

## CATALOG OF NEARBY EXOPLANETS<sup>1</sup>

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### ABSTRACT

We present a catalog of nearby exoplanets. It contains the 172 known low-mass companions with orbits established through radial velocity and transit measurements around stars within 200 pc. We include five previously unpublished exoplanets orbiting the stars HD 11964, HD 66428, HD 99109, HD 107148, and HD 164922. We update orbits for 83 additional exoplanets, including many whose orbits have not been revised since their announcement, and include radial velocity time series from the Lick, Keck, and Anglo-Australian Observatory planet searches. Both these new and previously published velocities are more precise here due to improvements in our data reduction pipeline, which we applied to archival spectra. We present a brief summary of the global properties of the known exoplanets, including their distributions of orbital semimajor axis, minimum mass, and orbital eccentricity.

*Subject headings:* planetary systems — stars: activity — stars: chromospheres

*Online material:* machine-readable tables

### 1. INTRODUCTION

It has now been more than 10 yr since the discovery of the first objects that were identified as planets orbiting normal stars. The epochal announcement in 1995 October of 51 Peg b (Mayor & Queloz 1995) was confirmed within a week (Marcy et al. 1997) and followed within 2 months by two other planets, 47 UMa b and 70 Vir b (Butler & Marcy 1996; Marcy & Butler 1996). The unexpected diversity and mass distribution of exoplanets was represented well by those first three planets, as the first one orbits close in, the second orbits beyond 2 AU, and the last resides in a very eccentric orbit. The paucity of companions having larger masses, with  $M \sin i$  between  $10M_J$  and  $80M_J$ , suggested a mass distribution separated from that of stars, rising with decreasing mass and peaking below  $1M_J$  (Marcy & Butler 2000; Halbwachs et al. 2000; Udry et al. 2003a).

During the past 10 yr, over 160 exoplanet candidates have been identified orbiting stars within 200 pc, and most have been detected by Doppler search programs based at the Keck, Lick, and Anglo-Australian Observatories (the California & Carnegie and Anglo-Australian planet searches; e.g., Butler et al. 1996; Tinney et al. 2001) and teams based at l'Observatoire de Haute Provence and La Silla Observatory (the Geneva Extrasolar

Planet Search; e.g., Mayor & Santos 2003). Other Doppler programs have contributed important discoveries of nearby planets (Cochran et al. 1997; Endl et al. 2003; Noyes et al. 1999; Kürster et al. 2003; Charbonneau et al. 2000; Sato et al. 2005). One nearby planet, TrES-1, has been discovered by its transit across the star (Alonso et al. 2004).

Here we present a catalog of all known exoplanets that reside within 200 pc, containing the vast majority of well-studied exoplanets. This distance threshold serves several purposes. First, nearby planets and their host stars are amenable to confirmation and follow-up by a variety of techniques, including high-resolution imaging and stellar spectroscopy with high signal-to-noise ratios, as well as astrometric follow-up (e.g., Benedict et al. 2001; McArthur et al. 2004). In addition, milliarcsecond astrometry for planet host stars within 200 pc can provide precise distance estimates, and most planet search target stars within 100 pc already have parallaxes from *Hipparcos* (Perryman et al. 1997). Third, nearby planet host stars are bright enough to permit precise photometric and chromospheric monitoring by telescopes of modest size, permitting careful assessment of velocity jitter, starspots, and possible transits (e.g., Henry 1999; Henry et al. 2000; Queloz et al. 2001; Eaton et al. 2003).

This paper updates the last published list of exoplanets (Butler et al. 2002). The growth of the field is reflected by the discovery of over 100 planets in the 3 yr since the publication of that list of 57 exoplanets.

About a dozen exoplanet candidates have been discovered that reside beyond 200 pc, including a half-dozen in the Galactic bulge found in the OGLE survey and a few other planets found by microlensing (e.g., Torres et al. 2003; Konacki et al. 2003; Bouchy et al. 2005a). Perhaps most notable are the first planets ever found outside our solar system, orbiting a pulsar (Wolszczan & Frail 1992). Such distant planets reside beyond the scope of this catalog.

We include known companions with minimum masses ( $M \sin i$ ) up to  $24M_J$ . This is well above the usual  $13M_J$  deuterium-burning limit for planets adopted by the IAU. We do this for two reasons. First, uncertainties in stellar mass and orbital inclination complicate the measurement of sufficiently precise masses to apply a robust  $13M_J$  cutoff. Second, there is little or no evidence indicating that such a cutoff has any relevance to the formation

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mechanisms of these objects. We therefore use a generous minimum mass criterion for inclusion in this catalog and decline to choose a precise definition of an “exoplanet.”

Two other planet candidates were detected by direct imaging, 2M 1207b (Chauvin et al. 2004) and GQ Lup b (Neuhäuser et al. 2005). We exclude these from the tabular catalog due to their considerably uncertain orbital periods, eccentricities, and masses. Similarly, we exclude many Doppler-detected planets due to their lack of data spanning one full period, which precludes a secure determination of their orbits and minimum masses.

One might question the value of a catalog of exoplanets in the face of such rapid discovery. Without question, the catalog presented here will become out of date before it is printed.<sup>11</sup> However, this catalog offers many attributes of unique value. First, it contains updated orbital parameters for 90 exoplanets, computed anew from our large database of Doppler measurements of over 1300 stars from the Lick, Anglo-Australian, and Keck Observatories obtained during the past 18, 7, and 8 yr, respectively (Butler et al. 2003; Marcy et al. 2005a). These new orbital parameters significantly supersede the previously quoted orbital parameters in most cases.

Second, we use the latest estimates of stellar mass to improve the precision of the minimum planet mass,  $M \sin i$  (Valenti & Fischer 2005). Third, the catalog contains Doppler measurements for the planet host stars in our database, allowing both further analyses of these velocities and novel combinations with other measurements. The publication of this archive foreshows a forthcoming work (J. T. Wright et al. 2006, in preparation) that will identify and catalog prospective exoplanets and substellar companions of indeterminate mass and orbital period. Finally, the catalog will serve as an archive of known nearby exoplanets and their parameters circa 2005. The catalog may serve ongoing exoplanet research, both observation and theory, and provide useful information for future exoplanet studies of nearby stars.

## 2. DATA

The radial velocity data here come from three sources: observations at Lick Observatory using the Hamilton spectrograph (Vogt 1987), at Keck Observatory using HIRES (Vogt et al. 1994), and at the 3.9 m Anglo-Australian Telescope (AAT) using UCLES (Diego et al. 1990). These instruments, their characteristics, and typical uncertainties in the radial velocities they produce are discussed in the discovery papers of the exoplanets found with them (in particular, Fischer et al. 1999; Butler et al. 1998; Tinney et al. 2001). We explicitly note here upgrades over the years that have significantly improved their precision at typical exposure times: the Hamilton spectrograph was upgraded in 1994 November, increasing the precision of a typical observation from 10–15 to  $\sim 4$  m s<sup>-1</sup>; in 2004 August HIRES was upgraded, increasing the precision of a typical observation from  $\sim 3$  to  $\sim 1$  m s<sup>-1</sup>; and the precision of UCLES data is 2–3 m s<sup>-1</sup>.

We have also revised our entire reduction pipeline, including an overhauled raw reduction package that includes corrections for cosmic rays and an improved flat-fielding algorithm, a more accurate barycentric velocity correction that includes proper-motion corrections, and a refined precision velocity reduction package that includes a telluric filter and a more sophisticated

TABLE 1  
RADIAL VELOCITIES FOR PLANET-BEARING STARS

Star Name (1)	Time (JD -2,440,000) (2)	Velocity (m s <sup>-1</sup> ) (3)	Uncertainty (m s <sup>-1</sup> ) (4)	Observatory (5)
HD 142 .....	10830.958715	-19.2	6.8	A
	11121.019444	-12.4	7.8	A
	11385.310558	32	12	A
	11411.202523	6	13	A
	11473.085035	-11.9	7.2	A
	11525.925093	6.4	8.5	A
	11526.953241	-5.7	6.2	A
	11683.331377	36.4	8.0	A
	11743.276539	34.5	7.3	A
	11745.264167	37	11	A
	11767.269896	4.2	8.0	A

NOTES.—Table 1 is published in its entirety in the electronic edition of the *Astrophysical Journal*. A portion is shown here for guidance regarding its form and content.

deconvolution algorithm. We also now correct for the very slight nonlinearity in the new HIRES CCD. We have improved the characterization of the charge transfer inefficiency in the old CCD that limited its precision to  $\sim 3$  m s<sup>-1</sup>, a problem not present in the new chip.

In previous works we have subtracted a constant velocity such that the median velocity of the set was zero (since these are differential measurements, one may always add an arbitrary constant to the entire set). Here we have applied an offset to the data so that the published orbital solution has  $\gamma = 0$ , where  $\gamma$  is the radial velocity of the center of mass of the system.

For the above reasons the measurements listed here are more precise and accurate than the values given in our previous publications and will not exactly match the values given in those works. There may also be slight differences in the binning of measurements made within about 2 hr.

## 3. RADIAL VELOCITIES

In the table of radial velocities for our stars (available in full in the electronic edition of the *Journal*), we report the time of observation, measured radial velocity, and formal uncertainty in each measurement. The uncertainties reported are measured from the distribution of velocities measured from each of 400 parts of each spectroscopic observation, as discussed in previous works (e.g., Marcy et al. 2005b), and do not include jitter. We present a sample of this data set in Table 1.

The table contains five columns. Column (1) contains the name of the star. Column (2) contains the time of observation as a Julian Date. Column (3) contains the measured precision radial velocity at that time, and column (4) contains the uncertainty in this measurement. Column (5) contains a key indicating which observatory made the observation: “K” for Keck Observatory, “A” for the AAT, and “L” for Lick Observatory.

In addition to the uncertainties published here, there are known sources of error associated with astrophysical jitter, the instrument, and the analysis. These sources combine to give an additional source of noise, collectively termed “jitter.” The magnitude of the jitter is a function of the spectral type of the star observed and the instrument used. Wright (2005) gives a model (for stars observed before 2004 August at Keck) that estimates, to within a factor of roughly 2, the jitter for a star based on a star’s activity, color,  $T_{\text{eff}}$ , and height above the main sequence. More recent measurements on HIRES will have less jitter due to the improved

<sup>11</sup> Note added in proof.—Indeed, after submission of this paper, C. Lovis et al. (Nature, 441, 305 [2006]) announced a triple-Neptune system orbiting HD 69830, A. P. Hatzes et al. (A&A, in press [astro-ph/0606517]) confirmed a 2.3  $M_{\text{Jup}}$  planet orbiting Pollux, J. T. Wright et al. (in preparation) announced a planet orbiting HD 154345 and a second planet orbiting HIP 14810, and J. A. Johnson et al. (in preparation) announced a hot Jupiter orbiting HD 185269. Our group will maintain an up-to-date version of the Catalog of Nearby Exoplanets at <http://www.exoplanets.org>.

TABLE 2  
PROPERTIES OF EXOPLANET HOST STARS

HD (1)	HIP (2)	Alternative Name (3)	R.A. (J2000.0) (4)	Decl. (J2000.0) (5)	$B - V$ (6)	$V$ (7)	Distance (pc) (8)	$T_{\text{eff}}$ (K) (9)	$\log g$ ( $\text{cm s}^{-2}$ ) (10)	[Fe/H] (11)	$v \sin i$ ( $\text{m s}^{-1}$ ) (12)	Mass ( $M_{\odot}$ ) (13)	References (14)	$S$ (15)	$\Delta M_V$ (16)	Jitter ( $\text{m s}^{-1}$ ) (17)
142.....	522		00 06 19.176	-49 04 30.69	0.52	5.70	25.64(42)	6249	4.185	0.100	10.35	1.24	VF5	0.16	0.28	4.3
1237.....	1292	GJ 3021	00 16 12.677	-79 51 04.25	0.75	6.59	17.62(16)	5536	4.56	0.120	...	0.90	Sn4	...	0.03	...
2039.....	1931		00 24 20.278	-56 39 00.17	0.66	9.00	89.8(9.1)	5941	4.384	0.315	3.25	1.17	VF5	0.18	0.60	3.7
2638.....	2350		00 29 59.872	-05 45 50.41	0.89	9.44	53.7(3.9)	5192	4.29	0.160	...	0.93	Sn5	...	0.31	...
3651.....	3093	54 Psc	00 39 21.806	+21 15 01.70	0.85	5.88	11.107(89)	5221	4.453	0.164	1.15	0.89	VF5	0.17	0.28	3.5
4208.....	3479		00 44 26.650	-26 30 56.45	0.66	7.78	32.7(1.2)	5600	4.517	-0.284	...	0.87	VF5	0.17	-0.33	3.7
4308.....	3497		00 44 39.268	-65 38 58.28	0.65	6.55	21.85(27)	5695	4.580	-0.310	...	0.90	VF5	...	-0.03	...
4203.....	3502		00 44 41.202	+20 26 56.14	0.77	8.70	77.8(7.7)	5702	4.361	0.453	1.23	1.13	VF5	0.14	1.27	4.0
6434.....	5054		01 04 40.151	-39 29 17.58	0.61	7.72	40.3(1.4)	5835	4.60	-0.520	...	0.79	Sn4	...	-0.14	...
8574.....	6643		01 25 12.517	+28 34 00.10	0.58	7.12	44.2(1.6)	6050	4.205	-0.009	4.52	1.15	VF5	0.14	0.43	4.1
9826.....	7513	$v$ And	01 36 47.843	+41 24 19.65	0.54	4.10	13.47(13)	6213	4.253	0.153	9.62	1.32	VF5	0.15	0.59	4.2
10647.....	7978		01 42 29.316	-53 44 27.00	0.55	5.52	17.35(19)	6105	4.345	-0.078	5.61	1.10	VF5	0.20	-0.18	4.2
10697.....	8159	109 Psc	01 44 55.825	+20 04 59.34	0.72	6.27	32.56(86)	5680	4.123	0.194	2.48	1.16	VF5	0.15	1.51	4.0
11977.....	8928		01 54 56.131	-67 38 50.29	0.93	4.70	66.5(2.1)	4970(70)	2.90(20)	-0.21(10)	2.40(1.0)	1.91	Sw5	...	5.73	...
11964.....	9094		01 57 09.606	-10 14 32.74	0.82	6.42	34.0(1.1)	5349	4.026	0.122	2.74	1.12	VF5	0.14	2.00	5.7
12661.....	9683		02 04 34.288	+25 24 51.50	0.71	7.43	37.2(1.1)	5743	4.423	0.362	1.30	1.11	VF5	<sup>a</sup>	0.58	3.5
13445.....	10138	GJ 86	02 10 25.934	-50 49 25.41	0.81	6.12	10.913(73)	5151	4.594	-0.268	2.37	0.77	VF5	0.25	-0.20	3.5
16141.....	12048	79 Cet	02 35 19.928	-03 33 38.17	0.67	6.83	35.9(1.8)	5794	4.217	0.170	1.93	1.12	VF5	0.14	0.86	3.6
17051.....	12653	$\iota$ Hor	02 42 33.466	-50 48 01.06	0.56	5.40	17.24(16)	6097	4.342	0.111	6.47	1.17	VF5	0.22	0.00	13
14810.....	14810		03 11 14.230	+21 05 50.49	0.78	8.52	52.9(4.1)	5485(44)	4.300(70)	0.231(30)	0.50(50)	0.99	Wr6	...	0.64	...
19994.....	14954	94 Cet	03 12 46.437	-01 11 45.96	0.57	5.07	22.38(38)	6188	4.242	0.186	8.57	1.35	VF5	...	0.99	...
20367.....	15323		03 17 40.046	+31 07 37.37	0.57	6.40	27.13(79)	6138	4.53	0.170	...	1.17	Sn4	...	0.07	...
20782.....	15527		03 20 03.577	-28 51 14.66	0.63	7.36	36.0(1.1)	5758	4.349	-0.051	2.36	0.98	VF5	...	0.09	...
22049.....	16537	$\epsilon$ Eri	03 32 55.844	-09 27 29.74	0.88	3.72	3.2180(88)	5146	4.574	-0.031	2.45	0.82	VF5	0.45	-0.10	9.5
23079.....	17096		03 39 43.095	-52 54 57.02	0.58	7.12	34.60(67)	5927	4.337	-0.150	2.99	1.01	VF5	0.16	-0.06	4.0
23596.....	17747		03 48 00.374	+40 31 50.29	0.63	7.25	52.0(2.3)	5904	3.970	0.218	4.22	1.23	VF5	...	1.02	...
27442.....	19921	$\epsilon$ Ret	04 16 29.029	-59 18 07.76	1.08	4.44	18.23(17)	4846	3.783	0.420	2.80	1.49	VF5	0.15	3.76	5.7
27894.....	20277		04 20 47.047	-59 24 39.01	1.00	9.36	42.4(1.6)	4875	4.22	0.300	...	0.75	Sn5	...	0.38	...
28185.....	20723		04 26 26.320	-10 33 02.95	0.75	7.80	39.6(1.7)	5656	4.45	0.220	...	0.99	Sn4	...	0.58	...
30177.....	21850		04 41 54.373	-58 01 14.73	0.77	8.41	54.7(2.3)	5607	4.311	0.394	2.96	1.07	VF5	0.15	0.80	3.5
33283.....	23889		05 08 01.012	-26 47 50.90	0.64	8.05	86.9(6.8)	5995(44)	4.210(70)	0.366(30)	3.20(50)	1.24	Jh6	...	1.38	...
33636.....	24205		05 11 46.449	+04 24 12.74	0.59	7.00	28.7(1.1)	5904	4.429	-0.126	3.08	1.02	VF5	0.18	-0.32	5.2
33564.....	25110		05 22 33.532	+79 13 52.13	0.51	5.08	20.98(23)	6250	...	-0.12	...	1.25	Nd4	...	0.38	...
37124.....	26381		05 37 02.486	+20 43 50.84	0.67	7.68	33.2(1.3)	5500	4.599	-0.442	1.22	0.83	VF5	...	-0.17	...
39091.....	26394	$\pi$ Men	05 37 09.892	-80 28 08.84	0.60	5.65	18.21(15)	5950	4.363	0.048	3.14	1.10	VF5	0.16	0.12	3.9
37605.....	26664		05 40 01.730	+06 03 38.08	0.83	8.67	42.9(2.4)	5391	4.37	0.310	...	0.80	Sn5	...	0.30	...
38529.....	27253		05 46 34.912	+01 10 05.50	0.77	5.95	42.4(1.7)	5697	4.049	0.445	3.90	1.47	VF5	0.17	2.71	5.7
41004 A.....	28393		05 59 49.649	-48 14 22.89	0.89	8.65	43.0(1.9)	5242	4.35	0.160	...	0.70	Sn5	...	0.63	...
41004 B.....	28393		05 59 49.649	-48 14 22.89	1.52	12.33	43.0(1.9)	3952 <sup>b</sup>	...	...	...	0.40	Z3	...	1.22	...
40979.....	28767		06 04 29.943	+44 15 37.60	0.57	6.74	33.33(91)	6089	4.302	0.168	7.43	1.19	VF5	0.23	0.17	15
45350.....	30860		06 28 45.710	+38 57 46.67	0.74	7.89	48.9(2.3)	5616	4.325	0.291	1.37	1.06	VF5	0.15	0.90	3.5
46375.....	31246		06 33 12.624	+05 27 46.53	0.86	7.91	33.4(1.2)	5285	4.533	0.240	0.86	0.92	VF5	0.19	0.69	3.5
47536.....	31688		06 37 47.619	-32 20 23.05	1.18	5.25	121.4(8.2)	4380(50)	...	...	1.93(50)	1.1, 3.0 <sup>c</sup>	Sw3	...	7.46	...
49674.....	32916		06 51 30.516	+40 52 03.92	0.73	8.10	40.7(1.9)	5662	4.560	0.310	0.42	1.06	VF5	0.21	0.22	6.6
50499.....	32970		06 52 02.024	-33 54 56.02	0.61	7.21	47.3(1.5)	6070	4.373	0.335	4.21	1.25	VF5	...	0.72	...
50554.....	33212		06 54 42.825	+24 14 44.01	0.58	6.84	31.03(97)	5929	4.285	-0.066	3.88	1.05	VF5	0.16	-0.03	4.0

