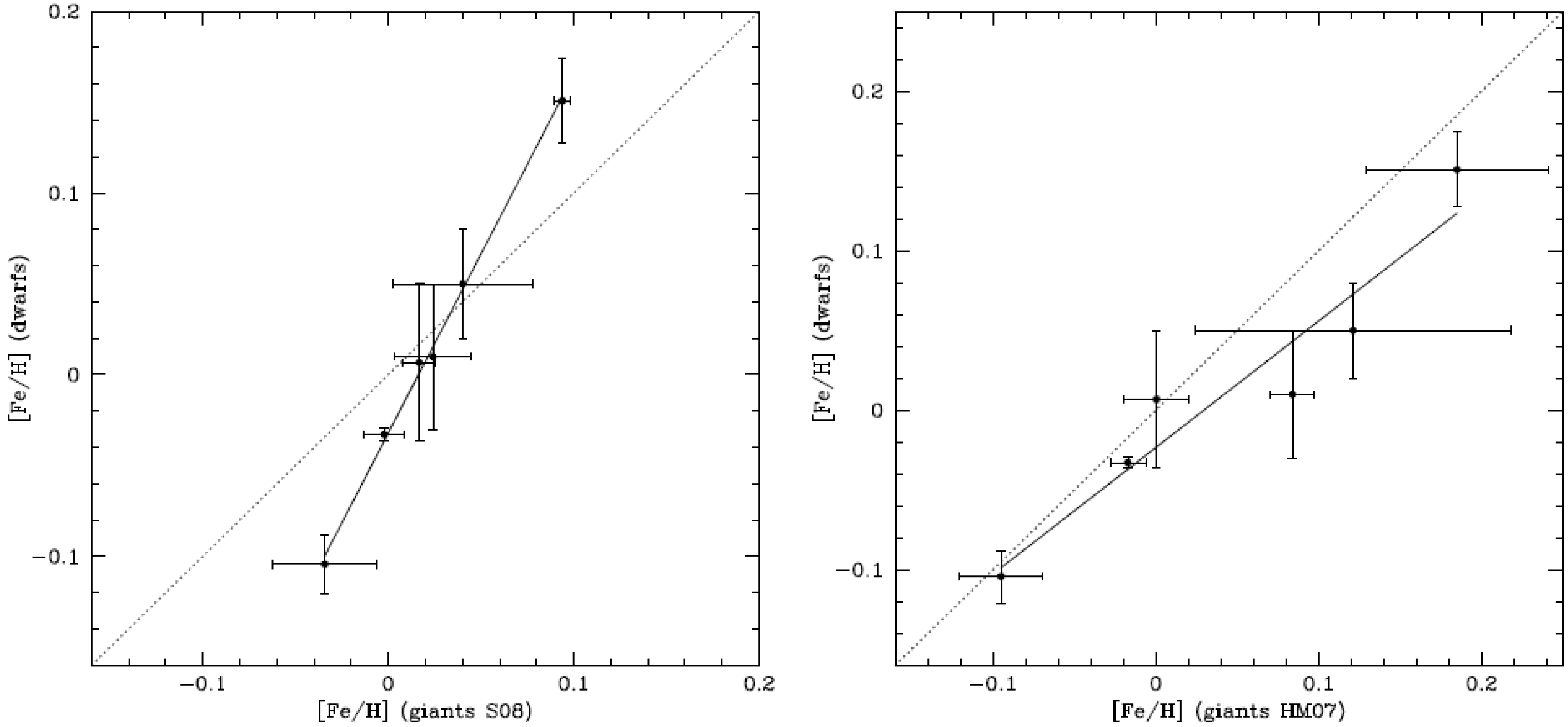
The metallicity scale of dwarf and giant stars.

Giancarlo Pace

Centro de Astrofísica da Universidade do Porto

FCT Fundação para a Ciência e a Tecnologia
MINISTÉRIO DA CIÊNCIA, TECNOLOGIA E ENSINO SUPERIOR

Does evolutionary stage affect abundance measurements?



