The Galactic chemical evolution of sulfur

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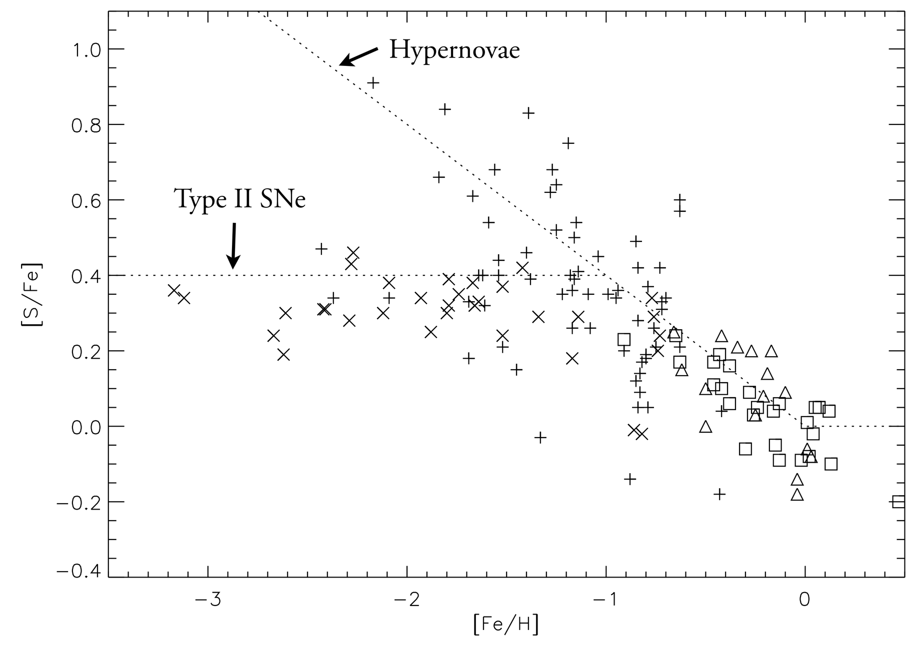
Context

In the literature there is no agreement on whether the Galactic chemical evolution of sulfur in the halo follows the traditional view of explosive nucleosynthesis in type II SNe (e.g. Nissen et al., A&A 469, 2007) or whether a new source is needed, like hypernovae (e.g. Nakamura et al., ApJ 555, 2001). The difference between the two scenarios is shown in the sulfur over-abundance for the metal-poor halo stars, see plot below.



Pluses Caffau et al., A&A 441, 2005
Squares Chen et al., A&A 390, 2002
Crosses Nissen et al., A&A 415, 2004
Triangles Ryde, A&A 455, 2006

Differences between previous sulfur abundance determinations of halo stars might be due to that both scenarios are needed to explain the evolution of sulfur (Caffau et al., A&A 441, 2005) or due to problems with the diagnostics used.

Aims

We intend to measure the sulfur abundance in a sample of halo stars using two diagnostics. Since we will be using the S I triplet around 1046 nm and the [S I] line at 1082 nm, which is not believed to be sensitive to non-LTE effects, we will also be able to estimate the effects due to non-LTE for the triplet.

Method

We have observed 10 halo giants using the CRIRES spectrometer at VLT and calculated synthetic spectra for them using MARCS model atmospheres (Gustafsson, A&A 486, 2008) and the BSYN program. The adopted stellar parameters (Fulbright et al., ApJ 595, 2003, Barbuy, A&A 191, 1988, Pilachowski et al., AJ 111, 1996) are listed in the table below.

