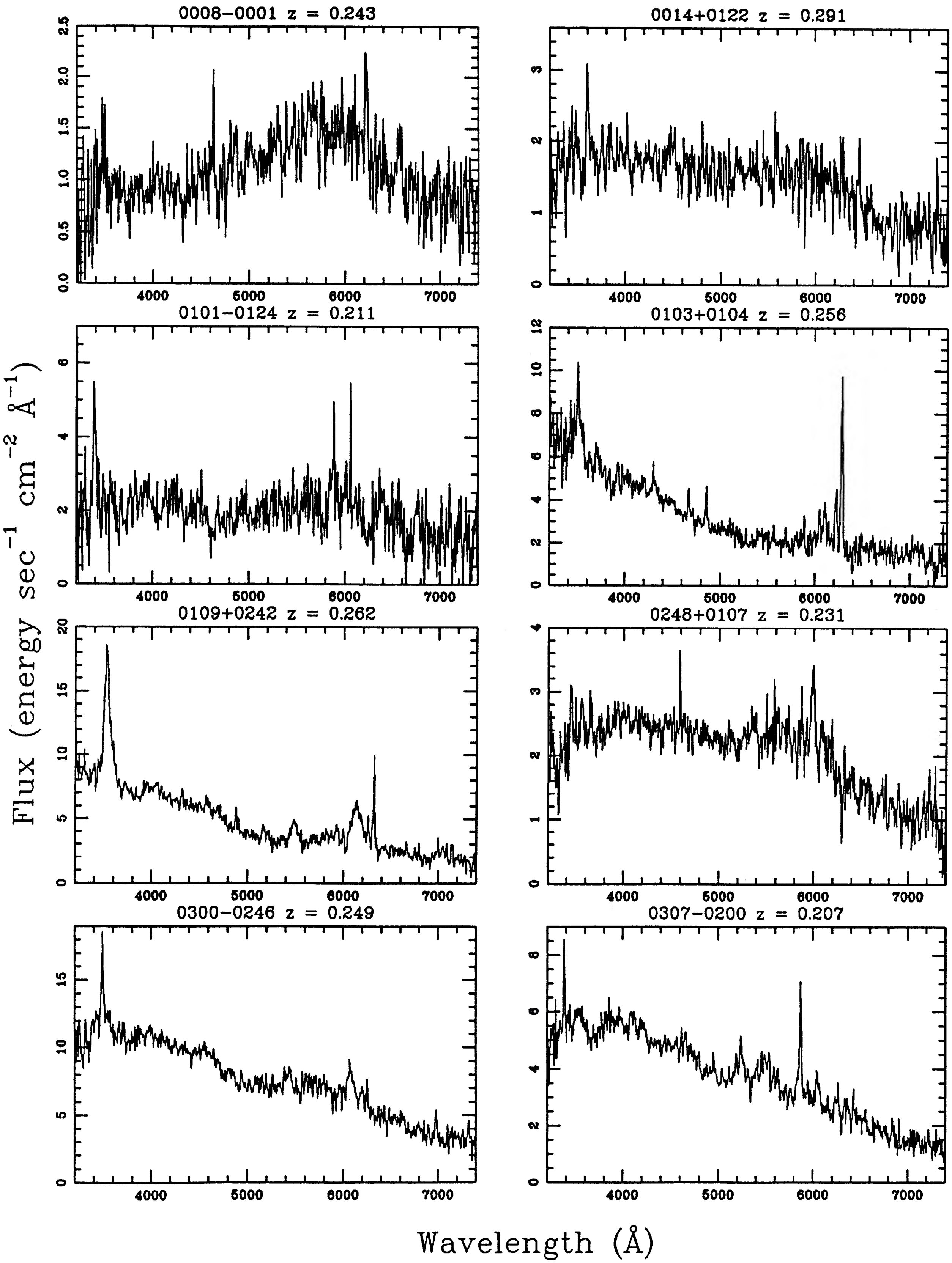

FIG. 3. Spectra of extragalactic objects with $z \geqslant 0.2$ and $M_{B_J} > -21.5$.