From Santos et al 2009

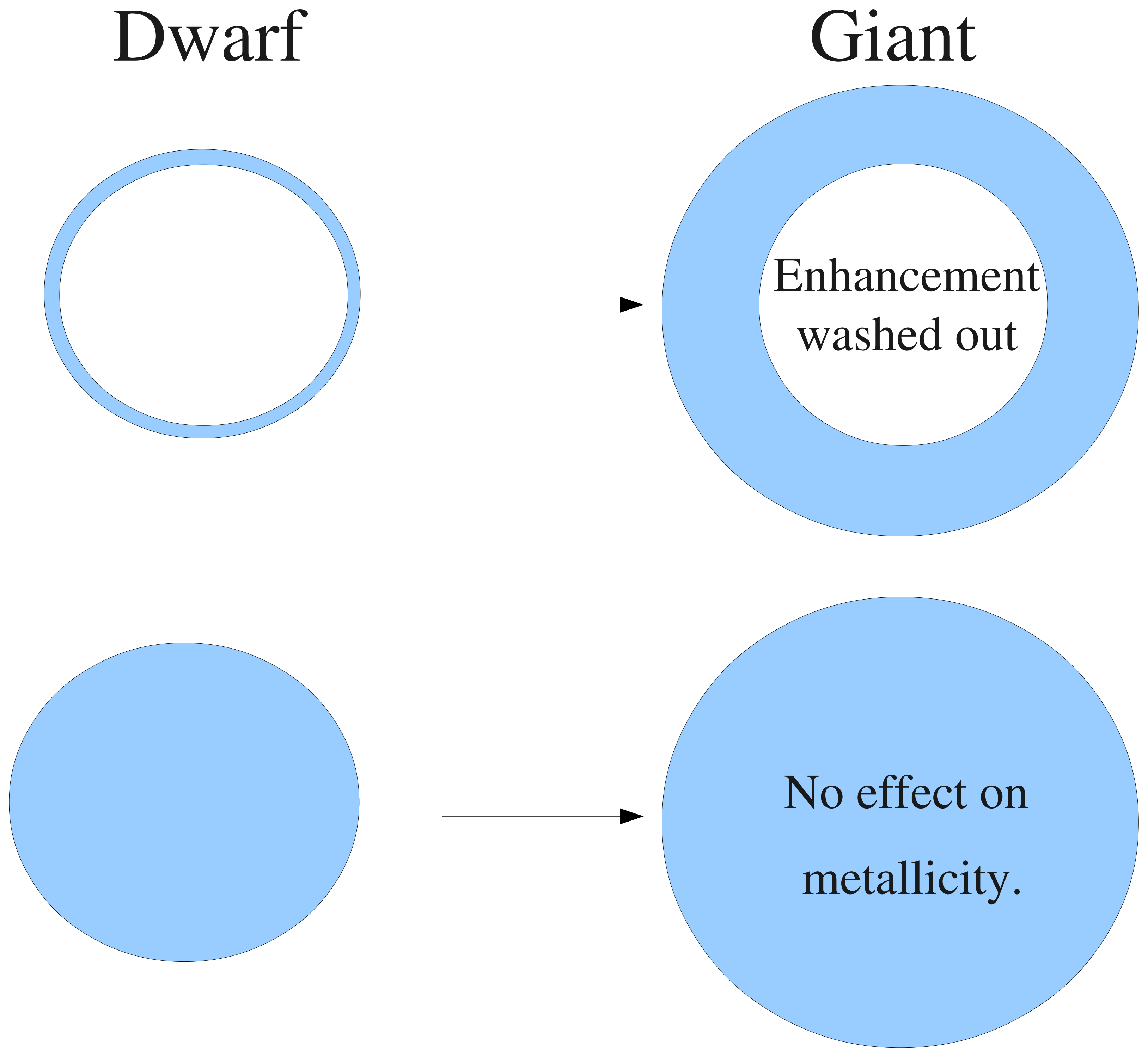
Strong impact on ...

