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OB Stars in the Tycho-2 and 2MASS Catalogues

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Abstract—The Tycho-2 proper motions and five-band Tycho-2 and 2MASS photometry for approximately 2.5 million common stars have been used to select OB stars and to determine the extinction and photometric distance for each of them. We have selected 37 485 stars and calculated their reddenings based on their positions in the two-color $V_T{-}H$, $J{-}Ks$ diagrams relative to the zero-age main sequence and the theoretical reddening line for B5 stars. Tests confirm that the selected stars belong to the spectral types O–B with a small admixture of later types. We calculate the extinction coefficient R and its variations with Galactic longitude based on the positions of the selected stars in the two-color $B_T{-}V_T$, $V_T{-}Ks$ diagram. The interstellar extinction for each star is calculated as the product of the reddening found and the coefficient R. The extinction and its variations with Galactic longitude agree well with the extinction based on the model by Arenou et al. (1992). Calibration of the relation between the absolute magnitude and reduced proper motion $V_T - A_{V_T} + 5 + 5\log\mu$ for Hipparcos stars has allowed us to calculate the absolute magnitudes and photometric distances for the selected stars. The distances found agree with those derived from the Hipparcos parallaxes within 500 pc. The distribution of the stars and the extinction variations with distance found show that the selected stars form an almost complete sample of stars with spectral types earlier than B5 within about 750 pc of the Sun. The sample includes many noticeably reddened stars in the first and second Galactic quadrants that are absent from the Hipparcos and Tycho Spectral Types Catalogues. This slightly changes the pattern of the distribution of OB stars compared to the classical pattern based on Hipparcos.

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INTRODUCTION

Multicolor photometry for a star theoretically allows the interstellar extinction toward the star and its luminosity and photometric distance to be determined without any knowledge of its trigonometric parallax and spectral type (Straizys 1977). The characteristics of a star can be refined based on its proper motion owing to the statistical correlation between proper motion and distance (Parenago 1954, pp. 86–87). This approach can allow the spiral pattern and other peculiarities of the Galactic structure to be determined from *complete* or almost complete samples of stars in large volumes of space based on large-scale photometric and astrometric catalogs.

OB stars are best suited to testing this method, because the unreddened stars among them can be easily identified by negative $B{-}V$ color indices or $B_T{-}V_T$ close to them. In addition, the concentration of OB stars to the Galactic plane and a noticeable reddening of many of them allow us to estimate the interstellar extinction and to compare it with the theoretical one.

In this paper, we selected putative OB stars, determined the interstellar extinction toward each of them, and calculated their most probable photometric distances. To this end, we used the Tycho-2 proper motions (Høg et al. 2000) and five-band (B_T, V_T, J, H, Ks) Tycho-2 and 2MASS photometry (Skrutskie et al. 2006) for approximately 2.5 million common stars.

THE SELECTION OF STARS

It follows from the properties of the $UBVRIJHK$ photometric system described in detail by Straizys (1977, pp. 135–140) that the reddening lines in the two-color $B{-}J$, $J{-}K$ diagrams are close to straight lines that deviate noticeably from the zero-age main sequence (ZAMS), which is also close to a straight line. This means that such two-color diagrams are

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Table 1. Theoretical slopes of the reddening lines and empirical mean slopes of the ZAMS for O–K stars for the two-color diagrams under consideration

Quantity	Value	ZAMS slope
$E_{(B_T-J)}/E_{(J-H)}$	10.1	5.4
$E_{(B_T-J)}/E_{(J-Ks)}$	6.4	4.6
$E_{(B_T-H)}/E_{(J-H)}$	11.2	6.4
$E_{(B_T-H)}/E_{(J-Ks)}$	7.1	5.4
$E_{(B_T-K)}/E_{(J-H)}$	11.8	6.6
$E_{(B_T-K)}/E_{(J-Ks)}$	7.5	5.6
$E_{(V_T-J)}/E_{(J-H)}$	7.0	3.3
$E_{(V_T-J)}/E_{(J-Ks)}$	4.4	2.8
$E_{(V_T-H)}/E_{(J-H)}$	8.0	4.3
$E_{(V_T-H)}/E_{(J-Ks)}$	5.1	3.6
$E_{(V_T-K)}/E_{(J-H)}$	8.6	4.5
$E_{(V_T-K)}/E_{(J-Ks)}$	5.5	3.8

convenient both for identifying stars of different spectral types and for estimating their reddenings. Here, we can use any other pair of visual and infrared photometric bands that are far apart in place of the $B-J$ color index and any pair of infrared bands (although the $H-Ks$ color index is only moderately informative) in place of the $J-K$ color index. The firmly established relationship of the B_T and V_T magnitudes to the B and V magnitudes (ESA 1977, Vol. 1, pp. 57–63) suggests that the reddening lines under consideration will be straight lines with an adequate accuracy even when B_T and V_T are used in place of B and V (recalculating the observed B_T and V_T magnitudes to B and V is not recommended by the Hipparcos Consortium (ESA 1977, Vol. 1, p. 57); therefore, below, we consider only B_T and V_T). The properties of all the bands used are known well enough to calculate the theoretical slopes of the reddening lines under consideration (i.e., the ratios of the color excesses) from them; they are given in Table 1.

The right column of the table gives the empirical mean ZAMS slopes calculated for 13 882 stars of luminosity class V and spectral types O–K according to the spectral classification from the Hipparcos Input Catalogue (Turon et al. 1993). These stars were selected from the Hipparcos Catalogue as the stars with the most accurate data: the components of their proper motions are known with an accuracy better than $0.002''$ yr^{-1}, the relative accuracy of the parallaxes is less than 0.1, the B_T and V_T magnitudes are known with an accuracy better than $0^m\!.1$, the stars are not attributed to binaries and multiples, and their spectral classification is known. Since they lie within 250 pc of the Sun, their reddenings are low.