TABLE 2—Continued

HD (1)	HIP (2)	Alternative Name (3)	R.A. (J2000.0) (4)	Decl. (J2000.0) (5)	$B - V$ (6)	$V$ (7)	Distance (pc) (8)	$T_{\text{eff}}$ (K) (9)	$\log g$ ( $\text{cm s}^{-2}$ ) (10)	[Fe/H] (11)	$v \sin i$ ( $\text{m s}^{-1}$ ) (12)	Mass ( $M_{\odot}$ ) (13)	References (14)	$S$ (15)	$\Delta M_V$ (16)	Jitter ( $\text{m s}^{-1}$ ) (17)
52265.....	33719		07 00 18.036	-05 22 01.78	0.57	6.29	28.07(66)	6076	4.263	0.193	4.67	1.20	VF5	0.15	0.24	4.1
63454.....	37284		07 39 21.851	-78 16 44.30	1.01	9.37	35.8(1.1)	4841	4.23	0.110	...	0.80	Sn5	...	0.02	...
65216.....	38558		07 53 41.322	-63 38 50.36	0.67	7.97	35.59(87)	5666	4.53	-0.120	...	0.92	Sn4	...	-0.28	...
66428.....	39417		08 03 28.665	-01 09 45.75	0.71	8.25	55.0(3.8)	5752	4.490	0.310	...	1.10	VF5	0.15	0.64	5.7
68988.....	40687		08 18 22.173	+61 27 38.60	0.65	8.20	58.8(3.3)	5960	4.413	0.324	2.84	1.18	VF5	0.15	0.45	3.7
70642.....	40952		08 21 28.136	-39 42 19.47	0.69	7.17	28.76(50)	5706	4.432	0.164	0.30	1.05	VF5	<sup>a</sup>	0.18	3.5
72659.....	42030		08 34 03.190	-01 34 05.58	0.61	7.46	51.4(2.7)	5920	4.236	-0.004	2.21	1.10	VF5	0.15	0.64	3.9
73256.....	42214		08 36 23.015	-30 02 15.46	0.78	8.08	36.5(1.0)	5636	4.30	0.260	...	1.05	Sn4	...	0.31	...
73526.....	42282		08 37 16.484	-41 19 08.77	0.74	8.99	94.6(9.0)	5584	4.159	0.250	2.62	1.05	VF5	...	1.21	...
74156.....	42723		08 42 25.122	+04 34 41.15	0.58	7.61	64.6(4.6)	6068	4.259	0.131	4.32	1.21	VF5	...	0.81	...
75289.....	43177		08 47 40.389	-41 44 12.45	0.58	6.35	28.94(47)	6095	4.335	0.217	4.14	1.21	VF5	0.15	0.28	4.0
75732.....	43587	55 Cnc, $\rho^1$ Cnc	08 52 35.811	+28 19 50.95	0.87	5.96	12.53(13)	5235	4.448	0.315	2.46	0.91	VF5	...	0.55	...
76700.....	43686		08 53 55.515	-66 48 03.57	0.75	8.16	59.7(2.4)	5668	4.299	0.345	1.35	1.13	VF5	<sup>a</sup>	1.09	3.5
80606.....	45982		09 22 37.568	+50 36 13.40	0.76	9.06	58(20)	5573	4.439	0.343	1.80	1.10	VF5	0.15	0.25	3.5
81040.....	46076		09 23 47.087	+20 21 52.03	0.68	7.72	32.6(1.3)	5700(50)	4.50(10)	-0.160(60)	2.0(1.0)	0.96	Sz6	...	-0.18	...
82943.....	47007		09 34 50.736	-12 07 46.37	0.62	6.54	27.46(63)	5997	4.421	0.265	1.35	1.18	VF5	...	0.27	...
83443.....	47202		09 37 11.828	-43 16 19.94	0.81	8.23	43.5(1.7)	5453	4.491	0.357	1.28	1.00	VF5	0.22	0.69	5.2
86081.....	48711		09 56 05.918	-03 48 30.32	0.66	8.73	91(10)	6028(44)	4.360(70)	0.257(30)	4.20(50)	1.21	Jh6	...	0.95	...
88133.....	49813		10 10 07.675	+18 11 12.74	0.81	8.01	74.5(6.4)	5494	4.230	0.340	2.20	1.20	Fi5	0.13	2.07	5.7
89307.....	50473		10 18 21.288	+12 37 15.99	0.59	7.02	30.88(94)	5898	4.341	-0.159	2.88	1.00	VF5	0.16	-0.14	4.0
89744.....	50786		10 22 10.562	+41 13 46.31	0.53	5.73	39.0(1.1)	6291	4.072	0.265	9.51	1.64	VF5	0.16	1.24	4.0
92788.....	52409		10 42 48.529	-02 11 01.52	0.69	7.31	32.3(1.0)	5836	4.658	0.318	0.26	1.13	VF5	0.15	0.30	3.5
93083.....	52521		10 44 20.915	-33 34 37.28	0.94	8.30	28.90(84)	4995	4.26	0.150	...	0.70	Sn5	...	0.37	...
	...	BD -10 3166	10 58 28.780	-10 46 13.39	0.90	10.08	80(10) <sup>d</sup>	5393	4.685	0.382	0.92	1.01	VF5	0.22	<sup>c</sup>	5.7
95128.....	53721	47 UMa	10 59 27.974	+40 25 48.92	0.62	5.03	14.08(13)	5882	4.377	0.043	2.80	1.08	VF5	...	0.34	...
99109.....	55664		11 24 17.358	-01 31 44.67	0.87	9.10	60.5(4.8)	5272	4.438	0.315	1.86	0.93	VF5	0.16	0.85	5.7
99492.....	55848	83 Leo B	11 26 46.277	+03 00 22.78	1.00	7.58	18.0(1.1)	4955	4.770	0.362	1.36	0.86	VF5	0.25	0.30	3.5
	57087	GJ 436	11 42 11.094	+26 42 23.65	1.49	10.67	10.23(24)	4002 <sup>b</sup>	...	...	...	0.41	Bu4	0.73	-0.66	3.9
101930.....	57172		11 43 30.111	-58 00 24.79	0.91	8.21	30.50(89)	5079	4.24	0.170	...	0.74	Sn5	...	0.42	...
102117.....	57291		11 44 50.462	-58 42 13.35	0.72	7.47	42.0(1.5)	5695	4.366	0.295	0.88	1.11	VF5	<sup>a</sup>	0.87	3.5
102195.....	57370		11 45 42.292	+02 49 14.34	0.83	8.07	28.98(97)	5200 <sup>b</sup>	...	-0.090(14)	...	0.93	Ge6	...	0.09	...
104985.....	58952		12 05 15.118	+76 54 20.64	1.03	5.78	102.0(5.4)	4794 <sup>b</sup>	...	...	...	1.60	St3	...	5.97	...
106252.....	59610		12 13 29.509	+10 02 29.90	0.63	7.41	37.4(1.3)	5870	4.364	-0.076	1.93	1.02	VF5	0.16	0.15	3.8
107148.....	60081		12 19 13.491	-03 19 11.24	0.71	8.01	51.3(2.6)	5797	4.446	0.314	0.73	1.12	VF5	0.16	0.68	3.5
108147.....	60644		12 25 46.269	-64 01 19.52	0.54	6.99	38.6(1.0)	6156	4.292	0.087	6.10	1.19	VF5	0.19	0.00	8.1
108874.....	61028		12 30 26.883	+22 52 47.38	0.74	8.76	68.5(5.8)	5551	4.349	0.182	2.22	1.00	VF5	...	0.75	...
109749.....	61595		12 37 16.378	-40 48 43.62	0.68	8.08	59.0(6.7)	5903(50)	4.403(70)	0.25(50)	2.50(50)	1.21	Fi6	...	0.75	...
111232.....	62534		12 48 51.754	-68 25 30.54	0.70	7.59	28.88(67)	5494	4.50	-0.360	...	0.78	Sn4	...	-0.18	...
114386.....	64295		13 10 39.823	-35 03 17.22	0.98	8.73	28.0(1.0)	4820	4.707	0.004	0.59	0.76	VF5	...	0.03	...
114762.....	64426		13 12 19.743	+17 31 01.64	0.52	7.30	40.6(2.4)	5953	4.545	-0.653	1.77	0.89	VF5	<sup>a</sup>	-0.28	4.3
114783.....	64457		13 12 43.786	-02 15 54.14	0.93	7.56	20.43(44)	5135	4.527	0.116	0.87	0.86	VF5	0.21	0.29	3.5
114729.....	64459		13 12 44.257	-31 52 24.06	0.59	6.68	35.0(1.2)	5821	4.143	-0.262	2.29	1.00	VF5	0.15	0.45	4.0
117176.....	65721	70 Vir	13 28 25.809	+13 46 43.63	0.71	4.97	18.11(24)	5545	4.068	-0.012	2.68	1.11	VF5	0.17	1.50	4.0
117207.....	65808		13 29 21.114	-35 34 15.59	0.72	7.26	33.0(1.0)	5724	4.507	0.266	1.05	1.08	VF5	0.15	0.58	3.5
117618.....	66047		13 32 25.556	-47 16 16.91	0.60	7.17	38.0(1.3)	5964	4.350	0.003	3.19	1.09	VF5	0.17	0.22	5.3
118203.....	66192		13 34 02.537	+53 43 42.70	0.70	8.05	88.6(6.4)	5600(150)	3.87	0.100(50)	4.70	1.23	Va6	...	1.78	...
120136.....	67275	$\tau$ Boo	13 47 15.743	+17 27 24.86	0.51	4.50	15.60(17)	6387	4.256	0.234	14.98	1.35	VF5	0.20	0.33	15

TABLE 2—Continued

HD (1)	HIP (2)	Alternative Name (3)	R.A. (J2000.0) (4)	Decl. (J2000.0) (5)	$B - V$ (6)	$V$ (7)	Distance (pc) (8)	$T_{\text{eff}}$ (K) (9)	$\log g$ ( $\text{cm s}^{-2}$ ) (10)	[Fe/H] (11)	$v \sin i$ ( $\text{m s}^{-1}$ ) (12)	Mass ( $M_{\odot}$ ) (13)	References (14)	$S$ (15)	$\Delta M_V$ (16)	Jitter ( $\text{m s}^{-1}$ ) (17)
121504.....	68162		13 57 17.237	-56 02 24.15	0.59	7.54	44.4(1.8)	6075	4.64	0.160	...	1.18	Sn4	...	0.12	...
128311.....	71395		14 36 00.561	+09 44 47.47	0.97	7.48	16.57(27)	4965	4.831	0.205	3.65	0.84	VF5	...	0.10	...
130322.....	72339		14 47 32.727	-00 16 53.31	0.78	8.04	29.8(1.3)	5308	4.408	0.006	1.61	0.88	VF5	0.23	-0.10	3.5
134987.....	74500	23 Lib	15 13 28.668	-25 18 33.65	0.69	6.47	25.65(64)	5750	4.348	0.279	2.17	1.10	VF5	0.15	0.62	3.5
136118.....	74948		15 18 55.472	-01 35 32.59	0.55	6.93	52.3(2.3)	6097	4.053	-0.050	7.33	1.23	VF5	0.16	0.82	4.2
	74995	GJ 581	15 19 26.825	-07 43 20.21	1.60	10.57	6.269(89)	3780 <sup>b</sup>	...	-0.25	...	0.31	Nd4	...	0.24	...
137759.....	75458	$\iota$ Dra	15 24 55.775	+58 57 57.84	1.17	3.29	31.33(50)	4548 <sup>b</sup>	...	...	...	1.05	Ad9	<sup>a</sup>	6.43	5.7
137510.....	75535		15 25 53.270	+19 28 50.54	0.62	6.26	41.8(1.6)	5966	3.995	0.373	7.98	1.42	VF5	0.16	1.43	4.0
330075.....	77517		15 49 37.691	-49 57 48.69	0.94	9.36	50.2(3.8)	5017	4.22	0.080	...	0.70	Sn5	...	0.47	...
141937.....	77740		15 52 17.547	-18 26 09.83	0.63	7.25	33.5(1.2)	5847	4.420	0.129	1.88	1.08	VF5	...	0.02	...
142415.....	78169		15 57 40.791	-60 12 00.93	0.62	7.33	34.6(1.0)	5902	4.382	0.088	3.43	1.09	VF5	...	-0.03	...
143761.....	78459	$\rho$ CrB	16 01 02.662	+33 18 12.63	0.61	5.39	17.43(22)	5823	4.365	-0.199	1.56	1.00	VF5	0.15	0.37	3.9
142022.....	79242		16 10 15.024	-84 13 53.80	0.79	7.70	35.87(87)	5499	4.36	0.190	...	0.90	Sn5	...	0.69	...
145675.....	79248	14 Her	16 10 24.314	+43 49 03.52	0.88	6.61	18.15(19)	5388	4.517	0.460	1.56	1.00	VF5	0.16	0.74	3.5
147513.....	80337		16 24 01.290	-39 11 34.73	0.62	5.37	12.87(14)	5930	4.612	0.089	1.55	1.07	VF5	...	-0.19	...
149026.....	80838		16 30 29.619	+38 20 50.31	0.61	8.15	78.9(4.9)	6147(50)	...	0.360(50)	6.00(50)	1.30	St5	...	0.88	...
150706.....	80902		16 31 17.586	+79 47 23.19	0.61	7.01	27.23(42)	5961	4.50	-0.010	...	0.98	Sn4	...	-0.32	...
149143.....	81022		16 32 51.050	+02 05 05.39	0.71	7.89	63.5(4.3)	5884(50)	4.071(70)	0.26(50)	4.00(50)	1.20	Fi6	...	1.31	...
154857.....	84069		17 11 15.722	-56 40 50.87	0.70	7.24	68.5(4.3)	5606	3.992	-0.220	1.44	1.22	VF5	...	2.03	...
160691.....	86796	$\mu$ Ara	17 44 08.703	-51 50 02.59	0.69	5.12	15.28(19)	5784	4.298	0.293	3.12	1.15	VF5	...	0.86	...
162020.....	87330		17 50 38.357	-40 19 06.06	0.96	9.10	31.3(1.4)	4845	4.901	0.112	2.32	0.78	VF5	...	-0.18	...
164922.....	88348		18 02 30.862	+26 18 46.81	0.80	7.01	21.93(34)	5385	4.506	0.170	1.84	0.94	VF5	0.16	0.36	5.7
168443.....	89844		18 20 03.932	-09 35 44.60	0.72	6.92	37.9(1.2)	5580	4.248	0.077	2.20	1.05	VF5	<sup>a</sup>	1.22	4.0
168746.....	90004		18 21 49.783	-11 55 21.66	0.71	7.95	43.1(1.8)	5564	4.518	-0.078	...	0.93	VF5	0.15	0.40	3.5
169830.....	90485		18 27 49.484	-29 49 00.71	0.52	5.90	36.3(1.2)	6221	4.057	0.153	3.83	1.43	VF5	...	0.82	...
	...	TrES-1	19 04 09.8	+36 57 57	0.78	11.79	150.0(6.0)	5250(75)	4.60(20)	0.000(90)	10.353(66)	0.89	Sz4	...	-0.35	...
177830.....	93746		19 05 20.774	+25 55 14.38	1.09	7.18	59.0(2.6)	4949	4.032	0.545	2.54	1.46	VF5	0.12	3.63	5.7
178911 B.....	94075		19 09 03.104	+34 35 59.45	0.75	7.97	47(11)	5668	4.554	0.285	1.94	1.06	VF5	0.17	0.77	3.8
179949.....	94645		19 15 33.228	-24 10 45.67	0.55	6.25	27.05(59)	6168	4.341	0.137	7.02	1.21	VF5	0.19	0.04	8.6
183263.....	95740		19 28 24.573	+08 21 29.00	0.68	7.86	52.8(3.0)	5936	4.403	0.302	1.56	1.17	VF5	0.14	0.72	3.6
186427.....	96901	16 Cyg B	19 41 51.972	+50 31 03.08	0.66	6.25	21.41(24)	5674	4.355	0.038	2.18	0.99	VF5	0.15	0.26	3.7
187123.....	97336		19 46 58.113	+34 25 10.29	0.66	7.83	47.9(1.6)	5815	4.359	0.121	2.15	1.08	VF5	0.15	0.43	3.7

