AGA5816: Galactic Chemical Evolution

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Activity 3

(Due April 17, 2025)

All results in this activity were obtained using the code provided in: `https://colab.research.google.com/drive/1fI62P9GFdCDgfIJpnd4hRAFUvujr0fOU#scrollTo=FJRDUj84hzFz`

Exercise 1. To plot the mass fraction of elements as a function of the atomic number, first it was necessary to calculate the total mass provided by Supernovas. This process was made considering

$$M_{SN} = N^{Ia}.M^{Ia} + N^{II}.M^{II}$$

in which N^{Ia} is the number of type Ia Supernovas and M^{Ia} is their respective mass. N^{II} and M^{II} are the equivalent values for type II Supernovas. Considering r as the ratio between N^{II} and N^{Ia}, we obtain

$$N^{II} = r.N^{Ia}$$

Therefore

$$M_{SN} = N^{Ia}.M^{Ia} + r.N^{Ia}.M^{II}$$

To compare the mass fraction of an element in comparison to Hydrogen, we adopt

$$X_i = \frac{Mi_{SN}}{M_H}$$

$$X_i = \frac{N^{Ia}.M_i^{Ia} + r.N^{Ia}.M_i^{II}}{M_H}$$

$$X_i = \frac{(10^8).M_i^{Ia} + r.(10^8).M_i^{II}}{(0,75).2.10^{11}}$$

$$X_i = 2/3.(M_i^{Ia} + M_i^{II}).10^{-3}$$

To conclude, we compare the mass fractions obatined for each element to the ones obtained for the Sun

$$ratio = log_{10}(\frac{X_i^{calculated}}{X_i^{Sun}})]$$

The results obtained for r are contained in table 1

r	**value**
Best fit	3,81
Fe	8,90
O	1,85

Table 1: Values of r obtained

The plot for the best fit is demonstrated in Figure 1.

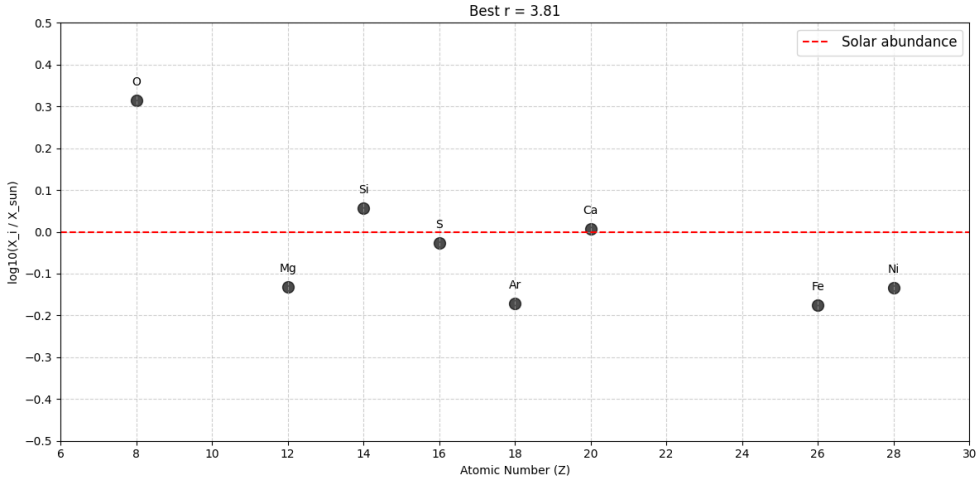

Figure 1: log10(Xi/Xsun) as a function of the atomic number Z

Analyzing the result obtained in Figure 1, it is possible to conclude that the adopted value of r = 3.81 fits the calculated points very well, balancing the values of each element.

Also, it is noticeable that there is a considerable difference between r for O and Fe. This happens due to the fact that O is a tracer of type II Supernovas, while Fe is produced mainly in SNIa. However, to match the amount of Oxygen presented, it would be necessary to increase the number of SNII, resulting also in an increase of r, which is the opposite from what is observed. This unexpected result derives from the lack of use of an IMF in our model and also from the adopted average for SNII yields. Both those factors unbalanced the model, inverting the expected values for r.