Revista Mexicana de Astronomía y Astrofísica, **31**, 159-169 (1995)

CALÁN-TOLOLO SURVEY. VII. ONE HUNDRED SOUTHERN QUASARS

J. Maza[1], P.F. Ortiz[1], M. Wischnjewsky[1], R. Antezana[1], and L.E. González[1]

Depto. de Astronomía, Universidad de Chile

Received 1995 July 10; accepted 1995 September 22

RESUMEN

Se presenta la séptima lista de la Exploración Calán-Tololo. Contiene información acerca de 100 cuasares australes, cuyas magnitudes B están en el intervalo $16 \leq B < 19.5$, con sólo 20 objetos más brillantes que $B = 18$. Los corrimientos al rojo z son tales que 69 objetos cumplen con $1.8 \leq z < 2.4$, 11 objetos tienen z tal que $2.4 \leq z < 3.4$ y 20 cuasares tienen un $z < 1.8$. Estos cuasares fueron encontrados en Cerro Calán explorando placas de prisma objetivo tomadas en el Observatorio Inter-Americano de Cerro Tololo, utilizando la cámara Curtis-Schmidt con el prisma ultravioleta delgado y placas IIIaJ. Se presentan cartas de identificación, coordenadas ecuatoriales, una estimación de la magnitud azul, B, y un corrimiento preliminar del rojo. Todos los cuasares de esta lista han sido confirmados espectroscópicamente, información que será publicada posteriormente (Maza & Ortiz 1996). Sólo doce de los quasares aquí reportados eran conocidos con anterioridad.

ABSTRACT

The seventh list of the Calán-Tololo Survey is presented. It contains information for 100 southern quasars with a B magnitude in the range $16 \leq B < 19.5$; only 20 quasars are brighter than $B = 18$. The redshifts z of these quasars are such that for 69 objects $1.8 \leq z < 2.4$, for 11 objects $2.4 \leq z < 3.4$ and for 20 quasars $z < 1.8$. These quasars were found at Cerro Calán, searching objective prism plates obtained at Cerro Tololo Inter-American Observatory, using the Curtis-Schmidt telescope, the thin UV prism and IIIaJ plates. Identification charts, equatorial coordinates, an estimated blue magnitude, B, and a preliminary redshift for every object are presented. All quasars in this list have been confirmed using slit spectroscopy. The spectroscopic data shall be presented elsewhere (Maza & Ortiz 1996). Only twelve of these quasars were known before.

Key words: **QUASARS – GENERAL**

1. INTRODUCTION

The Calán-Tololo Survey (hereinafter CTS) is an objective prism survey conducted at Cerro Calán (Department of Astronomy, Universidad de Chile) in Santiago, using photographic plates obtained at Cerro Tololo Inter-American Observatory (CTIO). We have used the Curtis-Schmidt telescope, IIIaJ plates and the thin UV prism. The CTS is a southern extension to the Tololo Survey (Smith 1975; Smith, Aguirre, & Zemelman 1976) and to the Michigan Survey (MacAlpine, Lewis, & Smith 1977; MacAlpine, Smith, & Lewis 1977a, 1977b; MacAlpine & Lewis 1978; MacAlpine & Williams 1981). The main goal of the CTS is the discovery of new quasars and emission line galaxies. A description of the survey, the procedure and other details can be found in Maza et al. 1988a, 1988b, 1989, 1991 and 1992.

List No. 1 of the Calán-Tololo Survey containing 30 new Seyfert 1 galaxies was published in 1989 (Maza et al. 1989). List No. 3 presenting 42 H II

[1] Visiting Astronomer at Cerro Tololo Inter-American Observatory, National Optical Astronomy Observatories, operated by the Association of Universities for Research in Astronomy under contract with the National Science Foundation of the U.S.A.

galaxies was published in 1991 (Maza et al. 1991). List No. 2 containing data for 40 Seyfert 1 galaxies was published in 1992 (Maza et al. 1992). List No. 4 presenting data for 50 Seyfert 1 galaxies was published in 1994 (Maza et al. 1994). List No. 5 containing data for 200 quasars was published in 1993 (Maza et al. 1993). List No. 6 containing data for 100 southern quasars was published in 1995 (Maza et al. 1995). The present list contains information for 100 additional quasars discovered in the Calán-Tololo Survey and fully confirmed by slit spectroscopy at Las Campanas Observatory (Carnegie Southern Observatory).

2. OBSERVATIONS

Objective prism photographic plates have been obtained for 266 fields in the southern hemisphere at galactic latitude b such that $|b| \geq 20°$, covering 5150 deg^2. To the original 163 fields of the CTS — see Figure 1 in Maza et al. 1989— additional strips at $\delta = -30°$ (strip "F"), $\delta = -50°$ (strip "G"), and $\delta = -55°$ (strip "H") have been added in the right ascension interval $19^h \leq \alpha \leq 6^h$.

We have used the Curtis-Schmidt telescope at CTIO equipped with the thin UV prism that yields a reciprocal dispersion of 1740 Å mm^{-1} at H_β, 1340 Å mm^{-1} at H_γ, and 1100 Å mm^{-1} at λ3727 Å (Blanco 1974). We have used Eastman Kodak IIIaJ plates baked in 2% forming gas and exposed to the sky limit (90 min) with spectra oriented north-south, without trailing. Objects as faint as 19th mag in B are visible at the plate limit. The UV prism spectral resolution at the Curtis-Schmidt plate scale (97″ mm^{-1}) is $\sim$30 Å at Hβ and $\sim$20 Å at λ3727 Å for a 2″ seeing.

