THE ASTROPHYSICAL JOURNAL, 409:28–41, 1993 May 20

THE *HUBBLE SPACE TELESCOPE*[1] SNAPSHOT SURVEY. IV. A SUMMARY OF THE SEARCH FOR GRAVITATIONALLY LENSED QUASARS

D. MAOZ,[2] J. N. BAHCALL,[2] D. P. SCHNEIDER,[2] N. A. BAHCALL,[3] S. DJORGOVSKI,[4,5] R. DOXSEY,[6]
A. GOULD,[2] S. KIRHAKOS,[2] G. MEYLAN,[6] AND B. YANNY[2]
Received 1992 October 9; accepted 1992 November 16

ABSTRACT

We report the concluding results of the *HST* Snapshot Survey for gravitationally lensed quasars. New observations of 153 high-luminosity $z > 1$ quasars are presented, bringing to 498 the total number of quasars observed in the survey. The new observations do not reveal new candidates for gravitational lensing. We present tables summarizing all of the snapshot observations, with measured V-magnitudes, accurate to 0.1 mag, for each of the quasars successfully observed. The tables are available on request in machine-readable form. The observed frequency of lensing of quasars into multiple images is 3–6 out of 502, depending on whether one counts candidates that are not yet securely confirmed and cases in which clusters play a role. This frequency is in the range predicted by calculations with a vanishing cosmological constant, assuming galaxies can be modeled by unevolving isothermal spheres dominated in their centers by dark matter. The observed frequency is an order of magnitude lower than expected in such models when the universe is strongly dominated by a cosmological constant. This conclusion is, however, sensitive to the model assumptions and to the precise number of actual lensed quasars.

Subject headings: cosmology: observations — gravitational lensing — quasars: general

1. INTRODUCTION

The Snapshot Survey is a search for cases of gravitational lensing among intrinsically luminous, high-redshift quasars using the *Hubble Space Telescope* (*HST*) Planetary Camera (PC). Despite the spherical aberration of *HST*'s primary mirror, the sharp core of the point-spread function affords the high spatial resolution needed to discover the small-separation lenses predicted to exist by theoretical models. Bahcall et al. (1992a, hereafter Paper I) described the objectives of the survey, its mode of operation, the sample definition, and the initial results of a small sample. Maoz et al. (1992b and 1993, hereafter Papers II and III) reported results from a progressively larger sample and compared the observed lensing frequency to existing theoretical models. The discovery of a possible subarcsecond lens system, the $z = 3.8$ quasar 1208+1011, reported by Maoz et al. (1992a) and Magain et al. (1992), was followed by *HST* multicolor imaging and spectroscopy as described in Bahcall et al. (1992b) and in Bahcall et al. (1992c), respectively. Star counts based on the Snapshot Survey images are described in Gould, Bahcall, & Maoz (1993). For all objects in the survey, finding charts and astrometric positions appear in Schneider et al. (1992).

In the present paper we report the concluding results of the Snapshot Survey following successful observations of nearly all of the quasar sample submitted to the Space Telescope Science Institute (STScI). In § 2 we describe the new observations and present tables summarizing all the observations of the survey. In § 3 we make notes on some individual objects from among the new observations. We summarize in § 4 the lensing statistics derived from the Snapshot Survey and compare the results with existing theoretical predictions.

2. OBSERVATIONS

This paper describes new Snapshot Survey observations carried out between 1992 March 18 and July 12. Papers I, II, and III presented observations of quasars from a well-defined sample of 354 objects selected from the catalog of Veron-Cetty & Veron (1987) with redshift, absolute magnitude, and Galactic latitude criteria ($z > 1$, $M_v < -25.5$, $|b| > 10°$; see Paper I). Following the observation of nearly all of these original objects, a sample of 163 additional quasars was constructed by applying the same criteria to a newer edition of the catalog (Veron-Cetty & Veron 1989). Quasars from the new sample are labeled as *HST* program 4027 and 4028. The new observations also include repeat observations of several quasars described in Papers I–III, labeled as programs 3159 and 4017.

Each quasar was observed for 230 s (260 s for quasars from program 3159) with the F555W filter (similar to V; see Griffiths 1990), using only gyroscope guiding in order to save the time required to acquire guide stars. This procedure produced trailed images, typically 0".5 long (see Paper I and Maoz et al. 1992a for examples).

The new observations described in this paper are summarized in Table1A, which combines the results from Papers II, III, and this paper into one list ordered by R.A. These tables have more accurately measured quasar magnitudes (see below), and minor corrections have been made in some of the entries listed in the tables in previous papers, so that the present list superceded previous data summaries. The first column gives the quasar name, excluding any prefixes to the 1950 coordinates. The second column gives another name for the object in cases where Veron-Cetty & Veron (1987) list the

[1] Based on observations with the NASA/ESA *Hubble Space Telescope*, obtained at the Space Telescope Science Institute, which is operated by the Association of Universities for Research in Astronomy, Inc., under NASA contract NAS5-26555.

[2] Institute for Advanced Study, Princeton, NJ 08540.

[3] Princeton University Observatory, Princeton, NJ 08544.

[4] Palomar Observatory, California Institute of Technology, Pasadena, CA 91125.

[5] Presidential Young Investigator.

[6] Space Telescope Science Institute, 3700 San Martin Drive, Baltimore, MD 21218.

object under that name. The third column lists the UT date the object was observed by *HST* (day/month/year), and the fourth column tabulates the *HST* program number. The fifth column gives the PC CCD chip (5–8) on which the quasar actually appears and the quasar's central pixel coordinates, where the pixel of each CCD that is nearest to the center of the mosaic has coordinates (1, 1). A "missed" entry in this column indicates that the quasar was not in the PC field of view. Column (6) lists the offset in arcseconds from the designated position on PC-6. Column (7) gives the drift rate in milliarcsec s^{-1} as measured from the length of the trail of the quasar or of a star in the field of view. Column (8) presents the V_{obs} magnitude measured for each object observed. The observed magnitudes have been remeasured from the PC images after cleaning a 60 pixel radius around each quasar of cosmic-ray events and using the recently published flux-calibration zero points of Hunter et al. (1992). These magnitudes are expected to be accurate to 0.1 mag (see Gould et al. 1993). Column (9) gives the V-magnitude tabulated by Veron-Cetty & Veron (1987, 1989). Column (10), labeled "Sel.," lists the method by which the quasar was first discovered. This parameter was found by searching the literature, and may be of interest to workers who are concerned about possible selection effects. This parameter is coded as "R" for radio-selected quasars, "C" for quasars selected based on colors, "S" for spectral methods that identify emission lines (e.g., objective prism surveys), "X" for X-ray–selected objects, and "O" for four quasars found by some other method (e.g., variability). Column (11) gives the redshift of the quasar. Column (12) lists the absolute magnitude, calculated from V_{obs} and the redshift of the quasar, assuming $H_0 = 100$ km s^{-1} Mpc^{-1}, $q_0 = 0.5$, a power-law spectral index of -0.5, and no correction for Galactic absorption.[7] Column (13) has coded comments, which are generally of a technical nature, for some of the objects. Objects for which notes were made in the "Notes on Individual Objects" sections of Papers II, III, and the present paper, are marked in the comments column as A2, A3, and A4, respectively. An empty entry in the first column indicates a repeated exposure of the quasar in the preceeding row, often one where the first attempt missed the target. Such multiple exposures of the same target are ordered chronologically.

Of the 169 new exposures presented here, eight missed the target. The median pointing error is 12″.7. The distribution of pointing errors has a maximum at $\sim 12''$ and falls off with an approximately Gaussian distribution for larger errors. The mean and rms pointing error of the successful gyro-guided observations is $14'' \pm 8''$, compared to $14'' \pm 9''$ measured in Paper III for the period 1991 September to 1992 March. The trailing rate under gyro control is 1.3 ± 0.7 milliarcsec s^{-1}, very similar to the 1.4 ± 0.7 milliarcsec s^{-1} found in Paper III. The *HST* gyroscope performance, measured by the pointing error and the trail rate, is therefore stable.

Each *HST* exposure was examined in order to identify the field of view, if possible, with at least two objects that were expected to appear. In some of the exposures (110 out of the 507 exposures in Table 1A), only one object is in the PC field of view, but no objects other than the quasar are expected, and the magnitude of the single object is within ~ 0.5 mag of that expected if it were the quasar. These "single-object" exposures are marked with a "D" in the comments column in Table 1A. Considering only the rate at which targets were missed (26 out of 507 in Table 1A), 5.6 of the single-object exposures would be expected to be of nearby stars rather than the targeted quasar. However, the requirements that such a nearby star be isolated and that it have a magnitude similar to that expected of the quasar reduce this number considerably. Only 34 out of the 450 snapshot exposures analyzed by Gould et al. (1993) had a single star in the PC field of view of brightness within ± 1 mag that of the quasar in that field. We then expect to have misclassified as the targeted quasar 0.4 of the single-object exposures, at most. We will therefore assume that all the single-object exposures are successful observations of the quasar. For five quasars from among the new observations, marked with a "G" in the comments column of Table 1, the identification of the quasar is uncertain.

Each exposure was searched by eye for evidence of gravitational lensing. A radius of 7″ around each quasar was searched for secondary images. The reader is referred to Papers I and II for the detection limits of multiple images, which were estimated by simulations designed to reproduce the conditions of the actual exposures.

We have not included in Table 1A the pilot observations of the Snapshot Survey, described in Paper I. About half of those observations missed the targeted quasars and the trail rate is 2–3 times larger than is typical for the subsequent exposures. Also, some of the pilot exposures are only 120 s (program 3034) and about half of the initial exposures were through the F785LP filter (similar to I), rather than the F555W filter. All of these differences warrant listing the Paper I observations separately. Table 1B lists the Paper I observations in the same format as Table 1A. We have included in Table 1B only observations for which the targeted quasar was in the field of view, and only quasars that were not subsequently reobserved. Tables 1A and 1B can be merged without repetition. Exposures through the F785LP filter are marked with an "I" in the V_{obs} column.[8]

Figure 1 compares the V-magnitudes we have measured to those tabulated by Veron-Cetty & Veron (1987, 1989), V_{obs} and V_{tab}, respectively, in Tables 1A and 1B. Note that the tabulated Veron magnitudes are biased toward being brighter than observed. The rms magnitude difference in the vertical direction about the diagonal line ($V_{tab} = V_{obs}$) is $+0.35$, -0.85 mag. This asymmetry is the result of the selection process of the sample: quasars having tabulated magnitudes that are much fainter than their real magnitudes did not satisfy the absolute magnitude selection criterion. The best estimate for the 1 σ uncertainty of the magnitudes in the catalog is therefore ± 0.85 mag. Some of the quasar magnitudes have been revised in the latest edition of Veron-Cetty & Veron (1991). Repeating the above calculation with the new edition, we find the error is slightly reduced, to ± 0.80 mag. This rather large rms magnitude difference quantifies the warning by Veron-Cetty & Veron (1991) that the magnitudes they list are only approximate.

3. NOTES ON INDIVIDUAL OBJECTS

0141+33—There is a 21.5 mag point source 7″ east of the quasar at P.A. 115°. From CCD imaging at the Palomar 1.5 m

[7] In previous papers we used V_{tab} to calculate absolute magnitudes and erroneously reported that a power-law index of -0.5 had been used to calculate the k-correction, when in fact -0.35 had been used. Also, the Galactic absorption was not applied consistently in all papers. The present listing supercedes the previous ones.

[8] Machine-readable versions of Tables 1A and 1B are available on request from the authors by electronic mail (maoz@guinness.ias.edu, jnb@iassns.bitnet).