- Atmosphere modeling
- Planet formation theory
- Chemical evolution of the Galactic disk, bulge, and solar neighborhood

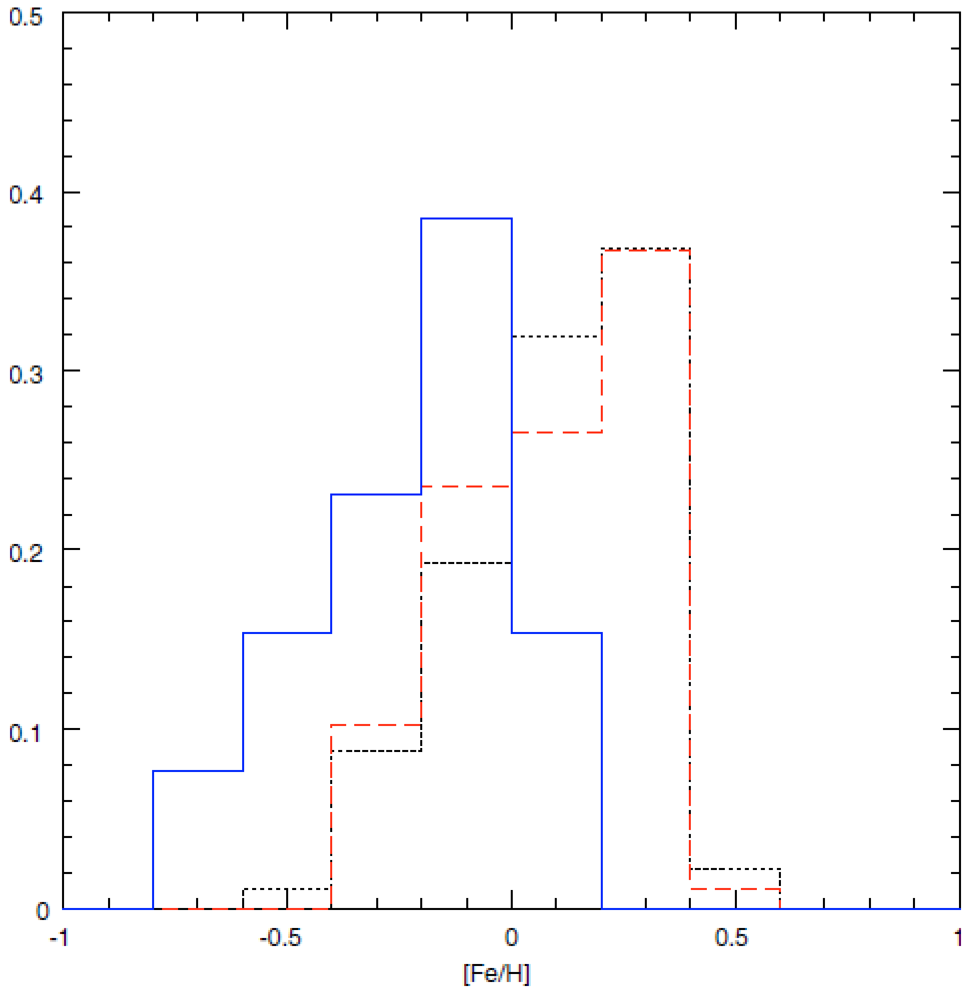
Planet formation

metallicity-planet connection:

higher formation probability
or
external origin?


Dwarf
Giant
Enhancement
washed out
No effect on
metallicity.

Pasquini et al (2007)