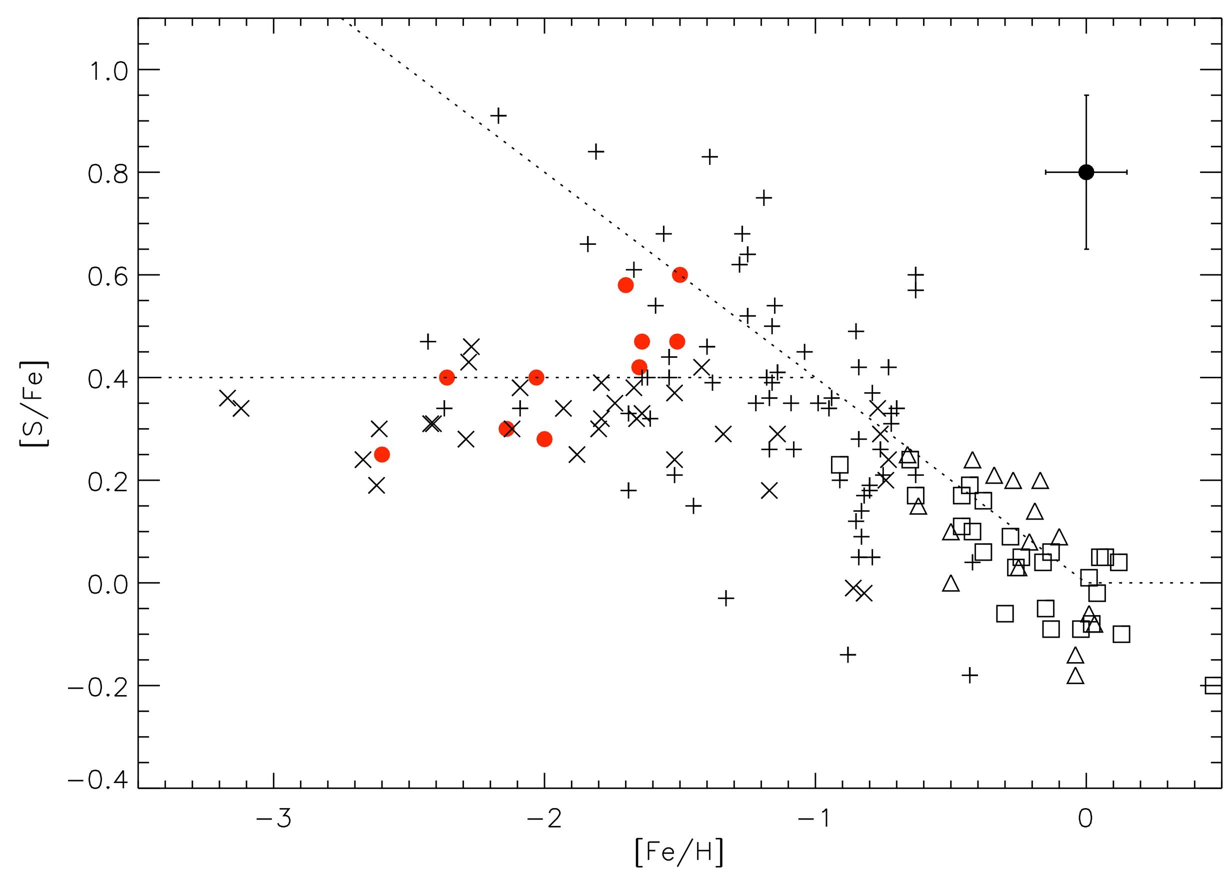
Star	Spectral type	T (K)	log(*g*) (cgs)	ξ_{micro} (km/s)	ξ_{macro} (km/s)	[Fe/H]	[S/Fe]
HD13979	G0	5040	1.3	1.5	5.5	-2.6	0.25
HD21581	G0	4900	2.24	1.5	4.8	-1.64	0.47
HD23798	K0III	4375	1.12	1.5	5.5	-2.03	0.40
HD26297	G5/G6IV	4350	1.46	1.5	5.0	-1.51	0.47
HD29574	G9III	4200	0.78	1.5	5.5	-1.70	0.58
HD36702	K0	4420	0.8	1.5	5.5	-2.0	0.28
HD44007	G5IV	4975	2.24	1.5	5.0	-1.65	0.42
HD83212	G8III	4460	1.2	1.5	5.0	-1.5	0.60
HD85773	F	4450	1.10	1.5	4.8	-2.36	0.40
HD103545	K0	4725	1.70	1.5	4.8	-2.14	0.30

The line list is taken from the VALD database, except the S I triplet and [S I] lines which are taken from the NIST database, see table below.