TABLE 1A

Summary of Full-Program Observations

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	−Mv[8]	Comments
0002 + 0507	UM18	09/07/91	3158	6(125,201)	6.5	1.3	16.3	16.21	S	1.89	27.4	
0002 − 008	UM197	13/05/91	3158	6(209,292)	2.6	1.5	18.5	18.	S	2.18	25.5	D
0004 + 171		06/08/91	3158	6(550,595)	18.9	3.4	18.7	18.5	R	2.89	25.9	
0004 − 408		02/05/92	4027	6(298,352)	4.1	0.4	18.1	18.3	S	2.03	25.7	
0007 − 0004	UM208	16/09/91	3158	6(509,360)	11.4	0.4	18.7	17.	S	2.31	25.4	
0007 − 353		13/11/91	3158	6(264,311)	2.1	0.8	17.9	18.04	S	2.03	25.9	
		23/04/92	4017	6(211,167)	4.7	0.	18.0	18.04	S	2.03	25.8	
0007 − 4044		02/05/92	4027	7(181,371)	24.9	0.9	18.8	18.6	S	2.47	25.4	D
0007 − 4239		19/07/91	3158	missed	> 24	1.1						
0009 − 0138	UM211	25/06/92	4027	6(231,788)	22.6	0.4	17.6	17.6	S	2.	26.2	
0012 + 0040	UM222	18/09/91	3158	7(306,199)	17.4	1.0	18.3	17.	S	1.46	24.9	
0013 − 0029	UM224	22/09/91	3158	6(61,254)	8.7	1.6	18.2	17.	S	2.09	25.7	F
0016 + 73		18/03/92	4027	6(710,106)	20.4	3.1	19.0	18.	R	1.78	24.6	
0018 − 422		17/07/91	3158	6(52,148)	10.3	5.1	18.6	18.6	S	2.86	25.9	
0019 + 0107	UM232	18/09/91	3158	6(75,228)	8.2	1.1	17.7	17.	S	2.13	26.2	
0020 − 408		30/04/92	4027	7(246,268)	20.3	0.9	18.7	18.8	S	2.63	25.7	
0021 + 0535	UM30	09/07/91	3158	7(233, 37)	10.4	1.7	19.1	18.	S	2.05	24.8	C
0021 − 1832	UM663	18/11/91	3158	7(222,142)	14.9	1.5	18.2	17.9	S	2.	25.6	
0024 + 22		05/08/91	3158	8(174,629)	37.8	7.7	17.0	16.57	C	1.11	25.6	A2
0027 + 0059	UM249	12/10/91	3158	7(510,385)	27.4	1.2	18.1	17.	S	1.46	25.1	
0027 + 0149	UM247	12/10/91	3158	7(390,178)	17.3	1.2	17.8	17.	S	2.35	26.3	D
0027 + 0514	UM42	20/05/92	4027	6(311,370)	5.0	1.7	18.4	18.4	S	2.26	25.7	
0027 − 1836	UM664	21/06/91	3158	missed	> 24	1.7						
	UM664	09/05/92	4017	6(471,361)	9.9	1.7	17.9	18.2	S	2.55	26.4	D
0029 + 0722		23/10/91	3158	6(106,146)	8.4	1.2	17.9	18.4	S	3.27	26.9	
0029 − 1209	UM665	21/06/91	3158	6(87,145)	9.1	2.4	18.3	18.	S	2.65	26.1	
0033 + 0951	4C09.01	23/10/91	3158	6(304,308)	2.6	1.2	17.7	17.5	R	1.92	26.0	D
0034 − 3308		01/12/91	3158	6(95,580)	15.4	2.7	17.7	17.8	S	2.18	26.3	
0035 − 4213		30/04/92	4027	6(335,335)	4.4	0.9	18.0	18.7	S	2.62	26.4	D
0037 − 0153	UM264	20/05/92	4027	6(195,209)	3.7	1.3	19.6	18.9	S	2.34	24.5	
0038 − 3936		02/12/91	3158	6(176,110)	7.6	2.7	18.3	18.	S	2.37	25.9	
0039 − 265		23/11/91	3158	6(359,437)	8.5	4.2	17.5	17.5	S	1.8	26.1	
0040 − 370		30/04/92	4027	6(443,323)	8.2	0.9	18.0	18.8	O	2.72	26.4	G
0041 − 261		14/09/91	3158	7(207,340)	23.5	1.2	17.2	17.3	S	2.50	27.1	D,F
0041 − 2707		14/09/91	3158	7(336,267)	20.5	1.1	18.0	17.4	S	2.78	26.5	
0041 − 4023		24/11/91	3158	5(419,186)	27.	1.5	19.9	18.4	S	2.50	24.4	D
0042.8 − 269		09/05/92	4027	6(364,342)	5.5	1.3	18.8	19.	S	2.90	25.8	
0043 + 0048	UM275	11/11/91	3158	6(62, 27)	13.3	0.8	17.9	17.	S	2.15	26.1	D,K
0043 − 3157		28/04/92	4027	6(71,107)	10.6	0.4	18.7	18.3	S	2.17	25.3	
0044 + 0131	UM276	19/07/91	3158	6(360,191)	5.2	0.9	17.9	17.	S	1.59	25.4	
0044 − 3253		02/05/92	4027	7(102,139)	16.3	0.4	17.5	17.7	S	1.57	25.8	
0045 − 0119	UM278	22/11/91	3158	5(236,236)	18.9	1.5	18.6	18.	S	2.53	25.7	
0045 − 0341	UM667	01/12/91	3158	8(378,369)	35.1	2.3	18.8	18.6	S	3.14	25.9	
0046 − 315		18/11/91	3158	5(195, 56)	19.3	1.9	18.4	17.7	R	2.72	26.0	D
0048 − 0119	UM281	22/11/91	3158	6(244,415)	6.6	0.8	17.4	16.	S	1.87	26.3	
0048 − 261		18/11/91	3158	8(429, 55)	29.4	1.5	19.1	18.1	S	2.25	25.0	
0048 − 3506		02/05/92	4027	6(58,559)	15.5	0.4	18.7	18.8	S	2.63	25.7	D
0049 + 0045	UM287	19/07/91	3158	8(557,673)	49.9	2.3	18.2	17.	S	2.27	25.9	D,F
0049 + 0124	UM288	19/07/91	3158	6(178, 44)	9.7	0.8	17.2	17.	S	2.31	26.9	
0049 − 2820	CS73	18/11/91	3158	7(111,161)	17.	1.5	18.2	18.1	S	2.27	25.9	D
0049 − 393		15/12/91	3158	6(412,218)	6.7	1.2	17.4	17.9	S	2.85	27.1	F
0052 − 410		16/12/91	3158	6(171,240)	4.1	0.8	17.7	18.1	S	2.06	26.2	
0055 + 0025	UM294	15/11/91	3158	7(56,552)	33.7	1.2	17.1	16.	S	1.92	26.6	F
0055 − 3844		15/12/91	3158	6(119,203)	6.7	1.5	18.4	18.4	S	2.35	25.7	
0055 − 4139		09/07/91	3158	8(522,296)	37.9	1.0	18.5	18.	S	2.64	25.9	
0056 + 0125		03/07/92	4027	6(346,284)	3.7	0.9	18.6	18.9	S	3.15	26.1	
0056 − 3924		09/12/91	3158	6(372,248)	4.7	1.2	17.5	17.3	S	1.41	25.6	
0058 + 0155	PHL938	16/11/91	3158	7(190,552)	32.6	1.2	17.1	17.16	C	1.93	26.6	

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	$-M_V$[8]	Comments
0059 − 2735		09/05/92	4027	6(41, 49)	13.3	1.7	18.0	17.	S	1.60	25.3	D
0059 − 4110		09/12/91	3158	6(303,157)	4.9	1.2	17.7	18.	S	1.96	26.1	
0100 − 261		09/05/92	4027	6(140,245)	5.3	1.7	18.8	18.7	S	2.54	25.5	D
0100 − 270		18/11/91	3158	8(186,149)	22.6	1.9	18.1	17.5	R	1.60	25.2	D,F
0100 − 3955		15/12/91	3158	6(342,281)	3.5	1.2	19.2	18.4	S	2.50	25.1	
0101 − 4216		10/07/91	3158	7(355,164)	16.3	1.2	17.1	17.5	S	1.90	26.6	
0102 − 1902	UM669	06/12/91	3158	5(61,256)	11.4	1.9	18.3	18.3	S	3.03	26.4	F
0102 − 4238		13/07/91	3158	8(267,161)	25.6	1.4	18.2	18.	S	2.33	25.9	F
0103 − 29		06/12/91	3158	7(44,393)	27.3	2.3	18.6	18.6	S	2.80	25.9	
0105 − 2634		09/05/92	4027	6(252,277)	0.8	1.3	18.2	17.3	S	3.51	26.8	
0105 − 391		24/12/91	3158	6(198, 45)	9.8	0.4	18.1	18.1	S	2.31	26.0	
0109 + 0213	UM87	03/07/92	4027	6(205,139)	5.9	1.3	17.3	17.8	S	2.35	26.8	D
0109 + 17		17/07/91	3158	7(184,211)	18.1	1.2	18.7	18.	R	2.15	25.3	
0109 − 353		27/12/91	3158	6(64,285)	8.6	2.7	16.9	17.4	O	2.41	27.3	
0112 − 329		29/12/91	3158	6(139,228)	5.5	0.0	17.6	17.5	S	1.59	25.7	D
0114 − 0856	UM670	28/06/91	3158	8(314,216)	28.0	1.0	17.7	17.4	S	3.16	27.0	
0115 − 0108	UM314	13/11/91	3158	8(283,180)	26.6	0.8	19.8	17.	S	2.19	24.2	D
0116 − 0210	UM315	28/06/91	3158	6(719,301)	20.0	1.0	17.9	18.	S	2.05	26.0	D
0117 − 1803	UM671	13/07/91	3158	6(249,281)	1.0	1.5	17.5	17.3	S	1.79	26.1	D
0119 − 04		28/06/91	3158	6(285,310)	1.4	1.0	17.0	16.88	R	1.95	26.8	
0119 − 358		29/12/91	3158	6(72,242)	8.3	0.0	17.8	17.8	S	1.80	25.8	
0121 − 329		28/12/91	3158	6(202,235)	2.9	1.2	17.7	17.9	S	2.33	26.4	
0122 − 00		13/11/91	3158	8(628, 73)	37.7	0.8	16.6	16.7	R	1.07	25.9	
0122 − 380		28/12/91	3158	7(114,248)	20.4	1.9	17.1	17.5	S	2.19	26.9	
0123 − 0209	UM322	28/06/91	3158	6(631,311)	16.0	1.2	17.9	18.	S	1.93	25.8	G
0123 − 365		05/01/92	3158	6(221,342)	3.8	1.5	18.6	18.5	S	2.46	25.6	
0123 − 368		02/05/92	4027	6(176,608)	15.3	1.3	18.5	18.3	S	2.16	25.5	
0125 − 0029	UM327	13/11/91	3158	7(181,333)	23.3	2.3	18.2	18.	S	2.07	25.7	
0125 − 400		04/01/92	3158	5(338,643)	28.4	1.9	17.5	17.1	S	1.39	25.5	D
0126 + 0301	UM104	17/11/91	3158	8(505,292)	37.1	1.5	17.9	17.	S	1.62	25.5	
0130 − 403		03/01/92	3158	7(229,141)	14.9	2.7	17.3	17.02	S	3.02	27.4	
0131 + 0058	UM338	03/01/92	3158	7(94,299)	22.8	2.7	18.1	17.	S	1.37	24.9	
0131 + 0120		07/06/92	4027	missed	> 24	0.9						
0132 + 20		06/08/91	3158	6(343,318)	4.2	5.2	17.9	17.5	C	1.78	25.7	D
0132 − 1947	UM672	10/07/91	3158	8(35, 45)	14.8	0.9	18.0	18.7	S	3.13	26.7	D
0135 − 0015	UM349	31/12/91	3158	6(108,218)	6.9	2.3	18.9	18.	S	2.15	25.1	D
0136 + 0600	UM121	11/06/92	4027	6(122,130)	8.3	1.7	19.6	18.5	S	2.35	24.5	
0136 + 176		08/08/91	3158	6(389,352)	6.6	2.7	18.7	18.5	R	2.73	25.7	
0136 − 231		10/07/91	3158	6(121,278)	6.1	1.4	17.8	18.	R	1.89	25.9	D
0137 − 0153	UM356	31/12/91	3158	6(66,232)	8.6	1.9	18.0	18.	S	2.24	26.0	
0138 − 381		31/12/91	3158	6(47,319)	9.6	1.2	17.8	17.6	S	2.87	26.8	
0140 − 306		02/01/92	3158	7(289,188)	16.9	1.5	18.0	18.5	S	3.13	26.7	
0141 + 33		14/06/92	4027	7(354, 48)	11.5	0.9	17.8	17.5	R	1.46	25.4	A4
0143 − 0101	UM368	12/01/92	3158	7(232, 72)	11.9	1.2	19.3	18.5	S	3.16	25.4	
0143 − 0135	UM366	30/12/91	3158	6(150,289)	5.	1.9	17.7	18.	S	3.14	27.0	
0145 + 0416	UM139	09/01/92	3158	6(50,130)	10.8	1.5	18.7	18.	S	2.03	25.1	
0146 + 0142	UM141	06/01/92	3158	missed	> 24							
0147 + 0146	UM142	06/01/92	3158	6(50,102)	11.	1.5	18.2	17.	S	1.39	24.8	
0148 − 0946	UM674	06/01/92	3158	7(282,342)	23.4	0.8	18.4	18.6	S	2.84	26.1	D
0148 − 516		17/07/91	3158	missed	70.0	0.5						A2
		07/03/92	4017	6(114,217)	6.7	1.5	18.5	18.2	C	2.53	25.8	D
0149 − 397		06/01/92	3158	7(582,187)	21.7	0.8	17.9	17.9	S	2.06	26.0	F
0150 − 0144	UM375	06/01/92	3158	6(547, 78)	14.6	1.2	18.2	18.	S	2.02	25.6	
0150 − 2015	UM675	06/01/92	3158	7(216,401)	26.1	1.2	17.4	17.1	S	2.15	26.6	
0151 + 0448	PHL1222	06/01/92	3158	6(152,219)	5.1	1.5	17.9	17.63	C	1.91	25.8	A3
0153 + 0430	UM148	13/11/91	3158	7(57,734)	41.3	2.7	17.9	17.	S	2.99	26.7	
0201 + 36*B*		07/08/91	3159	6(214,328)	3.5	0.	17.9	17.5	R	2.90	26.7	
0202 − 5112	JL280	28/04/92	4027	7(114, 61)	13.	2.2	17.5	17.9	R	1.69	26.0	A4
0205 − 379		21/01/92	3159	7(138,209)	18.5	1.5	17.5	17.4	S	2.42	26.7	A3
0206 + 0008	UM400	29/09/91	3159	6(253,269)	0.5	0.8g	17.3	17.	S	1.89	26.4	J
0207 + 0041	UM403	29/09/91	3159	6(285,256)	1.	1.2g	18.8	18.	S	2.19	25.2	J,D