Our method of selecting a quasar candidate relies on the presence of emission lines in the spectrum. Strong emission lines present in the spectrum of a high redshift quasar (Lα, most of the time) are resolved on our objective prism spectra, allowing a clear separation between quasar candidates and high redshift starburst galaxies. The most favorable case to select a quasar candidate is when Lα lies near λ4000 Å and the C IV line (λ1549 Å) is at λ5000 Å, corresponding to a quasar at a redshift $z \sim 2.2$. The lines used for candidate selection on the objective prism plates are: Lα ($\sim$ 75% of the time), C IV and Mg II (at λ2798 Å). In a few cases, broad absorption lines quasars (BALs) have been found because their spectrum looks quite conspicuous on the objective prism plates; they look like unusual carbon stars.

3. LIST No. 7

Figure 1 presents identification charts and Table 1 contains the corresponding data for 100 additional quasars found and confirmed in our survey. Quasar candidates were selected from the objective prism plates and they were confirmed using slit spectroscopy at the 2.5-m du Pont telescope at Las Campanas Observatory (Carnegie Institution of Washington Southern Observatory). Only twelve of the quasars presented here were known before, according to the sixth edition of the catalogue of quasars by Véron-Cetty & Véron (1993); they are identified in Table 1 by an asterist after the CT number.

Table 1 contains, for quasars numbered from 501 to 600 a name, labeled "Object" obtained from a contraction of the letter designating the strip on the sky, the field number in the strip and the candidate number in that field. For example, object C1610 is the tenth candidate selected in area "C16" (sixteenth field in strip "C") (see Figure 1 in Maza et al. 1989).

Equatorial coordinates (J2000.0) were obtained using the Digitized Sky Survey (DSS), the STSDAS software package and the corresponding tasks in the IRAF working environment on SUN workstations at Cerro Calán. A preliminary set of coordinate for each candidate was obtained by overlaying a grid on the objective prism plate. Then a 15′ × 15′ image was extracted from the DSS. The object was identified in that image and coordinates were obtained using the plate solution in the header of each image. The astrometric accuracy of these coordinates is better than 1 arcsecond.

Column 5 in Table 1 presents a B magnitude estimated from the ESO Quick Blue Chart for every object south of $-15°$. The CCD sequence F342–10 from Stobie, Sagar, & Gilmore (1985) was used for our eye estimates made by one of us (RA). Then these B magnitudes were compared with the instrumental magnitudes from the DSS, yielding a fit for 97 objects with a scatter of $\pm$0.34 mag. Using that relationship and the DSS, we estimated B values for objects 515, 521, and 525, which are located north of $-15°$. As quasars in Table 1 could present photometric variability it is necessary to emphasize that the magnitudes quoted here correspond to an eye estimate made on direct plates taken at least 15 years ago; those magnitudes do not necessarily correspond to the apparent magnitudes of the quasars in the objective prism plates.

Column 6 in Table 1 presents preliminary values for the redshifts of these quasars. These figures were obtained at the telescope when the spectroscopic confirmation of the quasars was made; they should be accurate to $\pm$0.02. (A comparison between the redshifts quoted here an those listed by Véron-Cetty & Véron (1993) for the twelve known quasars produces a fit with a rms of 0.020). The details of the spectrophotometry shall be presented elsewhere (Maza & Ortiz 1996). The final redshift value will be reported there.

Finally the last column of Table 1 presents the ESO Quick Blue chart number where these quasars can be found.