TABLE 2—Continued

HD (1)	HIP (2)	Alternative Name (3)	R.A. (J2000.0) (4)	Decl. (J2000.0) (5)	$B - V$ (6)	$V$ (7)	Distance (pc) (8)	$T_{\text{eff}}$ (K) (9)	$\log g$ ( $\text{cm s}^{-2}$ ) (10)	[Fe/H] (11)	$v \sin i$ ( $\text{m s}^{-1}$ ) (12)	Mass ( $M_{\odot}$ ) (13)	References (14)	$S$ (15)	$\Delta M_V$ (16)	Jitter ( $\text{m s}^{-1}$ ) (17)
187085.....	97546		19 49 33.367	-37 46 49.98	0.57	7.22	45.0(2.3)	6075	4.276	0.088	5.09	1.16	VF5	...	0.35	...
188015.....	97769		19 52 04.543	+28 06 01.36	0.73	8.24	52.6(2.6)	5746	4.445	0.289	...	1.09	VF5	0.15	0.63	3.5
189733.....	98505		20 00 43.713	+22 42 39.07	1.20	7.50	19.25(32)	5050(50)	4.53(14)	-0.030(40)	3.5(1.0)	0.82	Bc5	...	1.32	...
190228.....	98714		20 03 00.773	+28 18 24.68	0.79	7.30	62.1(3.1)	5348	3.976	-0.180	1.85	1.16	VF5	...	2.30	...
190360.....	98767	GJ 777 A	20 03 37.405	+29 53 48.50	0.75	5.73	15.89(16)	5552	4.385	0.213	2.20	1.01	VF5	...	0.66	...
192263.....	99711		20 13 59.845	-00 52 00.76	0.94	7.79	19.89(45)	4975	4.604	0.054	2.63	0.81	VF5	0.49	0.04	7.7
195019.....	100970		20 28 18.636	+18 46 10.19	0.66	6.87	37.4(1.2)	5788	4.225	0.068	2.47	1.07	VF5	0.15	0.86	3.7
196050.....	101806		20 37 51.710	-60 38 04.14	0.67	7.50	46.9(2.0)	5892	4.267	0.229	3.27	1.15	VF5	0.15	0.76	3.6
202206.....	104903		21 14 57.769	-20 47 21.15	0.71	8.08	46.3(2.4)	5788	4.493	0.354	2.30	1.12	VF5	...	0.43	...
208487.....	108375		21 57 19.848	-37 45 49.04	0.57	7.47	44.0(2.0)	6067	4.335	0.022	4.61	1.13	VF5	0.17	0.01	5.4
209458.....	108859		22 03 10.800	+18 53 04.00	0.59	7.65	47.1(2.2)	6099	4.382	0.014	4.49	1.14	VF5	...	0.15	...
210277.....	109378		22 09 29.866	-07 32 55.15	0.77	6.54	21.29(36)	5555	4.495	0.214	1.80	1.01	VF5	0.16	0.62	3.5
212301.....	110852		22 27 30.920	-77 43 04.52	0.56	7.76	52.7(2.0)	6000	...	-0.18	...	1.05	Nd4	...	0.06	...
213240.....	111143		22 31 00.367	-49 25 59.77	0.60	6.81	40.7(1.3)	5968	4.222	0.139	3.97	1.22	VF5	0.16	0.73	3.9
	113020	GJ 876	22 53 16.734	-14 15 49.32	1.60	10.16	4.702(46)	3787 <sup>b</sup>	...	...	...	0.32	Mc8	...	-0.03	...
216435.....	113044	$\tau^1$ Gru	22 53 37.931	-48 35 53.83	0.62	6.03	33.29(81)	5999	4.154	0.244	5.78	1.30	VF5	0.16	1.19	4.0
216437.....	113137	$\rho$ Ind	22 54 39.483	-70 04 25.35	0.66	6.04	26.52(41)	5849	4.231	0.225	3.13	1.19	VF5	0.15	0.93	3.7
216770.....	113238		22 55 53.710	-26 39 31.55	0.82	8.11	37.9(1.5)	5423	4.40	0.260	...	0.90	Sn4	...	0.56	...
217014.....	113357	51 Peg	22 57 27.980	+20 46 07.80	0.67	5.45	15.36(18)	5787	4.449	0.200	2.57	1.09	VF5	0.15	0.37	3.7
217107.....	113421		22 58 15.541	-02 23 43.39	0.74	6.17	19.72(29)	5704	4.541	0.389	...	1.10	VF5	...	0.66	...
222404.....	116727	$\gamma$ Cep	23 39 20.849	+77 37 56.19	1.03	3.21	13.793(99)	4791 <sup>b</sup>	3.33(10)	0.180(80)	1.5(1.0)	1.59	Fu4	...	4.21	...
222582.....	116906		23 41 51.530	-05 59 08.73	0.65	7.68	41.9(2.0)	5727	4.342	-0.029	2.29	0.99	VF5	0.16	0.21	3.7
224693.....	118319		23 59 53.833	-22 25 41.21	0.64	8.23	94(10)	6037(44)	4.380(70)	0.343(30)	3.50(50)	1.33	Jh6	...	1.36	...

NOTES.—Units of right ascension are hours, minutes, and seconds, and units of declination are degrees, arcminutes, and arcseconds. For succinctness, we express uncertainties using parenthetical notation, where the least significant digit of the uncertainty, in parentheses, and that of the quantity are understood to have the same place value. Thus, “0.100(20)” indicates “0.100 ± 0.020,” “1.0(2.0)” indicates “1.0 ± 2.0,” and “1(20)” indicates “1 ± 20.” Table 2 is also available in machine-readable form in the electronic edition of the *Astrophysical Journal*.

<sup>a</sup> No  $S$ -value available: star is assumed to be very inactive.

<sup>b</sup> No effective temperature available:  $T_{\text{eff}}$  is estimated from  $B - V$  using Flower (1996).

<sup>c</sup> This giant star has a poorly determined mass; both estimates are plausible.

<sup>d</sup> BD -10 3166 appears to be a metal-rich K0 dwarf. Based on its spectroscopic similarity to 55 Cnc (Gonzalez et al. 1999), a star 4.1 mag brighter in  $V$  band, we can crudely infer a distance  $\sim 7$  times greater than that star, or  $\sim 80$  pc.

<sup>e</sup> No parallax available: star is assumed to be on the main sequence.

REFERENCES.—(Ad9) Allende Prieto & Lambert 1999 (also available via the VizieR Online Data Catalog J/A+A/352/555); (Bc5) Bouchy et al. 2005b; (Bu4) Butler et al. 2004; (Da6) da Silva et al. 2006; (Fi5) Fischer et al. 2005; (Fi6) Fischer et al. 2006; (Fu4) Fuhrmann 2004; (Ge6) Ge et al. 2006, [http://vo.obspm.fr/exoplanetes/encyclo/planet.php?p1=HD+102195&p2=b](http://vo.obspm.fr/exoplanetes/encyclo/planet.php?p1=HD+102195&p2=b;); (Jh6) J. A. Johnson et al. 2006, in preparation; (Mc8) Marcy & Benitz 1989; (Nd4) Nordström et al. 2004; (Sn4) Santos et al. 2004a; (Sn5) Santos et al. 2005; (St3) Sato et al. 2003; (St5) Sato et al. 2005; (Sw3) Setiawan et al. 2003; (Sz4) Sozzetti et al. 2004; (Sz6) Sozzetti et al. 2006; (VF5) Valenti & Fischer 2005; (Wr6) J. T. Wright et al. 2006, in preparation; (Z3) Zucker et al. 2003.

characteristics of the new CCD. Nonetheless, we adopt this model as an additional source of noise for all observations at all telescopes. We report these adopted jitter values in Table 2.

#### 4. ERRORS

We calculated uncertainties in orbital parameters through the following method, described in Marcy et al. (2005b): We subtracted the best-fit orbital solution from the data and interpreted the residuals as a population of random deviates with a distribution characteristic of the noise in the data. We randomly selected deviates from this set, with replacement, and added this “noise” to the velocities calculated from the best-fit solution at the actual times of observation. We then found the best-fit orbital solutions to this mock data set. Repeating this procedure 100 times, we produced 100 sets of orbital parameters. We report the standard deviation of each individual parameter over the 100 trials as the  $1\sigma$  errors listed in Table 3. For the derived quantities  $a$  and  $M \sin i$ , we calculated these quantities from each mock data set and report the standard deviation in those quantities propagated with an assumed error of 10% in the stellar mass (which dominates the error budget for many planets).

Uncertainties in  $e$  and  $\omega$  become non-Gaussian when  $\sigma_e \gtrsim e/2$ ; in particular,  $\omega$  and  $\sigma_\omega$  become ill defined when  $e = 0$ . In order to report uncertainties in an intuitive manner, we calculate  $\sigma_e$  in such cases as the geometric mean of  $\sigma_e \cos \omega$  and  $\sigma_e \sin \omega$ . In other words, for cases when  $\sigma_e \gtrsim e/2$ , we effectively model the uncertainties as a two-dimensional Gaussian in  $(e \cos \omega, e \sin \omega)$ -space where the values of  $e$  and  $\omega$  reported in Table 3 are the coordinates of the center of the Gaussian and the error in  $e$  is its width.

For succinctness, we express uncertainties using parenthetical notation, where the least significant digit of the uncertainty, in parentheses, and that of the quantity are understood to have the same place value. Thus, “0.100(20)” indicates “0.100 ± 0.020,” “1.0(2.0)” indicates “1.0 ± 2.0,” and “1(20)” indicates “1 ± 20.”

Spectroscopic parameters from SPOCS (Valenti & Fischer 2005) have typical errors of 44 K in  $T_{\text{eff}}$ , 0.06 dex in  $\log g$ , 0.03 dex in  $[\text{Fe}/\text{H}]$ , and 0.5 km s<sup>-1</sup> in  $v \sin i$ . Errors in the corresponding parameters from Santos et al. (2004a, 2005) are 50 K, 0.12 dex, and 0.05 dex, respectively ( $v \sin i$  is not quoted in these sources). We quote errors in parameters from other sources explicitly.

#### 5. STELLAR PROPERTIES

Table 2 represents a compilation of data on the properties of the host stars for the nearby exoplanets. Columns (1) and (2) list the HD and *Hipparcos* numbers of the stars, and column (3) acts as a gloss for the Flamsteed, Bayer, or commonly used Gliese designations (e.g., 51 Peg,  $v$  And, GJ 86), many of which appear in Table 3.

*Hipparcos*<sup>12</sup> provides accurate distances and positions to all stars in this catalog save two, BD -10 3166 and the host star of TrES-1. We quote coordinates,  $B - V$ ,  $V$  magnitude, and distance to stars from the *Hipparcos* catalog in columns (4)–(8).

Columns (9)–(13) contain  $T_{\text{eff}}$ ,  $\log g$ , abundance,  $v \sin i$ , and mass for these stars, collected from the references listed in column (14). Most of these reported values come from the SPOCS catalog (Valenti & Fischer 2005), whose measurements are based on detailed spectroscopic analysis and evolutionary models, and the catalogs of Nordström et al. (2004) and Santos et al. (2004a, 2005).

Column (15) lists Mount Wilson  $S$ -values for many of the stars, most of which are drawn from Wright et al. (2004), Tinney et al.

(2002), and Jenkins et al. (2005), but some of which are new to this work, measured in the manner described in Wright et al. (2004). Column (16) lists the height of the star above the main sequence,  $\Delta M_V$  (a function of  $M_V$  and  $B - V$  defined in Wright 2004). Column (17) lists the jitter predicted by the model of Wright (2005) for those stars for which we have updated orbital parameters. We have added these jitter values in quadrature to the formal uncertainties when fitting for the orbital parameters listed in Table 3. This procedure is also discussed in Marcy et al. (2005b).

#### 6. CATALOG OF NEARBY EXOPLANETS

Table 3 presents the Catalog of Nearby Exoplanets. For planets with recently published velocities and orbits (e.g., the HD 190360 system in Vogt et al. 2005) or those for which we have insufficient data for an orbital fit or no data at all (e.g., HD 1237b), we quote the most recently published solution. For all others, the orbital parameters in Table 3 represent the best-fit orbital solutions to the velocities in Table 1.

The name of each host star appears in column (2). Where available, we use Bayer designations or Flamsteed numbers to identify a star (e.g., 51 Peg, not HD 217014) since these names are more mnemonic than HD and *Hipparcos* catalog numbers, which are cross-referenced in Table 2. For stars with no HD number (e.g., GJ 86), we use the most common designation in the literature. Column (3) gives the component name (b, c, etc.) of each planet. Component names are ostensibly assigned in order of discovery.

Columns (4)–(10) report the parameters of the best-fit solution to the observed radial velocities:  $P$ , the sidereal orbital period of the planet in days;  $K$ , the semiamplitude of the reflex motion of the star in m s<sup>-1</sup>;  $e$ , the eccentricity of the planet’s orbit;  $\omega$ , the longitude of periastron of the planet’s orbit in degrees;  $T_p$ , the time of periastron passage as a Julian Date;  $T_t$ , the predicted midtime of transit assuming  $i = 90^\circ$ ; and the magnitude of a linear trend (in m s<sup>-1</sup>) subtracted from the velocities required to achieve the fit. We have not calculated  $T_p$  or  $T_t$  values for orbital parameters collected from the literature, but we report them where present. Parameters for dynamical fits in Table 3 from the literature may use slightly different definitions of these parameters, using Jacobi coordinates and synodic periods (e.g., Rivera et al. 2005).

Columns (11) and (12) contain the minimum mass ( $M \sin i$ ) and orbital semimajor axis ( $a$ ) of the planet, calculated from the orbital parameters and the mass of the host star ( $M_\star$  given in Table 2) using the following definitions:

$$M \sin i = K \sqrt{1 - e^2} \left[ \frac{P(M_\star + M \sin i)^2}{2\pi G} \right]^{1/3}, \quad (1)$$

$$\left( \frac{a}{\text{AU}} \right)^3 = \left( \frac{M_\star + M \sin i}{M_\odot} \right) \left( \frac{P}{\text{yr}} \right)^2, \quad (2)$$

where  $G$  is the gravitational constant.

