Extrasolar planets in stellar multiple systems

T. Roell[1], R. Neuhäuser[1], A. Seifahrt[1,2,3], and M. Mugrauer[1]

[1] Astrophysical Institute and University Observatory Jena, Schillergäßchen 2, 07745 Jena, Germany
   e-mail: troell@astro.uni-jena.de
[2] Physics Department, University of California, Davis, CA 95616, USA
[3] Department of Astronomy and Astrophysics, University of Chicago, IL 60637, USA

ABSTRACT

Aims. Analyzing exoplanets detected by radial velocity (RV) or transit observations, we determine the multiplicity of exoplanet host stars in order to study the influence of a stellar companion on the properties of planet candidates.
Methods. Matching the host stars of exoplanet candidates detected by radial velocity or transit observations with online multiplicity catalogs in addition to a literature search, 57 exoplanet host stars are identified having a stellar companion.
Results. The resulting multiplicity rate of at least 12 % for exoplanet host stars is about four times smaller than the multiplicity of solar like stars in general. The mass and the number of planets in stellar multiple systems depend on the separation between their host star and its nearest stellar companion, e.g. the planetary mass decreases with an increasing stellar separation. We present an updated overview of exoplanet candidates in stellar multiple systems, including 15 new systems (compared to the latest summary from 2009).

Key words. extrasolar planets – stellar multiple systems – planet formation

1. Introduction

More than 700 extrasolar planet (exoplanet) candidates were discovered so far (Schneider et al. 2011, www.exoplanet.eu), but the knowledge of their properties is strongly affected by observational bias and selection effects. Taking the solar system as an archetype, the target lists of exoplanet search programs so far originally consist of mostly single and solar like stars (regarding the spectral type and age). But the first planet candidate detected by the RV technique was found around the primary of the close spectroscopic binary γ Cep (Campbell et al. 1988; Hatzes et al. 2003; Neuhäuser et al. 2007), which demonstrates the existence of planets in binaries.

In the last years, imaging campaigns found stellar companions around several dozen exoplanet host stars formerly believed to be single stars (see e.g. Raghavan et al. 2006; Mugrauer & Neuhäuser 2009, and references therein). Most of these exoplanet candidates are in the S-type orbit configuration (exoplanet surrounding one stellar component of a binary), while the orbit of a planet around both stellar binary components is called P-type orbit. Such circumbinary planets are detectable by measuring eclipse timing variations as done for NN Ser (Beuermann et al. 2010), HW Vir (Lee et al. 2009), DP Leo (Qian et al. 2010), HU Aqr (Qian et al. 2011; Hinse et al. 2012), and UZ For (Dai et al. 2010; Potter et al. 2011). Kepler-16 (AB)b, Kepler-34 (AB)b, and Kepler-35 (AB)b are detected by measuring the transit lightcurve and eclipse timing variations (Doyle et al. 2011; Welsh et al. 2012), thus these are confirmed circumbinary planets. Due to a different formation and evolution scenario for planets in a P-type orbit (compared to the more common S-type orbit), this paper only considers exoplanets found in a S-type orbit.

Multiplicity studies, as done by Mugrauer et al. (2007b) or Eggenberger et al. (2007), are looking for stellar companions around exoplanet host stars by direct imaging. As summarized in Mugrauer & Neuhäuser (2009), these studies found 44 stellar companions around stars previously not known to be multiple, which results in a multiplicity rate of about 17 %, while Raghavan et al. (2006) found a host star multiplicity of about 23 %. The multiplicity rate of solar like stars[1] was determined by Raghavan et al. (2010) to (46 ± 2) %. Duquennoy & Mayor (1991) measured the multiplicity of 164 nearby G-dwarfs (within 22 pc) to 44 % (57 % considering incompleteness).

2. Extrasolar planets in stellar multiple systems

The Deuterium Burning Minimum Mass (DBMM) of 13 $M_{\rm Jup}$ is currently the most common criterion to distinguish a brown dwarf from a planet. However, we make use of the *Extrasolar Planets Encyclopaedia* (hereafter EPE) in this paper and thus apply the definition of Schneider et al. (2011) who includes all confirmed substellar companions with a mass of less than 25 $M_{\rm Jup}$ within a 1σ uncertainty. Due to a missing publication of the planet detection, the exoplanet candidates GJ 433 b, ρ CrB b, 91 Aqr b, ν Oph b&c, τ Gem b, HD 59686 b, HD 106515A b, HD 20781 b&c, and HD 196067 b are not included in this paper. Also, the stellar binary HD 176051, where Muterspaugh et al. (2010) detected the astrometric signal of an exoplanet around one of the two stellar components, is not included in this study: Because the planet was found by ground based astrometric observation (using an optical interferometer), this detection still need to be confirmed by other techniques and the final planetary mass depends on which of the stellar components is the host star.

The multiplicity of an exoplanet host star is defined (in this paper) by either a published common proper motion or an entry in the *Catalogue of Components of Double and Multiple Stars* (hereafter CCDM) by Dommanget & Nys (2000). In case, the

---

[1] defined as all main-sequence stars with a spectral type from F6 to K3 within 25 parsec, see Raghavan et al. (2010)
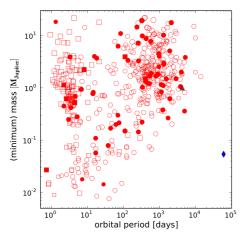
Fig. 1. The (minimum) mass of extrasolar planets detected by RV (circles) or transit (squares) observations over their orbital period. Exoplanets around single stars are shown as open markers, while exoplanets in stellar multiple systems are coded by filled symbols. Jupiter is shown as a filled triangle and the filled diamond marks Neptune.

Fig. 2. Mass distribution of exoplanets detected by RV or transit observations around single stars (left column), in stellar multiple systems (middle column), and for all kind of host stars (right column) fitted by a power law (dashed line, upper values) and a log-normal distribution (solid line, lower values)

stellar multiplicity is only mentioned in the CCDM, all stellar components were checked on common proper motion using other catalogs (see appendix). By searching the literature and matching the host stars of exoplanet candidates detected with transit or RV observations listed in the EPE (date: 2012/02/08) with the CCDM, 57 stellar multiple systems (47 double and 10 triple systems) with at least one exoplanet out of 477 systems in total are identified. The resulting multiplicity rate of about 12 % is less than previously published values (see table 1). An explanation for that can be the increasing number of transiting exoplanets in the last years, which are included in this paper but excluded by previous studies. The host star multiplicity of transiting exoplanets is most likely still underestimated, because multiplicity studies around such host stars, like done by Daemgen et al. (2009), have just recently started.

Table 1. Multiplicity of solar like and exoplanet host stars.

Multiple	Single	Double	Triple or higher	Reference
		solar like stars		
46 %	54 %	34 %	9 %	1
44 %	56 %	38 %	4 %	2
		exoplanet host stars		
22.9 %	77.1 %	19.8 %	3.1 %	3
17.2 %	82.8 %	14.8 %	2.4 %	4
11.95 %	88.05 %	9.85 %	2.1 %	5

1: Raghavan et al. (2010), 2: Duquennoy & Mayor (1991)
3: Raghavan et al. (2006), 4: Mugrauer & Neuhäuser (2009)
5: this work

The complete list of the 57 multiple systems harboring exoplanet candidates can be found in the tables A.4, A.5, and A.6. Furthermore, the proper motions of all these stars gathered from online catalogs are shown in the tables A.1, A.2, and A.3. The latest published summary, done by Mugrauer & Neuhäuser (2009), listed 44 planetary systems in a stellar multiple system. However, two of these systems are excluded in this study, namely HD 156846 AB (after Reffert & Quirrenbach (2011) published astrometric mass limits of $m_{pl} = (10.5 \ldots 660.9)\,M_{Jup}$,
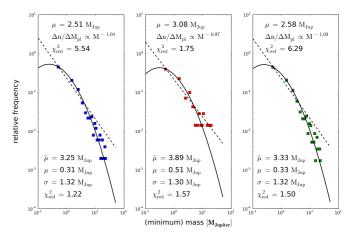
the EPE planetary status changed to unconfirmed), and 91 Aqr (the planet detection itself is still not published in a refereed paper). In addition to that 42 systems, 15 new systems are listed and marked by the symbol ¤ in the tables A.4, A.5, and A.6.

