TempLogG TNG fundamental parameter determination from Strömgren photometry

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Abstract. Photometry can be used to determine the fundamental parameters of many stars in a short time, including the effective temperature, the luminosity or surface gravity, an initial abundance guess of certain elements, the spectral type, the magnitude and the existence of a peculiarity. This wealth of possible physical parameters has led to many calibrations in various photometric systems. Besides the Johnson UBV system one of the most widely used photometric systems is the Strömgren system together with the Hβ measurement. Empirical calibrations and model atmospheres are continuously improved over the time. Thus the main goal of this work was to collect up to date improvements of the fundamental parameter determinations and integrate them in an easy to use and later easy to upgrade and extend GUI driven program which is written in a modern programming language. The first extensive test of the convenience of the program was the preparation of part of the input data for the Corotsky database which is developed for the target selection process of the COROT satellite mission.

1. TempLogG TNG

The first step is the photometric classification and the selection of the spectral region of calibration. The Strömgren calibration code was written by E. Fresno (1994). The spectral region from B0–F0 is difficult to calibrate because the parameters which determine the effective temperature and surface gravity, Hβ and c0, switch roles. Stars on the boundaries of regions are put through an algorithm similar to the one applied by Philip el al. (1976) to determine their spectral region. Additional to the five spectral regions for the main sequence stars the program checks if the star is a supergiant according to criteria of Gray (1991). As it is not possible to separate main sequence stars from giants, "MS" includes the luminosity classes V, IV and III. "SG" includes the the luminosity classes Ia, Ib, Iab and II.
After a spectral region has been assigned to the star the interstellar extinction is taken into account and the intrinsic colors are computed. With the intrinsic colors it is then possible to calculate the fundamental parameters either by an empirical interpolation formula or directly by interpolation and iteration in a synthetic color grid which has been computed by a model atmospheric code.

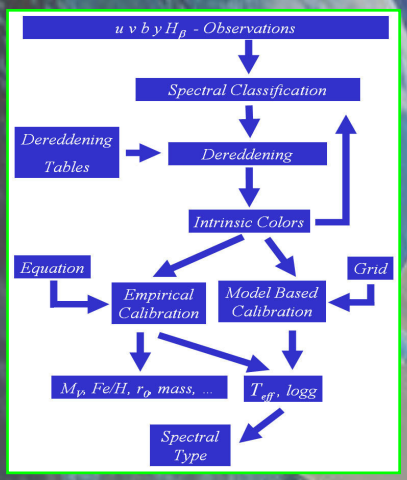

Fig.. 1: TempLogG TNG flowchart

2. The Comparison Sample

One of the goals in building TempLogG TNG was to have an easy to use tool to compare the results of different existing calibrations. Since a variety of calibrations has been published over the years, it is interesting to test them on a sample of stars with well known temperatures, gravities and metallicities.
The used sample has to be as large as possible in order to obtain a statistical sound conclusion. Therefore the catalogue of Strobel (1997) has been used. The catalogue is a compilation of published atmospheric parameters (T_{eff}, log g, [Fe/H]) and spectral types obtained from high resolution, high signal-to-noise spectroscopic observations. It contains determinations of Teff, logg and [Fe/H] for 2490 different stars. The literature is taken from publications between January 1980 and December 1995.
The first step was to find Strömgren measurements for all of these stars. This was done by using the Simbad Astronomical Database. For 1334 stars color indices could be obtained. The rest of the stars had to be removed from the sample. 56 stars were not inside the range of the calibrations and had also to be removed.

After processing the stars with TempLogG TNG the computed fundamental parameters can be compared. Figures 2 and 3 show the differences between spectroscopic and photometric estimated temperatures and gravities.