Columns (13) and (14) report the quality of the fit as the rms of the residuals and  $\chi_\nu^2$  for the appropriate number of degrees of freedom, and column (15) reports the number of observations used in the fit. Column (16) contains the reference for the quantities in columns (4)–(10), (13), (14), and (15). For many planets (e.g., 51 Peg b), other groups have published an orbital solution independent of ours. In these cases, we cite the most recent such solution parenthetically in column (16). When this independent

<sup>12</sup> VizieR Online Data Catalog, I/239 (ESA 1997).

TABLE 3  
CATALOG OF NEARBY EXTRASOLAR PLANETS

PLANET			PERIOD	$K$	$e$	$\omega$	$T_p$	$T_t$	TREND	$M \sin i$	$a$	rms	$\sqrt{\chi^2_\nu}$	$N_{\text{obs}}$	REFERENCES
Number	Name	Component	(days)	( $\text{m s}^{-1}$ )	(6)	(deg)	(JD $-2,440,000$ )	(JD $-2,440,000$ )	( $\text{m s}^{-1} \text{yr}^{-1}$ )	( $M_J$ )	(AU)	( $\text{m s}^{-1}$ )	(14)	(15)	(ALTERNATIVE)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
1.....	HD 142	b	350.3(3.6)	33.9(4.7)	0.26(18) <sup>a</sup>	303 <sup>a</sup>	11963(43)	11737(25)	-10.4(1.1)	1.31(18)	1.045(61)	12	1.5	53	Bu6
2.....	HD 1237	b	133.71(20)	167.0(4.0)	0.511(17)	290.7(3.0)	11545.86(64)	...	...	3.37(49)	0.495(29)	19	2.8	61	Nf1
3.....	HD 2039	b	1120(23)	153(22)	0.715(46)	344.1(3.6)	12041(13)	10992(26)	3.5(1.5)	6.11(82)	2.23(13)	11	0.84	41	Bu6
4.....	HD 2638	b	3.44420(20)	67.40(40)	0 <sup>b</sup>	0 <sup>b</sup>	13323.2060(20)	...	...	0.477(68)	0.0436(25)	3.3	...	28	Mo5
5.....	54 Psc	b	62.206(21)	16.0(1.2)	0.618(51)	233.3(7.4)	12189.83(68)	12176.3(1.9)	...	0.227(23)	0.296(17)	6.6	1.3	163	Bu6
6.....	HD 4208	b	828.0(8.1)	19.06(73)	0.052(40) <sup>a</sup>	345 <sup>a</sup>	11040(120)	10440(16)	...	0.804(73)	1.650(96)	3.4	0.72	41	Bu6
7.....	HD 4308	b	15.560(20)	4.07(20)	0.000(10)	359(47)	13311.7(2.0)	...	...	0.0467(70)	0.1179(68)	1.3	1.4	41	U6
8.....	HD 4203	b	431.88(85)	60.3(2.2)	0.519(27)	329.1(3.1)	11918.9(2.7)	11558.7(7.2)	-4.38(71)	2.07(18)	1.164(67)	4.1	0.80	23	Bu6
9.....	HD 6434	b	21.9980(90)	34.2(1.1)	0.170(30)	156(11)	11490.80(60)	...	...	0.397(59)	0.1421(82)	11	...	130	My4
10.....	HD 8574	b	225.0(1.1)	64.1(5.5)	0.370(82)	2(16)	11475.6(5.5)	11504.8(7.3)	...	1.96(22)	0.759(44)	23	1.6	26	Bu6 (Pr3)
11.....	$v$ And	b	4.617113(82)	69.8(1.5)	0.023(18) <sup>a</sup>	63 <sup>a</sup>	11802.64(71)	11802.966(33)	...	0.687(58)	0.0595(34)	13	1.4	268	Bu6 (Nf4)
12.....	$v$ And	c	241.23(30)	55.6(1.7)	0.262(21)	245.5(5.3)	10158.1(4.5)	10063.9(3.8)	...	1.98(17)	0.832(48)	...	...	...	...
13.....	$v$ And	d	1290.1(8.4)	63.4(1.5)	0.258(32)	279(10)	8827(30)	8127(39)	...	3.95(33)	2.54(15)	...	...	...	...
14.....	HD 10647	b	1003(56)	17.9(4.6)	0.16(22) <sup>a</sup>	336 <sup>a</sup>	10960(160)	10221(83)	...	0.93(18)	2.03(15)	9.4	1.4	28	Bu6 (My3)
15.....	109 Psc	b	1076.4(2.4)	115.0(1.5)	0.1023(96)	108.9(8.2)	10396(29)	10350.4(5.6)	...	6.38(53)	2.16(12)	6.8	1.4	59	Bu6
16.....	HD 11977	b	711.0(8.0)	105.0(8.0)	0.400(70)	351.5(9.5)	11420.0	...	...	6.5(1.2)	1.94(11)	29	...	...	Sw5
17.....	HD 11964	b	2110(270)	9.0(1.5)	0.06(17) <sup>a</sup>	168 <sup>a</sup>	12290(420)	11870(120)	0.67(30)	0.61(10)	3.34(40)	5.4	0.87	87	Bu6
18.....	HD 12661	b	262.53(27)	74.19(85)	0.361(11)	296.3(2.6)	10214.1(2.9)	10046.1(2.5)	...	2.34(19)	0.831(48)	7.8	1.1	108	Bu6
19.....	HD 12661	c	1679(29)	29.27(88)	0.017(29) <sup>a</sup>	38 <sup>a</sup>	12130(330)	12368(22)	...	1.83(16)	2.86(17)	...	...	...	...
20.....	HD 13445	b	15.76491(39)	376.7(2.9)	0.0416(72)	269(16)	11903.36(59)	11895.551(76)	-94.9(1.0)	3.91(32)	0.1130(65)	12	2.1	42	Bu6 (Q0)
21.....	79 Cet	b	75.523(55)	11.99(87)	0.252(52)	42(14)	10338.0(3.0)	10344.1(1.6)	...	0.260(28)	0.363(21)	3.7	0.82	71	Bu6
22.....	$\iota$ Hor	b	302.8(2.3)	57.1(5.2)	0.14(13) <sup>a</sup>	346 <sup>a</sup>	11227(46)	10998(19)	...	2.08(26)	0.930(54)	19	1.3	25	Bu6 (Nf 1b)
23.....	HIP 14810	b	6.6740(20)	420.7(3.0)	0.1480(60)	153.0(2.0)	13694.500(40)	...	...	3.84(54)	0.0692(40)	8.3	1.4	15	Wr6
24.....	94 Cet	b	535.7(3.1)	36.2(1.9)	0.300(40)	41.0(8.0)	10944(12)	...	...	1.69(26)	1.428(83)	8.1	...	48	My4
25.....	HD 20367	b	469.5(9.3)	29.0(3.0)	0.320(90)	135(16)	11860(18)	...	...	1.17(23)	1.246(75)	10	...	27	U3
26.....	HD 20782	b	585.860(30)	115(12)	0.925(30)	147.0(3.0)	11687.1(2.5)	...	...	1.78(34)	1.364(79)	5.0	1.0	29	Jo6
27.....	$\epsilon$ Eri	b	2500(350)	18.6(2.9)	0.25(23) <sup>a</sup>	6 <sup>a</sup>	8940(520)	9330(200)	...	1.06(16)	3.38(43)	12	1.0	120	Bu6 (H0)
28.....	HD 23079	b	730.6(5.7)	54.9(1.1)	0.102(31)	55(17)	10492(37)	10551(14)	...	2.45(21)	1.596(93)	4.8	0.69	19	Bu6
29.....	HD 23596	b	1565(21)	124.0(3.0)	0.292(23)	274.1(3.9)	11604(15)	...	...	7.8(1.1)	2.83(17)	9.2	1.1	39	Pr3
30.....	$\epsilon$ Ret	b	428.1(1.1)	32.2(1.4)	0.060(43) <sup>a</sup>	216 <sup>a</sup>	10836(55)	10692.2(8.6)	...	1.56(14)	1.271(73)	6.5	1.1	55	Bu6
31.....	HD 27894	b	17.9910(70)	58.10(50)	0.0490(80)	132.9(9.7)	13275.46(48)	...	...	0.618(88)	0.1221(71)	4.0	...	20	Mo5
32.....	HD 28185	b	383.0(2.0)	161(11)	0.070(40)	351(25)	11863(26)	...	...	5.72(93)	1.031(60)	10	...	40	Sn1
33.....	HD 30177	b	2770(100)	146.8(2.8)	0.193(25)	34(15)	11437(72)	11738(16)	...	10.45(88)	3.95(26)	10	0.96	22	Bu6
34.....	HD 33283	b	18.1790(70)	25.2(2.0)	0.480(50)	155.8(8.0)	13017.60(30)	...	...	0.330	0.145	3.6	0.77	25	Jh6
35.....	HD 33636	b	2127.7(8.2)	164.2(2.0)	0.4805(60)	339.5(1.4)	11205.8(6.4)	9396(12)	...	9.28(77)	3.27(19)	8.9	0.98	38	Bu6 (Pr3)
36.....	HD 33564	b	388.0(3.0)	232.0(5.0)	0.340(20)	205.0(4.0)	12603.0(8.0)	...	...	9.1(1.3)	1.124(65)	6.7	...	15	Ga5
37.....	HD 37124	b	154.46	27.5	0.055	140.5	10000.11	...	...	0.64(11)	0.529(31)	18	1.9	52	Vo5 (U3)
38.....	HD 37124	c	2295.00	12.2	0.200	266.0	9606.00	...	...	0.683(88)	3.19(18)	...	...	...	...
	HD 37124	c <sup>c</sup>	29.3 <sup>c</sup>	13.2 <sup>c</sup>	0.160 <sup>c</sup>	290.0 <sup>c</sup>	9981.3 <sup>c</sup>	...	...	0.170 <sup>c</sup>	0.170 <sup>c</sup>	5.1 <sup>c</sup>	1.1 <sup>c</sup>	...	...
39.....	HD 37124	d	843.60	15.4	0.140	314.3	9409.40	...	...	0.624(63)	1.639(95)	...	...	...	...
40.....	$\pi$ Men	b	2151(85)	196.4(1.3)	0.6405(72)	330.24(67)	7820(170)	5920(260)	...	10.27(84)	3.38(22)	5.5	0.93	42	Bu6



TABLE 3—Continued

PLANET			PERIOD (days)	$K$ (m s <sup>-1</sup> )	$e$	$\omega$ (deg)	$T_p$ (JD -2,440,000)	$T_i$ (JD -2,440,000)	TREND (m s <sup>-1</sup> yr <sup>-1</sup> )	$M \sin i$ ( $M_J$ )	$a$ (AU)	rms (m s <sup>-1</sup> )	$\sqrt{\chi^2_\nu}$	$N_{\text{obs}}$	REFERENCES (ALTERNATIVE)
Number (1)	Name (2)	Component (3)													
41.....	HD 37605	b	54.23(23)	262.9(5.5)	0.737(10)	211.6(1.7)	12994.27(45)	...	...	2.86(41)	0.261(15)	4.7	...	27	Cc4
42.....	HD 38529	b	14.3093(13)	56.8(1.6)	0.248(23)	91.2(6.2)	9991.59(23)	9991.56(17)	...	0.852(74)	0.1313(76)	13	1.6	162	Bu6
43.....	HD 38529	c	2165(14)	170.3(1.7)	0.3506(85)	15.7(1.9)	10085(15)	10319(13)	...	13.2(1.1)	3.74(22)				
44.....	HD 41004A	b	963(38)	99(60)	0.74(20)	97(31)	12425(37)	...	...	2.6(1.8)	1.70(11)	10	...	149	Z4
45.....	HD 41004B	b	1.328300(12)	6114(71)	0.081(12)	178.5(7.8)	12434.880(29)	...	...	18.4(2.6)	0.0177(10)	600	...	149	Z4
46.....	HD 40979	b	263.84(71)	112.0(5.0)	0.269(34)	318(10)	10748.1(8.6)	10561.2(6.4)	...	3.83(36)	0.855(49)	23	1.3	65	Bu6
47.....	HD 45350	b	967.0(6.2)	64.2(2.5)	0.798(53)	342.4(8.6)	11822(13)	10894(16)	...	1.96(17)	1.96(11)	4.4	0.96	40	Bu6 (Ed6)
48.....	HD 46375	b	3.023573(65)	33.65(74)	0.063(26)	114(24)	11071.53(19)	11071.359(37)	...	0.226(19)	0.0398(23)	4.2	0.97	50	Bu6
49.....	HD 47536	b	712.13(31)	113(11)	0.200(80)	261(24)	11599(22)	...	...	5.20(99) <sup>d</sup>	1.613(93) <sup>d</sup>	26	0.97	39	Sw3
50.....	HD 49674	b	4.94737(98)	12.04(88)	0.087(95) <sup>a</sup>	264 <sup>a</sup>	11882.38(88)	11880.00(18)	...	0.105(11)	0.0580(34)	4.7	0.66	39	Bu6
51.....	HD 50499	b	2480(110)	22.9(3.0)	0.14(20)	262(36)	11230(230)	...	-4.8	1.75(53)	3.87(26)	4.8	1.1	35	Vo5
52.....	HD 50554	b	1224(12)	91.5(7.6)	0.444(38)	7.4(4.3)	10646(16)	10767(18)	...	4.46(48)	2.28(13)	12	1.1	51	Bu6 (Pr3)
53.....	HD 52265	b	119.290(86)	42.1(3.1)	0.325(65)	243(15)	10833.7(4.2)	10790.1(6.7)	...	1.09(11)	0.504(29)	10	1.6	28	Bu6 (Nf1b)
54.....	HD 63454	b	2.817822(95)	64.30(70)	0 <sup>b</sup>	0 <sup>b</sup>	13111.1290(50)	...	...	0.385(55)	0.0363(21)	7.1	...	57	Mo5
55.....	HD 65216	b	613(11)	33.7(1.1)	0.410(60)	198.0(6.0)	10762(25)	...	...	1.22(19)	1.374(82)	6.8	...	70	My4
56.....	HD 66428	b	1973(31) <sup>c</sup>	48.3(2.7) <sup>c</sup>	0.465(30) <sup>c</sup>	152.9(3.9)	12139(16)	12012.1(7.1)	...	2.82(27)	3.18(19)	2.9	0.46	29	Bu6
57.....	HD 68988	b	6.27711(21)	184.7(3.7)	0.1249(87)	31.4(3.5)	11548.84(16)	11549.663(40)	-23.8(1.7)	1.86(16)	0.0704(41)	13	2.8	28	Bu6
58.....	HD 70642	b	2068(39)	30.4(1.3)	0.034(43) <sup>a</sup>	205 <sup>a</sup>	11350(380)	10707(48)	...	1.97(18)	3.23(19)	4.3	0.90	28	Bu6
59.....	HD 72659	b	3630(230)	42.5(1.2)	0.269(38)	258(13)	11673(89)	10060(240)	...	3.30(29)	4.77(37)	4.2	0.83	32	Bu6
60.....	HD 73256	b	2.54858(16)	269.0(8.0)	0.029(20)	337(46)	12500.18(28)	...	...	1.87(27)	0.0371(21)	15	...	40	U3b
61.....	HD 73526	b	187.499(30)	76.1(5.1)	0.390(54)	172(29)	10038(15)	...	...	2.04(29)	0.651(38)	9.2	0.95	30	T6
62.....	HD 73526	c	376.879(90)	67.4(3.6)	0.400(54)	183(13)	10184.5(8.6)	...	...	2.26(27)	1.037(60)				
63.....	HD 74156	b	51.643(11)	112.0(1.9)	0.6360(91)	181.5(1.4)	11981.321(91)	...	...	1.80(26)	0.290(17)	11	1.3	95	Nf4
64.....	HD 74156	c	2025(11)	104.0(5.5)	0.583(39)	242.4(4.0)	10901(10)	...	...	6.00(95)	3.35(19)				
65.....	HD 75289	b	3.509267(64)	54.9(1.8)	0.034(29) <sup>a</sup>	141 <sup>a</sup>	10830.34(48)	10829.872(38)	...	0.467(41)	0.0482(28)	6.6	1.1	30	Bu6 (U0)
66.....	55 Cnc	b	14.652(10)	73.38(82)	0.01(13)	168(33)	10004.354(10)	...	...	0.833(69)	0.1138(66)	7.3	1.6	300	MA4 (Nf4)
67.....	55 Cnc	c	44.36(25)	9.60(86)	0.071(12)	115(11)	10036.29(25)	...	...	0.157(20)	0.238(14)				
68.....	55 Cnc	d	5552(78)	47.5(1.5)	0.091(80)	181.6(6.7)	12685(69)	...	...	3.90(33)	5.97(35)				
69.....	55 Cnc	e	2.7955(20)	5.80(81)	0.09(28)	187(41)	10000.12(32)	...	...	0.0377(59)	0.0377(22)				
70.....	HD 76700	b	3.97097(23)	27.6(1.7)	0.095(75) <sup>a</sup>	30 <sup>a</sup>	11213.32(67)	11213.89(12)	...	0.233(24)	0.0511(30)	6.9	1.0	35	Bu6
71.....	HD 80606	b	111.4487(32)	481.9(2.1)	0.9349(23) <sup>b,f</sup>	301 <sup>b</sup>	13199.0517(56)	13093.109(90)	...	4.31(35)	0.468(27)	5.4	1.0	46	Bu6 (Nf1)
72.....	HD 81040	b	1001.7(7.0)	168.0(9.0)	0.526(42)	81.3(7.2)	12504(12)	...	...	6.9(1.1)	1.94(11)	26	1.8	26	Sz6
73.....	HD 82943	b	219.50(13) <sup>g</sup>	59.3(5.2) <sup>g</sup>	0.39(26) <sup>g</sup>	121.0(3.1) <sup>g</sup>	...	...	...	1.81(21)	0.752(43)	8.0	1.4	165	Le6 (My4)
74.....	HD 82943	c	439.2(1.8) <sup>g</sup>	41.70(91) <sup>g</sup>	0.020(98) <sup>g</sup>	260(10) <sup>g</sup>	...	...	...	1.74(19)	1.194(69)				
75.....	HD 83443	b	2.985698(57)	56.2(1.7)	0.012(23) <sup>a</sup>	117 <sup>a</sup>	11211.79(69)	11211.565(25)	...	0.398(35)	0.0406(23)	9.0	0.99	51	Bu6 (My4)
76.....	HD 86081	b	2.13750(20)	207.70(80)	0.0080(40)	251(40)	13694.80(30)	...	...	1.5	0.0346	3.2	0.81	26	Jh6
77.....	HD 88133	b	3.41587(59)	36.1(3.0)	0.133(72) <sup>a</sup>	349 <sup>a</sup>	13016.31(32)	13013.705(95)	...	0.299(33)	0.0472(27)	6.2	0.96	21	Bu6
78.....	HD 89307	b	2900(1100) <sup>f</sup>	37.2(3.9) <sup>c</sup>	0.01(16) <sup>a,c</sup>	353 <sup>a</sup>	12520(230)	12800(260)	...	2.61(37)	3.9(1.3)	14	1.2	12	Bu6
79.....	HD 89744	b	256.80(13)	267.3(5.0)	0.6770(72)	194.4(1.2)	11505.33(39)	11487.03(76)	7.7(1.4)	8.58(71)	0.934(54)	16	1.3	50	Bu6 (K0)
80.....	HD 92788	b	325.81(26)	106.0(1.7)	0.334(11)	276.4(2.8)	10759.2(2.7)	10585.3(2.4)	...	3.67(30)	0.965(56)	7.9	1.0	58	Bu6 (My4)
81.....	HD 93083	b	143.58(60)	18.30(50)	0.140(30)	333.5(7.9)	13181.7(3.0)	...	...	0.368(54)	0.477(28)	2.0	...	16	Lv5
82.....	BD -10 3166	b	3.48777(11)	60.9(1.4)	0.019(23) <sup>a</sup>	334 <sup>a</sup>	11171.22(69)	11168.832(31)	1.97(69)	0.458(39)	0.0452(26)	5.7	0.84	31	Bu6