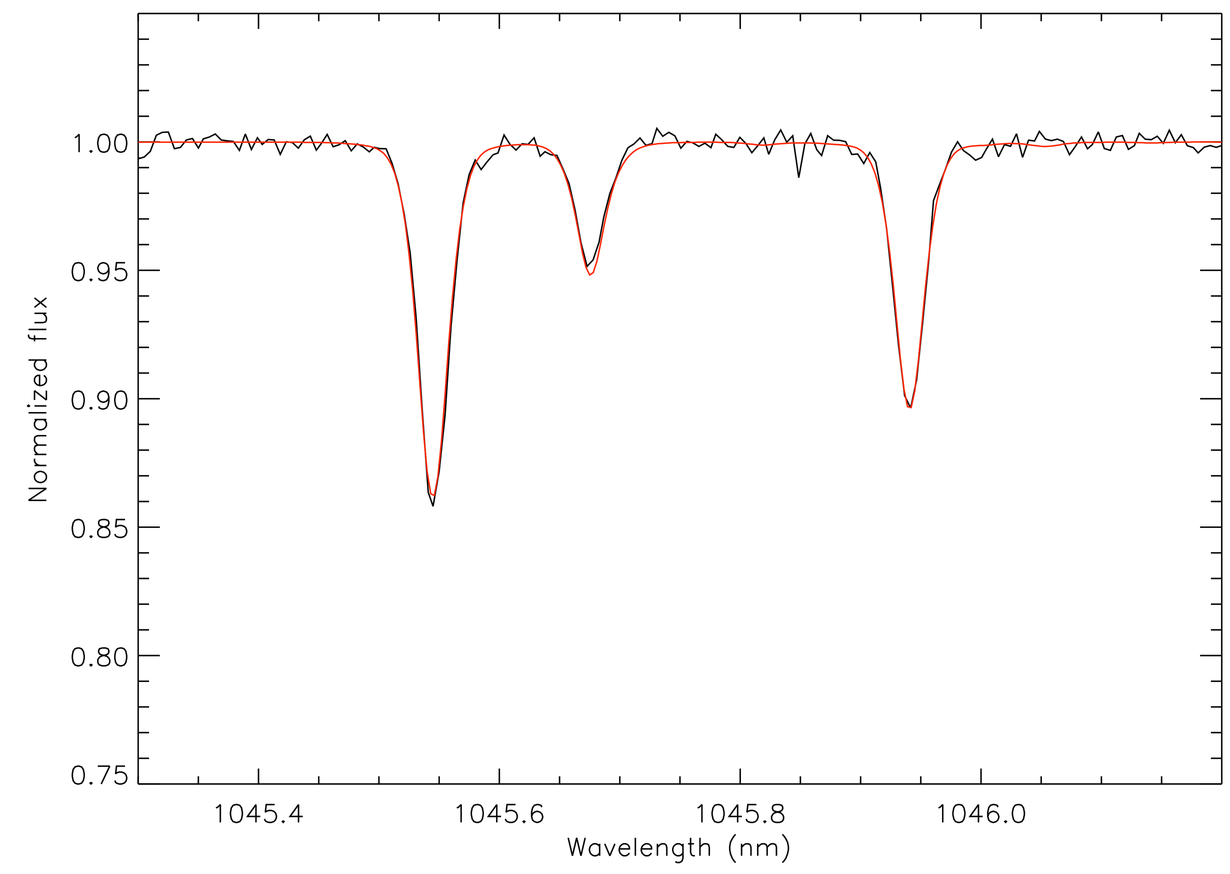
Element	Wavenumber (cm^{-1})	Wavelength (air) (nm)	χ_{exc} (eV)	log(*gf*)
S I	9561.771	1045.5449	6.860	0.26
S I	9560.575	1045.6757	6.860	-0.44
S I	9558.153	1045.9406	6.860	0.03
[S I]	9239	1082.1176	0.000	-8.617

Preliminary results

So far we have only used the triplet around 1046 nm to determine the sulfur abundances. These first results are shown as red dots in the plot below and they seem to favour a type II SN scenario for the formation of sulfur. Typical errors are indicated in the upper right hand corner.



In the plot below we show an example of the observed spectra from one of our stars and, in red, our fitted synthetic spectra.



Future investigations

The next step in our investigation is to determine the sulfur abundance of the stars using the [S I] line. Unfortunately there is an unidentified feature in the vicinity of, or even on top of, the line in every spectrum, which might be an instrumental effect.

We also intend to calculate a 3D hydrodynamical model for a typical giant in trying to estimate corrections for not handling the convection properly in our 1D models.