3. Comparison of extrasolar planets in stellar multiple systems and around single stars

Marcy et al. (2005a) fitted the histogram of all known RV exoplanet minimum masses by a simple power-law and found an exponent of -1.05 for the mass distribution. That exponent is in good agreement with a sample of synthetic exoplanets detectable by current RV observations modeled by Mordasini et al. (2009). In our work, planets currently found by RV or transit observations are analyzed (see Fig. 1). Using also a simple power-law (see Fig. 2), an exponent of -1.03 was found for the mass distribution of all exoplanet candidates, which is similar to the results of previous works. For exoplanet candidates in stellar multiple systems and around single stars, the exponent is -0.97 and -1.04, respectively. The mean of the planetary masses is about 2.5 M_{Jup} for planets around single stars and 3.1 M_{Jup} for the case of stellar multiplicity. In addition to the power-law, we also fit a log-normal distribution to the planetary masses. The probability distribution function (PDF) and the expectation value $\hat{\mu}$ of a log-normal distribution for a measure x can be calculated by

$$\mathrm{PDF}(x, \mu, \sigma) = e^{-\frac{(\ln x - \mu)^2}{2\sigma^2}} / (x\,\sigma\,\sqrt{2\pi}), \quad \hat{\mu} = e^{\mu + \sigma^2/2} \quad (1)$$

where μ and σ are the mean value and the standard deviation of the distribution. To determine the χ^2 value (shown in Fig. 2) the Python package "SciPy" (Jones et al. 2001) was used.

As one can see in Fig 2, the log-normal fit results in a better χ^2_{red} than the power-law fit. The expectation values for the mass of exoplanets around single stars and in stellar multiple systems differ, hence the power-law as well as the log-normal fit lead to the conclusion that the mass distribution of exoplanets in stellar multiple systems are pushed towards higher planetary masses, compared to the mass distribution of exoplanets around single stars.

However, the statistic of the exoplanet host star multiplicity is still affected by observational bias and selection effects of the originally planet search programs. Most multiplicity studies so

Table 2. Critical semi-major axis a_{crit} for planets in close stellar binaries, calculated according to Holman & Wiegert (1999).
§ ... HD 19994 B itself is a close stellar binary with a total mass of $M_{BC} = 0.9\,M_\odot$ (Roell et al. 2011).
‡ ... Values for eccentricity and semi-major axis of HD 19994 are taken from Eggenberger et al. (2004).

Host star	M_{host} [$M_\odot$]	M_{comp} [$M_\odot$]	μ_{bin}	e_{bin}	a_{bin} [AU]	a_{crit} [AU]	e_{pl}	a_{pl} [AU]	$r_{pl}^{apastron}$ [AU]	References
γ Cep A	1.40	0.41	0.23	0.41	20.2	3.86	0.05	2.05	2.15	Neuhäuser et al. (2007)
HD 41004 A	0.70	0.42	0.38	0.40	20.0	3.38	0.39	1.60	2.28	Chauvin et al. (2011)
HD 196885 A	1.33	0.45	0.25	0.42	21.0	3.84	0.48	2.60	3.85	Chauvin et al. (2011)
HD 126614 A	1.15	0.32	0.22	≤ 0.6	36.2	≥ 4.24	0.41	2.35	3.13	Howard et al. (2010)
HD 19994 A	1.34	0.90§	0.40	0.0‡	~ 100‡	~ 31	0.30	1.42	1.85	Roell et al. (2011); Mayor et al. (2004)

far were carried out after the planet detection. Hence, most of the host stars are solar like (regarding the age and spectral type), but they are also originally selected as single stars. To avoid the adaption of such selection effects, systematic searches for planets in stellar multiple systems, like described in Desidera et al. (2007) or Roell et al. (2010), are needed.

4. Influence of a close stellar companion on planet properties

In the previous section, the difference in the mass of exoplanets around single stars and in stellar multiple systems was discussed. In order to unveil the cause of this difference, a closer look on the influence of a stellar companion around the exoplanet host star is advisable. In Fig. 3 we plot the planetary (minimum) mass over the projected separation of the exoplanet host star and its nearest stellar companion. Because all systems analyzed in this paper are hierarchical, the exoplanet host star and its nearest stellar companion can be treated as a binary system. The order of the stellar multiplicity is not relevant, but the planetary minimum mass decreases with an increasing projected stellar separation (dashed line in Fig. 3). Furthermore, multi-planet systems are only present in stellar systems with a projected stellar separation larger than about 100 AU and up to now, no planet was found in a stellar binary with a projected separation of less than 10 AU. The two planets below the dashed line in Fig. 3 are the planetary system around GJ 667 C, a component of a hierarchical triple star system at a distance of 7 pc. The true semi-major axis is likely
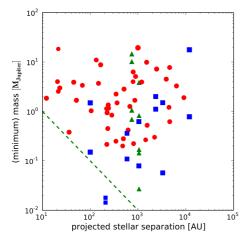

Fig. 3. Planetary (minimum) mass over the projected separation of the exoplanet host star and its nearest stellar companion. The markers represent the number of planets per system (dots ... one planet, squares ... two planets, triangles ... three or more planets). The size of the symbols represent the mass of the exoplanet host star.
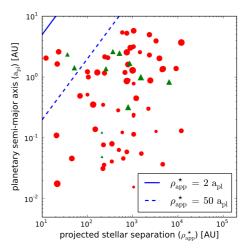

Fig. 4. Planetary semi-major axis over the projected stellar separation (dots ... stellar binary, triangles ... triple star). The five systems in the upper left ($\rho_{app}^\star < 50\,a_{pl}$) are shown in more detail in table 2. The size of the symbols represent the (minimum) mass of the exoplanet.

larger than the measured projected separation and the true planetary mass could also be larger than the measured minimum mass. These observational bias effects could explain, why GJ 667 C is the only system left of that dashed line in Fig. 3.

Holman & Wiegert (1999) determine a formula to calculate the critical semi-major axis a_{crit} for a stable planetary orbit coplanar to the stellar orbit with the semi-major axis a_{bin}, which varies from $a_{crit} \simeq (0.02 \ldots 0.45)\,a_{bin}$, depending on the mass ratio μ_{bin} and the eccentricity e_{bin} of the stellar binary. Table 2 listed the five systems, where the apparent separation is less than 50 times the planetary semi-major axis (see Fig. 4) including the corresponding critical semi-major axis. Except for the exoplanet HD 196885 Ab, which grazes an "unstable region" during the apastron passage, all these systems are clearly stable. However, considering the age of the F8V star HD 196885 A of 2.0 ± 0.5 Gyr (Correia et al. 2008), the planetary system can also be regarded as long-term stable.

5. Summary

Analyzing the host star multiplicty of exoplanets detected by RV or transit observations, 57 exoplanet host stars with stellar companions are identified and presented in the appendix, including 15 new systems (compared to the latest published summary in 2009). The resulting multiplicity rate for exoplanet host stars of at least 12 % is about four times smaller than the multiplicity of solar like stars. No planet is found so far in stellar binaries with a projected separation of less than 10 AU and multi-planet systems

3

were only found in stellar systems with a projected separation larger than 100 AU. The planetary (minimum) mass decreases with an increasing projected stelllar separation.