TABLE 3—Continued

PLANET			PERIOD (days)	$K$ (m s <sup>-1</sup> )	$e$	$\omega$ (deg)	$T_p$ (JD -2,440,000)	$T_r$ (JD -2,440,000)	TREND (m s <sup>-1</sup> yr <sup>-1</sup> )	$M \sin i$ ( $M_J$ )	$a$ (AU)	rms (m s <sup>-1</sup> )	$\sqrt{\chi_r^2}$	$N_{\text{obs}}$	REFERENCES (ALTERNATIVE)
Number (1)	Name (2)	Component (3)													
83.....	47 UMa	b	1089.0(2.9)	49.3(1.2)	0.061(14)	172(15)	10356(34)	...	...	2.63(23)	2.13(12)	7.4	1.0	90	Fi2 (Nf4)
84.....	47 UMa	c	2594(90) <sup>c</sup>	11.1(1.1) <sup>c</sup>	0.00(12) <sup>c</sup>	127(56)	11360(500)	...	...	0.79(13)	3.79(24)	...	...	...	...
85.....	HD 99109	b	439.3(5.6)	14.1(2.2)	0.09(16) <sup>a</sup>	256 <sup>a</sup>	11310(80)	11110(35)	...	0.502(70)	1.105(65)	6.3	0.87	41	Bu6
86.....	83 Leo B	b	17.0431(47)	9.8(1.0)	0.254(92)	219(22)	10468.7(1.4)	10463.78(80)	1.29(21)	0.109(13)	0.1232(71)	3.6	0.80	51	Bu6
87.....	GJ 436	b	2.643943(84)	18.3(1.0)	0.207(52)	357(24)	11551.69(11)	11549.557(68)	...	0.0673(65)	0.0278(16)	4.9	0.79	55	Bu6
88.....	HD 101930	b	70.46(18)	18.10(40)	0.110(20)	251(11)	13145.0(2.0)	...	...	0.299(43)	0.302(17)	1.8	...	16	Lv5
89.....	HD 102117	b	20.8133(64)	11.98(95)	0.121(82) <sup>a</sup>	279 <sup>a</sup>	10942.2(2.6)	10931.1(1.0)	...	0.172(20)	0.1532(88)	3.8	0.75	44	Bu6 (Lv5)
90.....	HD 102195	b	4.1150(10)	64	0.060(30)	110(10)	13731.70(50)	...	...	0.48	0.049	...	...	...	Ge6
91.....	HD 104985	b	198.20(30)	161.0(2.0)	0.030(20)	310(30)	11990(20)	...	...	6.33(91)	0.779(45)	24	3.2	26	St3
92.....	HD 106252	b	1516(26)	152(21)	0.586(65)	294.9(6.2)	10385(27)	9244(51)	...	7.10(65)	2.60(15)	9.1	0.78	15	Bu6 (Pr3)
93.....	HD 107148	b	48.056(57)	10.9(2.0)	0.05(17) <sup>a</sup>	75 <sup>a</sup>	-31(12)	-29(12)	1.03(51)	0.210(36)	0.269(16)	4.4	1.4	35	Bu6
94.....	HD 108147	b	10.8985(45)	25.1(6.1)	0.53(12)	308(24)	10828.86(71)	10820.7(1.5)	...	0.261(40)	0.1020(59)	12	1.1	54	Bu6 (Pp2)
95.....	HD 108874	b	395.27(92)	37.91(95)	0.068(24)	250(35)	9739(38)	...	...	1.37(12)	1.055(61)	3.7	0.74	49	Vo5
96.....	HD 108874	c	1599(46)	18.35(86)	0.253(42)	20(100)	9590(110)	...	...	1.02(10)	2.68(17)	...	...	...	...
97.....	HD 109749	b	5.23947(56)	28.58(87)	0 <sup>b</sup>	0 <sup>b</sup>	13014.91(85)	...	...	0.277(24)	0.0629(36)	2.7	0.59	21	Fi6
98.....	HD 111232	b	1143(14)	159.3(2.3)	0.200(10)	98.0(6.0)	11230(20)	...	...	6.84(98)	1.97(12)	7.5	...	38	My4
99.....	HD 114386	b	938(16)	34.3(1.6)	0.230(30)	273(14)	10454(43)	...	...	1.34(20)	1.71(10)	10	...	58	My4
100.....	HD 114762	b	83.8881(86)	615.2(6.7)	0.3359(91)	201.7(1.4)	9805.36(34)	9788.23(29)	...	11.68(96)	0.363(21)	24	1.1	45	Bu6 (Lt9)
101.....	HD 114783	b	496.9(2.3)	29.36(83)	0.085(33)	93(25)	10840(37)	10836.0(7.6)	2.95(40)	1.034(89)	1.169(68)	4.7	1.1	54	Bu6
102.....	HD 114729	b	1114(15)	18.8(1.3)	0.167(55)	93(30)	10520(67)	10515(21)	...	0.95(10)	2.11(12)	4.9	0.95	42	Bu6
103.....	70 Vir	b	116.6884(44)	316.3(1.7)	0.4007(35)	358.71(54)	7239.82(21)	7138.27(21)	...	7.49(61)	0.484(28)	7.4	1.0	74	Bu6 (Nf4)
104.....	HD 117207	b	2597(41)	26.60(93)	0.144(35)	73(16)	10630(120)	10723(41)	...	1.88(17)	3.79(22)	4.4	0.84	43	Bu6
105.....	HD 117618	b	25.827(19)	12.8(2.2)	0.42(17)	254(19)	10832.2(1.8)	10821.8(2.4)	...	0.178(21)	0.176(10)	5.5	0.79	57	Bu6
106.....	HD 118203	b	6.13350(60)	217.0(3.0)	0.309(14)	155.7(2.4)	13394.230(30)	...	49.7(5.7)	2.14(31)	0.0703(41)	18	...	43	Da6
107.....	$\tau$ Boo	b	3.312463(14)	461.1(7.6)	0.023(15) <sup>a</sup>	188 <sup>a</sup>	6957.81(54)	6956.916(28)	-18.7(1.1)	4.13(34)	0.0481(28)	62	1.7	98	Bu6
108.....	HD 121504	b	63.330(30)	55.80(90)	0.030(10)	265(12)	11450.0(2.0)	...	...	1.22(17)	0.329(19)	12	...	100	My4
109.....	HD 128311	b	458.6(6.8)	66.8(8.7)	0.25(10)	111(36)	10211(76)	...	...	2.19(20)	1.100(65)	18	1.9	...	Vo5
110.....	HD 128311	c	928(18)	76.2(4.6)	0.170(90)	200(150)	10010(400)	...	...	3.22(49)	1.76(11)	...	...	...	...
111.....	HD 130322	b	10.70875(94)	109.6(4.2)	0.025(32) <sup>a</sup>	149 <sup>a</sup>	212.9(2.1)	211.2(1.1)	...	1.089(98)	0.0910(53)	11	2.4	12	Bu6 (U0)
112.....	23 Lib	b	258.31(16)	50.03(54)	0.243(11)	358.3(3.7)	10331.7(2.2)	10119.4(1.8)	2.91(22)	1.62(13)	0.820(47)	4.0	0.89	90	Bu6
113.....	HD 136118	b	1193.1(9.7)	212.8(5.8)	0.351(25)	311.4(3.1)	10598(13)	9734(24)	...	12.0(1.0)	2.37(14)	22	1.2	37	Bu6
114.....	GJ 581	b	5.3660(10)	13.20(40)	0 <sup>b</sup>	0 <sup>b</sup>	11004.300(60)	...	...	0.0521	0.0406(23)	2.5	...	20	Bf5
115.....	$\iota$ Dra	b	511.098(89)	307.6(2.3)	0.7124(39)	91.58(81)	12014.59(30)	12014.32(19)	-18.1(1.1)	8.82(72)	1.275(74)	14	1.9	119	Bu6
116.....	HD 137510	b	804.9(5.0)	418(31)	0.359(28)	31.0(3.8)	11762(27)	11851.3(9.4)	...	22.7(2.4)	1.91(11)	17	1.8	10	Bu6 (Ed4)
117.....	HD 330075	b	3.387730(80)	107.00(70)	0 <sup>b</sup>	0 <sup>b</sup>	12878.8150(30)	...	...	0.624(88)	0.0392(23)	2.0	...	21	Pp4
118.....	HD 141937	b	653.2(1.2)	234.5(6.4)	0.410(10)	187.72(80)	11847.4(2.0)	...	...	9.7(1.4)	1.517(88)	8.7	1.6	81	U2
119.....	HD 142415	b	386.3(1.6)	51.3(2.3)	0.500 <sup>b</sup>	255.0(4.0)	11519.0(4.0)	...	...	1.69(25)	1.069(62)	11	...	137	My4
120.....	$\rho$ CrB	b	39.8449(63)	64.9(2.4)	0.057(28) <sup>a</sup>	303 <sup>a</sup>	10563.2(4.1)	10539.58(35)	...	1.093(98)	0.229(13)	6.9	0.97	26	Bu6 (Ny7)
121.....	HD 142022	b	1928(46)	92(65)	0.53(20)	170.0(9.0)	10941(75)	...	...	4.5(3.4)	2.93(18)	10	...	76	Eg6
122.....	14 Her	b	1754.0(3.2)	90.7(1.0)	0.3872(94)	19.6(1.7)	11368.4(5.9)	11530.0(4.9)	...	4.98(41)	2.85(16)	5.6	1.4	49	Bu6 (Nf4)
123.....	HD 147513	b	528.4(6.3)	29.3(1.8)	0.260(50)	282.0(9.0)	11123(20)	...	...	1.18(19)	1.310(77)	5.7	...	30	My4
124.....	HD 149026	b	2.87598(14)	43.2(2.3)	0 <sup>b</sup>	0 <sup>b</sup>	13526.36846(88)	13527.08746(88) <sup>h</sup>	...	0.360(35)	0.0432(25)	5.7	2.0	16	Cb6 (St5)

