A&A 525, A26 (2011)
DOI: 10.1051/0004-6361/200913895

Astronomy & Astrophysics

The mass ratio and initial mass functions in spectroscopic binaries

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Received 17 December 2009 / Accepted 8 September 2010

ABSTRACT

Context. Spectroscopic binaries are important in studies of binary star-formation, since original information linked to the forming stars, such as the mass ratio, can be kept in the system and observationally retrieved.

Aims. We aim to derive the more probable mass ratio distributions, to test a possible Initial Mass Functions acting on the formation of spectroscopic binaries, and to derive the value of q_0, the minimal mass ratio for which both binary components are simultaneously in the main sequence.

Methods. The sample has 249 systems, selected from the Ninth Catalogue of Spectroscopic Binaries, with selection criteria that include only those systems with periods longer than four days and magnitudes brighter than $m_V = 7.0$, and main-sequence primaries, to avoid mass exchange. Monte Carlo simulations of observational parameters were performed. We performed simulations by comparing an observational quantity, $Y_{\rm obs}$, equal to $f(m)/m_1$, where $f(m)$ is the mass function, to theoretical $Y_{\rm th}$, which is a function of the system inclination (assumed to be random), and of the mass ratio $q = m_2/m_1$. We considered a minimal mass ratio q_0, which is the limiting condition, to ensure that both components are simultaneously on main sequence, avoiding evolutionary effects leading to mass exchange and loss of information on the original masses. Calculations were done using several q_0 values. The form of the distribution of mass ratios was studied by simulations of Y, involving several functions, with slopes which are increasing, decreasing, constant, or bimodal. Other simulations were done by the generation of stars following several initial mass function laws. We combined pairs of stars generated from different IMFs, assuming that binaries arise from the pairing of stars simultaneously formed. In this case, several values of q_0 were also used in the input equations.

Results. Our results indicate that decreasing q distributions match better with observations and also that a unique IMF gives better fits to observations than a composite IMF, with a slope around 1.4, rather than the widely used 2.35 slope. Values of q_0 tend to be lower than what is suggested by previous studies, which point to q_0 around 0.2; all simulations suggest that q_0 values as low as 0.08 produce the best fits to observations.

Key words. binaries: spectroscopic

1. Introduction

The understanding of star formation can benefit from data of binary stars, since these systems carry information which is lost when single stars form (Larson 2001). However, formation processes of binary and multiple stars are far from being completely understood. Possible processes include simultaneous condensation from a common primordial nebula, fission, and after-condensation capture. Numerical simulations involving now available high-performance computing have provided some new insights on this question (Tohline & Durisen 2001). Alternative approaches can use models describing those processes taking as a fundamental parameter the mass ratio, $q = m_2/m_1$ (m_1 and m_2 being the primary and second masses of the binary components), on the grounds that some values of q are only possible from certain processes, and that different physical processes can favor higher or lower values of the mass ratio. The form of the mass ratio distribution, $f(q)$, has been the object of extensive discussion on whether $f(q)$ decreases or increases with increasing q, if it has a bimodal behavior, or if $f(q)$ depends on the orbital period. Model-fitting approaches have produced results in every direction. Decreasing functions, of the form $q^{-7/3}$, were suggested by Jaschek & Ferrer (1972); this function has some theoretical background, because it is the original mass function of Salpeter (1955), as pointed out by Jaschek (1969). Besides, this paper by Jaschek and Ferrer introduced the parameter q_0, the minimal mass ratio that ensures that both stars are simultaneously at the main sequence, thus avoiding conditions where evolutionary processes lead to mass exchange and loss of information on primordial component masses. Concerning mass ratio distributions, similar results were published more recently by Heacox (1998). However, more results have been published favoring other $f(q)$'s. Hogeveen (1990, 1992a,b) finds that $f(q)$ can be a power law, either decreasing or increasing, depending on whether the sample (from Batten et al. 1978 Eighth Catalogue of Spectroscopic Binaries – SB) was formed by single-line (SBI) or double-line (SBII) systems. This calls attention to the extent to which selection effects can influence results. Increasing $f(q)$s, with peaks near high q's were suggested by Lucy & Ricco (1979), among others, for close SBs; however, most studies with similar results (Garmany et al. 1980; Abt & Levy 1985; Levato et al. 1987; Fekel et al. 1988) are based on samples composed

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of close systems, where contact or mass exchange lead to loss of information on the original mass of the components. Bimodal distributions have been suggested by Trimble (1974), and as well by Abt & Levy (1976); finally, both q^n and bimodal distributions were the results of model-fittings by Dabrowski & Beardsley (1977) and Trimble & Ostriker (1978). Also based on Batten's Eighth Catalogue is the study by Fisher et al. (2005) concerning a sample of local field stars, which indicated a q distribution of field binaries with many q values near unity, and thus dominated by double-lined systems. The above results indicate that confusion does exist, a problem that can be approached by the use of carefully selected samples where biases are minimized. The recent release of a large database on spectroscopic binary stars has allowed more significant model-fitting tests. The choice of spectroscopic systems is convenient because of the availability of useful parameters, especially radial velocities, which in visual binaries lack the necessary accuracy and amplitude. Using a selected sample of spectroscopic binaries as a reference, the scope of this work is threefold: to look for the more probable mass ratio distributions, to test Initial Mass Functions acting during binary formation, and to derive values for the parameter q_0; to reach these objectives, we performed Monte Carlo simulations involving assumptions on mass ratio distributions, on initial mass functions, and testing several q_0 values.

2. Data and basic methodology

Following former compilations of spectroscopic binary observational parameters, for example, that by Batten et al. (1978), we selected the observational sample from the online version of the Ninth Catalogue of Spectroscopic Binary Orbits (Pourbaix et al. 2004), which provides information on 2385 systems. Observational biases are certainly present, and several criteria were applied to compile a sample with a bias as small as possible, as follows:

a) An important bias in the Ninth Catalogue is that the percentage of eclipsing binaries is statistically increased. This happens because variability is easily detected, and systems with deeper eclipses are even more easily discovered, because they have components of similar brightness and, therefore, with higher mass ratios. This bias in favor of eclipsing SBs is stronger in fainter systems. To minimize this bias, the sample included only binaries brighter than $m_V = 7.0$, on the grounds that those objects belonging to the bright star catalogue (BSC) and its Supplement (Warren & Hoffleit 1987), which list systems brighter than $m_V = 7.0$, have been extensively observed and few spectroscopic systems, if any, remain undetected.
b) Mass exchange may influence the evolution of close systems, so to ensure a sample that conserves the original information of both components, the sample included only systems with periods longer than four days, corresponding to orbits with semi-major axis of about 7.4 million kilometers. This value is about 40% higher than the largest O stars in the sample, and accordingly, systems with possible contact between the components were not included in the compilation. This criterion leads to the exclusion of certain pairs of multiple systems (HD 25 204, HD 36 695, HD 71 663, HD 157 482, HD 201 433), even if these systems would have remained in the sample due to other criteria.
c) Another condition imposed to avoid mass exchange was the exclusion of all systems with non-main sequence primaries. These last two criteria are complementary, producing a sample with non-interacting stars even for the eventual systems which, being formed by capture, do not have coeval components.