References

Anglada-Escudé, G., Arriagada, P., Vogt, S. S., et al. 2012, ArXiv e-prints: 2012arXiv1202.0446A
Bakos, G. Á., Noyes, R. W., Kovács, G., et al. 2007, ApJ, 656, 552
Bakos, G. Á., Pál, A., Latham, D. W., Noyes, R. W., & Stefanik, R. P. 2006, ApJ, 641, L57
Beuermann, K., Hessman, F. V., Dreizler, S., et al. 2010, A&A, 521, L60+
Bouchy, F., Udry, S., Mayor, M., et al. 2005, A&A, 444, L15
Burke, C. J., McCullough, P. R., Valenti, J. A., et al. 2007, ApJ, 671, 2115
Butler, R. P., Marcy, G. W., Fischer, D. A., et al. 1999, ApJ, 526, 916
Butler, R. P., Marcy, G. W., Vogt, S. S., et al. 2003, ApJ, 582, 455
Butler, R. P., Marcy, G. W., Williams, E., Hauser, H., & Shirts, P. 1997, ApJ, 474, L115+
Butler, R. P., Tinney, C. G., Marcy, G. W., et al. 2001, ApJ, 555, 410
Butler, R. P., Wright, J. T., Marcy, G. W., et al. 2006, ApJ, 646, 505
Campbell, B., Walker, G. A. H., & Yang, S. 1988, ApJ, 331, 902
Chauvin, G., Beust, H., Lagrange, A.-M., & Eggenberger, A. 2011, A&A, 528, A8
Chauvin, G., Lagrange, A., Udry, S., & Mayor, M. 2007, A&A, 475, 723
Chauvin, G., Lagrange, A.-M., Udry, S., et al. 2006, A&A, 456, 1165
Cochran, W. D., Hatzes, A. P., Butler, R. P., & Marcy, G. W. 1997, ApJ, 483, 457
Correia, A. C. M., Udry, S., Mayor, M., et al. 2008, A&A, 479, 271
Daemgen, S., Hormuth, F., Brandner, W., et al. 2009, A&A, 498, 567
Dai, Z.-B., Qian, S.-B., Fernández Lajús, E., & Baume, G. L. 2010, MNRAS, 409, 1195
Desidera, S. & Barbieri, M. 2007, A&A, 462, 345
Desidera, S., Carolo, E., Gratton, R., et al. 2011, A&A, 533, A90
Desidera, S., Gratton, R., Endl, M., et al. 2007, ArXiv e-prints: 2007arXiv0705.3141D
Dommanget, J. & Nys, O. 2000, A&A, 363, 991
Doyle, L. R., Carter, J. A., Fabrycky, D. C., et al. 2011, Science, 333, 1602
Dumusque, X., Lovis, C., Ségransan, D., et al. 2011, A&A, 535, A55
Duquennoy, A. & Mayor, M. 1991, A&A, 248, 485
Eggenberger, A., Mayor, M., Naef, D., et al. 2006, A&A, 447, 1159
Eggenberger, A., Udry, S., Chauvin, G., et al. 2007, A&A, 474, 273
Eggenberger, A., Udry, S., & Mayor, M. 2003, in Astronomical Society of the Pacific Conference Series, Vol. 294, Scientific Frontiers in Research on Extrasolar Planets, ed. D. Deming & S. Seager, 43–46
Eggenberger, A., Udry, S., & Mayor, M. 2004, A&A, 417, 353
Fischer, D., Driscoll, P., Isaacson, H., et al. 2009, ApJ, 703, 1545
Fischer, D. A., Butler, R. P., Marcy, G. W., Vogt, S. S., & Henry, G. W. 2003a, ApJ, 590, 1081
Fischer, D. A., Laughlin, G., Marcy, G. W., et al. 2006, ApJ, 637, 1094
Fischer, D. A., Marcy, G. W., Butler, R. P., Vogt, S. S., & Apps, K. 1999, PASP, 111, 50
Fischer, D. A., Marcy, G. W., Butler, R. P., et al. 2001, ApJ, 551, 1107
Fischer, D. A., Marcy, G. W., Butler, R. P., et al. 2003b, ApJ, 586, 1394
Fischer, D. A., Vogt, S. S., Marcy, G. W., et al. 2007, ApJ, 669, 1336
Forveille, T., Bonfils, X., Lo Curto, G., et al. 2011, A&A, 526, A141+
Ginski, C., Mugrauer, M., Seeliger, M., & Eisenbeiss, T. 2012, MNRAS, 421, 2498
Guenther, E. W., Hartmann, M., Esposito, M., et al. 2009, A&A, 507, 1659
Han, I., Lee, B. C., Kim, K. M., et al. 2010, A&A, 509, A24+
Hatzes, A. P., Cochran, W. D., Endl, M., et al. 2003, ApJ, 599, 1383
Hinse, T. C., Lee, J. W., Goździewski, K., et al. 2012, MNRAS, 420, 3609
Høg, E., Fabricius, C., Makarov, V. V., et al. 2000, A&A, 355, L27
Holman, M. J. & Wiegert, P. A. 1999, AJ, 117, 621
Howard, A. W., Johnson, J. A., Marcy, G. W., et al. 2010, ApJ, 721, 1467
Johnson, J. A., Marcy, G. W., Fischer, D. A., et al. 2006, ApJ, 652, 1724
Jones, E., Oliphant, T., Peterson, P., et al. 2001, SciPy: Open source scientific tools for Python
Jones, H. R. A., Butler, R. P., Tinney, C. G., et al. 2006, MNRAS, 369, 249
Jones, H. R. A., Paul Butler, R., Marcy, G. W., et al. 2002, MNRAS, 337, 1170