Mean ZAMS slopes close to those in Table 1, but with a lower accuracy due to the reddening of distant stars were obtained for the stars of the Tycho Spectral Types (TST) Catalogue (Wright et al. 2003). The distribution of 76 735 TST stars of luminosity class V and various spectral types with the most accurate Tycho-2 and 2MASS photometry in the two-color V_T-H, $J-Ks$ diagram is shown in Fig. 1: 8499 OB stars, 18 122 A stars, 24 624 F stars, 13 721 G stars, 9732 K stars, and 2037 M stars. We see that, in agreement with the theory, the ZAMS is close to a straight line, while the stars of different spectral types are well separated from one another. The giants, which are not shown in the figure, occupy approximately the same region in the diagram as the dwarfs.

The OB stars are noticeably displaced by reddening parallel to the theoretical reddening line for B5 stars shown in the figure (the line slope was taken from Table 1). In addition to them, a number of noticeably reddened F stars was revealed, which has not yet been explained. These stars and a number of A stars fall into the same region of the diagram as the reddened OB stars.

In addition, due to ZAMS nonlinearity, some of the reddest K and M stars also lie in the diagram below the reddening line for B5 stars, in the region where the OB stars can be only at a reddening higher than $1^m\!.4$, which is encountered only for some shell stars. In this paper, when selecting OB stars, we rejected the stars with a reddening higher than $1^m\!.4$.

We see that any sample of OB stars made on the basis of such a two-color diagram should contain some number of A and F stars and a negligible number of G, K, and M stars. To exclude the stars of spectral types later than B from the sample, we can select only the stars below the B5 rather than B9 reddening line, but we then lose some of the B stars together with the late-type stars.

Let us test the efficiency of selecting OB stars using the distribution of 8121 stars classified in TST as O–B5 stars of various luminosity classes as an example (in what follows, we consider only the main body of the TST Catalogue with 35 1863 stars). Figure 2 shows the distribution of these 8121 stars in the V_T-H, $J-Ks$ diagram. It also shows the ZAMS and the theoretical reddening line for O and B5 stars. The following conclusions can be drawn from the figure:

(1) the stars under consideration actually lie mostly between these reddening lines;

(2) there are many reddened stars;

(3) about 3% of the stars under consideration lie not in the strip between the O and B5 reddening

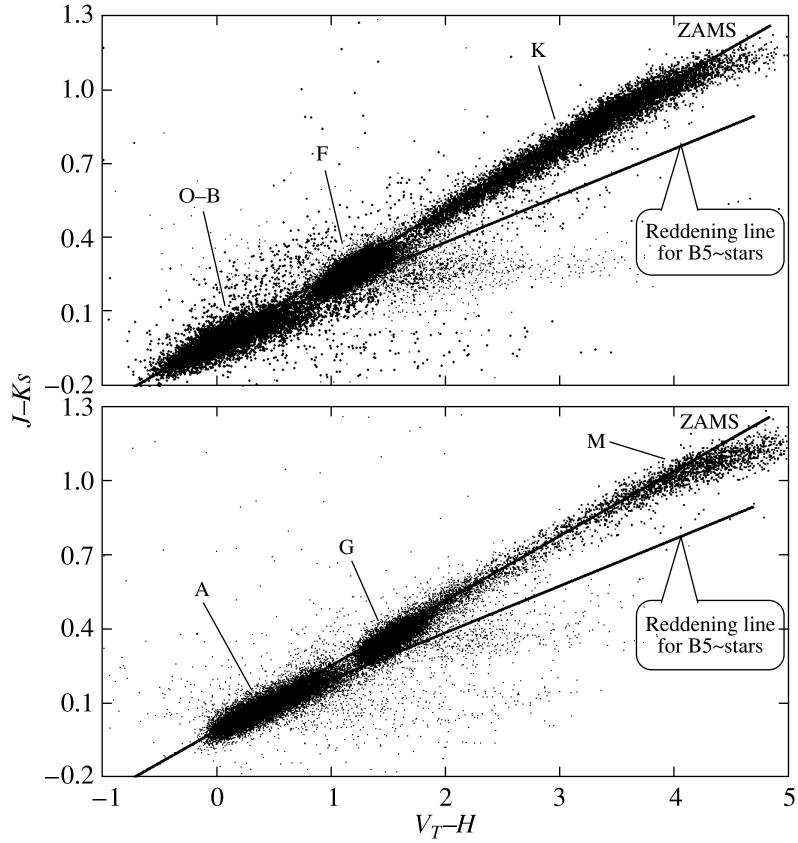

Fig. 1. Distribution of stars of luminosity class V and various spectral types from the Tycho Spectral Types Catalogue in the two-color V_T-H, $J-Ks$ diagram: (a) 8499 OB stars, 24 624 F stars, 9732 K stars; (б) 18 122 A stars, 13 721 G stars, 2037 M stars.