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	−Mv[8]	Comments
0207 − 398		28/09/91	3159	6(241,253)	1.	g	17.0	17.15	S	2.81	27.5	
0213 + 0123	UM415	09/10/91	3159	6(250,242)	1.1	g	17.6	17.	S	1.44	25.5	
0215 + 165		02/02/92	3159	6(251,344)	3.5	0.0	17.5	18.	R	1.90	26.2	
0216 + 0803		02/11/91	3159	6(247,244)	1.1	g	18.1	18.1	S	2.99	26.5	L
0220 − 142		12/10/91	3159	6(239,223)	2.	g	18.8	18.5	R	2.43	25.4	
0222 − 415		02/02/92	3159	6(270,369)	4.6	1.2	17.6	17.7	S	2.	26.2	
0224 − 419		28/04/92	4027	6(94,181)	8.1	2.2	17.9	18.4	S	2.13	26.0	
0225 − 014		28/06/91	3159	7(266,300)	21.6	1.9	18.6	18.15	R	2.03	25.2	
0226 − 038		08/10/91	3159	6(242,259)	0.9	g	17.2	16.96	R	2.06	26.7	
0229 + 13		29/09/91	3159	6(258,258)	0.3	1.5g	17.9	17.71	R	2.07	26.0	J
0232 − 04		01/10/91	3159	6(246,225)	1.8	g	16.3	16.46	R	1.43	26.8	
0239 − 1527	UM677	01/10/91	3159	6(233,263)	1.3	g	18.1	18.6	S	2.79	26.4	
0242 − 410		12/10/91	3159	6(239,250)	1.2	g	17.9	18.1	S	2.21	26.1	
0244 − 128		11/11/91	3159	6(232,260)	1.3	g	18.4	17.1	R	2.2	25.6	
0247 + 0141		27/06/92	4027	6(264,330)	2.9	0.9	18.8	18.77	S	2.69	25.6	D
0248 + 43		08/08/91	3159	7(283,115)	13.7	2.7	17.6	15.5	R	1.31	25.3	A2
0249 − 1826	UM679	29/01/92	3159	6(185, 96)	7.9	1.2	18.6	18.6	S	3.21	26.2	D
0249 − 2212	UM678	27/09/91	3159	6(254,213)	2.2	g	17.7	18.4	S	3.2	27.1	
0250 + 0140		27/06/92	4027	6(298,344)	3.8	1.3	18.6	18.8	C	2.64	25.8	
0252 + 0136		28/06/91	3159	7(27,445)	29.7	1.9	17.2	18.06	S	2.45	27.0	H,F
0254 + 0000	US3390	27/06/92	4027	6(287,576)	13.5	0.9	18.2	18.4	C	2.24	25.8	
0254 − 404		02/02/92	3159	6(509,147)	11.7	0.4	17.1	17.4	S	2.29	27.0	
0256 − 0000		28/06/91	3159	8(721,209)	43.5	2.3	17.8	18.72	S	3.36	27.1	D
0256 − 005		28/06/91	3159	8(362, 61)	26.8	1.5	17.5	17.2	R	1.99	26.3	
0301 − 0035		28/06/91	3159	missed	> 24	2.7						
		07/03/92	4017	7(105, 45)	12.6	1.5	18.0	18.53	S	3.20	26.8	
0302 + 1705		01/07/92	4027	6(346,215)	4.1	0.9	18.9	19.	S	2.88	25.7	D,F
0302 − 0019		28/06/91	3159	6(186,453)	8.8	1.7	17.6	18.37	S	3.28	27.2	D
0302 − 223		26/01/92	3159	6(167,150)	6.4	0.8	16.9	16.4	X	1.41	26.2	
0304 − 392		01/10/91	3159	6(255,231)	1.4	g	17.4	17.6	S	1.97	26.4	
0308 − 1920	UM682	07/11/91	3159	6(248,220)	2.	g	17.9	18.3	S	2.76	26.6	
0321 − 337		02/02/92	3159	8(344,123)	27.4	2.7	18.0	17.81	S	1.98	25.8	D
0321 − 375		28/04/92	4027	7(215,497)	30.2	1.7	18.4	17.2	S	2.25	25.7	
0321 − 397		17/05/92	4027	6(592,582)	19.7	0.	17.8	17.	S	1.09	24.7	D
0321 − 421		17/05/92	4027	6(660,532)	20.6	0.	18.0	16.9	S	1.81	25.6	
0324 − 407		26/01/92	3159	6(265,274)	0.5	0.8	17.8	17.6	S	3.06	26.9	D
		30/04/92	3159	6(407,613)	16.3	1.3	17.7	17.6	S	3.06	27.0	D
0326 − 403		28/04/92	4027	7(103,400)	26.8	2.2	18.1	18.3	S	2.10	25.8	
0329 − 255		15/10/91	3159	6(250,214)	2.2	g	17.8	17.51	R	2.69	26.6	
0329 − 378		09/05/92	4027	6(522,339)	11.6	1.3	16.7	16.	S	1.75	26.8	
0329 − 385		02/02/92	3159	6(237,249)	1.3	0.4	17.3	16.92	S	2.42	26.9	
0334 − 2029	UM683	11/06/92	4027	6(195,410)	7.	1.3	18.2	19.1	S	3.13	26.5	D
0334 − 335		09/05/92	4027	6(145,231)	5.3	1.3	18.0	17.6	S	1.49	25.2	L
0335 − 336		09/05/92	4027	6(169,258)	4.	0.9	18.5	18.5	X	2.27	25.6	
0335 − 363		09/05/92	4027	7(623,408)	30.5	0.9	18.2	18.	S	2.02	25.6	
0336 − 359		10/05/92	4027	7(643,426)	31.6	0.9	17.8	17.8	S	2.01	26.0	
0338 − 394		02/02/92	3159	6(474,196)	9.5	1.2	17.4	18.4	S	2.59	26.9	D
0339 − 367		26/04/92	4027	missed	> 24	1.3						
0347 − 241		11/08/91	3159	8(734,115)	42.6	1.3	17.1	17.5	R	1.88	26.6	
0347 − 383		15/10/91	3159	6(248,209)	2.4	g	17.8	17.3	S	3.23	27.0	
		31/03/92	3159	6(145,252)	5.1	0.8	17.8	17.3	S	3.23	27.0	
0351 + 187		12/07/92	4027	5(43,462)	13.6	2.2	20.2	19.	R	2.71	24.2	D
0351 − 3749		15/10/91	3159	6(258,235)	1.2	g	18.4	17.8	S	3.01	26.2	
		29/03/92	3159	6(97,297)	7.3	1.2	18.1	17.8	S	3.01	26.5	
0352 − 2732	UM684	14/10/91	3159	6(247,250)	0.9	g	17.9	18.	S	2.82	26.6	
	UM684	31/03/92	3159	5(68, 55)	14.7	1.2	18.3	18.	S	2.	25.5	
0353 − 383		26/01/92	3159	7(167, 50)	11.6	1.2	17.2	17.5	S	1.96	26.6	
0355 − 48		23/04/91	3159	6(240,261)	1.0	g	16.6	16.38	R	1.01	25.8	
0400 − 2706	UM685	02/04/92	4027	6(594,330)	14.5	0.4	18.4	18.9	S	2.83	26.1	
0402 − 362		07/10/91	3159	6(220,241)	2.1	1.5g	16.9	17.17	R	1.42	26.2	J
0420 + 003		02/04/92	4027	6(506,589)	17.5	0.8	19.0	19.1	S	2.92	25.6	D