Kharchenko, N. V. 2001, Kinematika i Fizika Nebesnykh Tel, 17, 409
Korzennik, S. G., Brown, T. M., Fischer, D. A., Nisenson, P., & Noyes, R. W. 2000, ApJ, 533, L147
Latham, D. W., Stefanik, R. P., Mazeh, T., Mayor, M., & Burki, G. 1989, Nature, 339, 38
Lee, J. W., Kim, S., Kim, C., et al. 2009, AJ, 137, 3181
Liu, Y.-J., Sato, B., Zhao, G., et al. 2008, ApJ, 672, 553
Lo Curto, G., Mayor, M., Benz, W., et al. 2010, A&A, 512, A48+
Lo Curto, G., Mayor, M., Clausen, J. V., et al. 2006, A&A, 451, 345
Lovis, C., Mayor, M., Bouchy, F., et al. 2005, A&A, 437, 1121
Lowrance, P. J., Kirkpatrick, J. D., & Beichman, C. A. 2002, ApJ, 572, L79
Marcy, G., Butler, R. P., Fischer, D., et al. 2005a, Progress of Theoretical Physics Supplement, 158, 24
Marcy, G. W., Butler, R. P., Fischer, D. A., et al. 2002, ApJ, 581, 1375
Marcy, G. W., Butler, R. P., & Vogt, S. S. 2000, ApJ, 536, L43
Marcy, G. W., Butler, R. P., Vogt, S. S., et al. 2005b, ApJ, 619, 570
Mayor, M., Udry, S., Naef, D., et al. 2004, A&A, 415, 391
McAlister, H. A., Hartkopf, W. I., Hutter, D. J., & Franz, O. G. 1987, AJ, 93, 688
McArthur, B. E., Endl, M., Cochran, W. D., et al. 2004, ApJ, 614, L81
Mordasini, C., Alibert, Y., Benz, W., & Naef, D. 2009, A&A, 501, 1161
Moutou, C., Hébrard, G., Bouchy, F., et al. 2009, A&A, 498, L5
Mugrauer, M. & Neuhäuser, R. 2005, MNRAS, 361, L15
Mugrauer, M. & Neuhäuser, R. 2009, A&A, 494, 373
Mugrauer, M., Neuhäuser, R., & Mazeh, T. 2007a, A&A, 469, 755
Mugrauer, M., Neuhäuser, R., Mazeh, T., Alves, J., & Guenther, E. 2004a, A&A, 425, 249
Mugrauer, M., Neuhäuser, R., Mazeh, T., Guenther, E., & Fernández, M. 2004b, AN, 325, 718
Mugrauer, M., Neuhäuser, R., Mazeh, T., et al. 2006a, AN, 327, 321
Mugrauer, M., Neuhäuser, R., Seifahrt, A., Mazeh, T., & Guenther, E. 2005, A&A, 440, 1051
Mugrauer, M., Seifahrt, A., & Neuhäuser, R. 2007b, MNRAS, 378, 1328
Mugrauer, M., Seifahrt, A., Neuhäuser, R., & Mazeh, T. 2006b, MNRAS, 373, L31
Muterspaugh, M. W., Lane, B. F., Kulkarni, S. R., et al. 2010, AJ, 140, 1657
Naef, D., Latham, D. W., Mayor, M., et al. 2001a, A&A, 375, L27
Naef, D., Mayor, M., Korzennik, S. G., et al. 2003, A&A, 410, 1051
Naef, D., Mayor, M., Lo Curto, G., et al. 2010, A&A, 523, A15+
Naef, D., Mayor, M., Pepe, F., et al. 2001b, A&A, 375, 205
Neuhäuser, R., Mugrauer, M., Fukagawa, M., Torres, G., & Schmidt, T. 2007, A&A, 462, 777
Patience, J., White, R. J., Ghez, A. M., et al. 2002, ApJ, 581, 654
Pont, F., Hébrard, G., Irwin, J. M., et al. 2009, A&A, 502, 695
Porto de Mello, G. F. & da Silva, L. 1997, ApJ, 476, L89+
Potter, S. B., Romero-Colmenero, E., Ramsay, G., et al. 2011, MNRAS, 416, 2202
Qian, S., Liao, W., Zhu, L., et al. 2010, MNRAS, 401, L34
Qian, S.-B., Liu, L., Liao, W.-P., et al. 2011, MNRAS, 414, L16
Queloz, D., Anderson, D., Collier Cameron, A., et al. 2010, A&A, 517, L1+
Queloz, D., Mayor, M., Weber, L., et al. 2000, A&A, 354, 99
Raghavan, D., Henry, T. J., Mason, B. D., et al. 2006, ApJ, 646, 523
Raghavan, D., McAlister, H. A., Henry, T. J., et al. 2010, ApJS, 190, 1
Reffert, S. & Quirrenbach, A. 2011, A&A, 527, A140+
Roell, T., Neuhäuser, R., & Seifahrt, A. 2010, in EAS Publications Series, Vol. 42, EAS Publications Series, ed. K. Goździewski, A. Niedzielski, & J. Schneider, 179–186
Roell, T., Seifahrt, A., Neuhäuser, R., Köhler, R., & Bean, J. 2011, in EAS Publications Series, Vol. 45, EAS Publications Series, ed. C. Turon, F. Meynadier and F. Arenou, 429–432
Roeser, S., Demleitner, M., & Schilbach, E. 2010, AJ, 139, 2440
Santos, N. C., Mayor, M., Naef, D., et al. 2001, A&A, 379, 999
Schneider, J., Dedieu, C., Le Sidaner, P., Savalle, R., & Zolotukhin, I. 2011, A&A, 532, A79+
Tinney, C. G., Butler, R. P., Marcy, G. W., et al. 2002, ApJ, 571, 528
Udry, S., Mayor, M., Naef, D., et al. 2000, A&A, 356, 590
van Leeuwen, F. 2008, VizieR Online Data Catalog, 1311, 0
Vogt, S. S., Butler, R. P., Marcy, G. W., et al. 2005, ApJ, 632, 638
Vogt, S. S., Marcy, G. W., Butler, R. P., & Apps, K. 2000, ApJ, 536, 902
Welsh, W. F., Orosz, J. A., Carter, J. A., & et al. 2012, Nature
Zacharias, N., Finch, C., Girard, T., et al. 2010, AJ, 139, 2184
Zacharias, N., Monet, D. G., Levine, S. E., et al. 2004, in BAAS, Vol. 36, AAS Meeting Abstracts, 1418–+
Zucker, S., Mazeh, T., Santos, N. C., Udry, S., & Mayor, M. 2003, A&A, 404, 775
Zucker, S., Mazeh, T., Santos, N. C., Udry, S., & Mayor, M. 2004, A&A, 426, 695
Zucker, S., Naef, D., Latham, D. W., et al. 2002, ApJ, 568, 363

Appendix A: Updated tables of extrasolar planets in stellar multiple systems

Table A.1. Exoplanet host stars having a common proper motion with another star. The ID of the host stars is the same as it is used in the EPE and the planet status is coded by R . . . published in a **R**efereed paper, S . . . **S**ubmitted to a professional journal, and C . . . announced by astronomers in professional **C**onferences. A planet status followed by the letter R in brackets means, the status on the EPE is not up-to-date and the planet detection is already published in a refereed paper. The fourth and fifth column show the proper motion listed in the catalog mentioned in the last column. For easy identification of the stellar companions in the online catalogs, the third column contains either the separation from the primary as calculated by the used online catalog or the latest separation measurement in case of published relative astrometric measurements.

CCDM . . .	*Catalog of Components of Double and Multiple stars*, Dommanget & Nys (2000)
ASCC-2.5 V3 . . .	*All-sky Compiled Catalogue of 2.5 million stars (3rd version, 2009)*, Kharchenko (2001)
HIP-2 . . .	*Hipparcos, the New Reduction*, van Leeuwen (2008)
Nomad-1 . . .	*Naval Observatory Merged Astrometric Dataset*, Zacharias et al. (2004)
UCAC-3 . . .	*Third U.S. Naval Observatory CCD Astrograph Catalog*, Zacharias et al. (2010)
PPMXL . . .	*The PPMXL catalog of positions and proper motions on the ICRS. Combining USNO-B1.0 and the two Micron All Sky Survey (2MASS).*, Roeser et al. (2010)
Tycho-2 . . .	*The Tycho-2 Catalogue of the 2.5 Million Brightest Stars*, Høg et al. (2000)