TABLE 4. AGNs with $Z_{em} \geqslant$ and $M_J >$ absolute magnitude cutoff.

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date	Notes
0008−0001	00 08 21.1	−00 01 50	0.243	18.4	09/29/89	
0014+0122	00 14 08.9	+01 22 47	0.291	18.7	09/29/89	
0101−0124	01 01 37.4	−01 24 53	0.211	18.8	11/01/89	
0103+0104	01 03 45.0	+01 04 17	0.256	18.3	10/13/88	
0109+0242	01 09 24.2	+02 42 52	0.262	18.4	09/29/89	
0248+0107	02 48 30.0	+01 07 09	0.231	18.5	09/29/89	Cp
0300−0246	03 00 15.3	−02 46 20	0.249	18.3	09/29/89	
0307−0200	03 07 46.9	−02 00 01	0.207	18.3	09/29/89	

Notes to TABLE 4

See Notes to Table 2

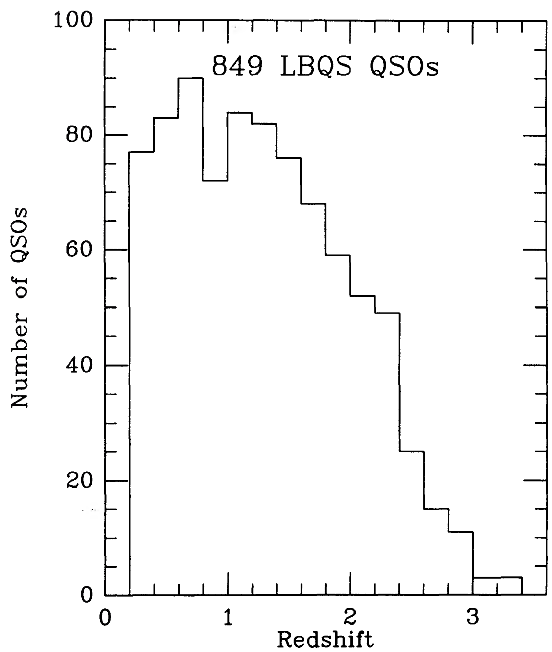

FIG. 4. Redshift histogram of the partially completed LBQS, including all objects in this Paper and those in Papers I–III.

TABLE 5. AGNs and emission-line galaxies.

Designation	R.A. (1950)	Dec. (1950)	z_{em}	B_J	UT Date
0020−0124	00 20 31.4	−01 24 22	0.167	17.3	09/29/89
0029+0130	00 29.44.3	+01 30 28	0.095	18.1	09/29/89
0051−0220	00 51 05.4	−02 20 58	0.187	17.7	09/29/89
0052−0038	00 52 53.8	−00 38 03	0.168	18.5	09/29/89
0101−0028	01 01 29.5	−00 28 58	0.083	18.6	09/29/89
0110+0203	01 10 24.2	+02 03 16	0.157	18.0	09/29/89
0254+0101	02 54 12.3	+01 01 47	0.177	17.7	09/29/89
0302−0016	03 02 27.5	−00 16 43	0.031	18.2	09/29/89
0307−0101	03 07 54.9	−01 01 11	0.080	16.3	11/01/89
2233+0210	22 33 54.8	+02 10 10	0.089	18.4	09/29/89
2348+0215	23 48 07.6	+02 15 28	0.069	18.6	09/29/89

grees, the figure that should be used for surface density and luminosity function calculations. Candidates fainter than $B_J = 16.0$ and brighter than the adopted limiting magnitude for each field (Table 1) were observed, irrespective of their direct image morphology. Candidate selection procedures have been described in Papers II and III. The additional candidates observed in the 0000 + 0000 field resulted from the application of the adjusted selection criteria described in Paper III.

2.2 Magnitude Calibration

Instrumental B_J magnitudes for the 0100 + 0000 field UKST direct IIIa-J plate were calibrated using a photometric sequence established from five distributed CCD frames in the field obtained with the Las Campanas 1 m telescope. For the 0300 + 0000 field, we have adopted the sequence used by Cristiani *et al.* (1989) to establish the magnitude scale for SA94, for which they kindly provided coordinates and magnitudes.