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	−Mv[8]	Comments
0420 − 388		01/10/91	3159	6(226,263)	1.6	g	17.0	16.92	S	3.12	27.7	J
0438 − 166		20/04/91	3159	6(253,237)	1.2	g	17.9	17.65	X	1.96	25.9	
0438 − 43		19/04/91	3159	6(248,258)	0.7	g	19.5	18.8	R	2.85	25.0	
0447 − 395		01/10/91	3159	6(233,239)	1.7	g	17.2	18.1	S	1.98	26.6	
0448 − 392		30/09/91	3159	6(227,237)	1.9	g	16.7	16.46	R	1.29	26.2	
		27/02/92	3159	6(69,347)	9.1	1.5	16.7	16.46	R	1.29	26.2	F
0451 − 28		19/04/91	3159	6(243,262)	0.9	g	18.2	18.5	R	2.56	26.1	
0451 − 418		11/08/91	3159	8(547,204)	36.7	1.3	18.0	18.2	S	2.13	25.9	
0453 − 423		11/05/91	3159	8(158,208)	23.	1.0	17.3	17.06	S	2.66	27.1	D
0456 − 395		10/05/92	4027	7(311,220)	18.3	1.3	17.7	18.	S	1.85	25.9	D
0504 + 03		02/04/92	4027	8(267, 75)	23.5	3.1	19.0	18.7	R	2.45	25.2	A4
0528 − 250		19/04/91	3159	6(255,254)	0.5	g	17.8	17.24	R	2.76	26.7	
0636 + 68		03/04/92	4027	6(105,133)	8.8	1.2	16.6	16.5	R	3.17	28.2	
0642 − 349		10/05/92	4027	7(262,160)	15.6	1.7	18.0	18.5	R	2.17	26.0	
0731 + 65		20/04/91	3159	6(246,245)	1.1	g	18.2	18.5	R	3.03	26.5	
0747 + 611		20/04/91	3159	6(238,228)	1.8	g	17.2	17.5	S	2.49	27.1	A2
0759 + 341		20/01/92	3159	6(66,344)	9.2	1.5	18.5	18.5	R	2.44	25.7	
0804 + 4959	OJ508	05/04/92	4027	6(422,265)	6.8	1.2	18.3	17.5	R	1.43	24.8	
0808 + 28		04/10/91	3159	6(252,264)	0.5	0.4g	18.3	18.	R	1.91	25.4	J
0809 + 5549	NGC2534	02/04/92	4027	6(255,301)	1.7	0.8	18.5	18.7	O	2.40	25.7	
0812 + 33*A*		14/10/91	3159	6(271,226)	1.6	g	19.2	18.	R	2.42	25.0	
		05/04/92	3159	6(184,569)	13.6	1.5	19.1	18.	R	2.42	25.1	
0820 + 29		02/04/92	4027	5(152,359)	15.8	0.8	19.0	18.5	R	2.37	25.2	
0827 + 24		14/10/91	3159	6(256,226)	1.6	g	17.5	17.7	R	2.05	26.4	
		31/03/92	3159	5(45,283)	10.7	1.5	18.1	17.7	R	2.05	25.8	K
0830 + 115		25/04/91	3159	6(236,260)	1.2	g	18.0	18.5	R	2.97	26.6	
0831 + 101		02/04/92	4027	8(378,109)	28.4	0.8	19.6	18.	R	1.76	23.9	D
0831 + 1248		03/11/91	3159	6(235,253)	1.3	g	18.1	17.8	S	2.75	26.4	
0836 + 1122		02/04/92	4027	6(305,296)	2.3	0.8	19.5	18.8	S	2.70	24.9	
0836 + 1932	4C19.31	08/11/91	3159	8(633,180)	39.5	0.8	17.6	17.73	R	1.69	25.9	D,F
0837 + 4701	US1443	19/10/91	3159	6(244,253)	0.9	g	17.3	17.5	C	1.56	26.0	
	US1443	05/04/92	3159	7(239,621)	35.4	1.2	17.2	17.2	C	1.56	26.1	
0838 + 4536	US1498	26/04/92	4027	6(52,202)	9.4	2.2	17.5	17.6	C	1.41	25.6	D,A4
0843 + 1339	4C13.39	25/01/92	3159	6(47,276)	9.3	1.2	17.5	17.8	R	1.88	26.2	
0846 + 1540		03/11/91	3159	6(247,255)	0.8	g	17.8	18.3	S	2.92	26.8	
0846 + 51*W*1		28/01/92	3159	6(56,629)	18.1	1.5	19.9	15.72	C	1.86	23.8	A3
0847.6 + 156		25/01/92	3159	6(237,314)	2.5	0.8	19.0	18.	S	2.66	25.4	
0848 + 1533	LB8755	02/11/91	3159	6(265,237)	1.1	g	17.8	17.93	C	2.01	26.0	
0848 + 1623	LB8775	29/10/91	3159	6(250,227)	1.6	g	17.6	17.9	C	1.93	26.1	
0851 + 1942	LB8863	25/01/92	3159	6(93,289)	7.4	1.2	18.1	18.07	C	2.21	25.9	
0854 + 1632		23/01/92	3159	8(223, 75)	21.9	0.8	19.2	18.5	S	2.54	25.1	
0854 + 1907	LB8956	06/11/91	3159	6(240,251)	1.1	g	18.0	17.7	C	1.89	25.7	
0856 + 124		02/04/92	4027	8(293, 96)	24.9	1.2	19.4	18.	R	1.76	24.1	
0859 − 14		21/01/92	3159	6(529,518)	15.8	5.4	17.0	16.6	R	1.33	26.0	
0903 + 1534		08/11/91	3159	6(258,247)	0.7	g	18.5	18.	S	2.66	25.9	
0903 + 175		08/11/91	3159	6(255,198)	1.7	g	18.0	17.3	X	2.77	26.5	A3
0907 + 381		02/11/91	3159	6(248,271)	0.7	g	17.6	18.	R	2.16	26.4	
0913 + 0715		24/10/91	3159	6(244,229)	1.7	g	18.1	17.1	S	2.77	26.4	
0919 − 260		26/04/92	4027	7(140,112)	14.5	1.3	18.2	18.41	R	2.30	25.9	
0920 + 580		14/06/92	4027	7(464,326)	24.3	1.7	17.0	17.5	S	1.38	26.0	
0932 + 367		01/11/91	3159	6(281,176)	3.8	g	18.4	18.5	R	2.84	26.1	
0932 + 501		08/11/91	3159	6(310,242)	2.2	g	16.9	17.24	S	1.88	26.8	
0933 + 733		24/04/91	3159	6(502,360)	12	g	17.3	17.	O	2.52	27.0	B
0941 + 26		26/10/91	3159	6(561,170)	14.3	2.3	18.0	18.	R	2.91	26.6	A3
0945 + 114		05/05/92	4027	6(79,300)	8.1	0.9	18.9	18.	R	2.14	25.0	D
0945 + 4337	US987	29/01/92	3159	6(138, 87)	9.3	1.2	18.2	17.99	C	1.89	25.5	
0945 − 321		25/06/92	4027	6(38,181)	10.3	0.4	19.8	19.8	R	2.14	24.1	
0946 + 301		27/01/92	3159	6(297,288)	1.8	1.2	16.2	16.38	C	1.22	26.6	
0953 + 549		07/10/91	3159	6(253,222)	1.8	g	17.4	17.5	S	2.58	26.9	
0955 + 4717		11/10/91	3159	6(242,259)	0.9	g	17.4	17.8	S	2.48	26.9	
0955 + 4739	OK492	14/10/91	3159	6(255,252)	0.6	g	18.7	18.	R	1.87	25.0	

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V_{obs}[5]	V_{tab}[6]	Sel[7]	Z	−Mv[8]	Comments
0956 + 1217		27/10/91	3159	6(250,254)	0.7	g	17.6	18.2	S	3.29	27.2	
0957 + 557		06/02/92	3159	6(209,274)	2.4	1.9	17.6	17.5	S	2.10	26.3	
0957 − 055		10/06/92	4027	6(212,353)	4.4	3.9	17.6	17.4	S	1.81	26.0	
0958 + 5509	MARK132	03/11/91	3159	6(198,256)	2.8	g	16.3	16.	S	1.75	27.2	
0959 − 075		13/06/92	4027	6(487,380)	10.9	0.9	17.7	17.7	S	1.56	25.6	
1002 − 249		26/04/92	4027	5(97,191)	13.3	1.3	17.9	17.5	S	2.44	26.3	
1003 − 026		09/06/92	4027	6(214,298)	2.6	1.3	17.6	18.	S	2.88	27.0	
1008 + 133		03/02/92	3159	6(217,353)	4.3	0.8	16.3	16.29	C	1.29	26.6	
1008 − 055		08/06/92	4027	7(302,255)	19.8	1.3	18.1	18.1	S	2.11	25.8	D
1009 − 321		05/07/92	4027	6(289,540)	12.	3.5	17.4	18.1	R	1.74	26.1	D
1011 + 091		03/11/91	3159	6(249,223)	1.8	g	17.7	17.8	X	2.26	26.4	
1017 + 1055		23/05/91	3156	missed	> 24	0.7						
		09/03/92	4017	missed	> 24	0.8						
10370 − 271		23/04/91	3156	6(255,260)	0.4	g	17.3	17.4	S	2.18	26.7	
1038 + 065	4C06.41	02/06/91	3156	6(243,264)	0.9	g	16.6	16.7	R	1.27	26.3	
1038 + 528		20/04/92	4027	7(615,291)	26.1	0.9	18.6	18.5	R	2.30	25.5	
10382 − 272		23/04/91	3156	6(243,263)	0.9	g	17.7	17.9	S	2.32	26.4	
1039 + 582		10/06/91	3156	7(235,253)	19.6	0.8	17.8	17.5	S	1.47	25.4	F
1045 + 60	4C60.15	23/05/91	3156	8(74,330)	25.	1.0	18.7	17.5	R	1.72	24.8	
1055 + 584		09/11/91	3156	8(200,177)	23.8	1.5	18.2	18.	S	2.24	25.8	D
1116 + 603		10/06/91	3156	8(109,210)	22.3	1.0	17.5	16.5	S	2.63	26.9	
1117 + 535		02/06/91	3156	6(240,228)	1.8	g	17.4	18.	S	1.92	26.3	
1120 + 0145	UM425	10/05/92	4027	6(142,534)	12.8	1.3	16.1	16.5	S	1.47	27.1	F,A4
1124 + 57		26/04/92	4027	missed	> 24	0.9						
1125 + 584		05/07/92	4027	6(216,405)	6.4	0.4	17.5	17.5	S	1.39	25.5	
1127 − 14		22/12/91	3156	7(270, 95)	12.8	0.4	17.2	16.9	R	1.19	25.5	
1128 + 574		10/05/92	4027	6(325,239)	2.9	0.9	18.0	18.5	S	2.23	26.0	
1133 + 1306		23/05/91	3156	7(217,593)	33.	0.6	18.9	18.8	S	2.87	25.7	D
1136 + 1214		23/05/91	3156	missed	> 24	0.9						A2
		27/11/91	3156	6(233,266)	1.3	g	18.0	17.6	S	2.89	26.6	A3
		07/03/92	4017	6(284,280)	1.2	0.8	17.6	17.6	S	2.89	27.0	
1137 + 30	US2778	23/05/91	3156	7(265,653)	36.	0.7	16.7	16.9	C	1.57	26.6	
1138 + 584		20/05/91	3156	7(311, 92)	12.	1.9	17.6	18.	S	2.40	26.6	
1139 + 2833	US2828	15/06/91	3156	missed	> 24	1.7						
	US2828	07/03/92	4017	6(470,667)	19.5	1.5	17.3	17.2	C	1.61	26.1	D
1139.5 + 286	US2813	23/05/91	3156	6(92,122)	9.5	1.0	17.7	17.6	C	1.69	25.8	
1146 + 111*D*		23/05/91	3156	5(444, 60)	19.	1.0	17.5	17.6	S	2.12	26.4	F
1148 + 38		29/04/91	3156	6(232,251)	1.4	g	17.2	17.04	R	1.30	25.7	
1148 − 00		07/07/91	3156	7(183,412)	26.7	2.6	17.2	17.6	R	1.98	26.6	D
1150 − 1740	POX5B	22/12/91	3156	6(410,210)	6.7	0.8	18.1	17.	S	2.21	25.9	
1151 + 0651		11/04/92	4027	6(188,326)	4.2	0.4	18.2	18.8	S	2.76	26.3	D
1155 − 1811	POX30	07/07/91	3156	8(339,245)	30.2	2.9	19.2	18.	S	2.25	24.9	
1157 + 014		22/07/91	3156	6(56,253)	8.9	0.7	17.3	17.74	R	1.98	26.5	
1158 − 1842	POX42	27/07/91	3156	7(412, 70)	13.4	0.9	17.0	17.01	S	2.44	27.2	
1159 + 123		19/04/91	3156	6(239,244)	1.3	g	17.4	17.5	S	3.51	27.6	
1202 − 20	POX62	23/04/91	3156	6(227,250)	1.6	g	18.9	18.	S	2.17	25.1	
1203 − 1603	POX61	29/12/91	3156	7(46, 55)	14.5	1.2	18.7	17.8	S	2.46	25.5	A3
1204 + 0935		13/04/92	4027	7(166, 55)	11.9	1.7	17.9	17.7	S	1.56	25.4	G
1204 + 597		02/05/92	4027	5(286,155)	21.5	0.9	17.4	17.5	S	1.37	25.6	A4,G
1205 + 0918		13/04/92	4027	7(236, 36)	10.3	0.9	18.2	18.3	S	2.08	25.7	C
1206 + 1155		19/04/91	3156	6(257,228)	1.5	g	17.6	17.9	S	3.10	27.1	
1206 + 1500		29/04/92	4027	6(338,382)	6.	3.5	18.1	18.2	S	2.6	26.2	D
1206 + 1727		24/04/92	4027	7(161, 59)	12.1	1.3	18.8	18.5	S	2.36	25.4	
1206 + 459		02/05/91	3156	6(237,228)	1.9	g	15.5	15.79	C	1.15	27.1	
1208 + 1011		22/07/91	3156	6(67,252)	8.4	0.9	17.9	17.5	S	3.80	27.2	A2
		23/12/91	3156	6(249,237)	1.3	g	17.9	17.5	S	3.80	27.2	A3
1208 + 1413		30/04/92	4027	8(489,106)	32.6	2.2	18.6	18.5	S	2.33	25.5	D
1208 + 1535		30/04/92	4027	8(447,126)	31.3	2.6	18.2	18.	S	1.94	25.5	
1209 + 0919		13/04/92	4027	6(149,359)	6.4	0.4	18.8	18.5	S	3.31	26.0	D
1209.1 + 10.7		15/06/91	3156	missed	> 24	0.9						
		06/03/92	4017	7(410, 61)	13.	1.5	18.1	17.76	S	2.19	25.9	D