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
11 Com A	R	9	-109.37 ± 1.26	89.25 ± 0.75	ASCC-2.5-V3
11 Com B	-	-	$-109 \pm$ n.s.	$85 \pm$ n.s.	CCDM
16 Cyg A	-	-	-133.39 ± 0.82	-163.08 ± 0.85	ASCC-2.5-V3
16 Cyg B	R	39.44	-147.77 ± 0.85	-158.39 ± 0.76	ASCC-2.5-V3
16 Cyg C	-	close C component about 3.4" away from A, see Patience et al. (2002)			
30 Ari A	-	-	137.66 ± 0.74	-14.98 ± 0.91	ASCC-2.5-V3
	-	A itself is a spectroscopic binary, see Guenther et al. (2009)			
30 Ari B	R	36.86	145.33 ± 1.21	-12.86 ± 0.94	ASCC-2.5-V3
55 Cnc A	R	-	-485.4 ± 0.9	-234.4 ± 0.7	Nomad-1
55 Cnc B	-	84.16	-488.0 ± 6.0	-234.0 ± 5.0	Nomad-1
91 Aqr A	S	-	370.70 ± 0.63	-16.22 ± 0.7	ASCC-2.5 V3
91 Aqr B	-	51.93	373.00 ± 2.41	-18.46 ± 2.41	ASCC-2.5 V3
91 Aqr C	-	52.03	370.00 ± 1.87	-20.34 ± 0.98	ASCC-2.5 V3
91 Aqr D	-	106.67	18.3 ± 8.4	-10.5 ± 7.8	Nomad-1
91 Aqr E	-	88.05	-9.4 ± 8.7	-25.2 ± 7.8	Nomad-1
γ Cep A	R	-	-48.8 ± 0.4	127.1 ± 0.4	Nomad-1
γ Cep B	-	0.02	imaged directly by Neuhäuser et al. (2007)		
γ^1 Leo A	R	-	306.35 ± 3.27	-160.77 ± 2.30	ASCC-2.5 V3
γ^1 Leo B	-	4.33	309.60 ± 1.32	-152.91 ± 0.75	ASCC-2.5 V3
γ^1 Leo C	-	325.15	-501.30 ± 1.05	-41.97 ± 1.28	ASCC-2.5 V3
γ^1 Leo D	-	366.86	-10.01 ± 1.53	-22.85 ± 1.21	ASCC-2.5 V3
τ Boo A	R	-	-479.53 ± 0.16	53.49 ± 0.13	HIP-2
τ Boo B	-	2.8	confirmed by Duquennoy & Mayor (1991)		
υ And A	R	-	-172.5 ± 0.5	-381.0 ± 0.4	Nomad-1
υ And B	-	55	confirmed by Lowrance et al. (2002)		
υ And C	-	110.27	-9.6 ± 2.3	$-3.5 \pm 2.$	Nomad-1
υ And D	-	273.20	16.3 ± 0.7	-4.7 ± 0.6	Nomad-1

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
GJ 667 AB	-	-	1129.76 ± 9.72	−77.02 ± 4.67	HIP-2
	-	-	1171.69 ± 2.70	−168.80 ± 2.79	ASCC-2.5 V3
	-	-	1161.4 ± 2.3	−172.3 ± 2.3	PPMXL
GJ 667 C	R	32.66	1049.0± n.s.	−91.0± n.s.	UCAC-3
		32.75	1155.0 ± 7.2	−214.4 ± 9.5	NOMAD-1

GJ 667 C has not a common proper motion within the measurement errors, but it can be ruled out as a background object. The large spread in the proper motion measurements can be possibly explained by the fact, that the AB component influences the relative astrometric measurements of the (AB)&C pair.

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
GJ 676 A	R	-	−259.2 ± 1.4	−185.6 ± 0.9	Nomad-1
GJ 676 B	-	48.98	−254.0 ± 8.0	−156.0 ± 23.0	Nomad-1
		47.78	−294.6 ± 7.4	−186.8 ± 7.0	UCAC-3
GJ 3021 A	R	-	433.8 ± 0.5	−57.9 ± 0.4	Nomad-1
GJ 3021 B	-	3.86	confirmed by Chauvin et al. (2006)		
Gl 86 A	R	-	2183.43 ± 3.20	661.70 ± 3.50	ASCC-2.5-V3
Gl 86 B	-	1.93	confirmed by Mugrauer & Neuhäuser (2005)		
HAT-P-1 A	-	-	30.0 ± 0.6	−42.3 ± 1.3	UCAC-3
HAT-P-1 B	R	10.93	32.6 ± 0.8	−43.2 ± 1.9	UCAC-3
WASP-8 A	S(R)	-	109.62 ± 2.05	10.02 ± 1.46	ASCC-2.5 V3
WASP-8 B	-		confirmed by Queloz et al. (2010)		
WASP-8 C	-	140.93	50.33 ± 1.39	−28.65 ± 1.08	ASCC-2.5 V3
XO-2 A	C(R)	-	−34.72 ± 2.50	−153.61 ± 2.40	ASCC-2.5 V3
XO-2 B	-	30.05	−33.02 ± 2.89	−154.11 ± 2.70	ASCC-2.5 V3
HD 142 A	R	-	575.2 ± 0.4	−39.9 ± 0.5	Nomad-1
HD 142 B	-	4.10	confirmed by Eggenberger et al. (2007)		
HD 3651 A	R	-	−460.22 ± 0.89	−370.22 ± 0.75	ASCC-2.5 V3
HD 3651 B	-	43.07	confirmed by Mugrauer et al. (2006b)		
HD 3651 C	-	168.26	10.81 ± 2.00	−1.48 ± 2.40	ASCC-2.5 V3
HD 7449 A	R	-	−161.6 ± 0.6	−138.9 ± 0.5	PPMXL
HD 7449 B		60.20	−162.5 ± 6.1	−137.5 ± 6.1	PPMXL
HD 16141 A	R	-	−155.33 ± 1.19	−437.42 ± 1.23	ASCC-2.5 V3
HD 16141 B	-	6.20	confirmed by Mugrauer et al. (2005)		
HD 11964 A	R	-	−366.10 ± 0.3	−240.83 ± 0.62	ASCC-2.5 V3
HD 11964 B	-	30.68	−369.98 ± 4.34	−245.47 ± 3.13	ASCC-2.5 V3
HD 19994 A	R	-	194.56 ± 0.37	−69.01 ± 0.30	HIP-2
HD 19994 BC	-	2.30	confirmed by Duquennoy & Mayor (1991)		
			close C component around B found by Roell et al. (2011)		
HD 20782 A	R	-	349.85 ± 0.80	−65.00 ± 1.07	ASCC-2.5 V3
HD 20782 B	-	253.71	349.76 ± 1.13	−68.44 ± 1.57	ASCC-2.5 V3
HD 27442 A	R	-	−48.09 ± 0.80	−166.69 ± 0.77	ASCC-2.5 V3
HD 27442 B	-	13.06	confirmed by Chauvin et al. (2006)		
HD 28254 A	S(R)	-	−66.9 ± 0.6	−144.0 ± 0.6	Nomad-1
HD 28254 B	-	4.3	confirmed by Naef et al. (2010)		
HD 38529 A	R	-	−79.22 ± 1.02	−142.22 ± 1.00	ASCC-2.5 V3
HD 38529 B	-	283.72	−81.79 ± 14.50	−117.47 ± 14.80	ASCC-2.5 V3
			B component confirmed by Raghavan et al. (2006)		
HD 40979 A	R	-	96.40 ± 1.19	−153.36 ± 0.70	ASCC-2.5 V3
HD 40979 BC	-	193.77	94.08 ± 1.85	−153.11 ± 1.65	ASCC-2.5 V3
	-		C component about 3.9" away from B found by Mugrauer et al. (2007a)		