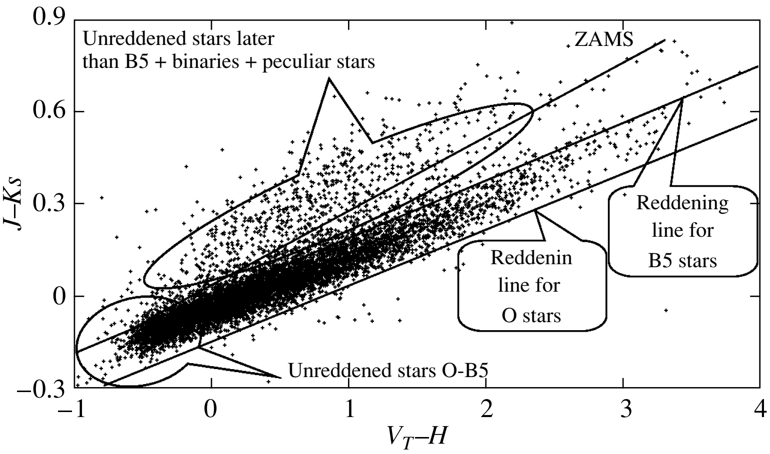

Fig. 2. Distribution of 8121 O–B5 stars from the Tycho Spectral Types Catalogue in the two-color V_T-H, $J-Ks$ diagram.

lines but mostly along the ZAMS and, as a detailed analysis shows, are mostly peculiar, binary with a composite spectrum, erroneously classified stars of later types, or have less accurate photometry.

Thus, the ZAMS and the reddening lines in the two-color diagrams under consideration are actually close to straight lines and have different slopes. Therefore, we can give an approximate spectral classification of a star based on its position in such a diagram relative to the point of intersection between the ZAMS and the reddening line on which the star lies. In this case, the classification accuracy depends

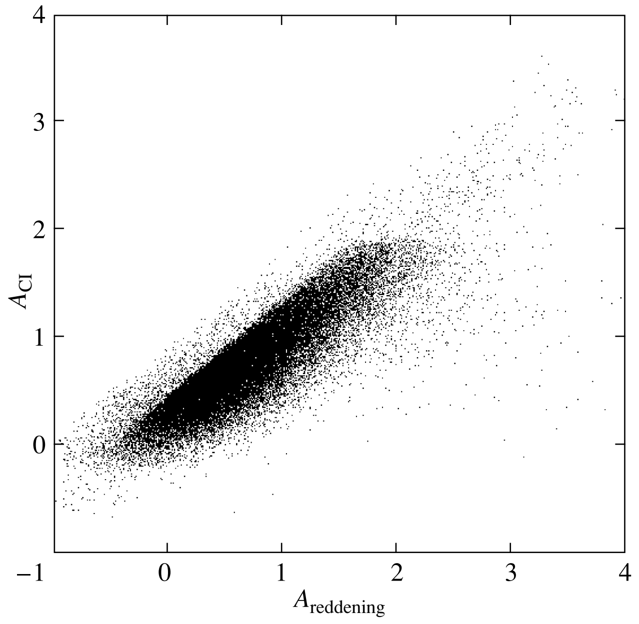

Fig. 3. Relationship between the extinction $A_{V_T\text{reddening}}$ calculated from the displacement of a star along the theoretical reddening line in the two-color diagram and the extinction $A_{V_T\text{CI}}$ calculated from the visual–infrared color index for 37 485 selected stars.

mainly on the accuracy of the photometry used. In fact, 2MASS and Tycho-2 are the first large-scale catalogs with fairly accurate multiband photometry: the median accuracies of the B_T, V_T, J, H, and Ks magnitudes for 2.5 million common stars are $0^m_.14$, $0^m_.10$, $0^m_.02$, $0^m_.03$, and $0^m_.02$, respectively. For approximately 2 300 000 common 2MASS and Tycho-2 stars (91%), at least one of the B_T-J, B_T-H, B_T-Ks, V_T-J, V_T-H, and V_T-Ks color indices and at least one of the $J-H$ and $J-Ks$ color indices has an accuracy better than $0^m_.2$. At a photometric accuracy of future catalog better than $0^m_.01$, the method under consideration will probably give a much more accurate spectral classification of stars.

When selecting the stars and calculating the reddening for each star, we used a two-color diagram with the four most accurate photometric magnitudes for the star. As putative OB stars, we selected all of the common 2MASS and Tycho-2 stars from 2 300 000 stars with accurate photometry located in the two-color diagrams under consideration in the region of earlier spectral types than the B5 reddening line to reduce the number of late-type stars in the sample, even if some of the late-B stars are lost. From about 200 000 stars with less accurate photometry, we selected those that, given the photometric accuracy, are guaranteed to fall into the region below the theoretical reddening line for B5 stars.

For bright ($J < 5^m$) stars, the 2MASS infrared photometry is inaccurate and the suggested method for selecting stars is inapplicable. However, all these stars have accurate Tycho-2 B_T and V_T photometry, appear in the Hipparcos Catalogue, lie mostly within 500 pc, and have a spectral classification. These stars were selected directly from the Hipparcos Catalogue when the following conditions were satisfied: (1) $J < 5^m$, $H < 5^m$, $Ks < 5^m$; (2) the accuracy of the 2MASS photometry in all three bands is lower than 0.15^m; (3) according to the spectral classification, these are OB stars; (4) $\pi > 0.002''$; (5) $M_V < -1^m$; and (6) $B_T-V_T < 0.5^m$. There were 85 such stars that were not selected by their photometry. Many of them belong to the nearest Scorpio–Centaurus OB association. Below, we assume these stars to be unreddened ones. Since the B_T and V_T magnitudes are known for them with an accuracy better than $0^m_.02$, the method of calculating and using the photometric distances considered below was applied for these stars just as for the remaining ones.