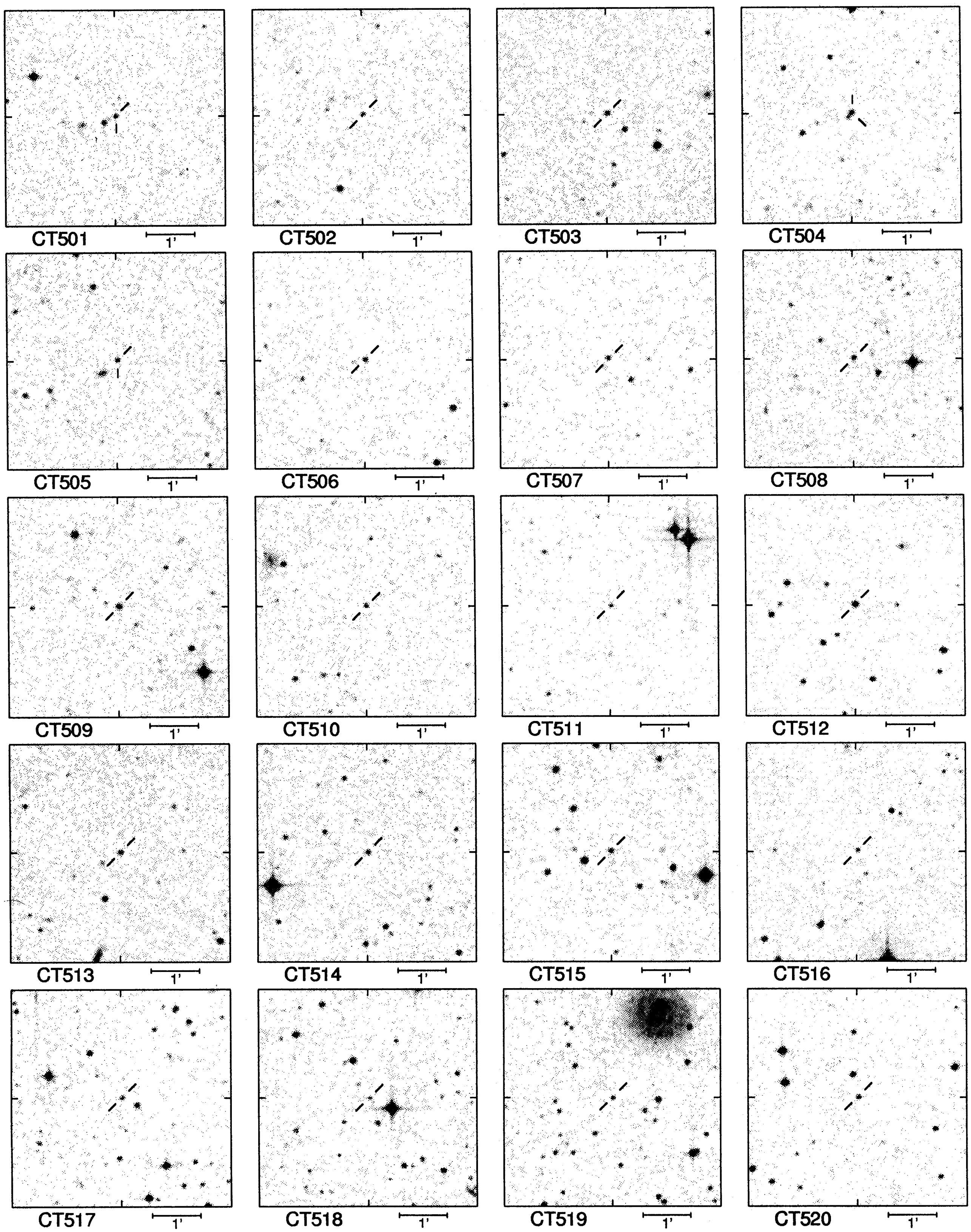

Fig. 1*a*. Objects 501–520. Finding charts for Calán-Tololo quasars from the Digitized Sky Survey (DSS). North is to the top and east to the left. Each chart covers $4' \times 4'$.

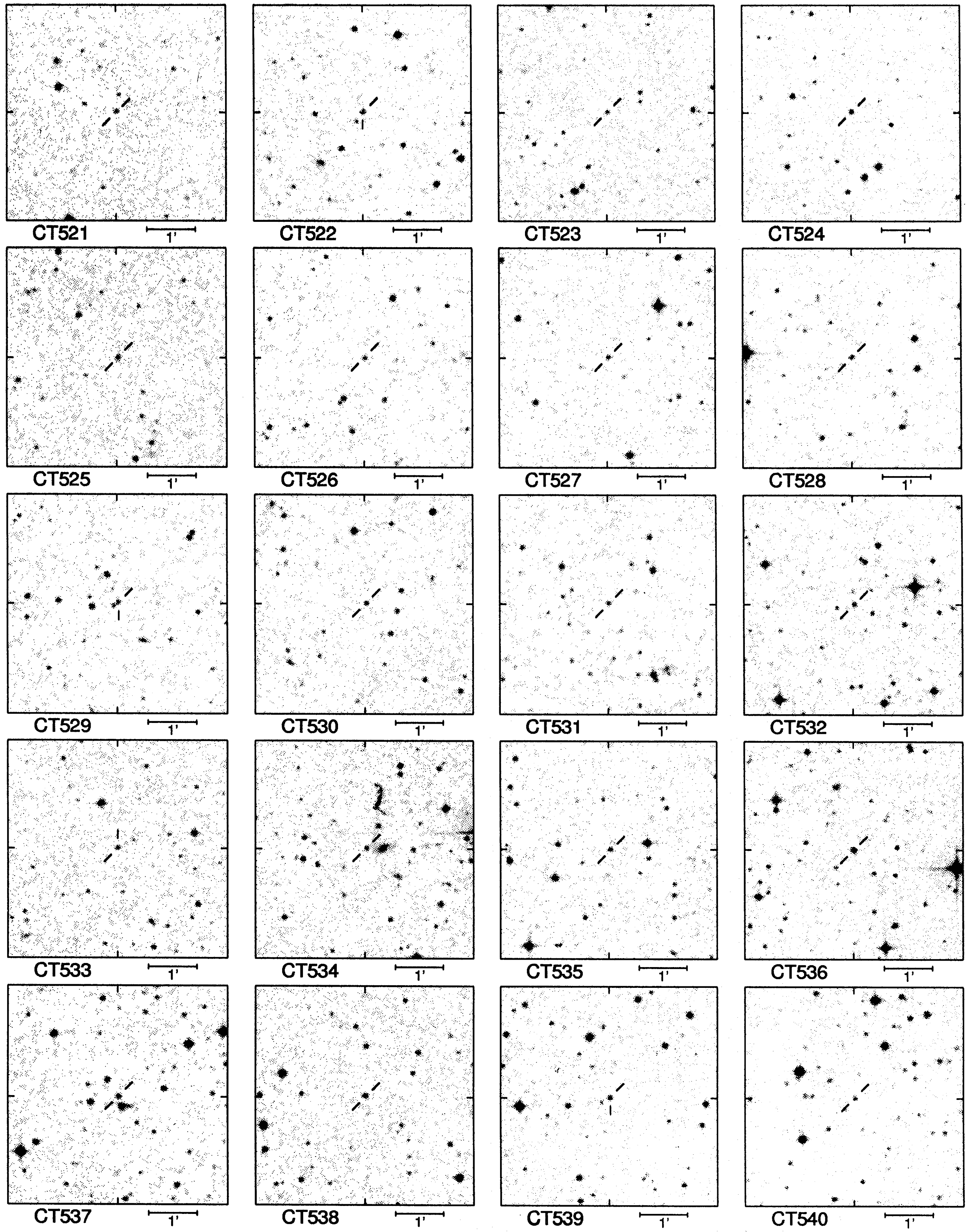

Fig. 1*b*. Same as Figure 1*a* for objects 521–540.