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
HD 41004 A	R	-	-41.72 ± 1.19	64.87 ± 1.34	ASCC-2.5 V3
HD 41004 B	R	1.19	-42.25 ± 1.08	65.16 ± 1.12	ASCC-2.5 V3
HD 46375 A	R	-	114.2 ± 0.9	-96.7 ± 0.7	Nomad-1
HD 46375 B		10.35	confirmed by Mugrauer et al. (2006a)		
HD 65216 A	R	-	-122.66 ± 1.34	145.77 ± 1.15	ASCC-2.5 V3
HD 65216 BC	-	7.14	confirmed by Mugrauer et al. (2007b)		
			C component 0.17" away from B found by Mugrauer et al. (2007b)		
HD 75289 A	R	-	-19.90 ± 0.66	-228.13 ± 0.73	ASCC-2.5 V3
HD 75289 B	-	21.47	confirmed by Mugrauer et al. (2004a)		
HD 80606 A	R	-	56.84 ± 1.37	10.02 ± 1.71	ASCC-2.5 V3
HD 80606 B		20.18	51.95 ± 1.32	9.97 ± 1.77	ASCC-2.5 V3
HD 89744 A	R	-	-120.12 ± 0.85	-138.66 ± 0.76	ASCC-2.5 V3
HD 89744 B	-	62.99	confirmed by Mugrauer et al. (2004b)		
HD 99491 (A)	-	-	-725.22 ± 0.64	180.30 ± 0.72	ASCC-2.5 V3
HD 99492 (B)	R	33.27	-727.57 ± 1.55	186.47 ± 1.55	ASCC-2.5 V3
HD 99492 (C)	-	204.56	5.36 ± 1.98	-13.72 ± 2.00	ASCC-2.5 V3
HD 101930 A	R	-	15.42 ± 1.30	348.29 ± 1.27	ASCC-2.5 V3
HD 101930 B	-	69.89	24.98 ± 4.01	351.54 ± 2.35	ASCC-2.5 V3
	-		B component confirmed by Mugrauer et al. (2007b)		
HD 109749 A	C(R)	-	-156.69 ± 1.47	-4.88 ± 1.54	ASCC-2.5 V3
HD 109749 B	-	8.42	-157.88 ± 1.42	-5.46 ± 1.28	ASCC-2.5 V3
HD 114729 A	R	-	-200.83 ± 1.23	-307.82 ± 1.11	ASCC-2.5 V3
HD 114729 B	-	8.05	confirmed by Mugrauer et al. (2005)		
HD 114762 A	R	-	-582.75 ± 1.12	-1.04 ± 1.07	ASCC-2.5 V3
HD 114762 B	-	3.26	confirmed by Patience et al. (2002)		
HD 125612 A	S(R)	-	-62.25 ± 1.66	-67.63 ± 1.50	ASCC-2.5 V3
HD 125612 B	-	89.99	confirmed by Mugrauer & Neuhäuser (2009)		
HD 126614 AB	S(R)	-	-151.66 ± 1.35	-148.66 ± 1.22	ASCC-2.5 V3
		-	-152.4 ± 1.0	-148.1 ± 0.9	Nomad-1
			B is 0.5" away from A, found by Howard et al. (2010)		
			and common proper motion confirmed by Ginski et al. (2012)		
HD 126614 C	-	41.80	-144.0 ± 4.0	-142.0 ± 3.0	Nomad-1
HD 132563 A	-	-	-56.38 ± 2.22	-68.87 ± 1.69	ASCC-2.5 V3
			A itself is a spectroscopic binary, see Desidera et al. (2011)		
HD 132563 B	R	3.79	-57.15 ± 2.11	-69.18 ± 1.62	ASCC-2.5 V3
HD 132563 C	-	64.77	-14.52 ± 1.57	7.36 ± 1.02	ASCC-2.5 V3
HD 137388 A	R	-	-46.72 ± 0.89	43.31 ± 0.97	HIP-2
HD 137388 B	-	21.31	-35.54 ± 14.33	74.43 ± 16.63	HIP-2
	-	21.32	-94.69 ± 58.77	38.04 ± 63.18	ASCC-2.5 V3
HD 142022 A	R	-	-340.52 ± 0.91	-31.04 ± 1.01	ASCC-2.5 V3
HD 142022 B	-	22.85	-359.70 ± 2.38	-26.28 ± 2.04	ASCC-2.5 V3
HD 147513 A	R	-	72.47 ± 0.93	3.43 ± 0.83	ASCC-2.5 V3
HD 147513 B	-	345.69	76.73 ± 2.17	1.94 ± 2.10	ASCC-2.5 V3
HD 177830 A	R	-	-40.83 ± 0.75	-50.13 ± 0.99	ASCC-2.5 V3
HD 177830 B	-	1.65	confirmed by Eggenberger et al. (2007)		

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
HD 178911 A	-	-	50.20 ± 1.87	190.05 ± 2.46	ASCC-2.5 V3
	-		51.89 ± 2.09	196.24 ± 2.31	HIP-2
	-		A itself is a spectroscopic binary, see McAlister et al. (1987)		
HD 178911 B	R	16.86	67.13 ± 2.11	190.50 ± 2.64	ASCC-2.5 V3
		16.85	55.14 ± 3.43	201.30 ± 4.39	HIP-2
HD 185269 A	R	-	-32.3 ± 0.5	-80.7 ± 0.6	PPMXL
HD 185269 B	-	4.51	confirmed by Ginski et al. (2012)		
HD 188015 A	R	-	55.61 ± 0.12	-91.62 ± 1.11	ASCC-2.5 V3
HD 188015 B	-	13	confirmed by Raghavan et al. (2006)		
HD 189733 A	R	-	-2.39 ± 0.87	-250.19 ± 0.80	ASCC-2.5 V3
HD 189733 B	-	11.37	confirmed by Bakos et al. (2006)		
HD 190360 A	R	-	683.3 ± 0.4	-524.0 ± 0.5	Nomad-1
HD 190360 B	-	178.00	686.8 ± 4.1	-530.3 ± 4.1	Nomad-1
HD 195019 A	R	-	349.54 ± 1.12	-57.27 ± 0.82	ASCC-2.5 V3
HD 195019 B	-	Multiplicity first mentioned by Fischer et al. (1999)			
HD 196050 A	R	-	-191.30 ± 0.85	-63.31 ± 0.99	ASCC-2.5 V3
HD 196050 BC	-	10.88	confirmed by Mugrauer et al. (2005)		
	-		C component about 0.4" away from B found by Eggenberger et al. (2007)		
HD 196885 A	R	-	47.4 ± 0.8	83.0 ± 0.5	Nomad-1
	-		56.5 ± 1.1	87.3 ± 1.2	Tycho-2
HD 196885 B	-	0.70	confirmed by Chauvin et al. (2011)		
HD 196885 C	-	183.06	-5.2 ± 1.4	-3.9 ± 1.3	Nomad-1
	-	183.12	-3.1 ± 1.5	-2.2 ± 1.4	Tycho-2
HD 204941 A	R	-	-298.24 ± 1.34	-124.68 ± 0.67	ASCC-2.5 V3
HD 204941 B	-	53.62	-308.85 ± 3.48	-124.13 ± 1.84	ASCC-2.5 V3
HD 212301 A	S(R)	-	79.12 ± 1.04	-92.37 ± 0.99	ASCC-2.5 V3
HD 212301 B	-	4.43	confirmed by Mugrauer & Neuhäuser (2009)		
HD 213240 A	R	-	-135.1 ± 0.6	-194.0 ± 0.4	Nomad-1
HD 213240 B	-	21.94	65.1 ± 5.0	-10.8 ± 1.5	Nomad-1
HD 213240 C	-	95.69	confirmed by Mugrauer et al. (2005)		
HD 222582 A	R	-	-145.4 ± 1.2	-111.0 ± 0.8	Nomad-1
HD 222582 B	-	109.42	-147.5 ± 4.4	-114.2 ± 4.4	Nomad-1

Table A.2. Exoplanet host stars listed in the CCDM, but unlikely a common proper motion pair (same columns as in A.1).