The final, homogeneous sample, had 249 systems, with primary spectral types distributed as follows: 29% OB, 55% AF, 16% GK. The list of stars is given in Table 2 at the end of this paper. This sample is significantly greater than those used in most of the papers cited in Sect. 1, and includes single (144 objects) and double-lined (105) systems.

A special mention has to be made concerning the paper by Fisher et al. (2005), because this paper, in a first analysis, has partially similar scopes and sources of data. However, an important objective for us was to derive values of q_0, a parameter which was not approached in their paper because it is seldom studied. Approaches to the other scopes are heavily influenced by the sample used, and here, it is true that the present sample of 249 systems is smaller than that of Fisher and collaborators, which has 371 objects; these samples, however, have some important differences. The larger sample was compiled with data from Batten's Eighth Catalogue and from private communications; it used all values of periods, thus allowing the inclusion of contact systems and evolved stars, where mass exchanges can occur, processes which modify the original mas ratios at system formation. Unfortunately, the paper by Fisher et al. (2005) does not provide the list of systems forming the sample used for their study, so a direct comparison is not possible. However, from their criteria of $d \leq 100$ pc and $M_V \leq 4$, it can be deduced that for later stars, G and K dwarfs are excluded, because of the luminosity criterion. On the earlier side, an examination of the Bright Star Catalogue suggests that there are significant differences between Fisher's and our sample. For example, from the BSC it is evident that the criterion for distances smaller than 100 pc only allows the inclusion, in Fisher's sample, of about eight dwarfs of spectral type B3 or hotter, not necessarily primaries of spectroscopic binaries. On the other hand, GK dwarfs make up 16% of primaries of our sample, which besides includes 31 B3, or earlier, dwarf primaries. The same reasoning extends to all B dwarfs. Consequently, even if the exact content of Fisher's list is not known, a clear perception arises that the ensemble of these differences is very significant and results in very different samples, for the spectral types and luminosity classes, and also for the volume of space studied.

Mass ratios can be directly derived from the radial velocities measured from SBIIs; however, with the present number of 105 systems, they are not enough to provide reliable information about the form of a mass ratio distribution. Besides, in doing this, the resulting sample presents a bias towards higher mass ratios, a perception already expressed at the modelings performed by Tout (1991). This author, and also Hogeveen (1992a), use different arguments to show that an inverse bias is present if only SBI systems are used. Indeed, both cite and use a former result, summarized in Fig. 1 of Staniucha (1979). The database used to produce this result carries the biases which are avoided in our sample. Also, given a fixed sample, the relative proportion of SBI to SBII will change steadily in favor of SBII, as time passes and observational techniques improve. Modeling this shifting subsamples separately would give unreliable results. So, the question is how to avoid those biases, and at the same time, how to put the observational information from systems with only one spectrum into a useful form. The so-called "mass function", $f(m)$, is a well known expression that addresses this problem. Not to be confused with the Initial Mass Function, the $f(m)$ for spectroscopic binaries is derived from Kepler's third

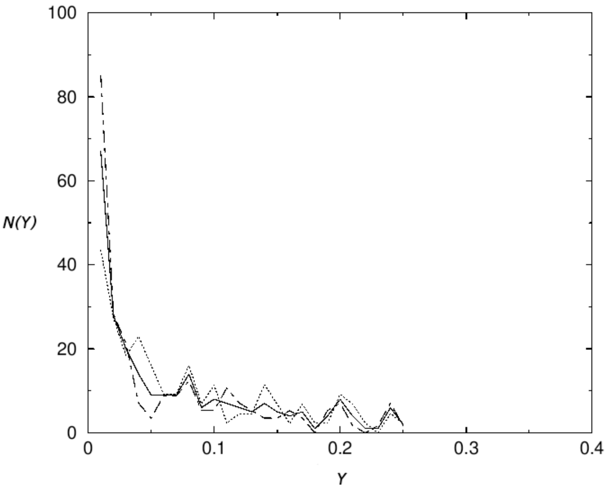

Fig. 1. Histogram for observed Y, from 249 spectroscopic binaries (solid line). Also shown are normalized tracings of sub-samples, for periods longer (dotted line) or shorter (dot-dashed line) than 40 days.

law, and has been presented and used in Halbwachs (1987) or in Duquennoy & Mayor (1991) among others. It is given by

$$f(m) = \frac{m_2^3 \sin^3 i}{(m_1 + m_2)^2} \tag{1}$$

with m_1 and m_2 defined as above, and i the inclination of the plane of the system with respect to the line of sight. The mass function can also be expressed in terms of observational quantities, in the form

$$f(m) = 1.0385 \times 10^{-7} {k_1}^3 P (1 - e^2)^{3/2} \tag{2}$$

where k_1 is the radial velocity of the primary component, in km s^{-1}, P is the period in days, and e is the system's orbital eccentricity. This allows the use of SBI in exactly the same way as for SBII, as was pointed by Trimbe (1990), with the advantage that only information from the primary is needed. In a lengthy analysis, and after stating that it is impossible to determine an overall mass-ratio distribution by adding the observed q distributions of SBI and SBII systems, Hogeveen (1992b) finally suggests that the observed q distribution of SBII systems is compatible with the assumption that all binary stars in the solar neighborhood have mass ratios distributed according to the intrinsic q distribution found from SBI systems. The purpose of this study is to perform a comparison of observational information from Eq. (2) with theoretical predictions from Eq. (1); here, a problem arises because to use Eq. (1) one has to know m_2, a piece of information that is absent from Eq. (2). This difficulty can be negotiated by dividing both Eqs. (1) and (2) by m_1. This gives, for the theoretical expression,

$$\frac{f(m)}{m_1} = \frac{q^3 \sin^3 i}{(1+q)^2} \equiv Y_{\rm th} \tag{3}$$

and for the observational equation

$$\frac{f(m)}{m_1} = \frac{1.0385 \times 10^{-7} {k_1}^3 P (1 - e^2)^{3/2}}{m_1} \equiv Y_{\rm obs}. \tag{4}$$

The modeling of $Y_{\rm th}$, as just defined, will be compared with observations, expressed by $Y_{\rm obs}$. To obtain $Y_{\rm obs}$, the masses of the primary stars are needed. With the spectral types (main sequence) of the primaries being known for all 249 objects in the sample, the masses of the primaries can be obtained from a spectral type-mass table, like that from Lang (1991), where missing spectral types had their masses determined by iteration. With data on periods and eccentricity from the Ninth Catalogue, it was possible to derive the mass function, and $Y_{\rm obs}$. The histogram for $Y_{\rm obs}$ is shown in Fig. 1. To investigate a possible dependency of the period on the mass function, the observational sample was divided into two groups: periods longer or shorter than 40 days, a value that approximately divides the sample into two equal parts. The normalized traces for these sub-samples are also shown in Fig. 1.

Table 1. List of mass ratio, q distributions used in the construction of histograms for theoretical Y.