As a result, we selected 37 485 stars. 98% of them have fairly accurate photometry, i.e., the color indices used have an accuracy better than 0.2^m, while the median accuracies of the B_T, V_T, J, H, and Ks magnitudes are $0^m_.04$, $0^m_.04$, $0^m_.02$, $0^m_.03$, and $0^m_.02$, respectively.

9997 and 21861 of the selected stars appear in the Hipparcos (27%) and TST (58%) Catalogues; the spectral classification of 15 395 stars (41%) has not been known until now. The selected 21 861 TST stars have the following distribution in spectral types (the ratio, in percent, of the number of selected stars to the total number of TST stars of a given type, i.e., the selection efficiency of stars of a given type, is given in parentheses): O—446 (70%), B0–B5—6021 (76%), B5–B9—6632 (34%), A0—4904 (24%), A1–A9—3571 (8%), F—236 (< 1%), G—28 (< 0.1%), K—20 (< 0.1%), M—3 (< 0.1%). It should be noted that the TST classification can be erroneous or approximate. For example, the number of A0 stars in TST is implausibly large. In other catalog, many of them are marked as B stars or, on the contrary, late-A stars. In addition, because of observational selection, southern stars dominate in TST. Therefore, our selection of OB (mostly O–B5) stars may be considered fairly efficient.

ALLOWANCE FOR THE REDDENING

For each of the selected stars, the reddening can be calculated as the displacement of the star relative to the ZAMS along the theoretical reddening line in the two-color diagrams considered. However, the bluest selected stars with low reddenings because of their proximity to the Solar system are rather

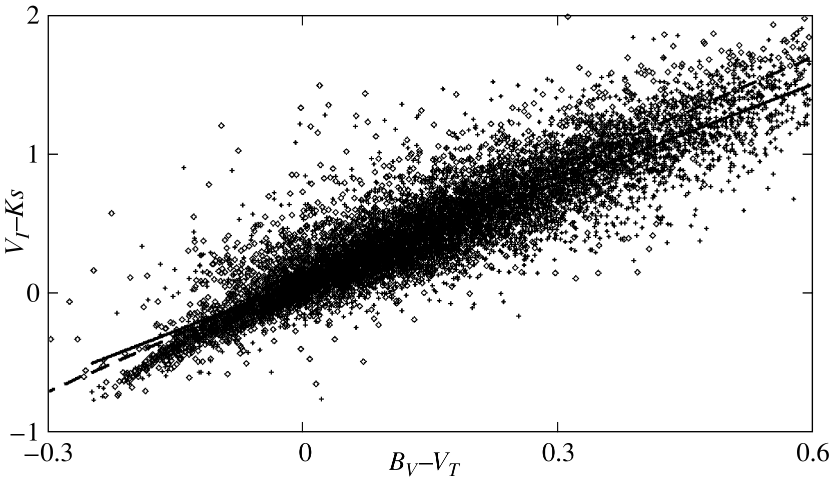

Fig. 4. Distribution of the selected stars in the two-color B_T-V_T, V_T-Ks diagram: for the second (crosses, solid line) and fourth (diamonds, dashed line) Galactic quadrants.

bright. Therefore, their infrared magnitudes were determined in the 2MASS project with a low accuracy, while infrared color indices like $J-Ks$ actually contain no useful information for the reddening calculation. Many of these stars lie in the diagrams considered to the left of the ZAMS and, thus, formally have a negative reddening. For a more realistic reddening estimate, we used visual—infrared color indices like B_T-J, which are theoretically related to the reddening, instead of the displacement of the star along the reddening line. Figure 3 shows that at the same coefficient R, the extinction calculated from the visual—infrared color index is close to that calculated from the displacement of the star along the reddening line and is negative for much fewer stars.

ALLOWANCE FOR THE EXTINCTION

The interstellar extinction A_{V_T} is commonly assumed to depend linearly on the reddening $E_{(B_T-V_T)}$: $A_{V_T} = RE_{(B_T-V_T)}$, where R is a coefficient that depends on the properties of the interstellar medium. Several methods have been suggested to determine the coefficient R. One of them is the method of extrapolating the extinction law described by Straizys (1977, pp. 39—40). Two visual bands and one farthest possible infrared band, for example, Ks, are used: $R = 1.12E_{(V_T-Ks)}/E_{(B_T-V_T)}$; i.e., the coefficient R is determined as the slope of the trend drawn through the "cloud" of stars in the two-color B_T-V_T, V_T-Ks diagram multiplied by 1.12. Different samples of stars can be considered and, thus, the dependences of R on various factors can be analyzed. In this paper, we restrict our analysis to the dependence of R on the Galactic longitude. Figure 4 shows a two-color B_T-V_T, V_T-Ks diagram for the selected stars located in the second and fourth Galactic quadrants. We see that the stars of different quadrants occupy mostly slightly different regions in the diagram and that the coefficient R in the fourth quadrant is appreciably larger than that in the second quadrant (in contradistinction to the mean reddening of stars). For the selected stars, the dependence of R on the Galactic longitude was found to be fitted, to a first approximation, by a sine wave: $2.8 + 0.18\sin(l + 115°)$, where l is the Galactic longitude in degrees.

The interstellar extinction A_{V_T} for each of the stars under consideration was calculated as the product of the coefficient R found and the previously calculated reddening of the star. Since the extinction was calculated individually for each star, this method allows one to consider in the future the spatial extinction variations, to detect large absorbing clouds, and, possibly, to construct an accurate three-dimensional interstellar extinction map for wide solar neighborhoods.