System	EPE planet status	r ["]	$\mu_\alpha \cos\delta$ [mas/year]	μ_δ [mas/year]	Catalogue
6 Lyn A	R	-	-30.0 ± 0.8	-338.8 ± 0.6	Nomad-1
6 Lyn B	-	169.91	3.6 ± 1.6	7.2 ± 1.6	Nomad-1
18 Del A	R	-	-47.9 ± 0.7	-34.3 ± 0.3	Nomad-1
18 Del B	-	197.34	10.8 ± 1.1	-12.6 ± 1.2	Nomad-1
18 Del C	-	235.69	-6.3 ± 1.6	-6.4 ± 3.2	Nomad-1
61 Vir A	R	-	-1070.00 ± 0.66	-1064.22 ± 0.49	ASCC-2.5 V3
61 Vir B	-	365.42	-31.65 ± 3.71	-13.56 ± 2.26	ASCC-2.5 V3
70 Vir A	R	-	-234.8 ± 0.7	-576.1 ± 0.5	Nomad-1
70 Vir B	-	268.29	3.9 ± 1.3	8.7 ± 0.9	Nomad-1
ϵ Tau A	R	-	107.2 ± 1.0	-36.7 ± 0.8	Nomad-1
ϵ Tau B	-	189.16	23.1 ± 1.5	-18.9 ± 1.9	Nomad-1

System	EPE planet status	r [']	$\mu_\alpha \cos \delta$ [mas/year]	μ_δ [mas/year]	Catalogue
κ CrB A		-	-8.0 ± 0.5	-347.4 ± 0.6	Nomad-1
κ CrB B		112.31	-3.8 ± 5.4	-20.4 ± 5.4	Nomad-1
τ Gem A	C	-	-31.0 ± 1.0	-48.3 ± 0.5	Nomad-1
τ Gem B	-		proper motion not known		
τ Gem C	-	59.91	-64.1 ± 9.0	-12.5 ± 9.0	Nomad-1
HIP 75458 A	R	-	-8.2 ± 0.3	17.3 ± 0.4	Nomad-1
HIP 75458 B	-	253.77	0.5 ± 1.1	-5.5 ± 1.3	Nomad-1
HD 33564 A	R	-	-79.22 ± 0.52	161.22 ± 0.62	ASCC-2.5 V3
HD 33564 B	-	24.47	52.00 ± 1.85	-156.6 ± 2.99	ASCC-2.5 V3
HD 62509 A	R	-	-625.6 ± 1.0	-45.9 ± 0.5	Nomad-1
HD 62509 B	-	30	proper motion not known		
HD 62509 CD	-	248.98	-4.5 ± 1.0	-3.7 ± 1.3	Nomad-1
HD 62509 E	-	281.26	-3.1 ± 0.7	-14.0 ± 0.8	Nomad-1
HD 62509 F	-	304.84	-6.5 ± 0.7	-2.3 ± 0.8	Nomad-1
HD 62509 G	-	152.77	6.0 ± 2.0	-4.5 ± 1.3	Nomad-1
HD 81688 A	R	-	-6.4 ± 0.6	-128.1 ± 0.5	Nomad-1
HD 81688 B	-	71.79	-15.0 ± 1.0	-43.8 ± 1.1	Nomad-1
HD 81688 C	-	84.05	-17.6 ± 1.1	-42.6 ± 0.7	Nomad-1
HD 102365 A	R	-	-1530.55 ± 0.67	402.73 ± 0.62	ASCC-2.5 V3
HD 102365 B	-	23.95	51.6 ± 4.4	-5.1 ± 4.3	UCAC-3
HD 110014 A	R	-	-76.90 ± 0.54	-24.01 ± 0.55	ASCC-2.5 V3
HD 110014 B	-	176.06	-27.19 ± 1.82	-18.01 ± 1.80	ASCC-2.5 V3
HD 110014 C	-	227.06	-9.09 ± 1.44	-1.29 ± 2.75	ASCC-2.5 V3
HD 110014 D	-	320.44	-26.04 ± 1.26	-0.94 ± 0.64	ASCC-2.5 V3
HD 121504 A	R	-	-250.5 ± 0.7	-84.0 ± 0.8	Nomad-1
HD 121504 B	-	36.32	-15.0 ± 1.5	2.3 ± 1.4	Nomad-1
HD 164922 A	R	-	389.7 ± 0.5	-602.4 ± 0.5	Nomad-1
HD 164922 B	-	96.39	6.4 ± 5.1	-3.9 ± 5.1	Nomad-1
HD 164922 C	-	93.09	-40.9 ± 5.2	-56.2 ± 4.1	UCAC-3
HD 192263 A	R	-	-63.3 ± 1.6	262.2 ± 0.7	Nomad-1
HD 192263 BC	-	72.38	13.6 ± 1.2	0.6 ± 1.7	Nomad-1
HD 192263 D	-	78.44	-4.3 ± 5.6	-7.9 ± 5.6	Nomad-1

Table A.3. Exoplanet host stars with companion candidates, but further epoch observations are needed (same columns as in A.1).

System	EPE planet status	r [']	$\mu_\alpha \cos \delta$ [mas/year]	μ_δ [mas/year]	Catalogue
WASP-2 A	S(R)		4.9 ± 3.9	-50.9 ± 6.7	UCAC-3
WASP-2 B	-	B is 0.76" away from A, second epoch needed, see Daemgen et al. (2009)			
TrES-2 A	S(R)		2.89 ± 2.50	-3.40 ± 2.40	ASCC-2.5 V3
TrES-2 B	-	B is 1.09" away from A, second epoch needed, see Daemgen et al. (2009)			
TrES-4 A	S(R)		-8.09 ± 4.80	-33.00 ± 4.40	ASCC-2.5 V3
TrES-4 B	-	B is 1.56" away from A, second epoch needed, see Daemgen et al. (2009)			

Table A.4. Extrasolar planets detected with transit or RV observations in closer binaries with a projected stellar separation of $\rho^\star_{app} \leq 1000$ AU, sorted by an increasing stellar separation. For the four closest systems a value for the binary semi-major axis (a_{bin}) is known from multi-epoch observations (listed in brackets in the $\rho^\star_{app}$ column). If RV and transit measurements are available the true mass of the exoplanet candidate is given in the table.

¤ ... new system compared to the latest published overview by Mugrauer & Neuhäuser (2009)

₵ ... B component is a brown dwarf, see Mugrauer et al. (2006b)

※ ... B component is a white dwarf, see Mugrauer & Neuhäuser (2005)

§ ... B component is a white dwarf, see Chauvin et al. (2007)

† ... Reffert & Quirrenbach (2011) determined an astrometric mass range for the planet candidate, which is given within the brackets in the planetary mass column