Number	$f(q)$	Function is
01	constant	constant
02	q	increasing
03	$q - q_0$	increasing
04	$1 - q$	decreasing
05	$1 - aq$	decreasing
06	q^{-2}	decreasing
07	$q^{-\frac{7}{3}}$	decreasing
08	$(q - q_0)^2$	bimodal
09	$\left[q - \frac{(1+q_0)}{2}\right]^2$	bimodal
10	$q^{\frac{1}{3}}$	increasing
11	$(q - q_0)^{\frac{1}{3}}$	increasing

3. Simulations from mass ratio functions

The function $Y_{\rm th}$ depends on the form of the distribution function of mass ratios, $f(q)$. The modeling of $Y_{\rm th}$, which will be compared to $Y_{\rm obs}$, thus totally depends on the expression of $f(q)$. This is done by assuming several test $f(q)$'s, which are each used to generate a $Y_{\rm th}$. With respect to the $\sin i$ dependency in Eq. (3), inclinations of systems are supposed to be random, as widely accepted (Halbwachs 1987). The choice of test $f(q)$'s must cover most of the possible slopes or forms. Table 1 lists the $f(q)$'s used in simulations.

The construction of the histograms for $Y_{\rm th}$ was made for each q distribution listed in Table 1, by generation of successive $Y_{\rm th}$ values using random numbers. The procedure is as follows: given any distribution $f(q)$,

$$\frac{\int_{q_0}^{q} f(q) {\rm d}q}{\int_{q_0}^{1} f(q) {\rm d}q} = x. \tag{5}$$

Here, x is a random number and the q_0 parameter is introduced, which is the minimal mass ratio that ensures that both stars are simultaneously at the main sequence, thus avoiding conditions where evolutionary processes lead to mass exchange and loss of information on primordial component masses; in this sense, q_0 is a critical parameter for this study, and finding its value is a result in itself. It can be determined from evolutionary lifetime models, following Iben (1964). A system in which the primary is too massive with respect to its secondary will never have both components simultaneously in the main sequence, because by the time the secondary arrives at the ZAMS, the primary will already have left it. The approximate limit of q_0 for coexistence as dwarfs would be around 0.17, as suggested by Giannone & Giannuzzi (1969) and Jaschek (1969). Solving the integrals (Eq. (5)) for each distribution leads to an expression for q that

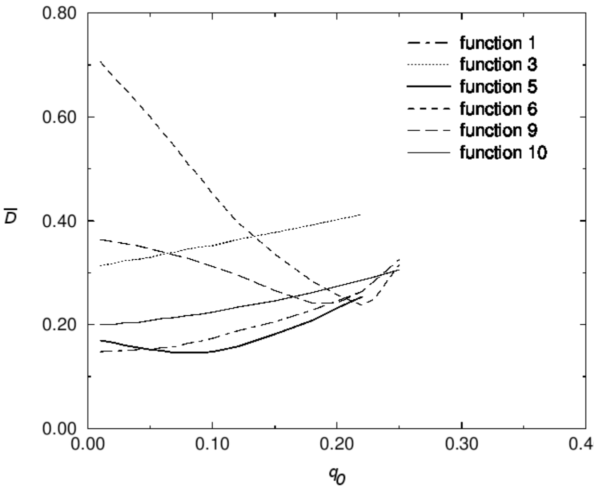

Fig. 2. Behavior of simulations of binary formation, compared to observations. Several mass distributions from Table 1 are shown. Distributions favoring lower mass ratios and values of q_0, the minimal mass ratio around 0.08 provides the best fits.

contains both q_0 and x. A similar procedure is performed for the sine component. Values of modeled $Y_{\rm th}$ (Eq. (3)) are generated in this way and successive executions lead to the construction of histograms, one for each adopted $f(q)$ distribution, where a q_0 value is adopted. These modeled histograms have to be compared to the $Y_{\rm obs}$ histogram. The comparison takes into account that the observational sample contains non-negligible noise, because it is relatively small (249 objects), even if it is one of the largest compiled to date. So, simulations for each $f(q)$ were, accordingly, generated up to 249 executions, producing histograms of $Y_{\rm th}$ which have the same size as the $Y_{\rm obs}$ histogram; the histogram for $Y_{\rm th}$ has a noise similar to the $Y_{\rm obs}$ noise and, because it has the same size, allows also a comparison on a normalized basis. Both distributions, $Y_{\rm obs}$ and $Y_{\rm th}$, are compared point-to-point for 25 partitions in the domain of possible Y values, which go from 0 to 0.25. The modulus of the difference within any partition k is

$$dif_k = \mid Y_{{\rm obs},k} - Y_{{\rm th},k} \mid \qquad (6)$$

and the total difference between the histograms is

$$D = \sum_{k=1}^{25} dif_k. \qquad (7)$$

This comparison is performed repeatedly to generate a mean difference, which is given by

$$\overline{D} = \sum_{j=1}^{N} D_j. \qquad (8)$$

Here, N was set to 1000, a value sufficient for the convergence of $\overline{D}$. This procedure, which has made on a normalized basis, produces values of D within the interval (0, 1), where $\overline{D} = 1$ means a model totally different from the observations. Values of D for selected test distributions from Table 1 are presented in Fig. 2, which also gives information on the minimal mass ratio, q_0.

4. Simulations from initial mass functions

Another modeling of the observed Y was performed by creating binary systems from the random combination, two by two, of stars generated following a formation law: the Initial Mass Function. The expression of the IMF, since its first formulation by Salpeter (1955), has been frequently modified. More recently, Kennicut (1998) suggested that observations are best fitted by a composite IMF, with a slope 1.4 for formation up to one solar mass, and a slope 2.35 for greater masses. However, the situation can be different when star-forming cores undergo fragmentation, a scenario studied by Goodwin & Kroupa (2005). In these cases, a binary can be formed after additional members are ejected from the system, leading to the formation of close binaries. This would fit the description of many spectroscopic binaries, in which case a slightly different IMF could apply. The fragmentation process can produce stars of different masses, the smaller ones are the first to be ejected. The two remaining masses may or may not obey a specific, even composite IMF. To test these possibilities we performed a simulation of the random combination of stars that are independently formed. Here, the variables are the minimum and maximum masses possible in the star-formation processes and the IMF slopes; many values around those suggested by Kennicut were tested. The minimal mass was set to 0.06 solar masses; the upper limit for stellar masses was set to 120 solar masses, a conservative approach to the value suggested by Figer (2005). The generation of masses m_1 and m_2 starts with the equation

$$\frac{\int_{m_{\rm min}}^{m} m^{-t} {\rm d}m}{\int_{m_{\rm min}}^{m_{\rm max}} m^{-t} {\rm d}m} = x \qquad (9)$$

where t, the slope of the IMF is also a variable with values t_1 and t_2, allowing the existence of a composite IMF (Kennicut 1998). The generation of m_1 and m_2 is subject to conditions that, if t is t_1, masses greater than a critical value (here, one solar mass) are discarded; and if t is t_2, masses smaller than the critical value are discarded. Here, t_1 and t_2 are first defined; which one will be used comes from a random sorting; this t_i value is then used to generate m_1, and after a new t_i definition, the mass m_2 is generated. Therefore, in all systems created by this simulation, IMFs for primaries and secondaries can be different. The same consideration for q_0 already made in Sect. 3 applies. Repeated executions are performed, and applied in Eq. (3) together with the random sin i, to produce a histogram of simulated $Y_{\rm th}$, which can be compared to the observations. We did this following the same procedure described in the previous section; the number of modules of point-to-point subtractions, observational minus modeling, was also set to be 1000. We show some results for various slopes and q_0 in Fig. 3.