TABLE 3—Continued

PLANET			PERIOD (days)	$K$ (m s <sup>-1</sup> )	$e$	$\omega$ (deg)	$T_p$ (JD -2,440,000)	$T_t$ (JD -2,440,000)	TREND (m s <sup>-1</sup> yr <sup>-1</sup> )	$M \sin i$ ( $M_J$ )	$a$ (AU)	rms (m s <sup>-1</sup> )	$\sqrt{\chi^2_\nu}$	$N_{\text{obs}}$	REFERENCES (ALTERNATIVE)
Number (1)	Name (2)	Component (3)													
125.....	HD 150706	b	264.9(5.8)	33.0(4.0)	0.38(12)	178(32)	11580(26)	...	...	0.95(22)	0.802(48)	6.8	...	20	U3 (My3)
126.....	HD 149143	b	4.07(70)	149.6(3.0)	0 <sup>b</sup>	0 <sup>b</sup>	13483.9(1.2)	...	10.0(2.0)	1.33(11)	0.0531(81)	4.7	1.1	17	Fi6 (Da6)
127.....	HD 154857	b	398.5(9.0)	52.0(5.0)	0.510(60)	50(11)	11963(10)	...	-14.3(3.5)	1.85(16)	1.132(69)	3.2	0.87	18	MC4
128.....	$\mu$ Ara	b	630.0(6.2)	37.4(1.6)	0.271(40)	259.8(7.4)	10881(28)	10596(18)	...	1.67(17)	1.510(88)	4.7	1.1	108	Bu6 (Sn4b)
129.....	$\mu$ Ara	c	2490(100)	18.1(1.1)	0.463(53)	183.8(7.9)	11030(110)	10750(110)	...	1.18(12)	3.78(25)	...	...	24	Sn4b
130.....	$\mu$ Ara	d	9.550(30)	4.10(20)	0.000(20)	4.0(2.0)	13168.940(50)	...	...	0.0471	0.0924(53)	0.90	...	24	Sn4b
131.....	HD 162020	b	8.428198(56)	1813.0(4.0)	0.2770(20)	28.40(23)	11990.6770(50)	...	...	15.0(2.1)	0.0751(43)	8.1	1.2	30	U2
132.....	HD 164922	b	1155(23)	7.3(1.2)	0.05(14) <sup>a</sup>	195 <sup>a</sup>	11100(280)	10780(68)	...	0.360(46)	2.11(13)	3.7	0.60	64	Bu6
133.....	HD 168443	b	58.11055(86)	475.8(1.6)	0.5296(32)	172.68(94)	10047.454(34)	10042.919(43)	...	8.01(65)	0.300(17)	5.9	1.3	106	Bu6 (U2)
134.....	HD 168443	c	1764.3(2.4)	297.4(1.2)	0.2175(15)	64.37(21)	10255.8(4.6)	10335.6(2.7)	...	18.1(1.5)	2.92(17)	...	...	...	...
135.....	HD 168746	b	6.4040(14)	28.6(1.7)	0.107(80) <sup>a</sup>	17 <sup>a</sup>	11757.83(47)	11758.92(19)	...	0.248(23)	0.0659(38)	3.9	0.79	16	Bu6 (Pp2)
136.....	HD 169830	b	225.62(22)	80.70(90)	0.310(10)	148.0(2.0)	11923.0(1.0)	...	...	2.9(1.3)	0.817(47)	8.9	...	112	My4
137.....	HD 169830	c	2100(260)	54.3(3.6)	0.33(02)	252.0(8.0)	12516(25)	...	...	4.1(1.6)	3.62(43)	...	...	...	...
138.....	TrES-1	b	3.0300650(80)	115.2(6.2)	0 <sup>b,i</sup>	...	...	13186.80600(20) <sup>h</sup>	...	0.759	0.0394(23)	14	...	8	As4
139.....	HD 177830	b	410.1(2.2)	32.64(98)	0.096(48) <sup>a</sup>	189 <sup>a</sup>	10254(42)	10154.4(9.1)	...	1.53(13)	1.227(71)	6.2	1.0	54	Bu6
140.....	HD 178911B	b	71.511(11)	346.9(4.2)	0.139(14)	172.3(5.0)	11378.23(83)	11364.97(33)	...	7.35(60)	0.345(20)	7.7	1.7	14	Bu6 (Z2)
141.....	HD 179949	b	3.092514(32)	112.6(1.8)	0.022(15) <sup>a</sup>	192 <sup>a</sup>	11002.36(44)	11001.510(20)	...	0.916(76)	0.0443(26)	12	1.1	88	Bu6
142.....	HD 183263	b	635.4(3.9)	87.3(3.2)	0.363(21)	231.5(5.7)	12103.0(7.5)	11910(11)	-25.5(1.6)	3.82(34)	1.525(88)	8.4	1.8	34	Bu6
143.....	16 Cyg B	b	798.5(1.0)	50.5(1.6)	0.681(17)	85.8(2.4)	6549.1(6.6)	6546.3(6.4)	...	1.68(15)	1.681(97)	7.3	0.99	95	Bu6
144.....	HD 187123	b	3.096598(27)	70.0(1.0)	0.023(15) <sup>a</sup>	17 <sup>a</sup>	10806.75(39)	10807.363(16)	-7.33(29)	0.528(44)	0.0426(25)	5.5	1.2	65	Bu6 (Nf4)
145.....	HD 187085	b	1147.0(4.0)	26(10)	0.75(10)	93(20)	10910(110)	...	1.30(10)	0.98(43)	2.26(13)	6.0	1.2	33	Jo6
146.....	HD 188015	b	461.2(1.7)	37.6(1.2)	0.137(26)	222(10)	11787(17)	11634.4(5.7)	2.64(54)	1.50(13)	1.203(70)	4.3	0.93	44	Bu6
147.....	HD 189733	b	2.21900(50)	205.0(6.0)	0 <sup>b</sup>	...	...	13629.38900(40)	...	1.15(17)	0.0312(18)	15	...	...	Bc5
148.....	HD 190228	b	1146(16)	91.0(5.0)	0.499(30)	100.7(3.0)	11236(25)	...	...	4.49(70)	2.25(13)	8.0	0.99	51	Pr3
149.....	HD 190360	b	2891(85)	23.50(50)	0.360(30)	12.4(9.3)	10630(100)	...	...	1.55(14)	3.99(25)	3.5	0.88	87	Vo5 (Nf3)
150.....	HD 190360	c	17.100(15)	4.6(1.1)	0.01(10)	154(32)	10000.07(90)	...	...	0.0587(78)	0.1303(75)	...	...	...	...
151.....	HD 192263	b	24.3556(46)	51.9(2.6)	0.055(39) <sup>a</sup>	200 <sup>a</sup>	10994.3(3.9)	10987.22(39)	...	0.641(61)	0.1532(88)	7.7	0.93	31	Bu6 (Sn3)
152.....	HD 195019	b	18.20132(39)	271.5(1.5)	0.0138(44)	231(20)	11015.5(1.1)	11008.449(40)	...	3.69(30)	0.1388(80)	16	1.5	154	Bu6
153.....	HD 196050	b	1378(21)	49.7(2.0)	0.228(38)	187(12)	10843(56)	10573(42)	...	2.90(26)	2.54(15)	8.4	1.3	44	Bu6 (My4)
154.....	HD 202206	b	255.870(60) <sup>j</sup>	564.8(1.3) <sup>j</sup>	0.4350(10) <sup>j</sup>	161.18(30) <sup>j</sup>	<sup>j</sup>	<sup>j</sup>	...	17.3(2.4)	0.823(48)	9.6	1.5	...	Cr5
155.....	HD 202206	c	1383(18) <sup>j</sup>	42.0(1.5) <sup>j</sup>	0.267(21) <sup>j</sup>	79.0(6.7) <sup>j</sup>	<sup>j</sup>	<sup>j</sup>	...	2.40(35)	2.52(15)	...	...	...	...
156.....	HD 208487	b	130.08(51)	19.7(3.6)	0.24(16) <sup>a</sup>	113 <sup>a</sup>	10999(15)	10994(10)	...	0.520(82)	0.524(30)	8.2	1.0	35	Bu6
157.....	HD 209458	b	3.52474554(18)	84.26(98)	0 <sup>b,k</sup>	0 <sup>b</sup>	12853.94426(14)	12854.82545(14) <sup>h</sup>	...	0.689(57)	0.0474(27)	5.0	1.4	64	W4 (Nf4)
158.....	HD 210277	b	442.19(50)	38.94(75)	0.476(17)	119.1(2.8)	10104.3(2.6)	10092.8(2.1)	...	1.29(11)	1.138(66)	3.8	0.90	69	Bu6 (Nf1b)
159.....	HD 212301	b	2.24572(28)	59.50(70)	0 <sup>b</sup>	0 <sup>b</sup>	13549.1950(40)	...	...	0.396	0.0341(20)	6.7	...	23	LC6
160.....	HD 213240	b	882.7(7.6)	96.6(2.0)	0.421(15)	201.0(3.2)	11499(12)	11347.7(9.4)	...	4.72(40)	1.92(11)	5.0	0.75	30	Bu6 (Sn1)
161.....	GJ 876	b	60.940(13) <sup>l</sup>	212.60(76) <sup>l</sup>	0.0249(26) <sup>l</sup>	175.7(6.0) <sup>l</sup>	<sup>l</sup>	<sup>l</sup>	...	1.93(27)	0.208(12)	4.6	1.2	155	R5 (De8)
162.....	GJ 876	c	30.340(13) <sup>l</sup>	88.36(72) <sup>l</sup>	0.2243(13) <sup>l</sup>	198.30(90) <sup>l</sup>	<sup>l</sup>	<sup>l</sup>	...	0.619(88)	0.1303(75)	...	...	...	...
163.....	GJ 876	d	1.937760(70) <sup>l</sup>	6.46(59) <sup>l</sup>	0 <sup>b,i</sup>	<sup>l</sup>	<sup>l</sup>	<sup>l</sup>	...	0.0185(31)	0.0208(12)	...	...	...	...
164.....	$\tau^1$ Gru	b	1311(49)	19.6(1.5)	0.070(78) <sup>a</sup>	100 <sup>a</sup>	10870(210)	10837(53)	...	1.26(13)	2.56(17)	6.3	1.1	58	Bu6
165.....	$\rho$ Ind	b	1353(25)	39.0(1.0)	0.319(25)	67.7(8.4)	10605(29)	10647(24)	...	2.26(19)	2.54(15)	5.3	1.0	39	Bu6 (My4)
166.....	HD 216770	b	118.45(55)	30.9(1.9)	0.370(60)	281(10)	12672.0(3.5)	...	...	0.65(11)	0.456(26)	7.8	...	16	My4

TABLE 3—Continued

PLANET			PERIOD (days)	K (m s <sup>-1</sup> )	e	$\omega$ (deg)	T <sub>p</sub> (JD -2,440,000)	T <sub>t</sub> (JD -2,440,000)	TREND (m s <sup>-1</sup> yr <sup>-1</sup> )	M sin i (M <sub>J</sub> )	a (AU)	rms (m s <sup>-1</sup> )	$\sqrt{\chi^2_{\nu}}$	N <sub>obs</sub>	REFERENCES (ALTERNATIVE)
Number (1)	Name (2)	Component (3)													
167.....	51 Peg	b	4.230785(36)	55.94(69)	0.013(12) <sup>a</sup>	58 <sup>a</sup>	10001.51(61)	10001.881(18)	-1.64(16)	0.472(39)	0.0527(30)	7.0	0.88	256	Bu6 (Nf4)
168.....	HD 217107	b	7.12690(22)	140.7(2.6)	0.130(20)	21.1(7.6)	-1.58(17)	...	...	1.41(12)	0.0748(43)	5.1	1.1	63	Vo5 (Nf1b)
169.....	HD 217107	c	3200(1000)	34(20)	0.55(20)	164(30)	11030(300)	...	...	2.21(66)	4.3(1.2)	...	...	...	Vo5 (Nf1b)
170.....	$\gamma$ Cep	b	905.0(3.1)	27.5(1.5)	0.120(50)	50(26)	-878(67)	...	...	1.77(28)	2.14(12)	15	1.2	111	H3
171.....	HD 222582	b	572.38(61)	276.3(7.0)	0.725(12)	319.01(87)	10706.7(2.8)	10199.8(3.8)	...	7.75(65)	1.347(78)	3.9	0.83	37	Bu6
172.....	HD 224693	b	26.730(20)	40.2(2.0)	0.050(30)	6(200)	13193.9(3.0)	...	...	0.71	0.192	4.07	0.85	24	Jh6

NOTES.—For succinctness, we express uncertainties using parenthetical notation, where the least significant digit of the uncertainty, in parentheses, and that of the quantity are understood to have the same place value. Thus, “0.100(20)” indicates “0.100 ± 0.020,” “1.0(2.0)” indicates “1.0 ± 2.0,” and “1(20)” indicates “1 ± 20.” Table 3 is also available in machine-readable form in the electronic edition of the *Astrophysical Journal*.

<sup>a</sup> When the uncertainty in  $e$  is comparable to  $e$ , uncertainties in  $\omega$  and  $e$  become non-Gaussian. See § 4.

<sup>b</sup> Parameter held fixed in fit.

<sup>c</sup> The period of HD 37124c is unclear. An alternative interpretation to the data with component “c” having a period of 29.3 days and slightly different parameters for the other two components is plausible. See Vogt et al. (2005) for details.

<sup>d</sup> The mass of HD 47536 is ill determined. The solution here is for  $M = 1.1 M_{\odot}$ .

<sup>e</sup> This parameter is highly uncertain with a non-Gaussian distribution of possible values and high covariance with other parameters.

<sup>f</sup> Eccentricity held fixed in fit. The quoted error in  $e$  represents the change in the  $e$  from the best fit required to increase the best-fit  $\chi^2$  by 1.

<sup>g</sup> The exoplanets in this system have significant interactions, which renders Keplerian orbital elements inadequate for describing their orbits, since these elements are time variable. Lee et al. (2006) report the mean anomaly of the inner and outer planets to be 356° and 227°, respectively, at a Julian Date of 2,451,185.1.

<sup>h</sup> This transit ephemeris is expressed as a Heliocentric Julian Date.

<sup>i</sup> Charbonneau et al. (2005) find  $e \cos \omega = 0.003 \pm 0.0019$ .

<sup>j</sup> The exoplanets in this system have significant interactions, which renders Keplerian orbital elements inadequate for describing their orbits, since these elements are time variable. Correia et al. (2005) report the mean longitude to be  $266.23 \pm 0.06$  and  $30.59 \pm 2.84$  for the inner and outer planets, respectively, at a Julian Date of 2,452,250.

<sup>k</sup> Laughlin et al. (2005) find  $e$  consistent with 0.

<sup>l</sup> The exoplanets in this system have significant interactions, which renders Keplerian orbital elements inadequate for describing their orbits, since these elements are time variable. Rivera et al. (2005) report the mean anomaly of the b, c, and d components at JD 2,452,490.0 to be  $175.5 \pm 6.0$ ,  $308.5 \pm 1.4$ , and  $309.5 \pm 5.1$ , respectively.

REFERENCES.—(As4) Alonso et al. 2004; (Bc5) Bouchy et al. 2005b; (Bf5) Bonfils et al. 2005; (Bu6) this paper; (Cb6) Charbonneau et al. 2006; (Cc4) Cochran et al. 2004; (Cr5) Correia et al. 2005; (Da6) da Silva et al. 2006; (De8) Delfosse et al. 1998; (Ed4) Endl et al. 2004; (Ed6) Endl et al. 2006; (Eg6) Eggenberger et al. 2006; (Fi2) Fischer et al. 2002; (Fi5) Fischer et al. 2005; (Fi6) Fischer et al. 2006; (Ga5) Galland et al. 2005; (Ge6) Ge et al. 2006, <http://vo.obspm.fr/exoplanetes/encyclo/planet.php?p1=HD+102195&p2=b>; (H0) Hatzes et al. 2000; (H3) Hatzes et al. 2003; (Jh6) J. A. Johnson et al. 2006, in preparation; (Jo6) Jones et al. 2006; (K0) Korzennik et al. 2000; (LC6) Lo Curto et al. 2006; (Le6) Lee et al. 2006; (Lt9) Latham et al. 1989; (Lv5) Lovis et al. 2005; (MA4) McArthur et al. 2004; (MC4) McCarthy et al. 2004; (Mo5) Moutou et al. 2005; (My3) [http://obswww.unige.ch/~naef/planet/geneva\\_planets.html](http://obswww.unige.ch/~naef/planet/geneva_planets.html); (My4) Mayor et al. 2004; (Nf1) Naef et al. 2001a; (Nf1b) Naef et al. 2001b; (Nf3) Naef et al. 2003; (Nf4) Naef et al. 2004; (Ny7) Noyes et al. 1997; (Pp2) Pepe et al. 2002; (Pp4) Pepe et al. 2004; (Pr3) Perrier et al. 2003; (Q0) Queloz et al. 2000; (R5) Rivera et al. 2005; (Sn1) Santos et al. 2001; (Sn3) Santos et al. 2003 (also available via the VizieR Online Data Catalog J/A+A/398/363); (Sn4b) Santos et al. 2004b; (St3) Sato et al. 2003; (St5) Sato et al. 2005; (Sw3) Setiawan et al. 2003; (Sw5) Setiawan et al. 2005; (Sz6) Sozzetti et al. 2006; (T6) Tinney et al. 2006; (U0) Udry et al. 2000; (U2) Udry et al. 2002; (U3) Udry et al. 2003a; (U3b) Udry et al. 2003b; (U6) Udry et al. 2006; (Vo5) Vogt et al. 2005; (W4) Wittenmyer et al. 2004; (Wr6) J. T. Wright et al. 2006, in preparation; (Z2) Zucker et al. 2002; (Z4) Zucker et al. 2004.