The derived extinction is compared with the extinction based on the widely used three-dimensional model by Arenou et al. (1992) in Fig. 5. Since the selected stars lie near the Galactic plane, we will restrict our analysis to the dependence of the extinction on the Galactic longitude. Figure 5a shows the extinction based on the model by Arenou et al. (1992) for 1129 selected Hipparcos stars located, according to their parallaxes, in a spherical layer from 400 to 500 pc. We see the well-known extinction variations with Galactic longitude. Figure 5b shows the extinction that we found for the same 1129 stars and Fig. 5c shows the extinction that we found for 3792 selected stars in the spherical layer from 400 to 500 pc according to the photometric distances calculated below in this paper. We emphasize that the data presented in Figs. 5a and 5c are completely independent. However, their good agreement is clearly seen (the results pertain to different magnitudes (V and V_T), but this difference

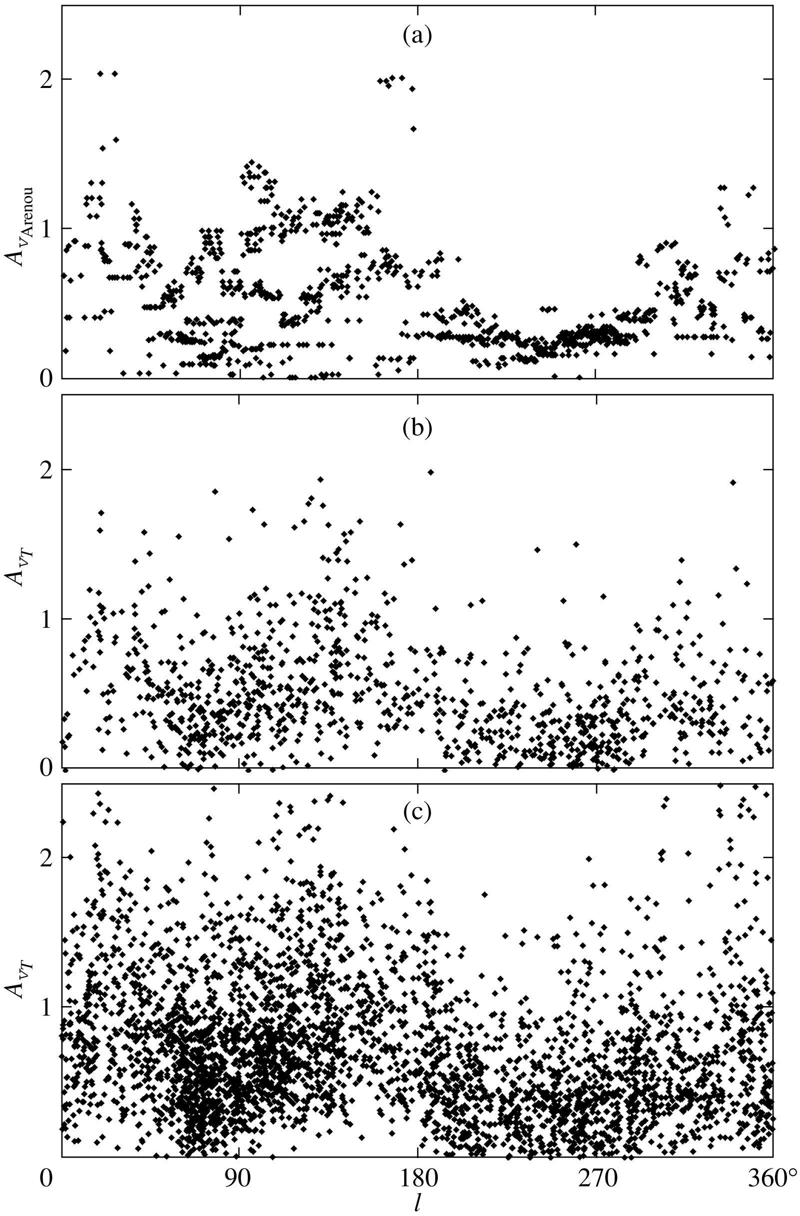

Fig. 5. Interstellar extinction versus Galactic longitude for the selected stars at distances from 400 to 500 pc: (a) based on the extinction model by Arenou et al. (1992) for 1129 Hipparcos stars with the distances calculated from the Hipparcos parallaxes; (b) the extinction that we found for the same 1129 stars; (c) the extinction that we found for all 3792 stars with photometric distances from 400 to 500 pc.

may be neglected in such a check comparison). Thus, the suggested method of allowance for the interstellar extinction yields plausible results.

CALCULATING THE PHOTOMETRIC DISTANCES

If there were no systematic motions of the stars relative to the Sun, for example, due to the Galactic rotation and the solar motion to the apex, and if there was no observational selection, then the reduced proper motion, $M'_{V_T} = V_T - A_{V_T} + 5 + 5\log\mu$, where V_T is the observed magnitude, A_{V_T} is the interstellar extinction, and $\mu = (\mu_\alpha \cos\delta^2 + \mu_\delta^2)^{-1/2}$ is the proper motion in arcseconds (Parenago 1954, p. 87), would be an adequate replacement for the absolute magnitude. Any other band can be used in place of the V_T photometric band.

Theoretically, the proper motion used should be corrected for all systematic motions of the stars and for the observational selection effects. In practice, however, this is not possible, since, for example, some of these corrections depend on the distance, which is unknown for most of the stars considered.