1993ApJ...409...28M

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V_{obs}[5]	V_{tab}[6]	Sel[7]	Z	−Mv[8]	Comments
1210 + 1507		30/04/92	4027	6(501,121)	11.9	3.0	17.4	17.3	S	1.68	26.0	
1210 + 1731		30/04/92	4027	8(153,129)	20.9	2.6	17.6	17.4	S	2.54	26.7	D
1211 + 33		08/03/92	3156	6(247,243)	1.1	g	17.6	17.	R	1.60	25.7	
1212 + 0854		12/04/92	4027	6(181,366)	5.7	1.7	18.0	18.2	S	2.35	26.1	
1212 + 1045		13/04/92	4027	7(110,306)	22.9	1.3	18.1	17.8	S	1.95	25.7	
1212 + 1551		03/05/92	4027	5(398,387)	26.4	1.7	18.1	18.2	S	1.95	25.7	
1213 + 0922		11/06/91	3156	8(641,351)	43.4	1.0	18.1	17.2	S	2.71	26.3	D
1213 + 1208		03/05/92	4027	7(169,188)	17.3	1.7	17.5	17.6	S	1.47	25.7	
1215 + 113		19/04/91	3156	6(245,250)	1.0	g	17.0	16.86	R	1.39	26.0	
1215 + 1202		03/05/92	4027	8(464, 56)	30.8	1.3	18.0	18.4	S	2.83	26.5	
1215 + 1527		03/05/92	4027	7(253, 53)	11.	0.9	19.0	18.6	S	2.74	25.5	D
1215 + 33		22/05/91	3156	6(180,177)	4.	2.1	18.1	17.5	R	2.60	26.2	
1215 + 6423	4C64.15	03/05/92	4027	7(232,122)	14.	1.3	18.1	17.4	R	1.29	24.8	D
1216 + 0947		13/04/92	4027	6(32,104)	12.1	1.3	18.5	18.4	S	2.31	25.6	D
1216 + 1656		11/04/92	4027	7(174,280)	21.1	0.4	18.3	18.1	S	2.83	26.2	D
1216 + 1754		20/04/92	4027	6(164,445)	8.9	1.3	17.9	18.	S	1.81	25.7	D
1221 + 114		03/05/92	4027	8(335, 67)	25.9	1.3	18.9	18.	R	1.76	24.6	
1221 + 545		19/06/91	3156	6(225,316)	2.8	2.0	18.5	18.	S	2.10	25.4	D
1222 + 1433		03/05/92	4027	5(44,257)	10.6	1.7	17.3	17.1	S	1.33	25.7	D,K
1222.9 + 1334		24/04/92	4027	7(134,121)	15.	0.9	18.3	18.	S	1.79	25.3	
1223 + 1723		28/04/92	4027	8(164,136)	21.5	2.2	19.0	18.1	S	2.42	25.2	G
1223 + 1753		03/05/92	4027	6(117,300)	6.5	2.2	18.1	18.1	S	2.92	26.5	
1224 + 1538		17/05/92	4027	7(208,398)	26.	0.	18.2	18.	S	1.76	25.3	
1225 + 1512		17/05/92	4027	7(637,119)	21.2	0.	18.4	18.	S	2.01	25.4	D
1226 + 1115		26/04/92	4027	missed	> 24	1.3						
1228 + 1216		17/05/92	4028	6(64,448)	11.7	0.	17.8	17.3	S	1.40	25.3	D
1228 + 1808		17/05/92	4027	6(111,185)	7.3	0.	18.2	18.3	S	2.64	26.2	
1228.0 + 07.8		10/06/91	3156	missed	> 24	1.5						
		06/03/92	4017	6(47,300)	9.4	1.5	17.7	17.47	S	1.81	25.9	
1228.5 + 07.6		11/06/91	3156	missed	> 24	0.9						
		06/03/92	4017	6(524,327)	11.6	1.2	18.6	17.5	S	1.88	25.1	D
1228.7 + 07.7		13/06/91	3156	6(182,231)	3.	1.4	17.9	17.6	S	2.39	26.3	
1229 + 142		17/05/92	4028	6(103,438)	10.2	0.4	18.1	18.5	S	2.86	26.4	
1230 + 1042		17/05/92	4028	6(438,494)	12.5	0.4	18.4	18.2	S	2.43	25.8	
1230 + 1052		15/05/92	4028	missed	> 24							
1230 + 1318		15/05/92	4028	7(87,563)	33.8	0.9	19.9	18.5	S	2.29	24.2	D
1230 + 1627		12/04/92	4028	7(110,350)	24.7	1.7	17.4	17.8	S	2.70	27.0	D
1232 + 0815		13/04/92	4028	6(253,383)	5.2	0.4	18.9	18.4	S	2.57	25.4	D
1232 + 1139		12/04/92	4028	7(152,252)	20.1	1.3	18.4	18.4	S	2.87	26.2	
1235 + 0857		13/04/92	4028	7(277,412)	26.5	0.9	17.8	18.2	S	2.88	26.8	D
1235 + 148		15/05/92	4028	5(85,224)	12.5	1.7	18.6	18.6	S	2.68	25.8	D
1237 + 1212		15/05/92	4028	8(208, 70)	21.2	1.7	18.6	18.4	S	2.31	25.5	
1237 + 1325		15/05/92	4028	7(252,484)	29.5	1.7	18.0	17.8	S	1.73	25.5	A4
1239 + 1435		15/05/92	4028	6(536,343)	12.2	1.7	17.3	17.9	S	1.93	26.4	D
1240 + 1504		16/05/92	4028	7(205,370)	24.8	1.3	18.0	18.	S	1.85	25.6	D
1240 + 1516		15/05/92	4028	7(174,331)	23.3	1.3	18.4	18.3	S	2.28	25.7	
1241 + 176		23/05/91	3156	8(65, 65)	15.	1.2	15.9	16.3	C	1.27	27.0	F
1242 + 1737		16/05/92	4028	7(361,274)	20.9	1.7	18.4	18.	S	1.86	25.3	D
1244 + 1129		16/05/92	4028	6(79,155)	9.2	1.7	18.0	18.4	S	3.16	26.7	
1244 + 1642		14/05/92	4028	5(139,305)	14.8	1.7	18.5	18.7	S	2.87	26.1	D
1244.9 + 34.7		29/04/91	3156	6(244,261)	0.8	g	18.5	18.	S	2.48	25.8	
1246 + 3746	BSO1	11/06/91	3156	5(652,231)	36.8	0.9	17.2	16.98	C	1.24	25.6	D
1247 + 268		27/07/91	3156	5(97,280)	12.9	0.2	15.6	15.9	C	2.04	28.2	
1248 + 401		20/06/91	3156	missed	> 24							
		07/03/92	4017	6(513,361)	11.5	1.2	16.1	16.28	C	1.03	26.3	
1254 + 047		26/12/91	3156	5(77,309)	12.2	1.9	16.4	16.14	C	1.02	26.0	
1256 − 17		10/06/91	3156	missed	> 24	1.0						
		06/03/92	4017	7(246, 30)	10.	1.5	17.1	17.8	R	2.06	26.8	C
1257 + 34	B201	29/04/91	3156	6(237,254)	1.2	g	16.7	16.79	C	1.37	26.3	
1258 + 2835	US136	14/05/92	4028	6(141,493)	11.2	1.7	17.2	17.4	C	1.36	25.8	D
1258 + 2839	W61972	07/07/91	3156	8(667, 47)	38.9	3.0	17.7	17.75	C	1.92	26.0	

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	$-Mv^8$	Comments
1259 + 3427	BSO6	23/07/91	3156	8(283, 78)	24.1	0.9	18.0	17.87	C	1.95	25.8	D
1300 − 243		05/01/92	3156	6(575,122)	14.7	1.5	18.2	17.85	S	2.26	25.9	D
1301 + 3042	W33211	08/11/91	3156	6(444, 46)	12.2	0.8	17.7	17.56	C	1.71	25.8	D
1303 + 3048	W22722	12/08/91	3156	6(242,209)	2.5	1.1	17.2	17.85	C	1.75	26.3	
1303 + 3121	W21541	10/08/91	3156	8(172,573)	37.1	2.6	20.1	17.7	C	2.04	23.7	D
1304 − 1207	POX123	16/08/91	3156	6(425,253)	7.0	1.8	18.1	18.	S	2.28	26.0	D
1309 + 3402	BSO8	16/08/91	3156	missed	> 24							
	BSO8	08/03/92	4017	7(289, 92)	12.7	0.8	17.7	17.43	C	1.75	25.8	
1309 − 056		20/08/91	3156	8(435,130)	31.0	1.2	17.6	17.44	S	2.18	26.4	
1311 − 270		22/04/91	3156	6(247,254)	0.8	g	17.4	17.43	R	2.19	26.6	A2
1313 − 1522		19/04/92	4028	7(58,233)	20.7	1.3	18.7	18.7	S	2.72	25.7	
1315 + 4722		06/07/91	3156	7(119,186)	17.8	2.4	18.3	18.	S	2.59	26.0	A2
1315 + 605		06/07/91	3156	5(225,402)	19.4	2.2	19.0	18.	S	1.98	24.8	A2
1317 + 2743	TON153	15/08/91	3156	8(87, 34)	16.4	1.8	16.1	15.98	C	1.02	26.3	D,H
1318 + 2903	TON155	23/06/91	3156	7(94,616)	36.0	0.9	17.4	17.27	C	1.70	26.1	
1318 − 113		06/12/91	3156	6(373,184)	5.8	1.9	17.8	17.68	S	2.31	26.3	
1323 + 6530	4C65.15	14/05/92	4028	6(393,134)	7.9	1.7	17.5	17.8	R	1.62	25.9	
1323 − 1042	POX188	31/01/92	3156	6(254,632)	15.9	1.5	18.0	17.	S	2.36	26.2	
1327 − 206		21/07/91	3156	6(120,227)	6.3	1.1	16.8	17.04	R	1.16	25.9	A2
1327 − 311		19/04/92	4028	6(210,164)	4.8	1.3	18.8	17.4	R	1.33	24.2	
1336 + 135		22/06/91	3156	6(476,711)	21.3	0.9	18.8	18.5	X	2.42	25.4	
1337 + 1121		03/12/91	3156	7(664, 45)	20.3	0.8	18.7	18.2	S	2.92	25.9	
1340 + 0959		22/08/91	3156	6(96,265)	7.2	1.5	19.0	18.5	S	2.94	25.6	
1346 − 036		14/12/91	3156	8(308,108)	25.7	0.4	17.4	17.27	S	2.35	26.7	
1347 + 1116		02/07/91	3156	6(260,269)	0.3	1.0	18.8	18.5	S	2.69	25.6	D
1351 + 31		14/05/92	4028	7(151, 38)	11.4	1.3	18.9	17.4	R	1.33	24.1	D,C
1352 + 011		14/07/91	3156	6(535,610)	19.0	3.7	16.2	16.04	C	1.12	26.4	F
1356 + 5806	4C58.29	28/12/91	3156	6(266,344)	3.5	1.9	17.2	17.37	R	1.37	25.8	
1358 + 1134		07/07/91	3156	8(715, 59)	41.1	2.5	17.6	16.5	S	2.57	26.7	
1359 − 058		16/04/92	4028	7(456,172)	18.1	1.7	17.6	17.6	S	2.	26.2	D,F
1400 + 0935		24/08/91	3156	7(219, 55)	11.3	1.2	18.9	18.5	S	2.98	25.7	G
1400 + 1126		04/12/91	3156	6(355,185)	5.2	g	18.9	18.9	S	3.17	25.9	F
1402 + 044		18/08/91	3156	6(610,446)	16.9	1.5	19.0	18.5	R	3.20	25.8	D
1402 − 012		25/08/91	3156	8(679,345)	44.7	1.8	18.3	18.16	R	2.51	26.0	D
1406 + 1221		03/07/92	4028	6(47,303)	9.4	0.9	18.3	18.9	S	2.97	26.3	D
1409 + 0930		16/08/91	3156	6(528,538)	16.4	1.7	18.1	18.6	S	2.85	26.4	D
1410 + 0936		25/08/91	3156	6(397,114)	8.6	2.0	17.8	18.8	S	3.24	27.0	
1413 + 373		15/08/91	3156	missed	> 24	0.8						
		07/03/92	4017	6(401,532)	13.	2.3	18.2	18.	R	2.36	26.0	D
1414 + 0859		09/12/91	3156	6(434,304)	7.6	0.8	19.0	18.6	S	2.70	25.4	
1423 + 1007		09/12/91	3156	6(175,371)	5.	1.5	19.8	18.4	S	2.78	24.7	A3
1429 + 1153		15/08/91	3156	6(301,171)	4.3	2.2	18.3	18.6	S	3.01	26.3	G
1438 − 347		30/04/91	3156	6(246,254)	0.8	g	17.1	17.	R	1.15	25.5	
1448 − 232		10/05/91	3156	7(377,138)	15.	1.2	17.1	16.96	R	2.20	26.9	F
1451 + 1223		07/08/91	3156	6(41,253)	9.6	1.4	19.1	18.6	S	3.25	25.7	D
1455 + 1221		07/07/91	3156	5(106,375)	14.1	2.2	19.1	18.7	S	3.06	25.6	
1508 − 05		19/05/92	4028	7(225,358)	24.2	2.6	17.7	17.2	R	1.19	25.0	
1511 + 103		12/04/92	4028	6(58,283)	8.9	2.2	17.3	17.73	R	1.55	26.0	
1517 + 176		11/04/92	4028	6(157,376)	6.7	0.4	18.5	17.5	R	1.40	24.6	
1520 + 41	SP43	12/05/91	3156	5(158, 62)	20.	4.2	18.7	17.5	S	3.10	26.0	
1522 + 101		07/07/91	3156	8(398, 71)	31.2	2.6	16.2	15.65	C	1.32	26.7	A2
1548 + 056		11/04/92	4028	7(293, 79)	12.2	1.3	19.5	17.7	R	1.42	23.6	
1548 + 0917		07/07/91	3156	8(112,109)	19.6	2.4	18.0	17.5	S	2.74	26.5	D
1556 − 245		22/05/92	4028	6(514,350)	11.4	0.4	19.2	19.	R	2.81	25.3	
1559 + 140		07/10/91	3156	missed	> 24	2.3						
		07/03/92	4017	6(266,180)	3.6	1.5	18.6	18.	R	2.24	25.4	
1559 + 173		28/12/91	3156	6(113,645)	17.6	1.9	18.5	18.	R	1.94	25.2	
1602 − 002		21/05/92	4028	missed	> 24	3.5						
1615 + 029		29/05/92	4028	7(72,292)	22.8	1.3	17.7	17.67	R	1.34	25.3	
1624.0 + 26.9		19/05/92	4028	5(312,408)	23.	0.9	19.8	18.5	S	2.18	24.2	
1629 + 6803	4C68.18	23/05/92	4028	6(83,703)	20.4	0.9	19.3	18.7	R	2.47	24.9	