TABLE 4  
INDEPENDENT ORBITAL SOLUTIONS

PLANET		PERIOD	$K$		$\omega$	$T_p$	TREND	$M \sin i$	$a$	rms	$\sqrt{\chi^2_\nu}$	$N_{\text{obs}}$	REFERENCES
Name	Component	(days)	( $\text{m s}^{-1}$ )	$e$	(deg)	(JD $-2,440,000$ )	( $\text{m s}^{-1} \text{yr}^{-1}$ )	( $M_J$ )	(AU)	( $\text{m s}^{-1}$ )	(12)	(13)	(14)
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
HD 8574	b	277.55(77)	66(5)	0.288(53)	3.6(10.9)	11467.5(6.6)	...	2.11	0.77	13	1.4	41	Pr3
$\nu$ And	b	4.61712(9)	77.2(1.3)	0.02(23)	242(37)	10004.28(48)	...	0.75(1)	0.059	15	2.1	71	Nf4
	c	238.10(46)	63.0(1.7)	0.185(28)	214(11)	10159.4(8.0)	...	2.25(6)	0.821	...	...	...	
	d	1319(18)	63.8(2.3)	0.269(36)	248(11)	9963(53)	...	3.95(13)	2.57	...	...	...	
HD 10647	b	1040(37)	18(1)	0.18(8)	68(17)	12261(47)	...	0.91	2.1	8.2	...	72	My3
HD 13445	b	15.78(4)	380(1)	0.046(4)	270(4)	11146.7(2)	-131	4	0.11	7	...	61	Q0
$\iota$ Hor	b	311.3(1.3)	68(4)	0.22(6)	79(13)	11309(20)	...	2.24(13)	0.91	23.2	1.5	88	Nf1b
$\epsilon$ Eri	b	2502(20)	19.0(1.7)	0.608(41)	48.9(4.1)	9195(14)	0.42(20)	0.86	...	14	...	225	H0
HD 33636	b	2828(750)	168(15)	0.55(10)	340.2(6.1)	11211(22)	...	10.58	4.08	9	1.0	47	Pr3
HD 45350	b	962.1(4.4)	57.4(1.8)	0.764(11)	388.7(4.1)	11827.4(9.4)	...	1.82(14)	1.920(69)	9.05	1.16	73	Ed6
HD 50554	b	1293(37)	104(5)	0.501(30)	355.7(4.4)	11832(15)	...	5.16	2.41	11.8	1.3	41	Pr3
HD 52265	b	119.60(42)	42(1)	0.35(3)	211(6)	11422.3(1.7)	...	1.05(3)	0.5	7.3	0.84	71	Nf1b
HD 75289	b	3.5098(7)	54(1)	0.024(21)	50(49)	11355.91(48)	...	0.42	0.046	7.5	...	88	U0
55 Cnc	b	14.647(1)	78.3(1.8)	0.030(23)	63(12)	10000.80(48)	...	0.91(2)	0.115	9.0	1.4	48	Nf4
	d	4545(1421)	37.8(3.9)	0.24(13)	347(23)	10568(200)	...	2.89(47)	5.28	...	...	...	
HD 80606	b	111.81(23)	411(31)	0.927(12)	291.0(6.7)	11973.72(29)	...	3.90(9)	0.47	17.7	...	61	Nf1
HD 82943	b	435.1(1.4)	45.8(1.0)	0.18(4)	237(13)	11758(13)	...	1.84	1.18	6.8	...	142	My4
	c	219.4(2)	61.5(1.7)	0.38(1)	124(3)	12284(1)	...	1.85	0.75	...	...	...	
HD 83443	b	2.98565(3)	58.1(4)	0.013(13)	11(11)	11497.5(3)	...	3.58	0.96	9.0	...	257	My4
HD 89744	b	256.0(7)	257(14)	0.70(2)	195(3)	10994(2)	...	7.2	0.88	20.5	1.6	88	K0
HD 92788	b	325.0(5)	106.2(1.8)	0.35(1)	279(3)	11090.3(3.5)	...	3.58	0.96	...	8.0	55	My4
47 UMa	b	1100.8(7.2)	53.6(1.9)	0.097(39)	300(20)	12915(64)	...	2.76(10)	2.11	7.4	1.1	44	Nf4
HD 102117	b	20.67(4)	10.2(4)	0.00(7)	162.8(3.0)	13100.1(1)	...	0.14	0.149	0.9	...	13	Lv5
HD 106252	b	1600(18)	147(4)	0.471(28)	292.2(3.2)	11871(17)	...	7.56	2.7	10.5	1.1	40	Pr3
HD 108147	b	10.901(1)	36(1)	0.498(25)	319.0(3.0)	11591.6(1)	...	0.4	0.104	9.2	...	118	Pp2
70 Vir	b	116.689(11)	314.1(2.0)	0.397(5)	359.40(92)	8990.39(33)	...	6.56(4)	0.456	6.1	0.93	35	Nf4
HD 130322	b	10.720(7)	115(2)	0.044(18)	204(23)	11287.38(68)	...	1.02	0.088	15.4	...	118	U0
HD 137510	b	798.2(1.4)	531.6(5.3)	0.402(8)	30.8(1.2)	12582.0(2.6)	...	26.0(1.4)	1.85(5)	15	...	76	Ed4
14 Her	b	1796.4(8.3)	90.3(1.0)	0.338(11)	22.6(2.0)	9582(12)	...	4.74(6)	2.8	11.3	1.6	119	Nf4
HD 149143	b	4.088(6)	163(8)	0.08(4)	42(35)	13588.00(40)	...	1.36	0.052	13.3	...	8	Da5
HD 168746	b	6.403(1)	27(1)	0.081(29)	16(21)	11994.7(4)	...	0.23	0.065	9.8	...	154	Pp2
HD 178911	b	71.487(18)	339.3(3.1)	0.1243(75)	169.8(3.6)	10305.70(62)	...	6.292(59)	...	11	...	51	Z2
HD 187123	b	3.0966(1)	70.7(1.7)	0 <sup>a</sup>	0 <sup>a</sup>	11010.972(27)	-8.9(9)	0.52(1)	0.042	10.5	1.2	57	Nf4
HD 190360	b	3902(1758)	20(3)	0.48(20)	1(13)	10557(89)	...	1.33(19)	4.8	9.3	1.3	69	Nf3
HD 192263	b	24.348(5)	61(1)	0 <sup>a</sup>	0 <sup>a</sup>	11979.28(8)	...	0.72	0.15	12.5	...	182	Sn3
HD 196050	b	1321(54)	55.0(6.2)	0.3 <sup>a</sup>	147(12)	12045(66)	...	3.02	2.43	7.2	...	31	My4
HD 209458	b	3.5246(1)	85.1(1.0)	0 <sup>a</sup>	0 <sup>a</sup>	12765.790(21)	...	0.699(7)	0.048	14.9	1.5	187	Nf4
HD 210277	b	436.6 <sup>a</sup>	52(9)	0.342(55)	104(13)	11410(13)	...	1.73(29)	1.09	7.5	0.82	42	Nf1b
HD 213240	b	951(42)	91(3)	0.45(4)	214(7)	11520(11)	...	4.5	2.03	11	...	72	Sn1
$\rho$ Ind	b	1256(35)	34.6(5.7)	0.29(12)	63(22)	10693(13)	...	1.82	2.32	7.2	...	21	My4
51 Peg	b	4.23077(4)	57.3(8)	0 <sup>a</sup>	0 <sup>a</sup>	12497.000(22)	...	0.468(7)	0.052	11.8	1.64	153	Nf4
HD 217107	b	7.1260(5)	140(1)	0.126(9)	24.4	11452.388(79)	43.3	1.275(13)	...	7.0	...	63	Nf1b

NOTES.—For succinctness, we express uncertainties using parenthetical notation, where the least significant digit of the uncertainty, in parentheses, and that of the quantity are understood to have the same place value. Thus, “0.100(20)” indicates “0.100  $\pm$  0.020,” “1.0(2.0)” indicates “1.0  $\pm$  2.0,” and “1(20)” indicates “1  $\pm$  20.” Table 4 is also available in machine-readable form in the electronic edition of the *Astrophysical Journal*.

<sup>a</sup> Parameter held fixed in fit.

REFERENCES.—(Ed4) Endl et al. 2004; (Ed6) Endl et al. 2006; (H0) Hatzes et al. 2000; (K0) Korzennik et al. 2000; (Lv5) Lovis et al. 2005; (My3) [http://obswww.unige.ch/~naef/planet/geneva\\_planets.html](http://obswww.unige.ch/~naef/planet/geneva_planets.html); (My4) Mayor et al. 2004; (Nf1) Naef et al. 2001a; (Nf1b) Naef et al. 2001b; (Nf4) Naef et al. 2004; (Pp2) Pepe et al. 2002; (Pr3) Perrier et al. 2003; (Q0) Queloz et al. 2000; (Sn1) Santos et al. 2001; (U0) Udry et al. 2000.

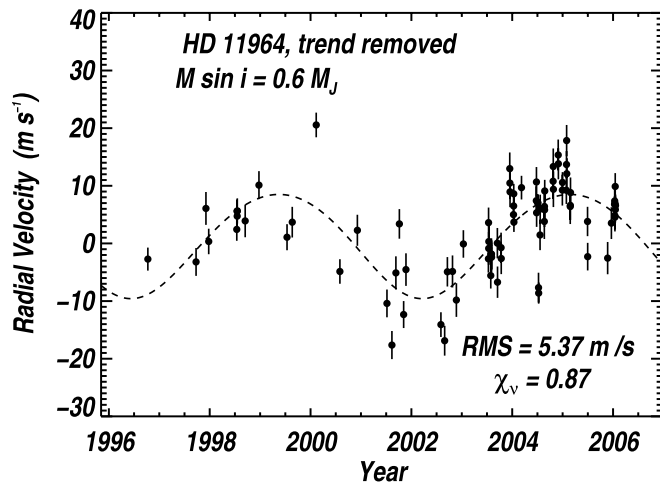


FIG. 1.—Best-fit orbit to the radial velocities measured at Keck Observatory for HD 11964, with  $P = 5.8$  yr,  $e \sim 0$ , and  $M \sin i = 0.6M_J$ .

solution is of comparable quality to that in Table 3, we reproduce it in Table 4.

## 7. NEW EXOPLANETS

We announce here five new exoplanets, HD 11964b, HD 66428b, HD 99109b, HD 107148b, and HD 164922b (see Figs. 1–5, respectively). Their orbital parameters and the properties of their host stars are listed among the other entries in the tables below. The data for these detections were obtained at Keck Observatory. All of these exoplanets orbit inactive stars ( $\log R'_{HK} < -5$ ) that are metal-rich ( $[\text{Fe}/\text{H}] > 0.1$ ).

HD 11964 is somewhat evolved, sitting 2 mag above the main sequence. The fit for HD 11964b is good, but the  $5.3 \text{ m s}^{-1}$  residuals are comparable to the  $9 \text{ m s}^{-1}$  amplitude, placing the exoplanetary interpretation of the velocity variations somewhat in doubt.

## 8. DISCUSSION

For many exoplanets we find an improved orbital solution when we superimpose a linear trend and the velocity curve. Such systems likely contain additional companions of indeterminate mass and orbital periods substantially longer than the span of the observations. When such systems are observed long enough that the radial velocity signature of these more distant companions begins to deviate from a linear trend, these fits naturally

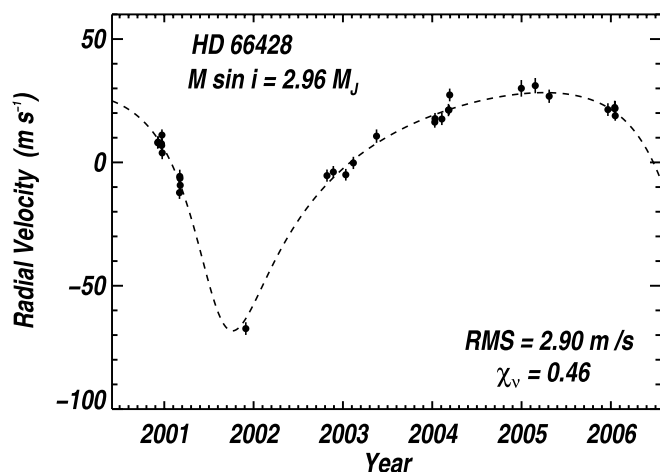


FIG. 2.—Best-fit orbit to the radial velocities measured at Keck Observatory for HD 66428, with  $P = 5.4$  yr,  $e = 0.5$ , and  $M \sin i = 3M_J$ .

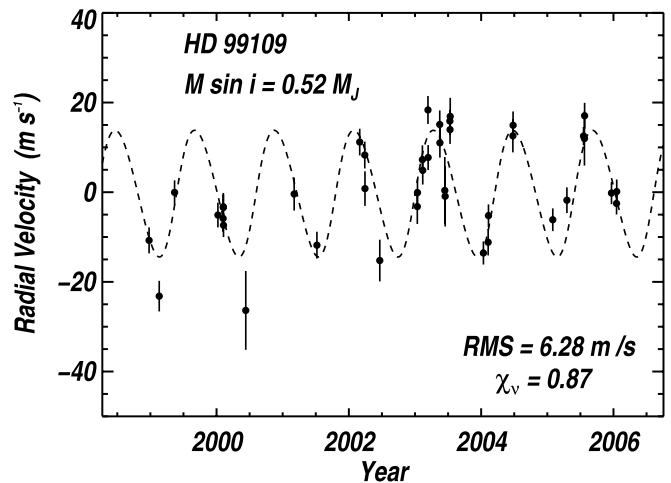


FIG. 3.—Best-fit orbit to the radial velocities measured at Keck Observatory for HD 99109, with  $P = 1.2$  yr,  $e \sim 0$ , and  $M \sin i = 0.5M_J$ .

become poor, even though double-Keplerian fits remain poorly constrained.

An excellent example is HD 13445b, which shows a strong trend of roughly  $-95 \text{ m s}^{-1}$ , consistent with the presence of a massive companion beyond 4 AU. The poor quality of the fit [ $(\chi^2_v)^{1/2} = 2.1$ ] may indicate curvature in the signal of the massive companion: indeed a double-Keplerian fit with an outer planet with  $P > 10$  yr produces a fit with an rms of  $4 \text{ m s}^{-1}$ . This may be consistent with reports of a massive companion at 20 AU (Eggenberger et al. 2003; Els et al. 2001). A second example is HD 68988, where the rms of the residuals of a double-Keplerian is  $3.3 \text{ m s}^{-1}$ , down from  $6.4 \text{ m s}^{-1}$  for a single-Keplerian plus trend model. In both of these cases the mass and period of the more distant companion are underconstrained, so the planetary nature of the companion is uncertain.

A forthcoming work (J. T. Wright et al. 2006, in preparation) will comb the archive of velocities in Table 1 for companions, such as HD 13345c and HD 68988c, of uncertain mass and orbital period.

*v And.*—The precision of the Lick data prior to 1995 is not as high as today (pre-1995 data scatter about the fit with an rms of  $\sim 100 \text{ m s}^{-1}$ ), and data before 1992 are particularly suspicious. The orbital elements in Table 3 represent a fit with data taken before 1992 excluded; Table 1 includes these pre-1992 data.

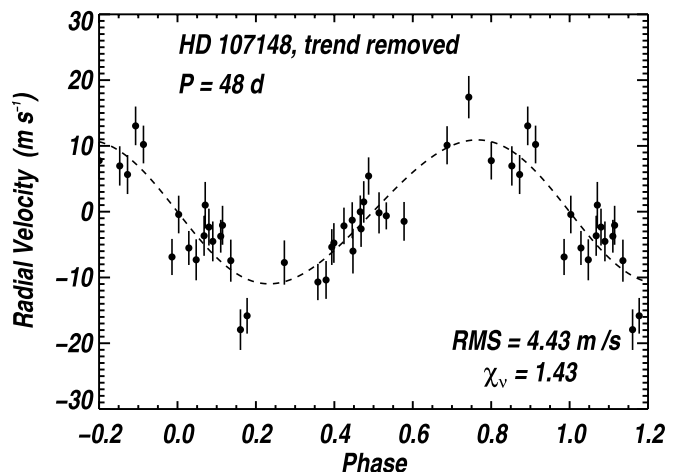


FIG. 4.—Best-fit orbit to the radial velocities measured at Keck Observatory for HD 107148, with  $P = 48$  days,  $e \sim 0$ , and  $M \sin i = 0.2M_J$ .

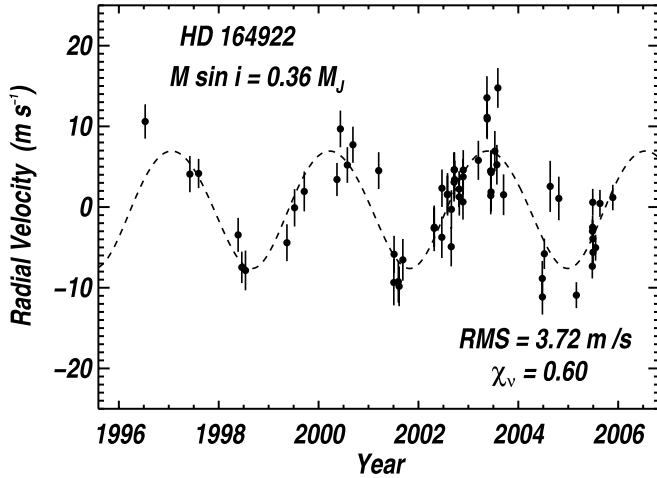


FIG. 5.—Best-fit orbit to the radial velocities measured at Keck Observatory for HD 164922, with  $P = 3.2$  yr,  $e \sim 0$ , and  $M \sin i = 0.4M_J$ .

*HD 73526b*, *HD 73526c*.—These planets are in a 2 : 1 orbital resonance. The dynamics of the system is discussed in Tinney et al. (2006).

$\tau$  Boo b.—The residuals to the fit of the 3.31 day planet orbiting  $\tau$  Boo show a trend of  $15 \text{ m s}^{-1} \text{ yr}^{-1}$  and may also show some curvature. The precision of the Lick data prior to 1995 is not as high as it is today (the fit for these times shows scatter of  $\sim 100 \text{ m s}^{-1}$ ) and may not be reliable for constraining the properties of the second companion.

*HD 149026b*.—This planet transits its parent star. Sato et al. (2005) find  $R = 0.726R_J \pm 0.064R_J$  and  $i = 85^\circ 8'_{-13}^{+16}$ . The semi-amplitude,  $K$ , and goodness-of-fit parameters in Table 3 represent the fit from data presented here, with  $P$  and  $T_t$  held fixed at the values from Charbonneau et al. (2006).

*TrES-1*.—This planet transits its parent star, 2MASS 19040985+3637574 (GSC 02652–01324). Alonso et al. (2004) find  $R = 1.08^{+0.18}_{-0.04} R_J$  and  $i = 88^\circ 5'_{-22}^{+15}$ . The semi-amplitude,  $K$ , and goodness-of-fit parameters in Table 3 represent the fit from data presented here, with  $P$  and  $T_t$  held fixed at the values from Alonso et al. (2004).