TABLE 6. Previously discovered QSOs not in LBQS.

Designation	R.A. (1950)	Dec. (1950)	m_{pub}	B_J	Notes
0049+014	00 49 59.5	+01 24 24	17.	17.8	c
0054−006	00 54 43.4	−00 40 46	18.	19.1	a
0101−025	01 01 44.2	−02 31 45	19.0	19.1	a
0105−008	01 05 53.3	−00 53 24	17.5	18.3	c
0248+021	02 48 34.7	+02 06 58	18.84	19.6	a
0250+020	02 50 40.7	+02 03 20	18.81	18.9	a
0252+0013	02 52.31.6	+00 13 15	17.28	17.8	c,e
0253+006	02 53 25.5	+00 41 07	19.0	18.9	a,b
0257+024	02 57 53.9	+02 28 59	16.1	16.0	d
0259+015	02 59 27.6	+01 34 31	18.5	18.8	a
0300−004	03 00 39.5	−00 26 41	18.2	18.4	c

Notes to TABLE 6

a — Object fainter than LBQS field limit
b — HB coordinates in error by more than 5 arcseconds
c — Spectrum overlapped on objective-prism plate
d — Object brighter than LBQS field limit
e — Cristiani *et al.* (1991)

2.3 QSOs Detected and Redshift Determinations

6 Å resolution spectra were obtained of each candidate with the blue channel of the MMT spectrograph at a moderate signal-to-noise ratio (~ 12) that is as uniform as possible for all QSOs in the LBQS. Of the 237 candidates in the two new fields presented here, 125 were found to be QSOs. All QSOs, including the supplementary group from the 0000 + 0000 field, are listed in Table 2 in order of right ascension. Column 1 gives the name, columns 2 and 3: the celestial coordinates (equinox 1950.0), column 4: the emission-line redshift, column 5: the B_J magnitude, column 6: the UT date of the MMT observation; and column 7: comments on the spectrum. As in previous papers we estimate our coordinate and magnitude accuracy to be ± 1 arcsec and ± 0.15 mag, respectively. Redshifts were derived using the composite spectrum of 718 LBQS QSOs (Francis *et al.* 1991) as a template against which to cross correlate the spectrum of each confirmed QSO.

Figure 1 presents flux-calibrated spectra of all objects listed in Table 2. As in Papers I–III, observations were generally made at low airmass using 2.5 arcsec apertures. To remove the effect of atmospheric refraction, which becomes a serious problem in the ultraviolet at airmasses exceeding 1.4, objects originally observed at airmasses $\geqslant 1.4$ were reobserved at low airmass using 5 arcsec apertures and the original higher signal-to-noise ratio spectra were then corrected to remove any strong "ultraviolet droops." A few objects still suffer from some light loss at wavelengths shortward of 4000 Å. Longward of this wavelength we estimate that the relative fluxes are accurate to $\pm 15\%$.

Figure 2 and Table 3 present the same information as contained in Fig. 1 and Table 2 for confirmed QSOs that are fainter than the LBQS limit in their corresponding field. These were observed for a variety of reasons and are included for completeness only. They should not be considered part of the LBQS sample.

Figure 3 and Table 4 present spectra and relevant parameters, respectively, for those extragalactic objects with $z \geqslant 0.2$ and $M_{B_J} > -21.5$, the adopted absolute magnitude threshold for the LBQS sample. In computing the absolute magnitude of the objects, a Hubble constant of 100 km s^{-1} Mpc^{-1}, $q_0 = 0.0$ and k corrections assuming the QSOs are represented by a simple power-law flux distribution $F(\nu) \propto \nu^{\alpha}$, with $\alpha = -1$ have been adopted.

Table 5 presents relevant parameters for extragalactic objects with $z < 0.2$, the adopted redshift threshold for the LBQS sample.