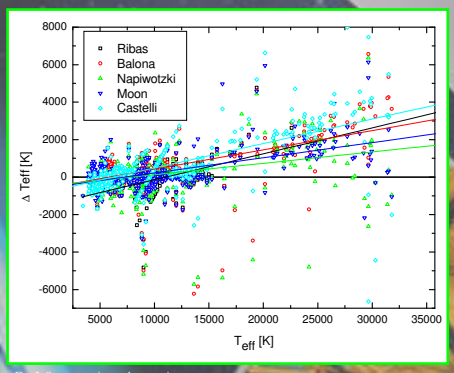

Fig. 2: Spectroscopic vs. photometric temperature

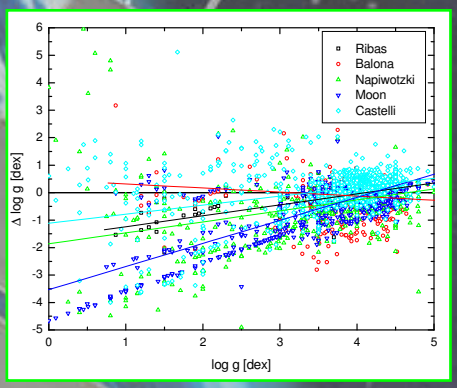

Fig..3: Spectroscopic vs. photometric gravity

Figure 4 shows all calibrations that are available in the program. The best calibration which were selected according to the comparison above are highlighted in yellow. Figure 5 shows the typical error for the chosen calibration for every spectral region.

Spectral Type	Calibration Error		
	T_{eff} [K]	log g [dex]	Fe/H [dex]
MS B0–A0	246±1596	-0.280±0.729	-0.228±0.709
MS A0–A3	104±425	-0.106±0.401	0.046±0.513
MS A3–F0	-3±391	-0.167±0.375	0.182±0.279
MS F0–G2	13±194	-0.143±0.375	-0.095±1.182
MS G2 ...	-141±343	-0.926±1.611	-0.228±0.709
SG B0–A5	-	-	-
SG A0–F5	-117±719	-	-
SG F5–G5	-563±535	-	-

Fig. 5: Calibration errors

3. The Corotsky Data

The observations for the Corotsky Input Catalogue were done on the 0.9 m telescope of the Observatorio de Sierra Nevada which belongs to the Instituto de Astrofísica de Andalucía. The Observations were carried out by Pedro Amado between 2002 and 2004 for 1526 stars in the eyes of Corot.
The Corotsky dataset was provided with individual errors of the observed colors. With these errors TempLogG was able to do an estimation of the internal error which is the error due to the uncertainty of the observed colors. Figure 6 shows the mean internal errors for the dataset for every spectral region.

Spectral Type	Internal Error		
	T_{eff} [K]	log g [dex]	Fe/H [dex]
MS B0–A0	407 ± 1347	-0.280±0.729	-0.228±0.709
MS A0–A3	92 ± 80	-0.106±0.401	0.046±0.513
MS A3–F0	47 ± 48	-0.167±0.375	0.182±0.279
MS F0–G2	52 ± 48	-0.143±0.375	-0.095±1.182
MS G2-K0	91 ± 14	-0.926±1.611	-0.228±0.709
SG B0–A5	-	-	-
SG A0–F5	61 ± 60	-	-
SG F5–G5	550 ± 1148	-	-

Fig. 6: Internal errors of the Corotsky dataset

4. Conclusion

TempLogG TNG is a program dedicated to the determination of fundamental parameters from Strömgren photometry. The program has up to date calibrations valid for normal single stars (non-Am, non-peculiar, without quoted emission lines, etc.) with a spectral type ranging from B0-K5 and for the luminosity classes I-V.

5. References

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Spectral Type	Calibration								
	Dereddening		Fe/H	M_v		T_{eff} /log g			
MS B0 – A0	Crawford		Smalley	Balona		Moon	Napiwotzki	Castelli	Balona
MS A0 – A3	Grosbol	Mathew	Haywood	Strömgren		Moon	Napiwotzki	Castelli	Balona
MS A3 – F0	Crawford		Haywood	Crawford	Domingo	Moon	Napiwotzki	Castelli	Balona
MS F0 – G2	Olsen		Haywood	Crawford		Moon	Napiwotzki	Castelli	Balona
MS G2 ...	Olsen		Olsen	Olsen		Moon	Napiwotzki		Castelli
SG B0 – A5	Kilkenny		-	Balona		Moon	Napiwotzki		Castelli
SG A0 – F5	Gray		-	Dambis		Gray			
SG F5 – G5	Gray		-	Arellano		Gray			

Fig. 4: Used Calibrations

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