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V_{obs}[5]	V_{tab}[6]	Sel[7]	Z	−Mv[8]	Comments
1634 + 176		03/08/91	3156	6(277, 42)	9.5	0.6	19.3	18.	R	1.89	24.4	
1658 + 5735	4C57.29	23/05/92	4028	5(73,260)	11.9	1.3	18.5	18.3	R	2.17	25.5	
1700 + 1802	4C17.73	19/05/92	4028	8(537, 58)	33.7	0.9	18.9	17.5	R	1.42	24.2	
1705 + 018		23/05/92	4028	5(88,276)	12.5	1.3	18.8	18.9	R	2.57	25.5	
1722 + 33		24/05/92	4028	6(761,176)	21.7	1.7	20.8	18.	R	1.87	22.9	A4
1756 + 237		23/05/92	4028	5(429, 66)	28.5	1.7	17.2	18.	R	1.72	26.3	A4
1831 − 711		18/05/92	4028	6(313,375)	5.3	1.7	17.4	17.5	R	1.36	25.6	
2008 − 159		20/05/92	4028	6(32,336)	10.4	1.3	18.3	17.2	R	1.18	24.4	C
2021 − 330		19/06/91	3156	6(120,180)	9.2	2.9	19.4	16.3	R	1.47	23.8	A2
2040 − 374		20/06/91	3156	6(698,519)	21.7	1.2	18.0	17.84	S	2.27	26.1	
2040 − 400		18/06/91	3157	6(198,422)	7.4	2.1	17.7	18.1	S	2.07	26.2	
2055 − 440		19/06/91	3157	7(399, 84)	13.7	3.2	17.6	17.9	S	2.06	26.3	
2116 − 358		19/10/91	3157	7(161,234)	19.3	1.5	17.5	17.35	S	2.34	26.6	
2118 − 4303	HA6	30/05/92	4028	7(227,195)	17.2	0.9	18.7	18.43	C	2.22	25.3	
2120 + 1651	3C432.0	29/05/92	4028	6(352,347)	5.3	0.	18.4	17.96	R	1.81	25.2	
2121 + 053		22/04/91	3157	6(260,240)	1.0	g	20.4	17.5	R	1.87	23.3	
2123 − 408		26/05/92	4028	6(308,263)	1.9	0.9	18.1	18.5	S	2.29	26.0	
2125 − 1335		20/05/92	4028	6(519,496)	14.9	0.9	18.6	18.7	S	2.95	26.0	
2126 − 15		06/06/91	3157	6(247,263)	0.7	g	17.0	17.3	R	3.27	27.8	A2
2131 − 4257	HA2	18/05/91	3157	missed	59.	1.4						E
	HA2	27/04/92	4017	5(395,747)	33.1	1.7	18.9	18.11	C	2.11	25.0	
2131 − 46	HA5	18/05/91	3157	7(333,623)	35.	0.4	18.5	18.47	C	2.94	26.1	
2134 + 004		30/04/91	3157	6(267,243)	0.9	g	17.1	16.79	R	1.93	26.6	
2136 + 141		24/04/91	3157	7(114,250)	20.	3.1	18.9	18.5	R	2.42	25.3	
2144 − 362		24/10/91	3157	5(100,131)	14.2	1.2	18.2	17.8	R	2.08	25.7	D
2149 − 306		16/05/91	3157	8(316,318)	30.	2.5	17.9	18.4	R	2.34	26.2	
2150 + 05		10/05/91	3157	6(320, 77)	8.3	2.5	18.0	17.77	R	1.97	25.8	
2153 − 204		14/05/91	3157	6(122,170)	7.2	1.9	17.4	17.01	R	1.30	25.5	
2153 − 2094		31/05/92	4028	7(107, 66)	13.4	1.7	17.6	18.1	C	1.81	26.0	
2154 − 2004		29/05/92	4028	7(370, 99)	13.8	0.4	17.8	18.3	C	2.01	26.0	
2156 + 29		22/04/91	3157	6(256,264)	0.3	g	20.1	17.5	R	1.75	23.4	
2158 − 214		14/05/91	3157	6(176,596)	14.8	1.8	17.9	18.15	C	2.07	26.0	
2204 − 408		18/05/91	3157	8(689,200)	41.	0.5	18.0	17.57	S	3.17	26.8	F
2204 − 573		16/07/91	3157	8(97,265)	23.9	0.6	17.3	17.36	R	2.72	27.1	
2205 − 2001	A1.1	29/05/92	4028	6(132,399)	8.1	1.3	18.9	17.95	O	1.71	24.6	D
2209 − 187*U*		10/10/91	3157	7(171,193)	17.5	0.8	17.6	17.8	C	2.09	26.3	
2211 + 0119		29/05/92	4028	missed	> 24	0.9						
2211 − 192*U*2		29/05/92	4028	6(705,591)	23.7	0.9	17.8	18.2	C	1.92	25.9	
2212 − 299		22/09/91	3157	7(383,349)	24.3	1.4	17.2	17.44	R	2.70	27.2	
2215 − 508		28/05/92	4028	6(188,420)	7.5	1.7	18.1	17.4	R	1.36	24.9	
2219 − 394		06/09/91	3157	6(137,376)	7.3	2.0	17.9	17.74	S	2.02	25.9	D
2222 + 05		28/05/92	4028	6(122,346)	7.	0.9	18.6	18.5	R	2.32	25.5	D
2222 − 396		22/09/91	3157	7(539,347)	26.5	1.6	17.7	17.9	S	2.18	26.3	
2223 + 21		06/06/91	3157	6(249,235)	1.4	g	17.5	18.	R	1.95	26.3	
2224 − 408		28/05/92	4028	6(36,353)	10.5	1.7	18.8	18.5	S	2.34	25.3	
2225 − 0534	PHL5200	15/10/91	3157	5(53,433)	13.2	1.5	18.2	17.7	C	1.98	25.6	
2225 − 404		28/05/92	4028	6(219,327)	3.3	1.7	18.1	18.28	S	2.02	25.7	
2227 − 3928		16/09/91	3157	6(94,126)	9.3	1.1	18.6	18.8	S	3.45	26.3	
2228 − 399		04/09/91	3157	5(399,339)	26.1	0.4	18.2	18.3	S	2.20	25.8	
2233 − 377		29/05/92	4028	6(192,200)	4.1	0.9	18.5	18.3	S	2.14	25.4	D
2236 − 2416	UM656	18/09/91	3157	7(50,529)	32.8	1.4	17.8	18.1	S	2.45	26.4	
2238 − 1730	UM657	06/11/91	3157	7(534,584)	35.8	1.5	17.5	17.2	S	1.36	25.5	
2240 − 419		19/05/91	3157	7(66,207)	17.	2.4	18.3	18.	S	2.08	25.6	
2240.9 − 3702		28/05/92	4028	7(228, 73)	12.	1.7	17.2	18.	S	1.82	26.4	D
2244 − 2218	UM658	13/11/91	3157	5(99, 48)	15.9	1.9	17.8	18.1	S	2.85	26.7	
2246 − 389		02/09/91	3157	7(182,536)	32.0	2.7	17.8	17.9	S	2.12	26.1	F
2251 + 24		06/12/91	3157	7(345,288)	21.4	1.9	18.5	17.8	R	2.33	25.6	A3
2254 + 024		20/07/91	3157	8(436,187)	32.2	0.5	18.2	17.	R	2.09	25.7	F
2258 − 391		06/09/91	3157	7(61,154)	17.6	1.2	17.9	18.	S	2.05	26.0	
2300 − 352		02/09/91	3157	6(66,145)	9.9	2.5	18.5	17.9	S	2.84	26.0	
2300 − 445		28/05/92	4028	7(318,109)	13.6	2.2	18.8	16.4	S	1.94	24.9	G

TABLE 1A—*Continued*

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	$-M_V$[8]	Comments
2301 − 442		28/05/92	4028	6(187,414)	7.3	2.2	18.0	18.2	S	2.06	25.9	D
2302 + 029		06/09/91	3157	6(219,231)	2.3	1.9	15.8	16.1	C	1.04	26.6	
2304 − 423		16/12/91	3157	6(347,379)	6.2	0.	17.5	17.6	S	2.61	26.9	
2318 + 0119		29/05/92	4028	missed	> 24	0.9						
2329 − 0204	UM164	12/10/91	3157	7(232,188)	16.9	1.2	18.0	17.	S	1.90	25.7	D
2329 − 376		31/05/92	4028	5(85,180)	12.9	1.7	18.1	18.1	S	1.84	25.5	D
2329 − 384		23/11/91	3157	6(285, 64)	8.6	1.2	17.2	17.04	R	1.2	25.5	
2335 − 18		14/09/91	3157	7(57,628)	36.8	1.2	17.2	17.34	R	1.44	25.9	D
2341 + 010	UM175	13/05/91	3157	7(480, 37)	14.	1.2	18.3	18.6	S	1.96	25.5	C
2341 − 2333	UM660	19/09/91	3157	6(479,461)	12.6	1.5	18.1	18.1	S	2.82	26.4	F
2345 + 061		30/05/91	3157	6(251,256)	0.6	g	18.1	17.5	R	1.54	25.2	
2348 − 011	UM184	13/05/91	3157	6(81,600)	16.5	1.3	18.8	18.	S	3.01	25.8	D
2348 − 4025		30/05/91	3157	6(269,239)	1.0	g	18.1	18.6	S	3.31	26.7	
2351 − 154		30/05/91	3157	6(257,242)	0.9	g	18.8	17.	R	2.66	25.6	
2352 − 455		30/05/91	3157	6(246,251)	0.9	g	19.7	17.5	R	1.86	24.0	
2353 + 154		30/05/92	4028	6(39,303)	9.8	2.2	18.3	18.	R	1.80	25.3	
2355 − 389		29/05/91	3157	6(274,203)	2.6	g	18.2	18.4	S	2.85	26.3	
2357 − 326		30/05/91	3158	6(256,232)	1.4	g	18.7	17.	R	1.27	24.2	F
2357 − 348		29/05/91	3157	6(255,232)	1.4	g	17.5	17.	S	2.07	26.4	
2358 − 161		30/05/91	3158	6(235,263)	1.2	g	18.3	18.	R	2.04	25.5	
2359 + 0653		13/07/91	3158	6(526, 68)	14.1	1.5	18.4	18.8	S	3.24	26.4	D
2359 − 0216	UM196	18/09/91	3158	7(304,188)	16.9	0.9	18.6	18.	S	2.82	25.9	F

[1] Listed for objects for which Veron-Cetty & Veron 1987 give a name that does not include the coordinates.
[2] Planetary Camera (PC) CCD number (5 through 8) and pixel coordinate with the origin at the PC apex.
[3] From the designated position on PC-6 (263,263), in arcseconds.
[4] In milliarcsec s^{-1}. "g" designates a coarse-track or fine-lock guided exposure.
[5] V magnitude determined from this *HST* exposure, accurate to $\approx \pm 0.1$ mag.
[6] V magnitude tabulated by Veron-Cetty & Veron 1987.
[7] Quasar discovery method: R-radio; C-color; S-spectral; X-X-ray; O-other.
[8] Assuming $H_0 = 100$ km s^{-1} Mpc^{-1}, $q_0 = 0.5$.