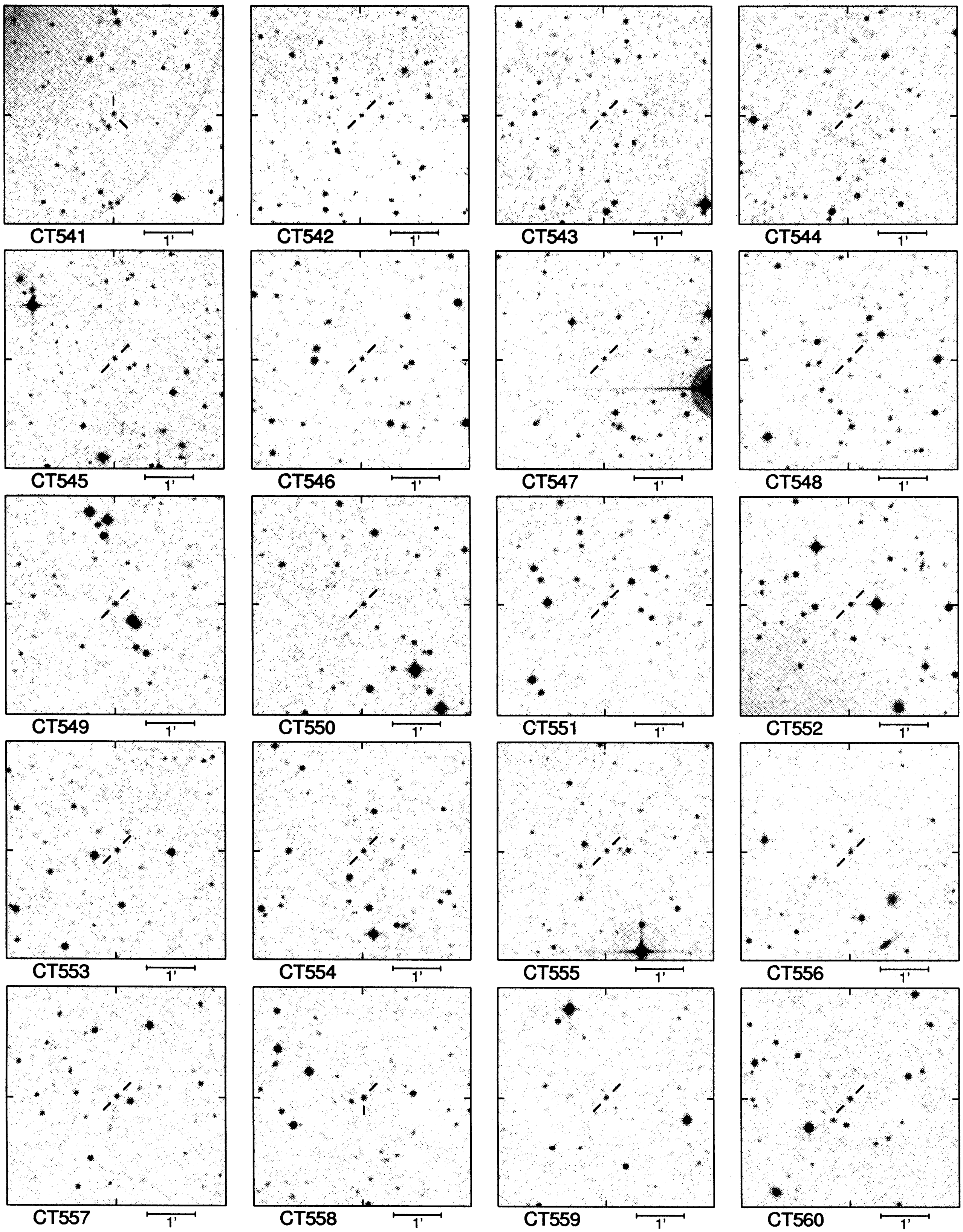

Fig. 1*c*. Same as Figure 1*a* for objects 541–560.

