HOMOGENIZATION OF STELLAR CATALOGUES THROUGH DATA INTERCOMPARISON

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ABSTRACT. The accuracies of some selected stellar catalogues of $T_{\rm eff}$ values have been estimated through data intercomparison. The technique of such estimating developed earlier for triples of catalogues has been adapted to a set of catalogues. A homogenized catalogue of $T_{\rm eff}$ values has been produced by weighted data averaging and compared with some available data.

Key words: Catalogues; stars: fundamental parameters.

1. Introduction

Catalogues of astrophysical parameters (APs: $T_{\rm eff}, \log g$, [Fe/H], etc.) provide important information about the detailed physical properties of each star observed, which encode the structure, star formation and chemical enrichment history of the Galaxy. To make the appropriate stellar samples more representative, different classification methods are used where the APs from some selected catalogues are involved to calibrate spectral or photometric data in large scale surveys. However the available catalogues are rather heterogeneous: there are systematical differences between the data, the estimates of accuracies of catalogues are differing and may be uncertain. The rapidly growing number of catalogues has imposed a need for refining procedures of merging catalogues of a kind of stellar data (APs, photometry etc.) into a respective mean data homogenized catalogue. A problem is being considered how to homogenize available stellar catalogues of APs published by different authors. Underlying procedures of merging catalogues should be a statistical weighting of data according to their statistical accuracies. For homogenization we use the published internal errors as well as the external errors of catalogues (the later values may be determined from data intercomparison). We treat only $T_{\rm eff}$ values in the present paper.

2. General principles

We try the following approach: to take one chosen catalogue (both extensive and precise) as a basic catalogue, to combine some selected catalogues into one scale and to average all data with the weights inversely proportional to the external errors of catalogues, their published internal errors are weighted too. The external errors of catalogues are determined from data intercomparison for triples of catalogues. If there are independent catalogues 1, 2, 3 having the stars in common (the systematical differences are removed), we may calculate the variances of data differences δ_{12}^2, δ_{13}^2, δ_{23}^2 and determine the errors of catalogues $\sigma_1, \sigma_2, \sigma_3$ from the variances.

In the present approach we treat the published rms errors of $T_{\rm eff}$ values from different catalogues as internal errors (σ_{int}), the errors of $T_{\rm eff}$ obtained from data intercomparision are treated as external errors (σ_{ext}). To obtain the final $T_{\rm eff}$ for every star (where n catalogues are available) we calculate

$$\sigma_i^2 = \sigma_{ext,i}^2 + \sigma_{int,i}^2 \, , \;\; T_{{\rm eff},final} = \frac{\sum_{i=1}^{n} (1/\sigma_i)^2 (T_{{\rm eff},i})}{\sum_{i=1}^{n} (1/\sigma_i)^2} . \quad (1)$$

With these data a homogenized catalogue of $T_{\rm eff}$ values may be created.

3. Selected catalogues and data analysis

Short description of the selected catalogues used in the present analysis is given in Table 1. The $\sigma T_{\rm eff}$ values are the published errors which characterize the catalogues; their means (with their standard deviations) or the presentative $\sigma T_{\rm eff}$ values are given for every catalogue. To deal with more homogeneous $\sigma T_{\rm eff}$, we introduce some appropriate subsamples of the catalogues whose published $\sigma T_{\rm eff}$ are within certain intervals of these estimates (given in the first column of Table 1), the means of $\sigma T_{\rm eff}$ for the catalogues and for their appropriate subsamples are about the same.

All possible comparisons of the $T_{\rm eff}$ values in these catalogues by pairs for the stars in common have been

Table 1: Catalogues of the $T_{\rm eff}$ values with their subsamples used in the present analysis

Reference*/Subsample	N	Type of data	Method	mean $\sigma T_{\rm eff}$(K)
1.	10999	V+2MASS photometry	SEDF Method	64 ± 14
$70 \geq \sigma T_{\rm eff} \geq 50$	6486	-	-	61 ± 6
2.	754	17 photometric colors	IRFM	67 ± 19
$80 \geq \sigma T_{\rm eff} \geq 60$	421	-	-	70 ± 4
3.	420	$JHKL$ photometry	IRFM	50 ± 16
$60 \geq \sigma T_{\rm eff} \geq 40$	235	-	-	47 ± 5
4.	189	$uvby - \beta$ photometry	synthetic photometry	25
5.	950	R, I, K photometry	calibration	46 ± 23
$70 \geq \sigma T_{\rm eff} \geq 30$	498	-	-	54 ± 8
6.	1039	spectroscopy, Keck+Lick	synthetic spectra	44
7.	465	spectroscopy, H.-Provence	line-depth ratios	7 ± 3
$10 \geq \sigma T_{\rm eff} \geq 4$	407	-	-	6 ± 2

* 1. Masana et al. (2006); 2. Ramirez, Melendez (2005); 3. Blackwell, Lynas-Gray (1997); 4. Edvardsson et al. (1993); 5. Taylor (2003a); 6. Valenti, Fisher (2005); 7. Kovtyukh et al. (2004, 2006).

Table 2: External errors of $T_{\rm eff}$ with their deviations for 7 referenced catalogues (their description is given in Table 1). The last line contains the mean published internal $\sigma T_{\rm eff}$ for the subsamples (or catalogues) taken from the last column of Table 1.

	Cat. 1	Cat. 2	Cat. 3	Cat. 4	Cat. 5	Cat. 6	Cat. 7
external error	59±6	73±5	54±9	45±12	52±9	62±10	36±10
internal error	61	70	47	25	54	44	6

performed; we have found that the mean differences are significant in some cases but the dependences of differences on $T_{\rm eff}$ are not significant. We have calculated the sample mean differences and the standard deviations for every pair of the catalogues (and/or subsamples) from Table 1. We use the subsamples instead of the catalogues when necessary and their data are treated to calculate the variances of data differences for each pair of subsamples (or catalogues) for the stars in common.

With the use of these variances and the technique presented in Malyuto (1993) we obtain three appropriate external errors of $T_{\rm eff}$ for every triple of catalogues (all possible triples are analysed). We average the errors obtained with the different riples to obtain the mean values. The results (the averaged errors with their deviations) are presented in the first line of Table 2 for all analysed catalogues.

It is interesting to confront the external errors for stars for the catalogues and the published internal errors (given in the last line of Table 2). These data do not differ significantly for the photometric data (catalogues 1, 2, 3 and 5) but they are rather different in the cases where we deal with synthetic photometry and spectral data (catalogues 4, 6 and 7). We underline the importance to use the external errors in combination with the published internal errors as some weights in averaging the $T_{\rm eff}$ values compiled from different catalogues.

To produce a homogenized catalogue of the $T_{\rm eff}$ values, we consider the Masana et al. (2006) data as one basic catalogue, the averaged data are calculated with the formulae (1) for the stars which are in common at least with one other catalogue of Table 1. The results will be treated in a separate paper.

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