NOTES.—*An*: See "Notes on Individual Objects" in Paper *n* of Snapshot series. B: Guided exposure, but quasar offset by 12″ for unknown reasons. C: Quasar image split between PC-6 and PC-7. D: Quasar not verified to be in the field of view, but likely present based on brightness and/or expected absence of additional objects. F: Possibly some point-spread function asymmetry at 0.1–0.2″ scales. E: Quasar just off PC-8. G: Identification uncertain. H: Quasar image split between PC-7 and PC-8. J: Poor fine-lock guiding attempt; multiple/trailed images. K: Quasar image split between PC-5 and PC-6. L: Cosmic ray event on or near quasar image core.

telescope we find that it is much redder than the quasar and therefore is likely a foreground star.

0202−5112 (*JL 280*)—There is possibly a 22 mag point-source 3″.5 west of the quasar at P.A. −96°. *B* and *R*-band exposures taken at the Cerro-Tololo Interamerican Observatory (CTIO) 0.9 m telescope do not reveal any object at this location, indicating it is probably an artifact.

0504+03—The *HST* image shows a point source 1 mag fainter than the quasar 2″.8 to the west at P.A. −98°. Images taken at the Palomar 1.5 m telescope show that both objects have similar colors. However, spectra of the components kindly obtained by R. Vermeulen and T. Readhead at the Palomar 5 m telescope show that the western object does not have the emission lines of the quasar.

0838+4536 (*US 1498*)—There is a 21.5 mag point source 4″.4 northwest of the quasar at P.A. −45°. Images taken at the Palomar 1.5 m telescope in the Thuan-Gunn *g*, *r*, and *i* bands show the companion is ∼0.3 mag bluer than the quasar. Spectroscopy should reveal the nature of this object.

1120+0154 (*UM 425*)—Meylan & Djorgovski (1989) discovered that the 21 mag point source 6″.6 northwest of the quasar at P.A. −29° is likely to be a gravitationally lensed image of the quasar. The *HST* image shows clearly the two components, and reveals no additional sources. We see no evidence for the $V = 21.8$ mag "C" object found by Meylan & Djorgovski to the east of the quasar, consistent with their suggestion that it is a galaxy.

1204+597—There is a galaxy 6″.7 northwest of the quasar at P.A. −40°. An ultraviolet *HST* spectrum of the quasar would provide interesting information about the galaxy's interstellar medium.

1237+1325—There is a somewhat diffuse 21.5 mag object, possibly a galaxy, 6″.9 north of the quasar at P.A. 19°. Ground-based observations are needed to verify its nature.

1756+237—This quasar resides in a relatively crowded field. There is an 18.7 mag point source 4″.6 north of the quasar at P.A. −15°. An additional faint 22 mag point source is seen 4″.1 southwest of the quasar at P.A. −122° and was already

1993ApJ...409...28M

TABLE 1B

SUMMARY OF SUCCESSFUL PILOT OBSERVATIONS

Quasar	Other Name[1]	Observation Date	Program Number	PC position[2] of Quasar	Offset[3]	Trail[4] Rate	V^5_{obs}	V^6_{tab}	Sel[7]	Z	−Mv[8]	Comments
0014 + 81		17/09/90	3034	7(635,443)	10.	5.0	I	16.5	R	3.41	27.8	A1
		05/11/91	3034	7(389,403)	1.	g	I	16.5	R	3.41	27.8	
		08/02/91	3092	7(404,740)	15.	3.9	I	16.5	R	3.41	27.8	
		17/02/91	3092	7(42,384)	15.	2.0	17.1	16.5	R	3.41	27.8	
0034 + 39	5C03.44	11/01/91	3092	8(728,100)	24.	6.6	17.8	17.95	R	1.94	25.9	
		08/02/91	3092	7(558,252)	9.	3.0	I	17.95	R	1.94	25.9	
0039 − 03	UM666	04/02/91	3092	7(505,251)	5.	4.0	I	18.5	S	2.74	26.2	
		07/02/91	3092	7(417,525)	5.	4.3	18.3	18.5	S	2.74	26.2	
0051 + 29		04/02/91	3092	7(502,378)	4.	4.1	I	17.8	R	1.83	25.8	
0145 + 38		06/02/91	3092	7(350,341)	3.	3.2	I	16.0	R	1.44	27.1	
0146 − 500		17/02/91	3092	7(419,249)	7.	5.6	I	18.3	R	2.26	25.8	D
0149 + 33		25/02/91	3092	7(487,558)	9.	4.0	18.3	18.5	R	2.43	25.9	
		25/02/91	3092	7(194,553)	11.	5.2	I	18.5	R	2.43	25.9	
0153 + 74		17/02/91	3092	7(140,619)	9.	4.0	18.0	16.0	R	2.34	26.1	
		17/02/91	3092	7(194,476)	15.	6.0	I	16.0	R	2.34	26.1	
0154 − 512		04/02/91	3092	7(436,557)	7.	3.0	I	17.3	R	1.66	24.8	
		17/02/91	3092	7(139,792)	23.	3.4	18.6	17.3	R	1.66	24.8	
0308 + 1902		09/03/91	3092	7(529,683)	23.	4.0	18.4	18.6	S	2.84	26.1	
		09/03/91	3092	7(530,650)	22.	3.8	I	18.6	S	2.84	26.1	
0348 + 06		01/03/91	3092	7(215,738)	17.	0.6	18.0	17.6	C	2.06	25.9	
		03/03/91	3092	7(97,695)	18.	5.8	I	17.6	C	2.06	25.9	
0454 + 039		08/03/91	3092	7(240,302)	6.	2.8	I	16.53	R	1.35	26.5	
0506 − 61		03/10/90	3034	7(762,185)	18.	4.6	18.5	16.85	R	1.09	24.0	A1
		09/01/91	3092	6(155,511)	22.	5.7	17.4	16.85	R	1.09	25.1	
0514 − 16		18/02/91	3092	7(33,699)	20.	5.8	16.9	16.95	R	1.28	26.0	H
		18/02/91	3092	8(696, 62)	22.	4.7	I	16.95	R	1.28	26.0	
0551 − 36		18/02/91	3092	8(354,163)	22.	1.7	18.0	17.57	S	2.32	26.1	
		18/02/91	3092	8(380,127)	21.	2.3	I	17.57	S	2.32	26.1	
0743 − 67		04/10/90	3034	7(585,576)	11.	5.5	17.0	16.37	R	1.51	26.2	A1
		04/10/90	3034	7(687,618)	15.	4.2	I	16.37	R	1.51	26.2	
		30/12/90	3092	7(578,288)	9.	4.9	16.9	16.37	R	1.51	26.3	
		08/01/91	3092	7(531,220)	10.	4.7	16.9	16.37	R	1.51	26.3	
		10/01/91	3092	7(515,716)	14.	4.3	I	16.37	R	1.51	26.3	
0749 + 37		08/03/91	3092	7(236,595)	15.	5.2	18.1	16.5	R	1.20	24.6	
		08/03/91	3092	7(319,522)	13.	4.8	I	16.5	R	1.20	24.6	
0819 − 032		12/03/91	3092	7(329,518)	13.	4.3	I	18.2	R	2.35	25.9	
0822 + 27		27/02/91	3092	7(179,630)	18.	6.4	I	17.7	R	2.06	25.0	D
		08/03/91	3092	7(283,721)	21.	4.7	18.9	17.7	R	2.06	25.0	D
1021 − 00		12/03/91	3092	7(411,672)	20.	4.3	I	18.53	R	2.55	25.8	
1039 + 81		27/03/91	3092	7(690,542)	22.	4.4	18.2	16.5	R	1.26	24.6	A1
1345 + 58	4C58.27	11/10/90	3034	6(229,522)	25.	4.3	17.5	17.5	R	2.04	26.3	
		11/10/90	3034	7(745,100)	20.	4.5	I	17.5	R	2.04	26.3	
1613.7 + 1715		11/10/90	3034	7(631,350)	10.	4.9	18.7	18.5	S	2.73	25.7	A1
		11/10/90	3034	7(504,538)	7.	3.7	I	18.5	S	2.73	25.7	
1621 + 392		18/02/91	3092	7(617,476)	15.	6.0	I	17.5	R	1.97	26.3	A1
1704 + 710		11/10/90	3034	7(564,432)	7.	5.0	17.7	17.5	X	2.00	26.1	
		11/10/90	3034	7(573,479)	8.	5.3	I	17.5	X	2.00	26.1	
1711 + 712		09/10/90	3034	7(366, 72	14.	4.0	I	17.5	X	1.60	25.9	D
		10/10/90	3034	7(646,270)	12.	4.0	17.4	17.5	X	1.60	25.9	D
1718 + 481		20/02/91	3092	7(342,736)	15.	5.0	15.0	14.71	C	1.08	27.8	
		20/02/91	3092	7(406,584)	8.	1.3	I	14.71	C	1.08	27.8	
1857 + 56	4C56.28	22/02/91	3092	8(370,194)	24.	5.3	I	17.3	R	1.60	26.0	A1

[1] Listed for objects for which Veron-Cetty & Veron 1987 give a name that does not include the coordinates.
[2] Planetary Camera (PC) CCD number (5 through 8) and pixel coordinate with the origin at the PC apex.
[3] From the designated position, in arcseconds.
[4] In milliarcsec s^{-1}. "g" designates a coarse-track or fine-lock guided exposure.
[5] *V*-magnitude determined from this *HST* exposure accurate to $\approx \pm 0.2$ mag. "I" designates an F785LP exposure.
[6] *V*-magnitude tabulated by Veron-Cetty & Veron 1987.
[7] Quasar discovery method: R-radio; C-color; S-spectral; X-X-ray; O-other.
[8] Assuming $H_0 = 100$ km s^{-1} Mpc^{-1}, $q_0 = 0.5$.

NOTES.—A1: see "Notes on Individual Objects" in Paper I; D: quasar not verified to be in the field of view, but likely present based on object brightness and/or expected absence of additional objects; H: quasar image split between PC-7 and PC-8.

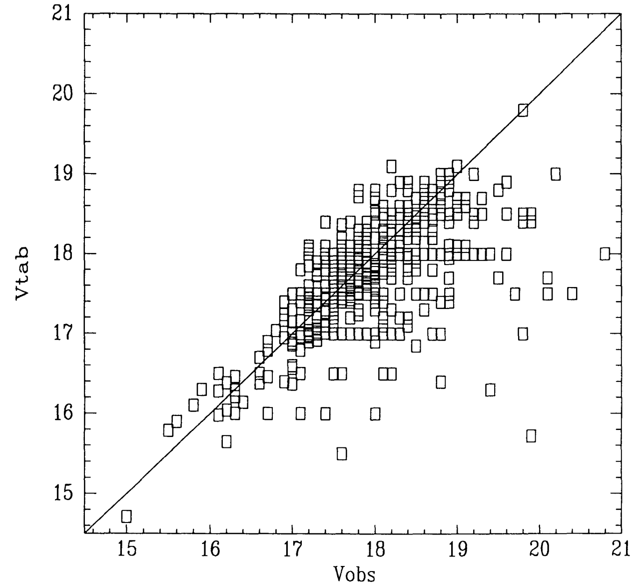

FIG. 1.—Plot of the quasar magnitudes V_{tab} tabulated by Veron-Cetty & Veron (1989) vs. the V_{obs} magnitudes measured by the Snapshot Survey. The diagonal line is $V_{tab} = V_{obs}$. Note the asymmetric distribution of points about the diagonal, caused by selection against quasars that are erroneously tabulated as being faint.

noted by Crampton, McClure, & Fletcher (1992). Broad-band imaging at the CTIO 1.5 m telescope shows that the companions and the quasar have similar colors. However, from spectroscopy at the Steward Observatory Multiple Mirror Telescope we find that both of these objects are foreground stars.