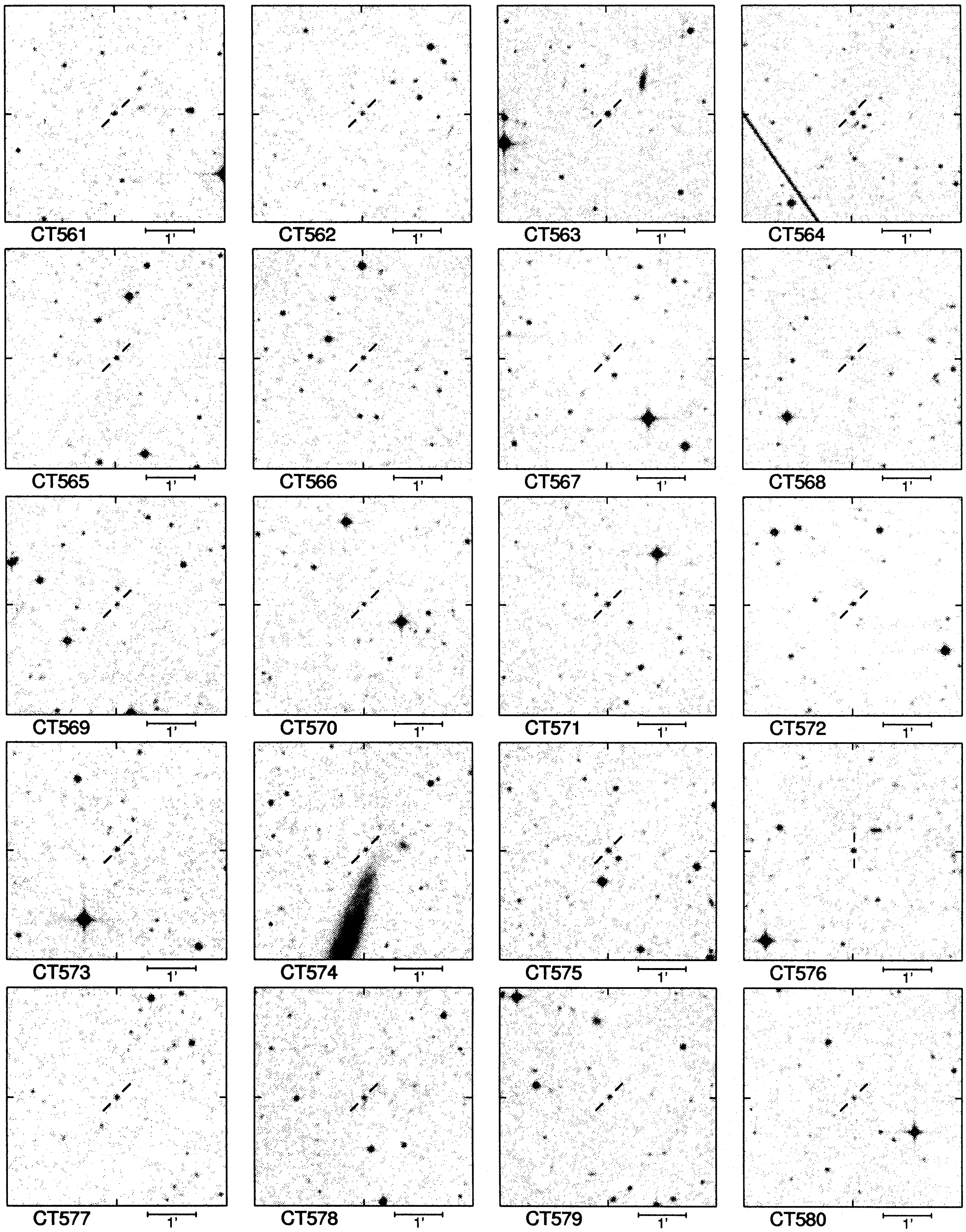

Fig. 1*d*. Same as Figure 1*a* for objects 561–580.