5. Discussion and concluding remarks

An inspection of Fig. 1 does not provide evidence of a period dependency on the Y distribution and, therefore, the form of $f(q)$ does not seems to be period-dependent. An analogous histogram is found in Fisher et al. (2005), with a different shape; indeed, since the criteria used to compile the samples are very different, a similarity is not expected. The question of the form of the mass ratio distribution in spectroscopic binaries as well as on the q_0 value can be addressed by an analysis of Fig. 2, where the histogram of the entire sample of 249 stars was compared with the various simulations; similar calculations using the subsamples for shorter and longer periods did not produce significantly different results. We analysed the evolution of D values because several q_0 are used in each q distribution. From Fig. 2 it is clear that those q distributions that are bimodal or

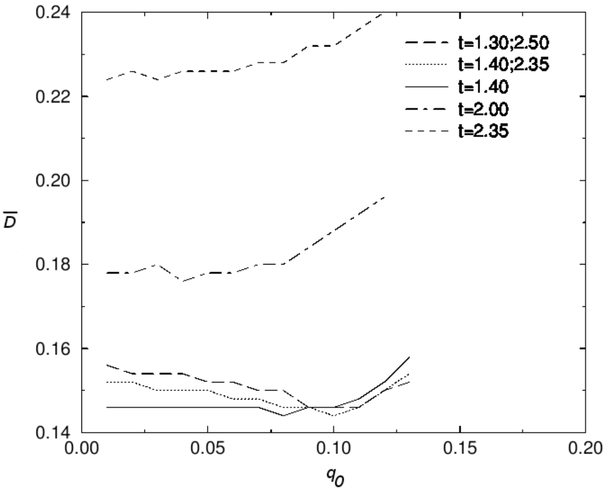

Fig. 3. Behavior of simulations of binary formation, compared to observations. Several slopes (the "t" parameter) of initial mass functions are shown. The IMFs with smaller slopes, together with $0.06 \le q_0 \le 0.1$, provide the best fits.

increase with q, have higher D, regardless of which q_0 is used. Therefore, this family of functions is unsuitable for the present simulations. Another group of functions seems to provide better fits. A mass ratio distribution with uniform probability (function 1) gives good results. However, linear, decreasing q functions in the form $f(q) = 1 - aq$ with $a \approx 0.5$, produce the best fits to observations, and also give important information on the q_0 value, which is around 0.08. These functions are preferred over function 1 because they provide information on the constraint on q_0, while function 1 only returns low D values for unphysical (i.e. too low) values of q_0. Function 5 with $a = 0.5$ seems to be the best compromise between low D and a physical q_0. Consequently estimates of q_0 around 0.2 do not produce the best results. A q_0 from 0.08 to 0.1, meaning that one component can be more than ten times more massive than the other, puts limits on the primary masses, giving preference to the formation of systems with non-massive primaries, and where both components, with low masses and slower evolutionary rates, can coexist as main-sequence stars. An examination of the observational sample shows that 29% of the primaries are OB stars; even if this frequency is higher than the frequency of OB stars in the Galaxy, it must be stressed that the sample may carry a bias toward brighter younger stars because it was limited to stars brighter than $m_V = 7.0$. This strongly suggests that the majority of SBs is composed of low-mass stars, and that a q_0 limit around 0.1, allowing simultaneous main sequence components, is the best fit to observations.

Considering the initial mass functions for spectroscopic binaries, Fig. 3 shows that steeper slopes, around 2.35, are not the best fits to observations. Indeed, slopes of about 1.4 seem to be more adequate, even when combined with steeper ones. With respect to q_0, differences between the three curves at the bottom of Fig. 3 are small, with slight advantage to the homogeneous distribution with slope 1.4, which has its minimum around $q_0 = 0.08$ to $q_0 = 0.1$, reinforcing the perception gained in the former paragraph. So, a reasonably good fit to observations is obtained from the pairing of stars that are independently formed; the standard IMF is not followed, which suggests an alternative process of binary formation, different from that of single field stars. The process of fragmentation, which is defined as break-up occurring during the dynamical collapse phase of protostellar clouds, leading to equal mass binaries and a dominance of high mass-ratios (Boss 1988), is not confirmed by the present study, because the best fit to observations comes from models with mass ratio distributions favoring low values of q. Processes of spectroscopic binary formation, as expected, are different from those of visual binaries.

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Table 2. Observational data. Column headings: system identification, primary spectral type, primary mass, primary magnitude, system period (days), system orbital excentricity, primary radial velocity ($\mathrm{km\,s^{-1}}$), mass function, Y value (from Eq. (4)); in last column, a "II" marks SBII systems.