3. COMPARISON WITH PREVIOUSLY KNOWN QSOs

The 136 QSOs listed in Table 2 combined with those presented in Papers I–III, brings the LBQS to the 82% completion level. As in the previous papers, we compare our list of QSOs with those in the Hewitt and Burbidge catalog (1987, 1989; hereafter referred to as HB) as a crude test of our candidate selection efficiency. We restrict our attention to objects with $z > 0.2$ and published magnitudes between 16.0 and 19.0, irrespective of the optical passband employed. We further include objects for which no magnitude is given in HB.

Of the 33 HB QSOs meeting our redshift and magnitude criteria, our procedures have independently identified 23. The remaining 10 are listed in Table 6, where the coordinates listed are those measured from our UKST direct plates. Six are fainter than the LBQS magnitude limit for the field in which they they appear, and one is too bright. The remaining three have spectra that overlap with those of nearby objects and were not processed.

In addition to those objects listed in HB, Cristiani *et al.* (1989, 1991) have compiled a list of QSOs in SA94 which significantly overlaps our 0300 + 0000 field. Of the 24 QSOs they find in SA94 that are ot listed in HB, our selection procedures identify 10 (flagged as "C" in Table 2). Of those remaining, 13 are fainter than the LBQS magnitude limit and one has an overlapped spectrum. We list only the latter in Table 6.

Thus, the 15 LBQS fields included in Papers I–IV contain 98 previously known QSOs whose spectra were processable and which were brighter than the LBQS magnitude threshold. Of these only one *bona fide* QSO, 1237 − 009 (cf. Paper III) and the BL Lac object 1210 + 121 (cf. Paper I) have escaped our detection. It should be pointed out, however, that most QSOs listed in HB were optically selected, so that our finding most of them is not a particularly demanding test of the LBQS selection procedures. Nonetheless, all three of the radio-selected HB QSOs in the two fields presented here (which are so noted in Table 2) were independently identified by the LBQS.

Figure 4 shows the redshifts histogram for the LBQS to date. The virtual absence of discontinuities in this histogram at any redshift and the extended range of the redshifts covered is an independent qualitative indicator of the success of the LBQS selection procedures.

We wish to thank Stefano Cristiani and Favio La Franca for sharing data with us in advanced of publication and for providing their SA94 photometric sequence. The LBQS is supported by National Science Foundation Grants Nos. AST 90-01181 and 90-05117, for which we are grateful. The LBQS would not have been possible without the active support of the United Kingdom Schmidt Telescope Unit and the staff of the Automated Plate Measuring facility. We further acknowledge the computing support provided by the Starlink Project which is funded by the UK SERC. F.H.C. gratefully acknowledges the hospitality of the Institute of Astronomy and the support of a Royal Society Guest Research Fellowship. P.J.F. is supported by an SERC postgraduate studentship.

REFERENCES

Cristiani, S., Barbieri, C., Iovino, A., La Franca, F., and Nota, A. 1989, A&AS, 77, 161

Cristiani, S., La Franca, F., Barbieri, C., Clowes, R. G., and Iovino, A. 1991, MNRAS (in press)

Foltz, C. B., Chaffee, F. H., Hewett, P. C., MacAlpine, G. M., Turnshek, D. A., Weymann, R. J., and Anderson, S. F. 1987, AJ, 94, 1423 (Paper I)

Foltz, C. B., Chaffee, F. H., Hewett, P. C., Weymann, R. J., Anderson, S. F., and MacAlpine, G. M. 1989, AJ, 98, 1959 (Paper II)

Francis, P. J., Hewett, P. C., Foltz, C. B., Chaffee, F. H., Weymann, R. J., and Morris, S. L. 1991, ApJ, 373, 465

Hewett, P. C., Foltz, C. B., Chaffee, F. H., Francis, P. J., Weymann, R. J., Morris, S. L., Anderson, S. F., and MacAlpine, G. M. 1991, AJ, 101, 1121 (Paper III)

Hewitt, A., and Burbidge, G. 1987, ApJS, 63, 1

Hewitt, A., and Burbidge, G. 1989, ApJS, 69, 1

United Kingdom Schmidt Telescope Handbook 1983, Royal Observatory, Edinburgh