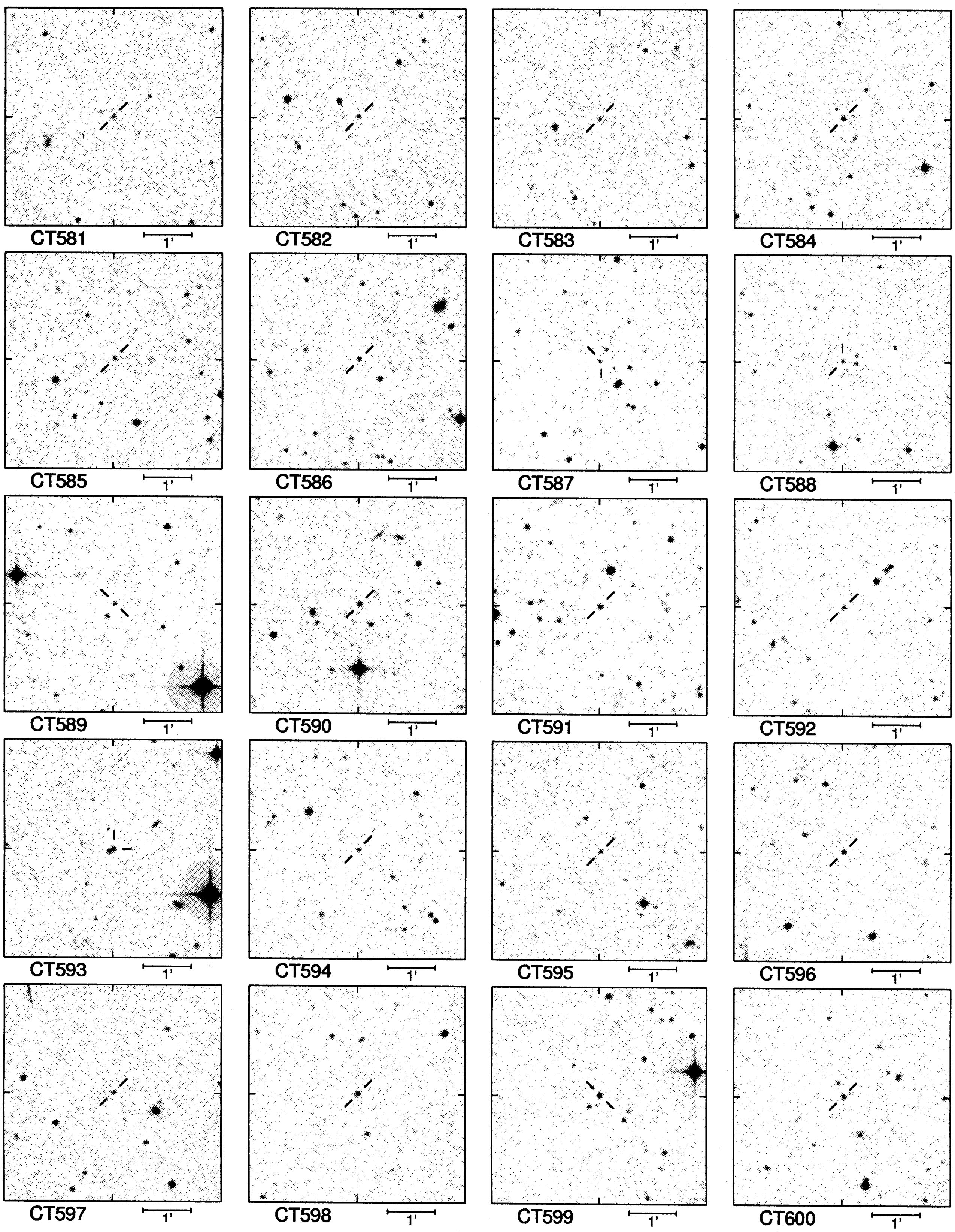

Fig. 1*e*. Same as Figure 1*a* for objects 581–600.

TABLE 1

CALÁN-TOLOLO SURVEY LIST NO. 7: QUASARS

CT#	Object	α (J2000.0) h	m	s	δ °	′	″	B	z	ESO
501*	C1610	0	04	29.80	−42	38	29.4	18.3	2.04	241
502	H1601	0	07	53.21	−52	21	11.7	18.7	2.18	149
503	H1704	0	11	17.70	−57	04	50.3	18.4	2.15	149
504	H1701	0	35	18.33	−52	49	08.2	17.8	2.70	150
505	H1801	0	39	05.23	−55	49	02.9	18.2	2.02	150
506*	A1717	0	42	43.89	−36	47	41.1	19.0	2.72	351
507	H1904	0	54	40.91	−53	32	18.9	18.1	2.28	151
508*	B1611	0	59	25.04	−41	10	44.8	17.4	2.05	295
509*	A1801	1	11	43.51	−35	03	01.4	16.6	2.41	352
510	C2003	1	14	25.08	−46	38	05.4	18.7	2.18	244
511*	H2009	1	23	04.89	−54	53	05.3	18.3	2.31	151
512	G3001	4	30	37.24	−48	55	23.9	16.2	1.94	202
513	G3006	4	41	10.95	−49	48	40.5	18.2	2.25	202
514	G3003	4	41	31.18	−47	54	25.4	18.7	2.37	202
515	R0530	10	48	59.97	−16	50	44.8	17.8	1.95	639
516	J0713	11	36	08.14	−21	27	44.5	19.0	2.10	571
517	M0711	11	36	56.13	−26	58	01.1	18.7	2.35	504
518	M0712	11	52	03.09	−26	37	25.3	19.0	2.04	504
519	M0811	11	54	58.38	−27	16	31.2	18.4	1.96	504
520	M0801	11	55	10.33	−22	32	47.8	17.6	2.23	572
521	R0939	11	59	06.08	−13	25	34.4	18.6	2.29	643
522	M0815	12	01	10.83	−22	33	49.8	18.2	1.92	572
523	M0816	12	02	01.89	−26	07	41.5	18.7	1.95	505
524	M0912	12	12	46.65	−23	45	20.6	17.7	1.9	505
525	R1037	12	21	08.74	−14	20	31.0	18.3	2.22	644
526	M0911	12	21	09.55	−23	15	38.9	19.0	2.32	506
527	M1009	12	32	18.06	−24	35	35.2	18.4	2.72	506
528	M1019	12	39	31.60	−25	21	30.8	18.2	0.35	506
529	M1011	12	43	36.89	−27	13	26.8	18.6	2.05	507
530	M1021	12	49	30.38	−24	43	14.8	18.4	1.43	507
531	M1237	13	06	42.49	−26	10	37.6	18.4	1.32	508
532	M1528	13	53	35.25	−24	21	08.7	18.2	1.88	510
533	M1529	13	56	00.23	−26	47	56.2	18.6	2.29	510
534	M1530	13	58	52.24	−26	55	43.3	18.4	2.10	510
535	M1521	14	01	33.53	−24	08	59.0	18.2	2.00	510
536	M1527	14	01	49.25	−24	55	30.4	16.5	0.50	510
537	M1615	14	11	51.51	−26	46	43.3	18.1	1.93	511
538	M1656	14	21	01.61	−23	07	31.3	18.3	2.71	511
539	M1655	14	22	36.62	−22	58	44.5	18.1	1.89	511
540	M1657	14	30	08.42	−25	44	14.9	18.7	1.96	511
541	M1730	14	47	29.18	−26	08	04.9	18.9	1.55	512
542	A0408	20	15	41.46	−35	55	49.6	18.4	1.29	400
543	B0206	20	19	54.57	−37	28	42.2	18.1	2.22	340
544	C0612	20	29	58.91	−43	18	35.6	18.2	2.20	285
545	H0503	20	32	13.99	−56	23	48.5	18.0	2.35	186

TABLE 1 (CONTINUED)