Id	Sp	m_1	V	P	e	k_1	f(m)	Y	SB
HD 358	A0 p	2.9	2.17	96.70050	0.53	27.74	0.1307179	4.507E−02	II
HD 434	A4 Vm	2.2	6.52	34.26010	0.38	33.60	0.1068118	4.855E−02	
HD 861	A2 m	2.49	6.64	11.21530	0.22	43.80	9.084E−02	3.648E−02	
HD 1 273	G2 V	0.95	6.84	411.4490	0.57	13.90	6.365E−02	6.700E−02	
HD 3 369	B5 V	5.9	4.35	143.6065	0.56	47.50	0.9089235	0.1540548	II
HD 3 443	G8 V	0.85	6.31	9 165.640	0.23	5.130	0.1180137	0.1388396	II
HD 3 901	B2 V	9.8	4.80	940.2000	0.40	11.90	0.1266737	1.292E−02	
HD 4 161	A1 V	2.7	5.63	4.467200	0.01	73.40	0.1834277	6.793E−02	II
HD 4 676	F8 V	1.11	5.07	13.83180	0.24	57.31	0.2473599	0.222	II
HD 4 727	B5 V	5.9	4.53	4.282700	0.03	71.70	0.1637175	2.774E−02	II
HD 4 775	B9.5 V	3.05	5.37	2 091.200	0.53	11.02	0.1756563	5.759E−02	
HD 6 118	B9 V	3.25	5.50	81.12000	0.90	54.30	0.1117029	3.437E−02	II
HD 7 345	F7 V	1.21	6.27	9.075300	0.04	53.40	0.1431687	0.1183212	II
HD 8 374	F2 m	1.54	5.58	35.37100	0.63	39.00	0.1020544	6.626E−02	II
HD 9 021	F6 V	1.24	5.82	134.0780	0.31	19.90	9.429E−02	7.604E−02	
HD 10 009	F7 V	1.21	7.00	10 540.00	0.79	9.327	0.1950920	0.1612331	II
HD 10 516	B2 Vep	9.8	4.07	126.6960	0.02	16.80	6.235E−02	6.362E−03	II
HD 11 291	B9 p	3.25	5.62	5.627000	0.02	26.50	1.086E−02	3.344E−03	
HD 11 636	A5 V	2.0	2.60	106.9940	0.88	34.09	4.716E−02	2.358E−02	II
HD 11 753	A3 V	2.35	5.11	41.48900	0.32	9.000	2.671E−03	1.136E−03	
HD 11 860	A0 V	2.9	6.65	7.439100	0.00	31.60	2.437E−02	8.406E−03	II
HD 11 909	K1 p	0.71	5.10	1 567.660	0.36	10.80	0.1665360	0.2345577	
HD 12 111	A4 V	2.2	4.54	15 011.50	0.34	4.000	8.298E−02	3.771E−02	
HD 13 974	G0 V	1.05	4.87	10.01950	0.01	10.52	1.211E−03	1.153E−03	
HD 14 214	F9 V	1.09	5.56	93.50000	0.45	19.40	5.049E−02	4.632E−02	
HD 15 138	F4 V	1.42	6.12	10.99030	0.18	46.50	0.1092242	7.691E−02	II
HD 15 814	F7 V	1.21	6.04	19.37870	0.39	24.00	2.172E−02	1.795E−02	II
HD 16 458	G8 p...	0.85	5.79	2 018.000	0.10	5.830	4.091E−02	4.813E−02	
HD 16 739	F9 V	1.09	4.92	330.9910	0.67	20.91	0.1285	0.1179	II
HD 16 908	B3V	7.6	4.66	490.0000	0.14	8.800	3.366E−02	4.429E−03	
HD 16 920	F2 V	1.54	5.20	12.92740	0.25	58.10	0.2390028	0.1551966	II
HD 18 894	F8 V	1.11	6.19	363.1000	0.69	24.00	0.1976693	0.1780804	II
HD 20 210	A9 m	1.66	6.24	5.543500	0.03	62.70	0.1417120	8.536E−02	
HD 21 242	G5 V	0.92	6.37	6.437870	0.00	57.86	0.1295	0.1407	II
HD 21 278	B5 V	5.9	4.98	21.65900	0.12	22.70	2.574E−02	4.363E−03	II
HD 22 203	B8 V	3.8	4.26	6.223600	0.20	107.0	0.7447429	0.1959850	II
HD 22 805	A2 V	2.49	6.11	20.48700	0.61	34.20	4.234E−02	1.700E−02	
HD 23 964	B9.5 V	3.05	6.72	16.72500	0.00	32.40	5.907E−02	1.936E−02	II
HD 24 587	B5 V	5.9	4.60	459.0000	0.18	21.70	0.4635988	7.857E−02	
HD 25 204	B3 V	7.6	3.47	33.07000	0.15	10.50	3.842E−03	5.055E−04	
HD 25 823	A0 p	2.9	5.19	7.227400	0.18	16.60	3.267E−03	1.126E−03	
HD 26 961	A2 V	2.49	4.59	701.7600	0.24	11.40	9.877E−02	3.967E−02	
HD 27 176	A8 V	1.69	5.65	4 145.720	0.17	7.355	0.1639	9.699E−02	II
HD 27 295	B9 Vp	3.25	5.35	4.452100	0.06	9.600	4.068E−04	1.251E−04	
HD 27 376	B8.5 V	3.52	3.55	5.010500	0.01	63.80	0.1351090	1.251E−04	II
HD 27 991	F7 V	1.21	6.44	2 295.090	0.71	12.36	0.1537837	0.1270940	II
HD 28 271	F7 V	1.21	6.38	460.7000	0.31	19.35	0.2966517	0.2451667	
HD 28 910	F0 V	1.6	4.65	488.5000	0.09	18.50	0.3173132	0.1983207	
HD 30 453	A8 m	1.69	5.86	7.050900	0.00	58.90	0.1496	8.853E−02	II
HD 30 455	G2 V	0.95	6.79	45.43140	0.34	13.74	1.017E−02	1.071E−02	
HD 30 869	F5 V	1.4	6.27	143.5300	0.61	18.00	4.32E−02	3.089E−02	
HD 32 537	F0 V	1.6	4.99	391.7000	0.37	5.800	6.364E−03	3.977E−03	
HD 32 964	B9.5 V	3.05	5.10	5.522700	0.10	103.8	0.6318338	0.2071586	II
HD 32 990	B2 V	9.8	5.50	58.31000	0.19	36.70	0.2832668	2.890E−02	
HD 34 364	B9 V	3.25	6.15	4.134600	0.00	107.2	0.5289618	0.1627575	II
HD 34 759	B5 V	5.9	5.22	35.50000	0.00	28.00	8.092E−02	1.371E−02	
HD 34 762	B8 V	3.8	6.33	5.433700	0.08	26.80	1.075E−02	2.831E−03	
HD 35 317	F7 V	1.21	6.11	22.58040	0.61	53.25	0.1761703	0.1455953	II
HD 35 411	B1 V	13.0	3.35	7.984100	0.00	145.2	2.538238	0.1952491	
HD 35 411	B1 V	13.0	3.35	3360.230	0.10	17.50	1.842224	0.1417095	
HD 36 485	B2 V	9.8	6.85	25.59200	0.26	10.00	2.392E−03	2.441E−04	
HD 36 695	B1 V	13.0	5.33	119.0880	0.29	13.50	2.667E−02	2.051E−03	
HD 36 964	B3 V	7.6	6.97	4.623900	0.12	48.10	5.228E−02	6.879E−03	
HD 37 017	B1.5 V	12.12	6.54	18.65560	0.31	36.00	7.767E−02	6.409E−03	
HD 37 041	O9.5 V	18.1	5.07	20.96433	0.23	101.3	2.0859	0.1152	

Table 2. continued.

