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The chemical composition of the very metal-poor carbon dwarf G77-61

Bertrand Plez[1], J.G. Cohen[2], and J. Meléndez[2]

[1]GRAAL, CNRS UMR 5024, cc072, Université Montpellier II, F-34730 Montpellier cedex 5, France; email: plez@graal.univ-montp2.fr

[2]Department of Astronomy, California Institute of Technology, MS 105-24 Pasadena, Ca 91125; email: jlc@astro.caltech.edu, jorge@astro.caltech.edu

Abstract. We have determined the chemical composition of the carbon dwarf G77-61, from Keck IR and optical spectra. We present here a new analysis with the oxygen abundance measured for the first time. We show that G77-61 is extremely metal-poor ([Fe/H] = −4), with large overabundances of C, N and O ([C/Fe] = 3.2, [N/Fe] = 2.2, [O/Fe] = 2.2). It also shows moderate enhancements of Ca and Mg, Na, and Cr of typically 0.5 dex relative to Fe. We discuss the possible origin of these peculiarities.

Keywords. Stars: carbon, stars: abundances, stars: Population II

1. Introduction

The star G77-61 was identified as a carbon dwarf by Dahn *et al.* (1977). It was claimed to be extremely Fe-poor ([Fe/H] = −5.5) by Gass *et al.* (1988). Dearborn *et al.* (1986) established it is a binary with a period of 245 days, suggesting a more massive white dwarf as companion. The more recent discovery of a number of very metal-poor carbon-rich stars in recent years has renewed the interest in G77-61. We carried out observations in the optical with HIRES at the Keck Observatory, at a resolution of 34000, and S/N = 100. Additional observations were made in the K band with NIRSPEC at a resolution of 19000 and a S/N = 160.

2. Analysis and results

The spectra were analysed through spectral synthesis, using MARCS model atmospheres (Gustafsson *et al.*, 2003). These models were especially computed for the stellar parameters, as the star is cool (4000 K, log g = 5) and has a peculiar chemical composition. An analysis based solely on the optical data has been published by Plez & Cohen (2005). This analysis was complicated by the very intense C_2, CN, and CH molecular bands. We found a low metallicity ([Fe/H] = −4.0), large C and N enhancements ([C/Fe] = +2.6, [N/Fe] = +2.6), a near-equilibrium $^{12}C/^{13}C = 5$, and moderate enhancements of Na, Mg, and Ca (about +0.5 dex). This was done assuming log A(O) = 5.0, as the O abundance was believed to be very low based on the near invisibility of CO bands in low-resolution spectra.We have now analysed K band spectra, allowing the derivation of the O abundance, despite the strong C_2 absorption. This O abundance (log A(O) = 6.9), much higher than previously thought, leads to a revision of the C and N abundances. Table 1 shows the CNO abundances derived from the sets of optical and IR spectra. Additional abundances may be found in Plez & Cohen (2005). The uncertainties are expected to be of the order of 0.15 dex. With the new CNO abundances in hand, we will proceed with a reanalysis of the optical spectra, to derive a consistent set of atomic abundances.

Table 1. CNO abundances for G77-61

Element	log A(X)	[X/Fe]
C (CH @ 4790 Å)	7.6	+3.2
N (CN @ 7930 Å)	6.0	+2.2
O (CO @ 2.3 μm)	6.9	+2.2

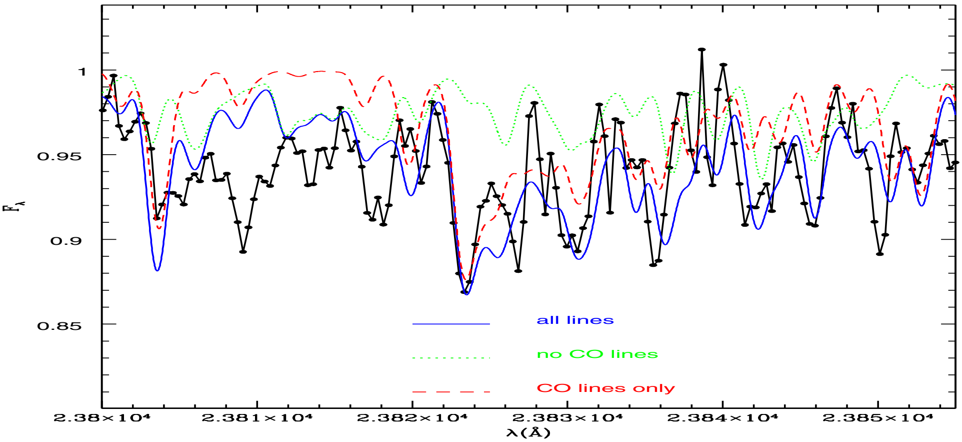

Figure 1. CO bandhead in G77-61, at 2.38μm. The black line and dots are observations, the full blue line is a synthesis with all lines included, the red dashed line is a synthesis with only CO lines, and the green dotted line is for all lines but CO.

3. Discussion

G77-61 has large enhancements of C, N and O, and is now similar to other carbon-rich extremely metal-poor stars. It has one of the most extreme C-enhancement, like HE0107-5240 ([C/Fe]=3.7, Christlieb *et al.* , 2004), but a much lower ^{12}C/^{13}C, like CS22949-027 (Depagne *et al.*, 2002), and CS29498-043 (Aoki *et al.* , 2004). The chemical composition is reminiscent of SN ejecta (Umeda & Nomoto, 2005), but the N and Na abundances cannot be explained by these models. The new rotating massive star models of Meynet *et al.* (2005) produce copious amount of N. One also has to remember that the companion to G77-61, suspected to be a white dwarf, has probably evolved along the AGB, and CN burning may have occurred, with N production along with a decrease of ^{12}C/^{13}C.

References

Aoki, W. *et al.* 2004, *ApJ* 608, 971
Christlieb, N. *et al.* 2004, *ApJ* 603, 708
Dahn, C.C. *et al.* 1977, *ApJ* 216, 757
Dearborn *et al.* 1986, *ApJ* 300, 314
Depagne, E. *et al.* 2002, *A&A* 390, 187
Gass, H., Liebert, J., & Wehrse, R. 1988, *A&A* 189, 194
gustafsson, B. *et al.* 2003, *in stellar atmosphere modelling, ASP Conf. Ser.* 288, 331
Meynet, G., Ekström, S., & Maeder, A. 2005, *A&A* in press
Plez, B., & Cohen, J.G. 2005, *A&A* 434, 1117
Umeda, H. & Nomoto, K. 2005, *ApJ* 619, 427

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