CT#	Object	α (J2000.0) h m	s	δ ° ′	″	B	z	ESO
546	A0518	20 39	13.86	−34 57	38.1	18.5	1.41	401
547	H0501	20 39	15.12	−53 50	37.5	18.3	2.17	186
548	C0613	20 44	59.40	−45 14	23.4	18.6	1.39	285
549	A0517	20 47	10.64	−33 21	08.9	18.4	2.09	401
550	A0519	20 51	19.51	−35 00	01.8	18.5	1.32	401
551*	A0520	20 54	29.01	−37 08	35.4	18.3	2.60	401
552	C0765	21 07	48.43	−46 26	51.4	18.2	2.06	286
553*	C0762	21 16	54.25	−43 32	34.6	18.1	2.0	286
554	C0761	21 17	39.46	−43 35	38.5	18.3	2.05	286
555	H0801	21 19	19.56	−56 48	41.3	18.2	2.32	188
556	H0803	21 20	18.66	−54 56	51.0	18.2	2.26	188
557*	B0505	21 26	18.47	−40 35	35.4	18.0	2.27	342
558*	C0906	21 37	47.83	−42 26	11.7	17.7	1.81	287
559*	C0903	21 38	21.36	−46 18	53.8	18.6	2.21	287
560*	C0905	21 39	40.03	−42 47	47.1	18.0	1.34	287
561	H0901	21 41	44.30	−55 09	30.2	18.0	1.92	188
562	B0611	21 45	32.46	−38 49	44.9	18.6	1.98	343
563	C1020	21 49	50.07	−44 44	06.0	16.0	1.51	288
564	C0908	21 50	15.97	−44 11	23.9	17.4	2.66	288
565	C1025	21 52	24.24	−43 21	18.2	17.6	2.00	288
566	C1019	21 55	45.79	−44 31	05.8	18.2	2.05	288
567	A0993	21 56	52.12	−36 48	48.9	19.4	1.94	404
568	C1028	22 00	53.93	−45 12	03.4	18.8	2.05	288
569	C1027	22 03	01.25	−45 03	46.0	18.4	2.20	288
570	C1021	22 05	08.77	−42 35	58.9	18.3	1.57	288
571	H1002	22 05	31.29	−54 05	41.3	17.7	1.15	189
572	A0986	22 06	38.07	−33 31	41.9	18.6	1.92	404
573	A0982	22 07	43.67	−34 24	05.8	18.2	2.26	404
574	C1107	22 10	54.05	−46 03	09.0	18.2	1.36	288
575	A1029	22 14	29.86	−35 24	09.0	18.0	2.07	404
576	H1105	22 15	31.14	−53 15	31.9	17.4	1.96	189
577	C1106	22 18	58.50	−43 50	31.3	17.0	1.44	289
578	H1101	22 22	55.19	−52 25	16.4	17.6	1.55	190
579	H1108	22 30	35.54	−56 49	31.2	18.8	2.03	190
580	C1209	22 32	11.36	−45 45	54.3	18.4	2.72	289
581	H1215	22 34	29.24	−56 24	38.6	18.5	2.07	190
582	H1103	22 40	18.84	−52 31	52.4	17.8	0.49	190
583	C1208	22 40	28.70	−44 53	16.9	18.8	2.20	289
584	H1201	22 42	33.89	−53 19	32.8	18.3	1.95	190
585	H1206	22 47	07.05	−54 08	57.0	18.6	2.09	190
586	H1207	22 47	33.77	−54 04	40.1	18.2	1.62	190
587	H1211	22 48	14.71	−54 30	56.1	19.2	2.19	190
588	H1208	22 49	54.95	−54 10	46.5	18.4	2.13	190
589	H1204	22 52	39.90	−53 43	40.8	18.3	2.18	191
590	H1205	22 59	21.02	−53 17	24.2	17.3	1.02	191
591*	C1432	23 03	50.01	−43 55	38.8	17.2	2.09	290
592	A1227	23 04	48.07	−35 25	46.8	19.1	2.38	407

TABLE 1 (CONTINUED)

CT#	Object	α (J2000.0) h	m	s	δ °	′	″	B	z	ESO
593	H1305	23	07	11.35	−56	29	54.6	18.0	2.49	191
594	H1404	23	17	32.95	−53	31	40.0	18.3	2.02	191
595	H1412	23	17	53.70	−55	14	20.7	18.6	2.11	191
596	H1405	23	18	20.75	−53	25	21.1	18.5	2.41	191
597	H1401	23	20	11.58	−52	20	41.9	18.1	2.20	191
598	A1425	23	36	45.47	−36	11	01.3	18.0	1.48	408
599	H1503	23	42	35.52	−55	34	39.2	16.7	2.70	192
600	H1610	23	48	17.20	−54	14	57.3	18.2	2.21	192

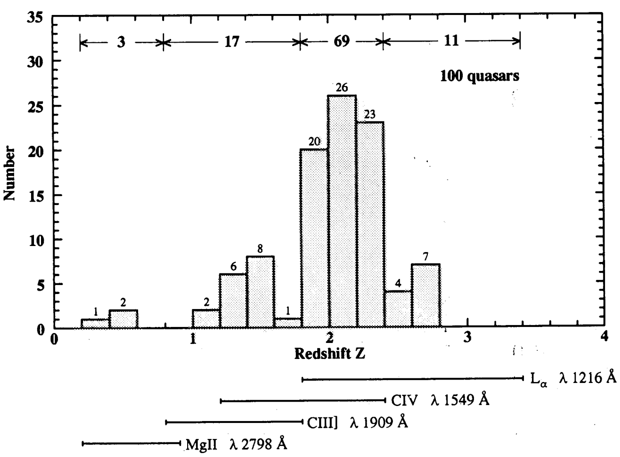

Fig. 2. Histogram of the redshift distribution of Calán-Tololo quasars contained in List No. 7. Horizontal lines at the bottom indicate the redshift range where the most prominent emission lines in quasars are found on our objective prism spectra.