Id	Sp	m_1	V	P	e	k_1	f(m)	Y	SB
HD 37 438	B2 V	9.8	5.15	27.86400	0.55	25.50	2.795E−02	2.852E−03	
HD 39 357	B9.5 V	3.05	4.54	5.969000	0.00	48.90	7.248E−02	2.376E−02	II
HD 39 587	G0 V	1.05	4.41	5 136.000	0.45	1.850	2.405E−03	2.290E−03	
HD 39 698	B2 V	9.8	5.90	7.996900	0.01	70.00	0.2848112	2.906E−02	II
HD 39 780	A0 V	2.9	6.19	8.569000	0.04	62.20	0.2136312	7.366E−02	II
HD 41 335	B2 Ven	9.8	5.21	80.86000	0.00	9.400	6.974E−03	7.117E−04	
HD 41 357	A4 m	2.2	5.35	28.28000	0.56	51.40	0.2267990	0.1030905	II
HD 41 511	B9 V	3.25	4.92	260.0000	0.13	21.00	0.2437442	7.499E−02	
HD 41 753	B3 V	7.6	4.40	131.2110	0.64	33.30	0.2282595	3.003E−02	
HD 42 083	A2 m	2.49	6.17	106.0000	0.63	40.50	0.3425007	0.1375505	II
HD 44 402	B3 V	7.6	3.02	675.0000	0.57	13.50	9.566E−02	1.258E−02	
HD 44 691	A3 m	2.35	5.50	9.945100	0.08	65.65	0.2900876	0.1234415	II
HD 45 088	K3 V	0.68	6.79	6.991900	0.15	56.60	0.1272407	0.1871187	II
HD 47 839	O7 Ve	26.5	4.66	9 247.000	0.67	9.400	0.3263146	1.231E−02	
HD 48 766	F6 V	1.24	6.28	4.258560	0.00	12.82	9.318E−04	7.514E−04	
HD 48 915	A1 V	2.7	1.47	18 276.70	0.59	2.400	1.381E−02	5.115E−03	
HD 51 424	A2 V	2.49	6.34	6 007.000	0.13	3.500	2.598E−02	1.043E−02	
HD 54 563	G8 V	0.85	6.43	113.3460	0.40	20.80	8.154E−02	9.594E−02	
HD 58 661	B9 pHgMn	3.25	5.72	1 834.000	0.30	5.000	2.066E−02	6.359E−03	
HD 59 543	B2 V	9.8	6.94	17.91100	0.52	45.60	0.10099127	1.121E−02	
HD 60 179	A1 V	2.7	1.58	9.212800	0.50	12.90	1.334E−03	4.940E−04	
HD 61 859	F7 V	1.21	5.97	31.50000	0.21	45.20	0.2823261	0.2333274	II
HD 64 096	G1 V	0.99	5.16	8 291.550	0.74	9.125	0.1990	0.2010	II
HD 66 824	A1 V	2.7	6.36	18.72200	0.17	64.60	0.5015938	0.1857755	II
HD 68 256	G5 V	0.92	6.20	6 302.000	0.11	4.280	5.022E−02	5.459E−02	
HD 68 351	B9 p	3.25	5.64	635.7300	0.55	9.600	3.402E−02	1.046E−02	
HD 68 520	B5 V	5.9	4.34	14.16830	0.00	66.70	0.4366181	7.400E−02	
HD 71 581	A1 V	2.7	6.56	4.596200	0.10	103.6	0.5228022	0.1936305	II
HD 71 663	A5 m	2.0	6.38	5.977100	0.00	42.10	4.631E−02	2.315E−02	II
HD 72 208	B9 pHg:	3.25	6.83	22.01160	0.38	48.20	0.2025841	6.233E−02	
HD 73 712	A9 Vn	1.66	6.78	48.71700	0.11	31.60	0.1567537	9.442E−02	II
HD 73 731	A5 m	2.0	6.30	35.20200	0.32	53.00	0.4628345	0.2314172	II
HD 75 759	B0 V	17.5	5.98	33.31100	0.63	121.3	2.891749	0.1652428	II
HD 75 767	G1 V	0.99	6.57	10.24806	0.00	23.59	1.397E−02	1.411E−02	
HD 76 370	A2 m	2.49	6.07	18.83020	0.49	13.73	3.333E−03	1.338E−03	
HD 76 644	A7 V	1.79	3.14	4 028.000	0.36	6.000	7.337E−02	4.098E−02	
HD 76 943	F5 V	1.4	3.97	7 980.700	0.15	4.000	5.126E−02	3.661E−02	
HD 77 350	B9 p	3.25	5.43	1401.400	0.35	7.700	5.461E−02	1.680E−02	
HD 77 464	B2.5 V	9.5	6.69	6.889500	0.00	127.0	1.465566	0.1542701	II
HD 78 316	B8 p	3.8	5.24	6.393300	0.13	67.40	0.1981563	5.214E−02	
HD 79 028	F9 V	1.09	5.17	16.23970	0.009	35.30	7.328E−02	6.723E−02	
HD 79 096	G9 V	0.82	6.51	988.0580	0.43	11.49	0.1145	0.1396	II
HD 79 193	A3 m	2.35	6.11	7.750500	0.09	70.10	0.2739000	0.1165532	II
HD 79 763	A1 V	2.7	5.97	15.98600	0.50	63.30	0.2734949	0.1012944	II
HD 81 809	G0 V	1.05	5.74	12 589.60	0.24	4.752	0.1277253	0.1216432	II
HD 81 858	F8 V	1.11	5.40	42 678.50	0.56	2.200	2.683E−02	2.417E−02	
HD 83 809	A5 V	2.0	3.52	14.49808	0.00	54.80	0.2477	0.1238	II
HD 86 118	B2 V	9.8	6.64	4.478000	0.28	167.0	1.916257	0.1955364	II
HD 86 146	F5 V	1.4	5.12	9.283500	0.00	18.90	6.508E−03	4.649E−03	II
HD 87 810	F3 V	1.47	6.67	12.94724	0.43	55.50	0.1667240	0.1134177	II
HD 88 215	F5 V	1.4	5.30	28.09800	0.07	10.10	2.984E−03	2.131E−03	
HD 89 822	A0 p	2.9	4.93	11.57910	0.26	38.90	6.372E−02	2.197E−02	II
HD 92 168	F8 V	1.11	5.85	7.799100	0.02	24.10	1.133E−02	1.020E−02	
HD 93 903	A3 m	2.35	5.79	6.166900	0.00	46.60	6.480E−02	2.757E−02	
HD 94 334	A1 V	2.7	4.68	15.83070	0.31	22.20	1.545E−02	5.725E−03	
HD 96 528	A5 m	2.0	6.46	40.45000	0.10	18.00	2.413E−02	1.206E−02	
HD 98 088	A3 Vp	2.35	6.14	5.905100	0.17	74.70	0.2446197	0.1040935	II
HD 98 231	G5 V	0.92	4.41	670.2400	0.53	8.950	3.042E−02	3.307E−02	
HD 99 967	K0 V	0.79	6.38	74.86100	0.03	28.80	0.1854612	0.2347610	
HD 101 013	K0 pBa3	0.79	6.14	1 710.900	0.19	6.070	3.760E−02	4.760E−02	
HD 101 606	F5 V	1.4	5.74	267.5078	0.85	39.07	0.2364242	0.1688744	II
HD 102 509	A7 V	1.79	4.53	71.69060	0.00	30.12	0.2034	0.1136	II
HD 103 578	A3 V	2.35	5.50	6.625400	0.02	57.60	0.1314091	5.591E−02	
HD 104 321	A4 V	2.2	4.64	282.6900	0.27	26.20	0.4713145	0.2142338	
HD 105 981	K2 V	0.69	5.66	461.0000	0.17	14.30	0.1339712	0.1941611	
HD 106 516	F5 V	1.4	6.11	843.9000	0.05	7.930	4.353E−02	3.109E−02	
HD 107 259	A2 V	2.49	3.88	71.79190	0.27	26.67	0.1262	5.070E−02	II

Table 2. continued.