*HD 189733b*.—This planet transits its parent star. Bouchy et al. (2005b) find  $i = 85^\circ 3' \pm 0^\circ 1'$  and  $R = 1.26R_J \pm 0.03R_J$ .

*HD 209458b*.—This planet transits its parent star. Brown et al. (2001) find  $i = 86^\circ 1' \pm 0^\circ 1'$  and  $R = 1.347R_J \pm 0.06R_J$ , and Laughlin et al. (2005) find an eccentricity consistent with 0. The semi-amplitude,  $K$ , and goodness-of-fit parameters in Table 3 represent the fit from data presented here, with  $P$  and  $T_t$  held fixed at the values from Wittenmyer et al. (2004).

## 9. DISTRIBUTION OF EXOPLANETS

Figures 6–11 show the distribution of the exoplanets in this catalog. One must take care when interpreting these figures for at least two reasons: (1) selection effects make some aspects of these distributions inconsistent with the parent population of exoplanets, and (2) the selection effects of the various planet search programs are different. Marcy et al. (2005a) analyze the properties and distribution of planets detected around 1330 FGKM dwarfs monitored at Lick, Keck, and the AAT and discuss the biases in and uniformity of that sample. The figures presented here are best interpreted as describing the distribution of properties of the known exoplanets as drawn from multiple, non-uniform samples, as opposed to that of the parent population of exoplanets.

The target list for the California & Carnegie and Anglo-Australian planet searches has been published in Wright et al. (2004), Nidever et al. (2002), and Jones et al. (2002). A complete target list for the Geneva group is not public and not recoverable, although a list of HARPS target stars is currently available on the ESO Web site.<sup>13</sup> Both searches may be considered roughly magnitude limited within a set of  $B - V$  bins excluding giant stars, but both groups have also added additional stars using other criteria (such as metallicity).

Figure 6 shows the minimum mass distribution of the 167 known nearby exoplanets with  $M \sin i < 15 \text{ AU}$ . The mass distribution shows a dramatic decrease in the number of planets at high masses, a decrease that is roughly characterized by a power law,  $dN/dM \propto M^{-1.1}$ , affected very little by the unknown  $\sin i$  (Jorissen et al. 2001). We have calculated the exponent in this power law with a linear least-squares fit to the logarithm of the mass distribution assuming Poisson errors. We neglected uncertainties in the masses of the planets due to uncertainties in stellar masses and the  $\sin i$  ambiguity. For this reason, and because the surveys that detected these planets have heterogeneous selection effects, we regard this power law simply as a rough description of the distribution of known planets. A. Cumming et al. (2006, in preparation) find, for the more uniform sample of the California & Carnegie planet search, that the distribution of planets with  $P > 100$  days is well fitted with a broken power law:

$$dN/dM \propto \begin{cases} M^{-1.2}, & M < 0.6M_J, \\ M^{-1.9}, & M > 0.6M_J. \end{cases} \quad (3)$$

The low end of this distribution suffers from a selection effect common to all Doppler surveys: low-mass planets induce small velocity variations and so are difficult to detect and underrepresented in Figure 6. Massive planets are easier to detect, making the apparent paucity of planets with  $M > 3M_J$  and that of objects with  $M > 12M_J$  (the “brown dwarf desert”) real.

Figure 7 shows the orbital distance distribution of the 167 known nearby exoplanets with  $0.03 \text{ AU} < a < 10 \text{ AU}$ . Since orbital distance is a function of orbital period, the existing Doppler

<sup>13</sup> See <http://www.eso.org/observing/proposals/gto/harps>.

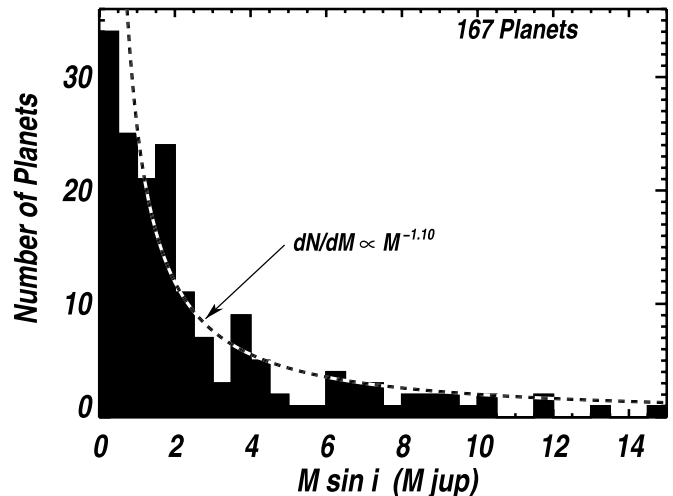


FIG. 6.—Minimum mass distribution of the 167 known nearby exoplanets with  $M \sin i < 15M_J$ . The mass distribution shows a dramatic decrease in the number of planets at high masses, a decrease that is roughly characterized by a power law,  $dN/dM \propto M^{-1.16}$ . Lower mass planets have smaller Doppler amplitudes and are thus more difficult to detect. This distribution represents results from many surveys and so is drawn from an inhomogeneous sample.

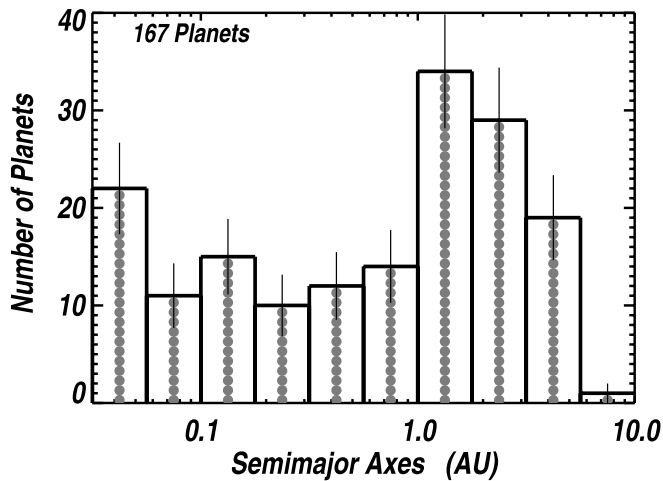


FIG. 7.—Orbital distance distribution of the 167 known nearby exoplanets with  $0.03 \text{ AU} < a < 10 \text{ AU}$  in logarithmic distance bins. Planets with  $a > 3 \text{ AU}$  have periods comparable to or longer than the length of most Doppler surveys, so the distribution is incomplete beyond that distance. This distribution represents results from many surveys and so is drawn from an inhomogeneous sample.

surveys are increasingly incomplete for  $a \gtrsim 3 \text{ AU}$ , corresponding to  $P \gtrsim 5 \text{ yr}$ . Note that the abscissa is logarithmic. Among the 1330 FGKM dwarfs studied by Marcy et al. (2005a), the occurrence rate of planets within 0.1 AU is 1.2%. A modest (flat) extrapolation beyond 3 AU (in logarithmic bins) suggests that there exist roughly as many planets at distances between 3 and 30 AU as below 3 AU, making the occurrence of giant planets roughly 12% within 30 AU. The rapid rise of planet frequency with semimajor axis beyond 0.5 AU portends a large population of Jupiter-like planets beyond 3 AU.

Figure 8 shows the distribution of periods among the known nearby “hot jupiters.” There is a clear “pileup” of planets with orbital periods near 3 days, suggesting that whatever orbital migration mechanism brings these giant planets close to their parent stars ceases when they reach this period. Alternatively, some breaking mechanism may stop them there, or may weaken inward of the distance, sending the planets into the star. Note that the Doppler surveys generally have uniform sensitivity to hot jupiters at all

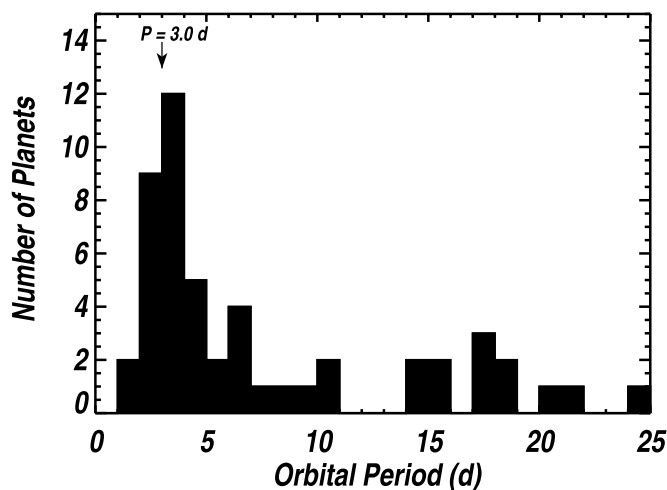


FIG. 8.—Distribution of periods among the known nearby hot jupiters. There is a clear pileup of planets with orbital periods near 3 days. Doppler surveys generally have uniform sensitivity to hot jupiters, so for massive planets there is no important selection effect contributing to the 3 day pileup. This distribution represents results from many surveys and so is drawn from an inhomogeneous sample.

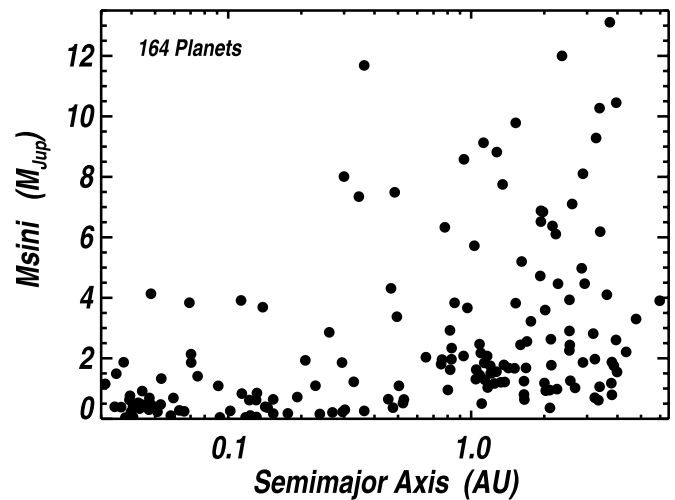


FIG. 9.—Minimum mass as a function of semimajor axis for the 164 known nearby exoplanets with  $0.03 \text{ AU} < a < 6.5 \text{ AU}$ . Doppler surveys are generally incomplete for exoplanets with  $a > 3 \text{ AU}$ , low-mass planets ( $M \sin i < 1M_J$ ) beyond 1 AU, and very low mass planets ( $M \sin i < 0.1M_J$ ) everywhere. This plot represents results from many surveys and so is drawn from an inhomogeneous sample.

of the orbital periods in Figure 8, so for massive planets there is no important selection effect contributing to the 3 day pileup.

Figure 9 shows minimum mass as a function of semimajor axis for the 164 known nearby exoplanets with  $0.03 \text{ AU} < a < 6.5 \text{ AU}$ . There is a dearth of close-in exoplanets with high mass that cannot be due to a selection effect since high-mass planets have large Doppler signatures; indeed Doppler surveys are generally complete with respect to high-mass, close-in exoplanets. Selection effects make detection of low-mass planets beyond 1 AU difficult, however, so it is not clear that the mass distribution for planets beyond 1 AU is different from that of hot jupiters.

Figure 10 shows orbital eccentricity as a function of semimajor axis for 168 known nearby exoplanets. Planets within 0.1 AU are nearly always on circular or nearly circular orbits, presumably due to tidal circularization. Beyond 0.3 AU, the

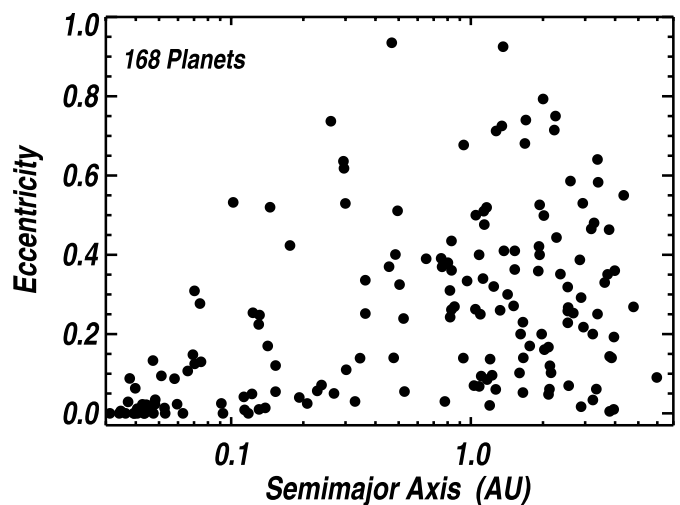


FIG. 10.—Orbital eccentricity as a function of semimajor axis for the 168 known nearby exoplanets. Planets within 0.1 AU are presumably tidally circularized. Beyond 0.1 AU, the distribution of eccentricities appears essentially uniform between 0 and 0.8. For most Doppler surveys, sensitivity is not a strong function of eccentricity for  $0 < e < 0.8$  and  $a < 3 \text{ AU}$ . This plot represents results from many surveys and so is drawn from an inhomogeneous sample.



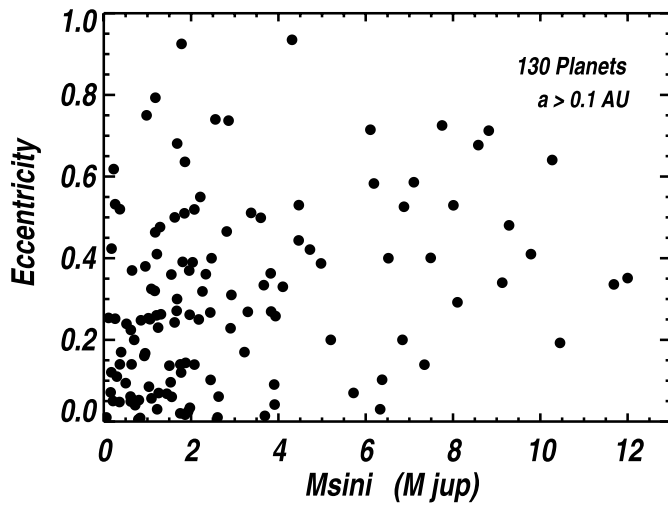


FIG. 11.—Distribution of orbital eccentricities as a function of minimum mass for the 130 known nearby exoplanets with  $M \sin i < 13M_J$ , excluding those for which  $a < 0.1$  AU, i.e., those planets that may have been tidally circularized. High-mass exoplanets ( $M \sin i > 5M_J$ ) have a slightly higher median eccentricity than lower mass exoplanets. The completeness of Doppler surveys increases with  $M \sin i$  and is generally insensitive to eccentricity. This distribution represents results from many surveys and so is drawn from an inhomogeneous sample.

distribution of eccentricities appears essentially uniform between 0 and 0.8. For most Doppler surveys, sensitivity is not a strong function of eccentricity for  $0 < e < 0.7$  and  $a < 3$  AU.

Figure 11 shows orbital eccentricity as a function of minimum mass for nearby exoplanets with  $M \sin i < 13M_J$ . We have excluded those planets that may have been tidally circularized, i.e., those for which  $a < 0.1$  AU. This figure shows no strong correlation between eccentricity and mass, but close inspection shows that high-mass exoplanets ( $M \sin i > 5M_J$ ) have a higher median eccentricity than lower mass exoplanets.

## 10. CONCLUSIONS

We have remeasured precise orbital elements for planets orbiting stars for which we have precision radial velocity data from Keck, Lick, and AAO using the latest data and improved data reduction techniques. In addition, we have compiled the pub-

lished orbital parameters of all other exoplanets within 200 pc, as well as spectroscopically derived stellar parameters of their host stars. Finally, we present four new extrasolar planets, bringing to 172 the total of known exoplanets in this catalog with a minimum mass  $M \sin i < 24M_J$ .

The 172 known exoplanets span a range of eccentricities, which weakly correlate with minimum planetary mass. Planets within 0.1 AU are nearly always in circular orbits, presumably due to tidal circularization. The 3 day pileup and the brown dwarf desert are both strongly apparent and unaffected by the important observational biases. Finally, the mass distribution increases sharply toward lower masses (roughly as the inverse of the minimum planetary mass) and toward larger orbital distance. Since these regions are where current surveys are most incomplete, this implies that many more low-mass and long-period planets await discovery as Doppler surveys cover a longer time baseline and become more precise. A forthcoming work will discuss some more speculative exoplanet candidates of this nature just emerging from our planet searches.

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The authors wish to recognize and acknowledge the very significant cultural role and reverence that the summit of Mauna Kea has always had within the indigenous Hawaiian community. We are most fortunate to have the opportunity to conduct observations from this mountain.

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