4. SUMMARY AND DISCUSSION

4.1. *Observations*

The new observations described above, combined with the previous observations in Tables 1A and 1B, bring the total number of quasars successfully imaged by the Snapshot Survey to 498.

Among the newly observed quasars described here, none show evidence of multiple components at scales less than 3″. Five quasars have point sources located at separations of 3″–7″. In three cases (0141+33, 0504+03, 1756+237), ground-based data indicate that the companion objects are foreground Galactic stars, and in another (1120+0154 = UM 425) the system is a known candidate for quasar lensing (see § 3). Among the objects previously discussed in Papers I, II, and III, one promising lens candidate was found, the redshift $z = 3.8$ quasar 1208+1011. For all the other quasars in Papers I, II, and III having companions within 7″, we have previously presented ground-based data indicating the companions are foreground stars.

Based on our previous experience with followup observations, we will assume that the one point source several arcseconds from a quasar for which ground-based data are lacking (0838+4536) is a foreground star. We will also assume that the eight quasars with uncertain identifications in the Snapshot exposures (marked "G" in Table 1A) are successful exposures of the quasars. If both 1208+1011 and 1120+0154 are lensed quasars, only two of the 498 quasars observed in the Snapshot sample are lensed into multiple images that are within our detection limits. In computing the observed number of lenses one must account for previously known lenses which satisfied the sample criteria but were eliminated from the sample to avoid duplication of other *HST* imaging programs (see Paper I). There were five such lensed quasars in our original sample (0142−100, 0957+561, 1115+080, 1413+117, and 2237+0305).

The lensed quasar 2237+0305 constitutes a special case. The Veron catalog, from which our sample was derived, is a heterogeneous collection of quasars discovered by many different selection criteria and compiled from the literature. Use of such a sample for studying lensing statistics is acceptable provided none of the quasars in the catalog were included in it based on their property of being either lensed or unlensed (Kochanek 1991b, e.g., has argued that the catalogs may in fact have some bias *against* the inclusion of quasars with moderate image separations). To our knowledge, all but one of the quasars in our sample were discovered and catalogued independent of their lensing properties. The one exception is 2237+0305. This object was discovered as a quasar *because* it is lensed; it was found serendipitously in a survey of bright nearby spiral galaxies (Huchra et al. 1985). If one searches for quasars that are projected very near the cores of known galaxies, one greatly increases the chances that any quasar discovered will be lensed. (This is, of course, an extremely inefficient way of finding quasars or lenses; a lensing galaxy as near as Huchra's lens is almost certainly unique. Kochanek (1993) predicts, however, that more such lensed quasars, albeit behind fainter galaxies, will be discovered in large-scale redshift surveys now under way). Including 2237+0305 in the sample would introduce a selection effect favoring lensed quasars that we do not account for in our calculation of the predicted lensing frequency. The only selection effect that favors lensed quasars that we do model is magnification bias. We therefore exclude 2237+0305 from the sample.

The observed frequency of lensing of quasars in our sample is then between four and six out of 502, depending on whether the lensing candidates 1208+1011 and UM 1120+0154 are included. For the purpose of comparing the observed lensing frequency to theoretical calculations of lensing by galaxies, it is also debateable whether 0957+561, which is lensed by a cluster of galaxies, should be included. Including this ambiguity, the observed lensing frequency is 3–6 out of 502.

4.2. *Comparison with Calculations*

In Papers I, II, and III we calculated the predicted frequency of gravitational lensing in our quasar sample assuming that the lenses are a nonevolving population of galaxies modeled as singular isothermal spheres (Turner, Ostriker, & Gott 1984; Fukugita & Turner 1991). We repeat this calculation here for the larger sample formed by including all the observations of the 498 quasars successfully imaged by 1992 July. The reader is referred to Papers I and II for the mathematical details.

Table 2 presents the results of the calculations of the predicted lensing frequency. The columns of the table give, for six different combinations of cosmological parameters, the expected number of lensed quasars and the probability of detecting the actually observed number of lensed quasars (last column in Table 2) given the model and assuming Poisson statistics. The parameter $\lambda \equiv \Lambda/(3H_0^2)$ is the dimensionless form of the cosmological constant.

In the first row of entries in Table 2, all of the observed sample was included in the calculation. The absolute magnitudes of the quasars, necessary for computing the magnification bias (see Paper II), were calculated from the *HST*

TABLE 2

PREDICTED AND OBSERVED NUMBERS OF LENSED QUASARS AND MODEL PROBABILITIES

	$\lambda = 0$		$\lambda + \Omega_0 = 1$				
METHOD	$\Omega_0 = 0$	$\Omega_0 = 1$	$\Omega_0 = 0$	$\Omega_0 = 0.1$	$\Omega_0 = 0.2$	$\Omega_0 = 0.3$	OBSERVED
Expected[a]	7.3	3.9	60.4	23.6	15.3	11.3	...
Probability	41%	20%	10^{-19}	10^{-5}	1%	7%	6
Probability	7%	45%	10^{-22}	10^{-7}	10^{-4}	0.4%	3
Expected[b]	3.2	1.7	26.8	10.5	6.8	5.0	...
Probability	11%	1%	10^{-6}	10%	48%	38%	6
Probability	60%	24%	10^{-8}	1%	9%	27%	3

[a] Includes $(3/2)^{1/2}$ factor in velocity dispersion (see § 4).
[b] Without $(3/2)^{1/2}$ factor in velocity dispersion.

observed magnitudes (M_V and V_{obs} in Tables 1A and 1B). These magnitudes are generally more accurate than those tabulated by Veron-Cetty & Veron (1987), which are often only rough estimates based on photographic plates (see Fig. 1). For every cosmology we give the probabilities of detecting either six or three lenses.

We have followed Turner et al. (1984) in assuming that the dominant mass distribution in elliptical and S0 galaxies has a velocity dispersion that is $(3/2)^{1/2}$ times the measured velocity dispersion. This correction was invoked in order to relate the dark matter density distribution to the distribution observed for the light in the centers of galaxies. Its relevance is, however, in question, since recent observations have shown that the central kiloparsecs of elliptical galaxies are perhaps not dominated by dark matter, but rather have mass-to-light ratios typical of a late stellar population (see de Zeeuw & Franx 1991 for a review). Rix, Schneider, & Bahcall (1992) have shown this to be the case in the bulge of a spiral galaxy, using the gravitational lens 2237+0305. They found that there is little dark matter (< 10%) within the inner Kpc of the lensing galaxy. The $(3/2)^{1/2}$ factor in the velocity introduces a factor $(3/2)^2 = 2.25$ increase in the predicted lensing frequency. In the second row in Table 2, we have scaled the results of the first row by 1/2.25 to obtain the prediction in the case where the observed velocity dispersions are used.

The results in Table 2 show that the predicted lensing frequency is sensitive to the details of the model. The first row reinforces the conclusion stated in Papers I–III that the observed lensing frequency is consistent with the predictions for standard cosmologies, but, with our present statistics, an order of magnitude lower than expected in cosmologies strongly dominated by a cosmological constant (see Caroll, Press, & Turner 1992 for a review of λ-dominated cosmologies). On the other hand, the calculation in the second row shows that if we have six lensed quasars, then although a strongly λ-dominated cosmology is still disfavored, a model with $\lambda = 0.9$ or less actually fits the observations better than the standard cosmologies, which predict too low a lensing rate. We conclude that more realistic lensing models (e.g., Maoz & Rix 1993), as well as confirmation of several ambiguous lens candidates (1120+0154 and 1208+1011), are required to fully exploit the observed sample of distant bright quasars.

To summarize, we have searched a total of 498 quasars for evidence of gravitational lensing, utilizing the high spatial resolution afforded by *HST*. Only one new gravitational lens candidate, the $z = 3.80$ quasar 1208+1011, has been found. Together with previously known gravitational lenses satisfying the sample selection criteria, the observed lensing frequency is between three and six out of 502. This is in agreement with the predictions of simple models, assuming standard cosmologies.

We thank R. Giacconi and H. S. Stockman for their support of the Snapshot Survey as an STScI Director's Discretion program, and L. Petro, O. Richter, and A. Saha for overseeing the survey at STScI. We are grateful to R. Vermeulen and T. Readhead for kindly obtaining for us a spectrum at the Palomar 5 m telescope. A. Kinney, C. Kochanek, H.-W. Rix, and K. Tomita are thanked for useful comments.

This work was supported by NASA grant NAG5-1618 (J. N. B., N. A. B., and D. P. S.), Space Telescope Science Institute grant GO-2775 (D. M), Hubble Fellowship HF-1013.01-90A (B. Y.), and NSF PYI award AST-9157412 (S. D.).

REFERENCES

Bahcall, J. N., Hartig, G., Jannuzi, B. T., Maoz, D., & Schneider, D. P. 1992c, ApJ, 400, L51
Bahcall, J. N., Maoz, D., Doxsey, R., Schneider, D. P., Bahcall, N. A., Lahav, O., & Yanny, B. 1992a, ApJ, 387, 56 (Paper I)
Bahcall, J. N., Maoz, D., Schneider, D. P., Yanny, B., & Doxsey, R. 1992b, ApJ, 382, L1
Blandford, R. D., & Narayan, R. 1992, ARA&A, 30, 311
Caroll, S. M., Press, W. H., & Turner, E. L. 1992, ARA&A, 30, 499
Crampton, D., McClure, R. D., & Fletcher, J. M. 1992, ApJ, 392, 23
de Zeeuw, P. T., & Franx, M. 1991, ARA&A, 29, 239
Fukugita, M., & Turner, E. L. 1991, MNRAS, 253, 99
Gould, A., Bahcall, J. N., & Maoz, D. 1993, ApJS, in press
Griffiths, R. 1990, WF/PC Instrument Handbook (Baltimore: Space Telescope Science Institute)
Huchra, J., Gorenstein, M., Kent, S., Shapiro, I., Smith, G., Horine, E., & Perley, R. 1985, AJ, 90, 691
Hunter, D., Faber, S., Light, R., & Shaya, E. 1992, in WFPC Final Orbital/Science Verification Report, ed. S. M. Faber (Baltimore: Space Telescope Science Institute), chap. 12
Kochanek, C. S. 1991a, ApJ, 373, 354
Kochanek, C. S. 1991b, ApJ, 379, 517
———. 1993, ApJ, in press
Magain, P., Surdej, J., Vanderriest, C., Pirenne, B., & Hutsemekers, D. 1992, A&A, 253, L13
Maoz, D., Bahcall, J. N., Schneider, D. P., Doxsey, R., Bahcall, N. A., Fillippenko, A. V., Goss, W. M., Lahav, O., & Yanny, B. 1992a, ApJ, 386, L1
Maoz, D., Bahcall, J. N., Schneider, D. P., Doxsey, R., Bahcall, N. A., Lahav, O., & Yanny, B. 1992b, ApJ, 394, 51 (Paper II)
———. 1993, ApJ, 402, 69 (Paper III)
Maoz, D., & Rix, H.-W. 1993, ApJ, submitted
Meylan, G., & Djorgovski, S. 1989, ApJ, 338, L1
Rix, H.-W., Schneider, D. P., & Bahcall, J. N. 1992, AJ, 104, 959
Schneider, D. P., et al. 1992, PASP, 104, 678
Turner, E. L., Ostriker, J. P., & Gott, J. R. 1984, ApJ, 284, 1
Veron-Cetty, M. P., & Veron, P. 1987, A Catalogue of Quasars and Active Nuclei (3d ed.; Munich: ESO)
———. 1989, A Catalogue of Quasars and Active Nuclei (4th ed.; Munich: ESO)
———. 1991, A Catalogue of Quasars and Active Nuclei (5th ed.; Munich: ESO)