Id	Sp	m_1	V	P	e	k_1	f(m)	Y	SB
HD 107 259	A2 V	2.49	3.88	4 791.900	0.08	4.820	5.519E−02	2.216E−02	
HD 107 935	A7 V	1.79	6.71	176.0800	0.19	19.40	0.1263484	7.058E−02	
HD 108 642	A2 m	2.49	6.52	11.78243	0.00	41.14	8.519E−02	3.412E−02	
HD 108 945	A2 pvar	2.49	5.44	18.81300	0.19	30.50	5.245E−02	2.106E−02	II
HD 110 854	A0 V	2.9	6.56	7.904000	0.03	69.60	0.2763723	9.530E−02	II
HD 112 486	A5 m	2.0	5.82	5.125900	0.00	65.80	0.1516542	7.582E−02	II
HD 114 911	B8 V	3.8	4.79	20.00520	0.12	56.50	0.3666450	9.648E−02	
HD 116 656	A2 V	2.49	2.27	20.53850	0.53	67.26	0.3957	0.1589	II
HD 116 658	B1 V	13.0	0.97	4.014500	0.18	120.0	0.6856863	5.274E−02	II
HD 120 710	B8 V	3.8	6.06	17.42800	0.21	17.00	8.310E−03	2.186E−03	
HD 121 648	F2 V	1.54	6.79	4.991670	0.00	89.85	0.3760	0.2441	II
HD 122 742	G8 V	0.85	6.36	3 617.000	0.48	6.410	6.079E−02	7.857E−02	
HD 125 248	A0 p	2.9	5.89	1 607.070	0.21	7.500	6.580E−02	2.269E−02	
HD 126 983	A2 V	2.49	5.36	11.82000	0.33	76.60	0.4640875	0.1863805	II
HD 128 620	G2 V	0.95	0.01	29 188.10	0.52	4.610	0.1850	0.1948	II
HD 129 132	G0 V	1.05	6.76	101.6060	0.12	19.00	7.081E−02	6.744E−02	
HD 129 132	G0 V	1.05	6.76	3 385.000	0.07	8.500	0.2242	0.2040	
HD 131 511	K1 V	0.71	6.00	125.3960	0.51	19.10	5.774E−02	8.133E−02	
HD 137 052	F5 V	1.4	4.93	226.9500	0.68	14.00	2.549E−02	1.820E−02	
HD 137 108	G0 V	1.05	4.98	15 189.00	0.27	4.709	0.1470	0.1400	II
HD 137 763	K1 V	0.71	6.83	889.6200	0.97	37.14	5.131E−02	7.227E−02	II
HD 137 909	F0 p	1.6	3.66	3 833.580	0.41	9.200	0.2352238	0.1470149	
HD 138 213	A5 m	2.0	6.15	105.9500	0.00	10.80	1.386E−02	6.930E−03	
HD 139 461	F6 V	1.24	6.48	887.6600	0.90	13.96	2.077E−02	1.675E−02	
HD 140 008	B6 V	5.0	4.74	12.26000	0.19	63.30	0.3056019	6.112E−02	II
HD 141 458	A0 V	2.9	6.82	28.94900	0.64	60.60	0.3035131	0.1046597	II
HD 142 096	B2.5 V	9.5	5.03	12.46190	0.40	33.50	3.745E−02	3.942E−03	
HD 142 883	B3 V	7.6	5.85	10.53500	0.58	64.00	0.1479528	1.946E−02	
HD 143 807	A0 pHg	2.9	5.12	35.47400	0.56	2.300	2.548E−05	8.789E−06	
HD 144 426	A3 m	2.35	6.28	8.855000	0.38	31.60	2.296E−02	9.772E−03	
HD 145 389	B9 p	3.25	4.24	560.5000	0.47	2.400	5.533E−04	1.702E−04	
HD 145 482	B2 V	9.8	4.59	5.780500	0.19	31.50	1.775E−02	1.811E−03	
HD 147 584	G0 V	1.05	4.90	12.97620	0.06	7.400	5.431E−04	5.172E−04	
HD 147 869	A2 p(Sr)	2.49	5.84	5.019928	0.21	14.83	1.589E−03	6.381E−04	
HD 149 632	A2 V	2.49	6.41	10.56000	0.43	62.40	0.1960833	7.874E−02	II
HD 151 613	F2 V	1.54	4.85	363.5700	0.35	6.000	6.703E−03	4.353E−03	
HD 152 830	F3 Vs	1.47	6.34	11.85859	0.36	27.44	2.066E−02	1.405E−02	
HD 153 597	F6 V	1.24	4.88	52.10890	0.21	17.60	2.757E−02	2.223E−02	
HD 153 808	A0 V	2.9	3.92	4.023500	0.02	70.70	0.1475734	5.088E−02	II
HD 154 905	F7 V	1.21	5.83	2 270.000	0.43	2.800	3.808E−03	3.147E−03	
HD 155 375	A1 m	2.7	6.60	23.24500	0.43	27.70	3.775E−02	1.398E−02	
HD 157 482	F9 Vn	1.09	5.56	2 018.800	0.67	12.89	0.1823576	0.1673005	II
HD 157 950	F3 V	1.47	4.53	26.27650	0.49	47.50	0.1937267	0.1317869	II
HD 158 261	A0 V	2.9	5.94	5.918200	0.03	25.10	9.705E−03	3.346E−03	
HD 159 082	B9.5 V	3.05	6.42	6.797500	0.07	48.90	8.193E−02	2.686E−02	
HD 159 560	A4 m	2.2	4.89	38.03400	0.03	10.00	3.944E−03	1.792E−03	
HD 160 346	K3 V	0.68	6.52	83.72800	0.22	5.700	1.488E−03	2.188E−03	
HD 160 922	F5 V	1.4	4.80	5.279800	0.00	35.80	2.515E−02	1.796E−02	II
HD 161 573	B4 V	6.86	6.85	19.08500	0.14	5.800	3.753E−04	5.472E−05	
HD 162 515	B9.5 V	3.05	6.51	6.678300	0.02	57.60	0.1324583	4.342E−02	
HD 162 780	B9 V	3.25	6.89	6.622600	0.54	13.20	9.431E−04	2.901E−04	
HD 163 840	G0 V	1.05	6.39	881.8080	0.41	11.22	9.807E−02	9.340E−02	II
HD 165 341	K0 V	0.79	4.02	32 280.50	0.50	3.657	0.1064	0.1347	II
HD 166 285	F5 V	1.4	5.68	199.5500	0.30	14.20	5.140E−02	3.671E−02	II
HD 166 865	K2 V	0.69	6.04	10.52785	0.37	39.14	5.256E−02	7.618E−02	II
HD 166 866	F7 V	1.21	5.68	1 247.200	0.97	44.79	0.1246728	0.1030354	II
HD 167 858	F1 V	1.57	6.62	4.485180	0.00	6.200	1.110E−04	4.070E−05	
HD 167 954	F8 V	1.11	6.85	120.0074	0.04	15.50	4.629E−02	4.171E−02	
HD 168 913	A5 m	2.0	5.63	5.127000	0.00	70.10	0.1972082	9.860E−02	II
HD 169 981	A2 V	2.49	5.88	9.612000	0.47	28.50	1.589E−02	6.381E−03	
HD 170 000	A0 p	2.9	4.18	26.76800	0.39	26.60	4.084E−02	1.408E−02	
HD 170 153	F7 V	1.21	3.57	280.5170	0.41	17.31	0.1146	9.474E−02	II
HD 171 978	A2 V	2.49	5.77	14.67400	0.21	38.60	8.190E−02	3.289E−02	II
HD 172 103	F4 V	1.42	6.65	39.52600	0.37	21.68	3.345E−02	2.355E−02	II
HD 173 282	F5 V	1.4	6.36	33.16070	0.72	49.80	0.1421	0.1015	II
HD 173 654	A2 Vm	2.49	5.90	4.765300	0.02	17.30	2.560E−03	1.028E−03	II
HD 174 933	B7 V	4.4	5.48	6.362400	0.12	17.70	3.585E−03	8.147E−04	

Table 2. continued.

