TABLE 1

SAMPLE OF THE FUNDPAR.PAR FILE WHICH CONTAINS THE WEIGHTS OF THE χ^2 FUNCTION

t1 = 200.00	# Characteristic length scale of Teff (K)
t2 = 0.10	# Characteristic length scale of Logg (dex)
t3 = 0.10	# Characteristic length scale of [Fe/H] (dex)
t4 = 0.10	# Characteristic length scale of Xita (km s^{-1})
w1 = 25000.00	# Chi2 Weight factor
w2 = 2500.00	# Chi2 Weight factor
w3 = 1111.00	# Chi2 Weight factor
w4 = 1111.00	# Chi2 Weight factor

The users are free to modify the values of the weights w_1,...,w_4 according to their own criteria. However, we show a simple example estimating aproximately the values of the weights. Adopting $\chi^2 = 1$ as the limiting case of a solution, each condition contributes, for example, with 0.25 to the sum $\chi^2 = 0.25 + ... + 0.25$. In this case the 4 conditions are taken equally important within χ^2, which is not always true. In the plot of abundance vs. excitation potential, we accept a maximum slope, for instance, of $c_1 \sim 0.015/4$ dex/eV, taking a difference of $\sim$0.015 dex in the abundance, for a total range of $\sim$4 eV in the excitation potential of Fe lines. Then, in the limiting case, $w_1 c_1^2 \sim 0.25$ and thus $w_1 \sim 18000$ eV^2/dex^2. The units of w_1 are forced so as to obtain a dimensionless product $w_1 c_1^2$. In the plot of abundance vs. $\log_{10}(W/\lambda)$ (where W and λ are the equivalent width and wavelength in Å, respectively), we accept a maximum slope (for example) of $c_2 \sim 0.015/1.5$, taking a difference of 0.015 dex in the abundance for a range of $\sim$1.5 in the $\log_{10}(W/\lambda)$ of Fe lines. Then, $w_2 c_2^2 \sim 0.25$ and thus $w_2 \sim 2500$. For the third condition, c_1 = [FeI/H] − [FeII/H] and we adopt a maximum difference of 0.015 dex. Then, $w_3 c_3^2 \sim 0.25$ and thus $w_3 \sim 1100$ dex^{-2}. Similarly, for w_4 result $w_4 \sim 1100$ dex^{-2}. In this estimation the weights w_1,...,w_4 turned out to be 18000 eV^2/dex^2, 2500, 1100 dex^{-2} and 1100 dex^{-2}, respectively, for a solution in which the four conditions contribute equally with 0.25 to the χ^2 function in the limiting case of $\chi^2 = 1$. In this example those solutions with $\chi^2 > 1$ do not verify the four conditions.

The user will probably have his/her own criteria for the values of w_1,...,w_4, instead of the values of the example explained the previous paragraph. The user is free to modify the values of w_1,...,w_4 (file `fundpar.par`) and this could result in more (or less) restrictive conditions. The code uses these values to define χ^2 and then search for the minimum of the function. Then, the user should read the values of the slopes and metallicities in the output files to verify if the four conditions are satisfied. The values of w_1,...,w_4 previously shown seem to verify in practice the requirements of minimization and verification of the four conditions. In Table 1 we show a sample of the file `fundpar.par` where the weights could be modified. Other parameters will be explained in the following sections.

According to the definition, χ^2 could be considered as a function that depends on the fundamental parameters $\chi^2 = \chi^2(T_{\rm eff},\ \log g,\ [{\rm Fe/H}],\ \xi)$. If χ^2 is not a minimum, the algorithm should determine the next set of four possible values. These new variables are used in another iteration (following Steps a to e) to derive a new model atmosphere, metallicity and, finally, a new value of χ^2. The algorithm that determines the next group of four parameters is called the downhill method, and explained in the next section.

In Table 2 we show a list of the input and output files used by FUNDPAR. The format of the input/output files is detailed in the file `install.txt`. There are two main directories (`datain` and `dataout`) containing the input and output files of the stars. The equivalent widths should be stored in separate files (one file per star), and the names of these files should be listed in another file called `filenames.txt`. The files `atlas.par`, `batch.par` and `fundpar.par` contain the values of some parameters used in the model calculation and abundance determination and will be explained in the next sections. After the execution of FUNDPAR, three output files per star are created: the ATLAS model atmosphere of the solution and two output files directly from the MOOG abundance de-