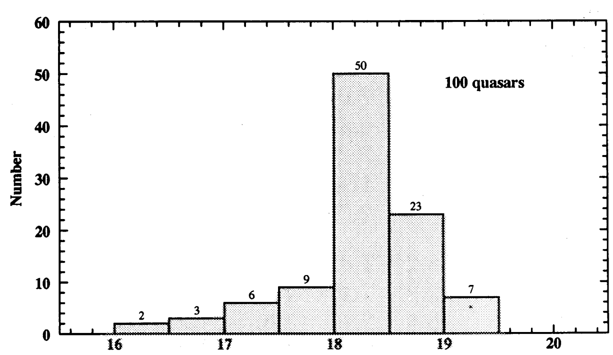

Fig. 3. Histogram of the B magnitude distribution of the Calán-Tololo quasars in List No. 7. Twenty objects have $B < 18$ and thirty have $B > 18.5$.

4. STATISTICAL PROPERTIES OF LIST No. 7

In List No. 5 (Maza et al. 1993) a preliminary analysis of the statistical properties of quasars found in the CTS was performed. Figure 2 presents a histogram of the redshifts for these one hundred new quasars. In the lower part of Figure 2, four horizontal lines show the redshift interval of visibility in our objective prism spectra for the most prominent emission lines present in quasars, as labeled to the right of the horizontal lines.

In the upper part of Figure 2 the redshift range has been divided in four intervals containing 3, 17, 69, and 11 objects respectively. If we divide in the same way the histogram in Figure 2 of List No. 5 (Maza et al. 1993), the numbers are 13, 23, 92 and 72 for a total of 200 objects (or 6.5%, 11.5%, 46%, and 36%, respectively). On the other hand List No. 6 (Maza et al. 1995) contains 7, 20, 53, and 20 quasars respectively, in those redshift intervals.

Figure 3 presents the histogram of the B magnitudes. A total of 82 quasars have a B mag in the interval (17.5, 19.0). A comparison between Figure 3 and Figure 3 in List No. 5 (Maza et al. 1993), and Figure 3 in List No. 6 (Maza et al. 1995) reveals this new group of quasars has the same photometric properties than the first three hundred quasars.

We thank the Director and personnel of Cerro Tololo and Cerro Las Campanas for their hospitality. We are indebted to J. García for help with SUN workstations. Computing facilities of the Centro de Procesamiento de Imágenes, Dept. of Astronomy, Universidad de Chile, are gratefully acknowledged. Prof. C. Anguita and Dr. L.E. Campusano read a draft of this paper and made interesting suggestions. This work was partially supported by FONDECYT under grants No. 92-1083 and No. 1950573.

REFERENCES

Blanco, V.M. 1974, PASP, 86, 841
MacAlpine, G.M., & Lewis, D.W. 1978, ApJS, 36, 587
MacAlpine, G.M., Lewis, D.W., & Smith, S.B. 1977, ApJS, 35, 203
MacAlpine, G.M., Smith, S.B., & Lewis, D.W. 1977a, ApJS, 34, 95
________.1977b, ApJS, 35, 197
MacAlpine, G.M., & Williams, G.A. 1981, ApJS, 45, 113
Maza, J., Ruiz, M.T., González, L.E., & Wischnjewsky, M. 1988a, in Progress and Opportunities in Southern Hemisphere Optical Astronomy, ed. V.M. Blanco & M.M. Phillips, A.S.P. Conf. Ser. No. 1, p. 410
________. 1988b, in Proceeding of a Workshop on Optical Surveys for Quasars, ed. P.S. Osmer, A.C. Porter, R.F. Green, & C.B. Foltz, A.S.P. Conf. Ser. No. 2, p. 154
________. 1989 (List No. 1), ApJS, 69, 349
Maza, J., Ruiz, M.T., Peña, M., González, L.E., & Wischnjewsky, M. 1991 (List No. 3), A&AS, 89, 389
Maza, J., Ruiz, M.T., González, L.E., & Wischnjewsky, M. 1992 (List No. 2), RevMexAA, 24, 147
Maza, J., Ruiz, M.T., González, L.E., Wischnjewsky, M., & Antezana, R. 1993 (List No. 5), RevMexAA, 25, 51
Maza, J., Ruiz, M.T., González, L.E., Wischnjewsky, M., & Antezana, R. 1994 (List No. 4), RevMexAA, 28, 187
Maza, J., Wischnjewsky, M., Antezana, R., & González, L.E., 1995 (List No. 6), RevMexAA, 31, 119
Maza, J., & Ortiz, P.F. 1996, in preparation
Smith, M. 1975, ApJ, 202, 591
Smith, M., Aguirre, C., & Zemelman, M. 1976, ApJS, 32, 217
Stobie, R.S., Sagar, R., & Gilmore, G. 1985, A&AS, 60, 503
Véron-Cetty, M.-P., & Véron. P. 1993, ESO Scientific Report No. 13

Roberto Antezana, Luis E. González, José Maza, Patricio F. Ortiz, and Marina Wischnjewsky: Departamento de Astronomía, Universidad de Chile, Casilla 36-D, Santiago, Chile. (jmaza@das.uchile.cl).