Id	Sp	m_1	V	P	e	k_1	f(m)	Y	SB
HD 175 426	B2.5 V	9.5	5.75	88.35200	0.37	39.70	0.4603478	4.845E−02	
HD 177 863	B8 V	3.8	6.29	11.91540	0.60	42.50	4.822E−02	1.269E−02	
HD 178 322	B6 V	5.0	5.87	12.47000	0.05	79.70	0.6531565	0.1306313	II
HD 178 428	G5 V	0.92	6.08	21.95536	0.08	13.42	5.457E−03	5.932E−03	
HD 178 449	F0 V	1.6	5.23	42.85700	0.00	13.10	1.000E−02	6.253E−03	
HD 178 911	G1 V	0.99	6.90	1 296.300	0.58	6.570	2.014E−02	2.035E−02	II
HD 180 939	B5 V	5.9	6.79	4.477300	0.00	55.00	7.735E−02	1.311E−02	II
HD 183 007	A3 p	2.35	5.69	164.6400	0.12	11.80	2.748E−02	1.169E−02	
HD 183 056	B8 p	3.8	5.11	35.02250	0.45	5.700	4.797E−04	1.262E−04	
HD 184 467	K1 V	0.71	6.59	494.0910	0.36	9.564	3.645E−	5.133E−02	II
HD 184 552	A8 m	1.69	5.66	8.115800	0.14	20.90	7.469E−03	4.419E−03	
HD 185 912	F5 V	1.4	5.86	7.640800	0.54	88.20	0.3246152	0.2318680	II
HD 188 164	A3 p	2.35	6.38	14.98590	0.56	42.90	6.987E−02	2.973E−02	II
HD 189 178	B5 Vp	5.9	5.41	70.23000	0.34	43.50	0.4993	8.462E−02	
HD 189 340	F8 V	1.11	6.21	1 786.270	0.59	4.688	9.988E−03	8.998E−03	II
HD 189 783	F5 V	1.4	6.98	4.469600	0.10	41.30	3.220E−02	2.300E−02	
HD 190 229	B9 p	3.25	5.67	61.54100	0.49	4.200	3.136E−04	9.650E−05	
HD 192 276	B7 V	4.4	6.92	7.185800	0.01	18.50	4.724E−03	1.073E−03	
HD 193 495	B8 V	3.8	3.08	8.677700	0.34	35.10	3.241E−02	8.529E−03	
HD 193 964	B9 V	3.25	5.62	5.298100	0.04	49.70	6.738E−02	2.073E−02	
HD 194 215	K3 V	0.68	5.84	377.6000	0.07	11.20	5.468E−02	8.042E−02	
HD 196 133	A0 p	2.9	6.70	87.68700	0.76	32.50	8.581E−02	2.959E−02	
HD 196 544	A2 V	2.49	5.44	11.03900	0.23	26.00	1.857E−02	7.458E−03	
HD 198 391	A1 Vs	2.7	6.33	10.88300	0.39	31.40	2.731E−02	1.011E−02	
HD 201 433	B9 V	3.25	5.55	154.0900	0.00	9.700	1.460E−02	4.493E−03	
HD 202 275	F5 V	1.4	4.49	2 082.100	0.46	12.40	0.2885978	0.2061413	II
HD 202 940	G5 V	0.92	6.55	21.34620	0.25	24.00	2.781E−02	3.023E−02	
HD 203 064	O7 V(f)	26.5	5.00	5.100000	0.00	30.00	1.430E−02	5.396E−04	
HD 203 439	A2 V	2.49	6.04	20.30000	0.44	45.70	0.1457058	5.851E−02	II
HD 203 858	A2 V	2.49	6.16	6.946300	0.00	71.40	0.2625758	0.1054521	II
HD 204 188	A8 m	1.69	6.08	21.72200	0.00	46.00	0.2195	0.1299	
HD 206 155	A3 m	2.35	6.93	1 464.000	0.52	4.400	8.071E−03	3.434E−03	II
HD 206 672	B3 V	7.6	4.67	26.33000	0.00	16.50	1.228E−02	1.616E−03	
HD 207 650	A0 V	2.9	5.09	5.304700	0.53	37.00	1.701E−02	5.867E−03	II
HD 208 132	A1 m	2.7	6.37	8.303440	0.19	21.80	8.434E−03	3.123E−03	
HD 208 509	A2 V	2.49	6.64	28.81840	0.12	17.10	1.461E−02	5.869E−03	
HD 208 776	G0 V	1.05	6.94	2 624.000	0.27	5.460	3.959E−02	3.770E−02	
HD 210 027	F5 V	1.4	3.76	10.21300	0.00	48.10	0.1180307	8.430E−02	II
HD 213 429	F7 V	1.21	6.26	630.1400	0.38	11.44	7.734E−02	6.392E−02	II
HD 214 608	F9 V	1.09	6.83	551.6000	0.05	13.10	0.1282963	0.1177030	II
HD 214 608	F9 V	1.09	6.83	10 957.30	0.30	5.900	0.2028748	0.1861237	II
HD 214 686	F7 V	1.21	6.89	21.70140	0.41	55.10	0.2860591	0.2364125	II
HD 216 608	A3 m	2.35	5.81	24.22800	0.20	5.800	4.617E−04	1.964E−04	
HD 217 792	F0 V	1.6	5.10	178.3177	0.53	21.30	0.1091249	8.820E−02	
HD 219 749	B9 pSi	3.25	6.48	48.30400	0.50	25.70	5.530E−02	1.701E−02	
HD 221 253	B3 V	7.6	4.88	6.066300	0.25	56.70	0.1042405	1.371E−02	
HD 221 950	F6 V	1.24	5.66	45.45900	0.37	40.10	0.2440906	0.1968473	II
HD 222 098	A2 V	2.49	6.26	11.22980	0.04	26.70	2.214E−02	8.893E−03	
HD 223 778	K3 V	0.68	6.40	7.753100	0.00	39.90	5.114E−02	7.521E−02	II
HD 224 930	G2 V	0.95	5.75	9 610.000	0.37	4.490	7.243E−02	7.642E−02	