

# Carbon Abundances in the Galactic Thin and Thick Disks

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**Abstract.** Although carbon is, together with oxygen and nitrogen, one of the most important elements in the study of galactic chemical evolution its production sites are still poorly known and have been much debated (see e.g. Gustafsson *et al.* 1999; Chiappini *et al.* 2003). To trace the origin and evolution of carbon we have determined carbon abundances from the forbidden [C I] line at 8727 Å and made comparisons to oxygen abundances from the forbidden [O I] line at 6300 Å in a sample of 51 nearby F and G dwarf stars. These data and the fact that the forbidden [C I] and [O I] lines are very robust abundance indicators (they are essentially insensitive to deviations from LTE and uncertainties in the stellar parameters, see, e.g., Gustafsson *et al.* 1999; Asplund *et al.* 2005) enable us to very accurately measure the C/O ratio as well as individual C and O abundances. Our first results indicate that the time-scale for the *main* source that contribute to the carbon enrichment of the interstellar medium operate on the same time-scale as those that contribute to the iron enrichment (and can possibly be AGB stars...)

**Keywords.** Stars: abundances, stars: kinematics, Galaxy: abundances, Galaxy: disk

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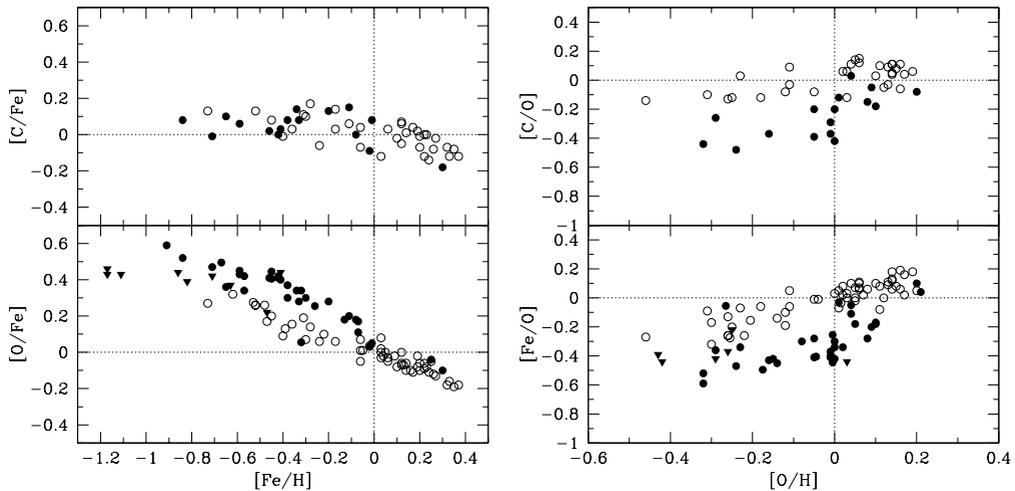
## 1. Observations, data reduction, and abundance analysis

Spectra for 16 thick disk stars and 35 thin disk stars (based on kinematical selection criteria, see Bensby *et al.* 2003, 2005) were obtained during six nights in September 2004 with the CES spectrograph on the ESO-3.6m telescope on La Silla. The spectra have a very high resolution of  $R \sim 220\,000$  and high signal-to-noise ratios of  $S/N \gtrsim 300$ .

Carbon abundances were determined by comparing synthetic spectra (based on 1-D, plane parallel, LTE stellar atmosphere models that were calculated with the Uppsala MARCS code, Gustafsson 1975; Edvardsson 1993) to the observed spectra. The method used for the analysis is the same as that used for the forbidden oxygen line at 6300 Å (Bensby *et al.* 2004). Stellar parameters were taken from Bensby *et al.* (2003, 2005). When synthesising the [C I] line a blending Fe I line was taken into account (e.g., Lambert & Swings 1967). Our analysis of the solar spectrum gives a carbon abundance in the Sun of  $\log \epsilon(\text{C}) = 8.41$ , in good agreement with Allende Prieto *et al.* (2002) and Asplund *et al.* (2005) who determined a solar carbon abundance of 8.39 using 3D models.

## 2. Results and discussion

Our first results regarding carbon abundances in the Galactic thin and thick disks are (Fig. 1): **(1)** While the [O/Fe] vs [Fe/H] trends separate well for the thin and thick disk samples, they are merged for [C/Fe] vs [Fe/H] and are mainly flat; **(2)** The two kinematic samples separate well (as expected) in the [C/O] vs [O/H] plot; **(3)** The thin disk sample in the same plot have a nearly constant [C/O] ratio; **(4)** The thick disk sample first shows



**Figure 1.** Our carbon trends relative to iron and relative to oxygen. For comparison we also show the  $[O/Fe]$  vs  $[Fe/H]$  and  $[Fe/O]$  vs  $[O/H]$  trends (Bensby *et al.* 2004, 2005). Thin and thick disk stars are marked by open and filled symbols, respectively. Filled triangles in the oxygen plots denote thick disks stars from Nissen *et al.* (2002).

a flat trend of  $[C/O]$  vs  $[O/H]$  for  $[O/H] < 0$  where C is depleted relative to O such that  $[C/O] = -0.3$  to  $-0.4$  dex but at  $[O/H] = 0$  the trend rises (sharply) to solar values.

A preliminary interpretation of these results is as follows: **(I)** In the thin disk the sources for O (SNII) and C (debated) are tuned such that a flat trend is created; **(II)** In the thick disk the processes are finely tuned up and until  $[O/H] = 0$ . At  $[O/H] = 0$  a new source of C gets active (or a source of O drops out); **(III)** Studying the  $[O/Fe]$  vs  $[Fe/H]$  trend we find that at  $[Fe/H] \simeq -0.45$  SNIa sets in (hence the appearance of the “knee” in the abundance plot). For  $[C/Fe]$  this does not happen. This means that the time-scale for the population that contributes C operates on the same time-scale as SNIa; **(IV)** These results could be exploited to derive an independent measure of the SNIa lifetimes (given an understanding of the sources of C).

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