[Fe/H] Calculator

The formula used to determine [Fe/H] is, as usual,

$$[\mathrm{Fe/H}] = \log\left[\frac{(\mathrm{N_{Fe}/N_H})_{\mathrm{star}}}{(\mathrm{N_{Fe}/N_H})_{\odot}}\right], \tag{1}$$

where $\mathrm{N_{Fe}}$ and $\mathrm{N_H}$ are the number of iron and hydrogen atoms per unit mass, respectively. The ratio between $\mathrm{N_{Fe}}$ and $\mathrm{N_H}$ is determined by

$$\frac{\mathrm{N_{Fe}}}{\mathrm{N_H}} = f_{\mathrm{Fe}}(\alpha) \times \frac{Z/m_Z(\alpha)}{(1-Y-Z)/m_H}, \tag{2}$$

where Y and Z are the abundances by mass of helium and metals heavier than helium, respectively; $f_{\mathrm{Fe}}(\alpha)$ is the number fraction of iron with respect to all the elements heavier than helium; m_H is the mass of the hydrogen atom; and $m_Z(\alpha)$ is the average atomic mass of heavy elements weighted by the number of atoms. It is important to note that $f_{\mathrm{Fe}}(\alpha)$ and $m_Z(\alpha)$ depend on the fraction of α-elements ([α/Fe]).

Thus, the relative iron abundance with respect to the solar iron abundance for any [α/Fe] value is

$$[\mathrm{Fe/H}]_{\alpha} = \log\left[\frac{f_{\mathrm{Fe}}(\alpha)}{f_{\mathrm{Fe}}(0)} \times \frac{m_Z(0)}{m_Z(\alpha)} \times \frac{Z}{1-Y-Z} \times \left(\frac{Z}{X}\right)_{\odot}^{-1}\right], \tag{3}$$

where the values of $f_{\mathrm{Fe}}(0)$ and $m_Z(0)$ are approximately 0.0235 and 17.03 m_H, respectively, for the solar chemical composition presented by Grevesse & Sauval (1998, Space Sci. Rev., 85, 161). In the case of the values of $f_{\mathrm{Fe}}(\alpha)$ and $m_Z(\alpha)$, they are interpolated for any α using the interpolation algorithm of Hill (1982, Publications of the Dominion Astrophysical Observatory Victoria, 16, 67) and the chemical distribution of elements for each [α/Fe] listed in http://webs.wichita.edu/physics/opacity/ (Ferguson et al. 2005, ApJ, 623, 585).