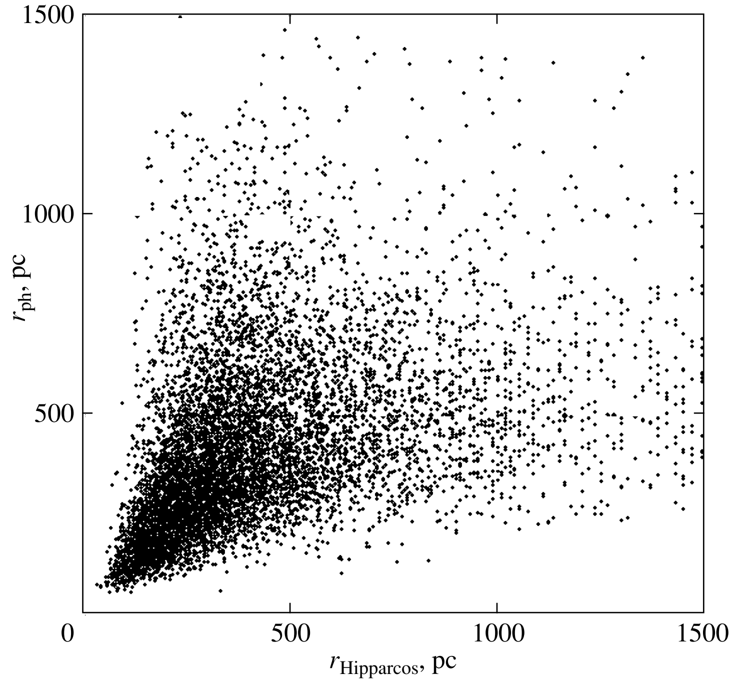

Fig. 6. Correlation of the derived photometric distances with the distances calculated from the Hipparcos parallaxes for 8525 selected stars.

The proper motions of all the selected stars were corrected for the Galactic rotation and the solar motion to the apex using formulas from Belikov et al. (2002). The Oort constants A and B, along with the apex coordinates $L_\odot$ and $B_\odot$ and the velocity of the solar motion $V_\odot$, were calculated by least squares from the proper motions and parallaxes of 2202 selected stars for which the Hipparcos parallaxes are known with a relative accuracy better than 0.2. The derived Oort constants $A = +13.5 \pm 1.0$ and $B = -14.2 \pm 1.0$ km s^{-1} kpc^{-1} and the apex characteristics $L_\odot = 63° \pm 2°$, $B_\odot = 24° \pm 3°$, and $V_\odot = 11.3 \pm 0.3$ km s^{-1} agree with the coordinates of the standard apex ($L_\odot = 57°$, $B_\odot = 22°$) and other determinations of the Oort constants, for example, by Bobylev (2004): $A = +13.7 \pm 0.6$ and $B = -12.9 \pm 0.4$ km s^{-1} kpc^{-1}.

Once the proper motions have been corrected for the Galactic rotation and the solar motion to the apex for all the selected stars, we calculated the reduced proper motions M'_{V_T} by taking into account the extinction A_{V_T} found. For 2202 selected stars whose parallaxes are known with a relative accuracy better than 0.2, we established a statistical correlation between the reduced proper motion and absolute magnitude: $M_{V_T} = 0.45M'_{V_T} - 1$. Using this formula, we calculated the absolute magnitude and then the photometric distance for each of the selected stars by taking into account the previously found extinction: $r_{ph} = 10^{(V_T - A_{V_T} - M_{V_T} + 5)/5}$.

The correlation of the derived photometric distances with the distances calculated from the Hipparcos parallaxes for 8525 selected stars is shown in Fig. 6: agreement between these quantities is clearly seen within 500 pc.

As was shown by Belikov et al. (2002), the photometric distances calculated by this method can differ from the true ones both systematically and randomly: each compact set of stars (e.g., a cluster) seems extended and, possibly, displaced in the radial direction. This effect requires a detailed analysis after which the three-dimensional distribution of stars can be considered. In particular, to refine the extinction and photometric distance for each star, we plan to use two trends in subsequent studies: (1) for the stars on the same line of sight, the extinction cannot decrease with distance; (2) according to Arenou et al. (1992), for the stars within 1.5 kpc near the Galactic plane, the extinction is described with an adequate accuracy by the equation $A_V = f(r)\sin(l + 20°)$, where $f(r)$ is a distance-dependent coefficient and l is the Galactic longitude in degrees. This formulas is probably also valid for A_{V_T}. Therefore, for each star, the well-known relation $A_{V_T} + 5\log(r) = V_T + 5 - M_{V_T}$, where A_{V_T} is the extinction, r is the distance, V_T is the observed magnitude, and M_{V_T} is the absolute magnitude, can be transformed into the following equation using the linear relation between absolute magnitude and reduced proper motion: $f(r)\sin(l + 20°) + 5\log r = V_T + 5 - k_1(V_T + 5 + 5\log\mu) + k_2$, where k_1 and k_2 are the coefficients common to all of the