Note	Host star	N_{Pl}	$M_{Pl} \sin i$ [M_{Jup}]	a_{Pl} [AU]	$\rho^\star_{app}$ [AU]	Reference
†	γ Cephei A	1	1.6 (5 ... 27)	2.04	12.4 (a_{bin} = 20.2)	Campbell et al. (1988); Hatzes et al. (2003) Neuhäuser et al. (2007); Reffert & Quirrenbach (2011)
※	Gl 86 A	1	4.01	0.11	20.7 (a_{bin} = 21)	Queloz et al. (2000); Mugrauer & Neuhäuser (2005)
	HD 41004 A	1	2.54	1.64	21.5 (a_{bin} = 20)	Zucker et al. (2004); Raghavan et al. (2006)
	HD 41004 B	1	18.40	0.02	21.5 (a_{bin} = 20)	Zucker et al. (2003); Raghavan et al. (2006)
	HD 196885 A	1	2.58	2.37	23.1 (a_{bin} = 21)	Correia et al. (2008); Fischer et al. (2009) Chauvin et al. (2011)
	τ Boo A	1	3.90	0.05	45.2	Butler et al. (1997); Raghavan et al. (2006)
	GJ 3021 A	1	3.37	0.49	68.6	Naef et al. (2001b); Mugrauer et al. (2007a)
	HD 177830 A	1	1.28	1.00	100.3	Vogt et al. (2000); Eggenberger et al. (2007)
	HD 142 A	1	1.03	1.00	105.0	Tinney et al. (2002); Raghavan et al. (2006)
	HD 114762 A	1	11.02	0.30	134.0	Latham et al. (1989); Mugrauer et al. (2005)
	HD 195019 A	1	3.70	0.14	149.2	Fischer et al. (1999); Raghavan et al. (2006)
¤	γ^1 Leo A	1	8.78	1.19	165.6	Han et al. (2010)
	HD 189733 A	1	1.13 (*true mass*)	0.03	220.0	Bouchy et al. (2005); Eggenberger et al. (2007)
	HD 16141 A	1	0.23	0.35	222.6	Marcy et al. (2000); Mugrauer et al. (2005)
¤	HD 185269 A	1	0.94	0.08	226.9	Johnson et al. (2006); Ginski et al. (2012)
	HD 212301 A	1	0.45	0.04	233.2	Lo Curto et al. (2006); Mugrauer & Neuhäuser (2009)
§	HD 27442 A	1	1.28	1.18	238.4	Butler et al. (2001); Chauvin et al. (2006) Raghavan et al. (2006); Mugrauer et al. (2007a)
¤	HD 28254 A	1	1.16	2.25	241.7	Naef et al. (2010)
	HD 114729 A	1	0.82	2.08	283.5	Butler et al. (2003); Mugrauer et al. (2005)
	HD 46375 A	1	0.25	0.04	345.7	Marcy et al. (2000); Mugrauer et al. (2006a)
¤	WASP-8 A	1	2.25 (*true mass*)	0.08	348.0	Queloz et al. (2010)
¤, ₵	HD 3651 A	1	0.20	0.28	478.4	Fischer et al. (2003a); Mugrauer et al. (2006b)
	HD 109749 A	1	0.28	0.06	495.6	Fischer et al. (2006); Desidera & Barbieri (2007)
	HD 99492 = HD 99491 B	1	0.11	0.12	589.4	Marcy et al. (2005b); Raghavan et al. (2006)
	HD 75289 A	1	0.42	0.05	621.4	Udry et al. (2000); Mugrauer et al. (2004a)
	HD 188015 A	1	1.26	1.19	676.0	Marcy et al. (2005b); Raghavan et al. (2006)
	υ And A	3	0.69 ... 11.6	0.06 ... 2.55	742.5	Butler et al. (1999); Lowrance et al. (2002)
¤	GJ 676 A	1	4.9	1.82	788.9	Forveille et al. (2011)
¤	HD 137388 A	1	0.22	0.89	809.4	Dumusque et al. (2011)
	HD 142022 A	1	4.40	2.80	890.8	Eggenberger et al. (2006); Raghavan et al. (2006)
¤	11 Com A	1	19.4	1.29	999.0	Liu et al. (2008)

Table A.5. Extrasolar planets detected with transit or RV observations in wider binaries with a projected stellar separation of $\rho_{\mathrm{app}}^{\star} > 1000$ AU), sorted by an increasing stellar separation. If RV and transit measurements are available the true mass of the exoplanet candidate is given in the table.

¤ ... new system compared to the latest published overview by Mugrauer & Neuhäuser (2009)

¶ ... closer component listed in the CCDM (formerly called B) was disproved by proper motion measurements, but a new wide stellar companion was found and confirmed by common proper motion (Mugrauer et al. 2005)

§ ... B component is a white dwarf, see Porto de Mello & da Silva (1997)

Note	Host star	N_{Pl}	$M_{\mathrm{Pl}} \sin i$ [M_{Jup}]	a_{Pl} [AU]	$\rho_{\mathrm{app}}^{\star}$ [AU]	Reference
	HD 11964 A	2	0.11 & 0.61	0.23 & 3.34	1044	Butler et al. (2006); Raghavan et al. (2006)
	55 Cnc A	5	0.02 ... 3.84	0.04 ... 5.77	1053	Butler et al. (1997); Marcy et al. (2002); McArthur et al. (2004)
	HD 80606 A	1	3.94 (*true mass*)	0.45	1197	Naef et al. (2001a); Moutou et al. (2009) Raghavan et al. (2006); Pont et al. (2009)
¤	HD 204941 A	1	0.27	2.56	1447	Dumusque et al. (2011)
	HAT-P-1 B	1	0.52 (*true mass*)	0.06	1557	Bakos et al. (2007)
	HD 101930 A	1	0.30	0.30	2227	Lovis et al. (2005); Mugrauer et al. (2007b)
¤	HD 7449 A	2	1.11 & 2.00	2.30 & 4.96	2348	Dumusque et al. (2011)
	HD 89744 A	1	7.99	0.89	2457	Korzennik et al. (2000); Mugrauer et al. (2004b)
	HD 190360 A	2	0.06 & 1.50	0.13 & 3.92	3293	Naef et al. (2003); Vogt et al. (2005); Raghavan et al. (2006)
¶	HD 213240 A	1	4.50	2.03	3905	Santos et al. (2001); Mugrauer et al. (2005)
§	HD 147513 A	1	1.00	1.26	4460	Mayor et al. (2004); Mugrauer & Neuhäuser (2005) Porto de Mello & da Silva (1997)
	HD 222582 A	1	7.75	1.35	4595	Vogt et al. (2000); Raghavan et al. (2006)
¤	XO-2 A	1	0.57 (*true mass*)	0.04	4619	Burke et al. (2007)
	HD 125612 A	3	0.06 ... 7.2	0.05 ... 4.2	4752	Fischer et al. (2007); Lo Curto et al. (2010) Mugrauer & Neuhäuser (2009)
	HD 20782 A	1	1.90	1.38	9133	Jones et al. (2006); Desidera & Barbieri (2007)
	HD 38529 A	2	0.78 & 17.70	0.13 & 3.69	11915	Fischer et al. (2001, 2003b); Raghavan et al. (2006)

Table A.6. Extrasolar planets detected with transit or RV observations in stellar systems with more than two components, sorted by the increasing projected separation of the host star and the nearest stellar component ($\rho_{\mathrm{app}}^{\star}$). For the closest systems a value for the binary semi-major axis (a_{bin}) is known from multi-epoch observations (listed in brackets in the $\rho_{\mathrm{app}}^{\star}$ column). If RV and transit measurements are available the true mass of the exoplanet candidate is given in the table.

¤ ... new system compared to the latest published overview by Mugrauer & Neuhäuser (2009)

Note	Host-star	N_{Pl}	$N_{\star}$	$M_{\mathrm{Pl}} \sin i$ [M_{Jup}]	a_{Pl} [AU]	$\rho_{\mathrm{app}}^{\star}$ [AU]	Reference
¤	HD 126614 A	1	3	0.38	2.35	36.2	Howard et al. (2010); Ginski et al. (2012)
	HD 19994 A	1	3	1.68	1.42	51.5	Mayor et al. (2004); Raghavan et al. (2006) Roell et al. (2011)
¤	GJ 667 C	2	3	0.018 & 0.014	0.05 & 0.12	227.0	Anglada-Escudé et al. (2012)
	HD 65216 A	1	3	1.21	1.37	256.3	Mayor et al. (2004); Mugrauer et al. (2007b)
¤	HD 132563 B	1	3	1.49	2.62	365.2	Desidera et al. (2011)
	HD 196050 A	1	3	3.00	2.50	511.2	Jones et al. (2002); Mugrauer et al. (2005) Eggenberger et al. (2007)
	HD 178911 B	1	3	6.29	0.32	794.3	Zucker et al. (2002); Eggenberger et al. (2003)
	16 Cyg B	1	3	1.68	1.68	859.7	Cochran et al. (1997); Raghavan et al. (2006)
¤	30 Ari B	1	3	9.88	0.995	1517	Guenther et al. (2009)
	HD 40979 A	1	3	3.32	0.81	6395	Fischer et al. (2003b); Eggenberger et al. (2003) Mugrauer et al. (2007a)