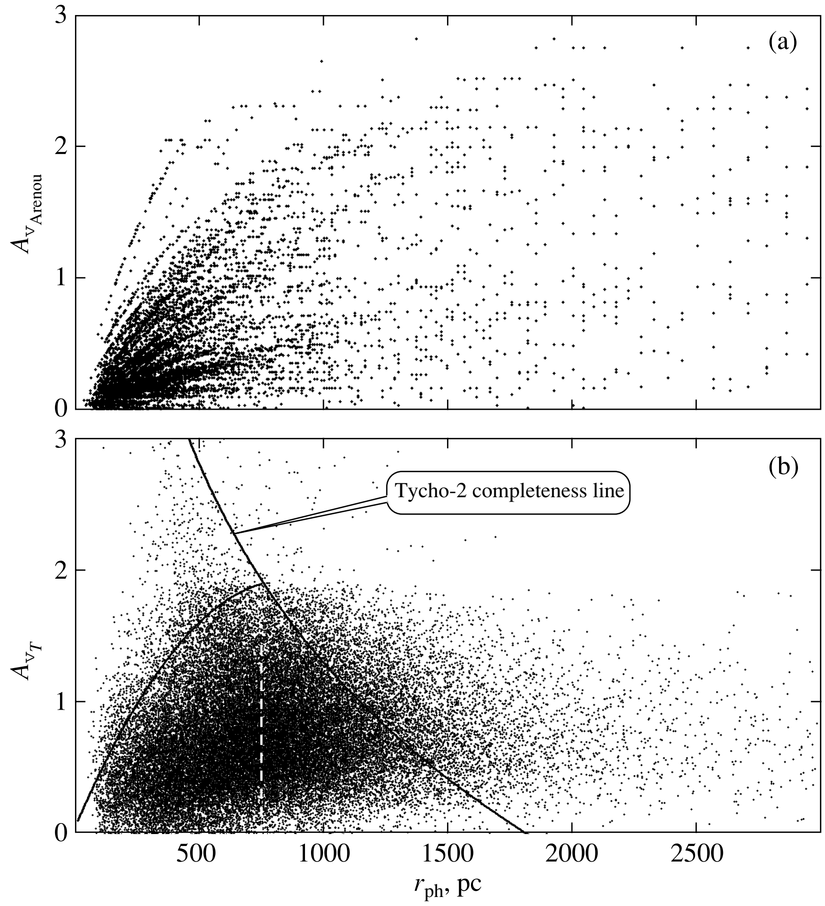

Fig. 7. Interstellar extinction versus distance: (a) extinction based on the model by Arenou et al. (1992), the distances were calculated from the Hipparcos parallaxes for 8937 selected stars; (b) extinction and photometric distances that we found for 37 318 selected stars within 3 kpc.

stars under consideration and refined by iterations along with r. This approach will allow not only the photometric distances, but also the extinction variations in the Galactic plane to be refined.

In Figs. 7a and 7b, extinction is plotted against distance: the extinction as derived by Arenou et al. (1992) versus the distance found from the Hipparcos parallaxes for 8937 selected stars and the extinction and photometric distances that we found for 37 318 selected stars within 3 kpc. We see a similar increase in extinction within the nearest kiloparsec. The curve in the lower left part of Fig. 7b illustrates this increase. However, we see from Fig. 7b that the extinction, on average, *decreases* with distance for distant stars. Such an unexpected result can be explained by the fact that we are dealing with a doubly limited sample of stars: we selected OB stars, i.e., mostly in a narrow range of absolute magnitudes, while the Tycho-2 Catalogue is complete only to a certain apparent magnitude. As a result, distant stars with high extinctions do not appear in the Tycho-2 Catalogue, in contradistinction to distant stars with low extinctions, and the extinction at which a star does not appear in the Tycho-2 Catalogue decreases with distance. The corresponding dependence is shown in Fig. 7b as a logarithmic Tycho-2 completeness line: $A_{V_T\text{lim}} = V_{T\text{lim}} - M_{V_T\text{lim}} + 5 - 5\log r$, where $A_{V_T\text{lim}}$ is the extinction at which the sample completeness breaks down, $V_{T\text{lim}} \approx 10^m$ is the apparent magnitude to which the Tycho-2 Catalogue is complete, $M_{V_T\text{lim}} \approx -1\overset{m}{.}3$ is the limiting absolute magnitude above which the OB stars are rare, and r is the distance. The stars seen in Fig. 7b to the right and above this completeness line have $M_{V_T} < -1\overset{m}{.}3$. The increase in their number with distance can be explained by an increase in the volume of space under consideration.

A few stars in the upper left part of Fig. 7b, to the left of both curves, are of considerable interest. They exhibit an abnormally high extinction and turned out to be mostly stars with shells and other peculiarities, which either actually provide a high extinction or do not allow the presented method to be applied to them. In both cases, the calculated photometric distance can be fictitious.

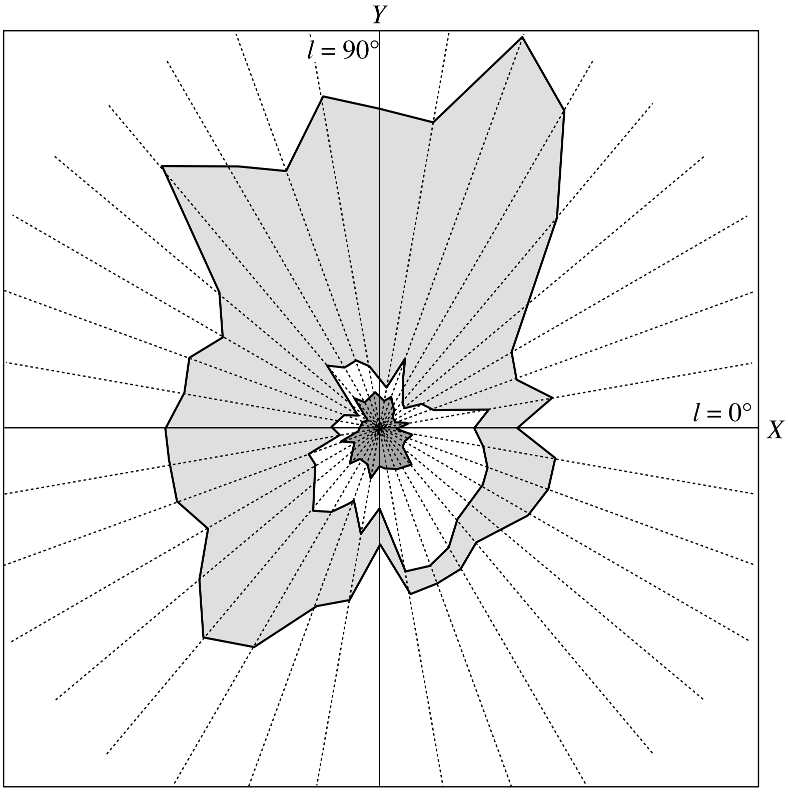

Fig. 8. Distribution of stars in Galactic longitude (the length of the radius vector in each 10-degree sector is proportional to the number of stars): the inner contour—5129 O—B7 stars from the Hipparcos Input Catalogue, the middle contour—13 168 O—B7 stars from the Tycho Spectral Types Catalogue, and the outer contour—37 485 stars selected in this paper.

The distance at which the Tycho-2 completeness line discontinues the naturally growing extinction should be considered to be the distance to which the sample of stars under consideration is almost complete with regard to stars earlier than some spectral type (bluer stars were selected more efficiently). This distance, 750 pc, is marked by the white dashed line. There are 20 843 of the 37 485 selected stars within 750 pc. Thus, the joint use of the 2MASS and Tycho-2 Catalogues allows us for the first time to consider an almost *complete* sample of stars of a certain spectral type in a large region of space. When the Hipparcos Catalogue was used, a similar region of space had a radius of several tens of parsecs. A large number of OB stars located at distances that are seemingly accessible to Hipparcos did not appear in this catalog, being fainter than the limiting magnitude: for example, a typical B5V star with $M_{V_T} = -1^m$ at a distance of 400 pc at $A_{V_T} = 1^m$ has $V_T = 8^m$ and, probably, did not appear in the Hipparcos Catalogue, which is complete in the Galactic plane only to $V_T \approx 7\overset{m}{.}3$.

Other things being equal, the higher the reddening of a star and the extinction toward it, the lower the probability of its falling into an *incomplete* sample. So, *incomplete* samples of luminous stars at large distances give an underestimated interstellar extinction. These effects can be eliminated only by considering *complete* samples of stars.

Thus, our study revealed a large number of noticeably reddened stars that are absent from the Hipparcos and TST Catalogues. A particularly great number of such stars were found in the first and second Galactic quadrants, which slightly modifies the idea of the distribution of OB stars based on Hipparcos data that has become classical over 10 years (see, e.g., Gontcharov 2004). In this paper, we restrict our analysis to the distribution of OB stars in Galactic longitude shown in Fig. 8: the length of the radius vector in each 10-degree sector is proportional to the number of stars, the inner, middle, and outer contours show, respectively, the distributions of 5129 O—B7 stars from the Hipparcos Input Catalogue, 13 168 O—B7 stars from TST, and 37 485 stars selected in this paper. The large number of TST stars in the fourth quadrant is the result of observational selection. The large number of stars selected here in the second and third octants can be explained by a high extinction, as we see from the figure, and is an argument that these stars represent a segment of the Local Spiral Arm extended approximately from the second to the sixth octant.

Table 2. Selected stars in known associations

Association	Number of stars OB, %	r_{Zeeuw}, pc	r_{ph}, pc
Lower Cen-Cru	71	116 ± 2	160 ± 11
Upper Cen-Lup	68	142 ± 2	146 ± 7
Upper Sco	43	144 ± 3	142 ± 12
Per OB3	77	185 ± 5	128 ± 6
Cep OB6	83	270 ± 12	218 ± 21
Per OB2	82	318 ± 27	363 ± 19
Vel OB2	61	410 ± 12	395 ± 19
Lac OB1	72	364 ± 22	512 ± 36
Trumpler 10	52	366 ± 23	358 ± 25
Collinder 121	75	592 ± 28	649 ± 29
Cep OB2	80	624 ± 42	766 ± 47

SELECTED STARS IN OB ASSOCIATIONS

Let us test the efficiency of selecting OB stars and the plausibility of the photometric distances found using 11 known associations studied by de Zeeuw et al. (1999) as an example. Table 2 gives the association name, the percentage of the OB stars that are association members according to the list by de Zeeuw et al. (1999) selected by the method presented here, the mean distance to the association based on early-type stars and its accuracy according to de Zeeuw et al. (1999), and the mean photometric distance to the association and its accuracy based on the stars selected here (the accuracy was calculated from the standard deviation of the distances). We see that the suggested method for selecting OB stars is fairly efficient. Clearly, there is acceptable agreement between the mean distances to the associations obtained by the two methods, no systematic discrepancy, and a high accuracy of the photometric distances. These results should be considered preliminary.

CONCLUSIONS

This study has shown that the method for determining the fundamental parameters of stars from multicolor photometry presented by Straizys (1977) can be fully implemented only now, based on large catalogs with homogeneous photometry at an accuracy level of $0\overset{m}{.}1$, such as Tycho-2 and 2MASS. The results obtained are important not only for studying Galactic structures, such as the Local Spiral Arm, but also for modern major astronomical projects whose key objective is to automatically classify millions of stars and extended objects by their multicolor photometry.

We used the method under consideration to efficiently select 37 485 putative OB stars from the entire set of 2.5 million stars of various spectral types. For them, we calculated plausible reddenings, extinction coefficients R, extinctions, absolute magnitudes, and photometric distances. We probably obtained an almost complete sample of O and early-B stars within 750 pc of the Sun and revealed many significantly reddened stars that were absent from the Hipparcos and TST Catalogues.

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