planet hosting giants:
full line

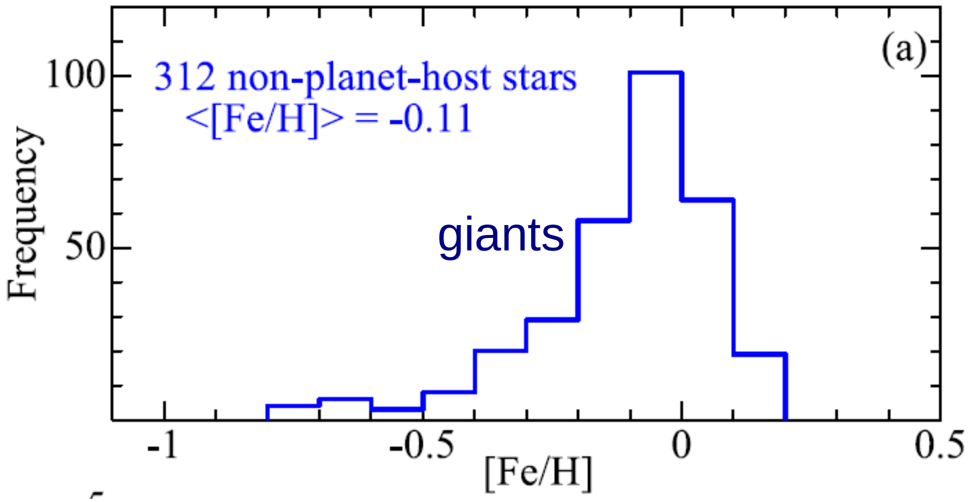
planet hosting dwarf with P>180days:
dashed line

all planet hosting stars:
dotted line

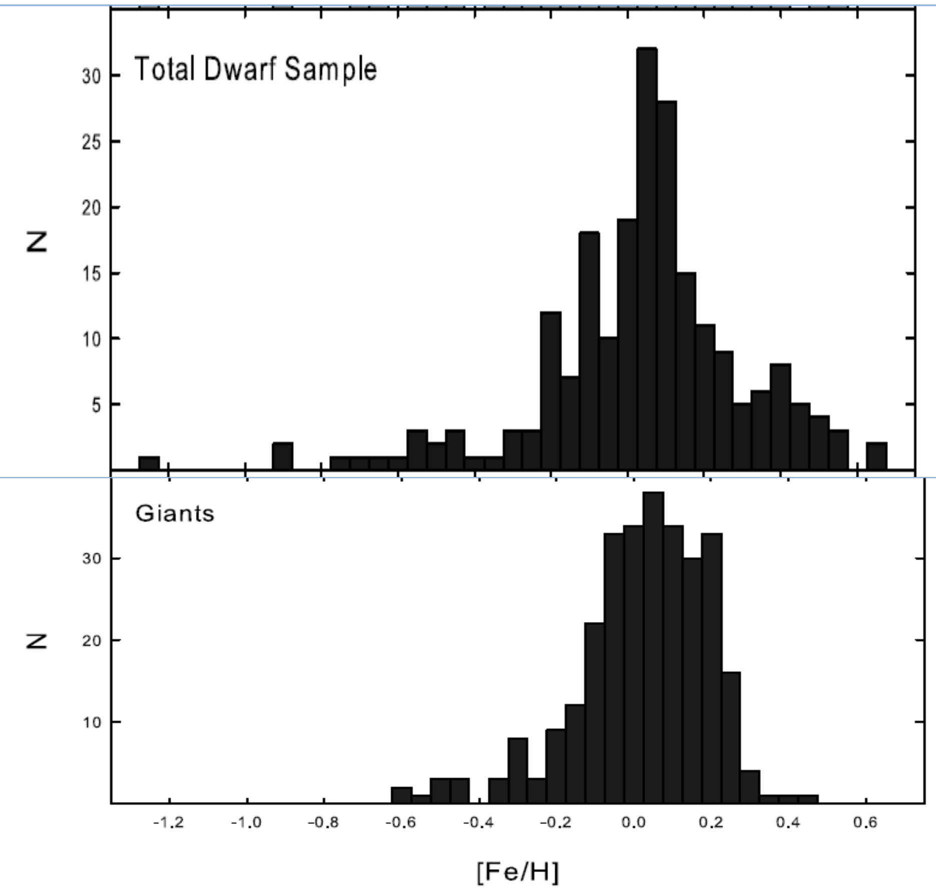
Abundance distribution in the solar neighborhood

The metallicity distribution of evolved stars is narrower than the metallicity distribution of dwarfs. There is a lack of giant stars at [Fe/H]>0.2 (Taylor & Croxall, 2005)

Abundance distribution in the solar neighborhood



Takeda et al. 2008



Luck & Heiter 2007

Abundance distribution in the solar neighborhood

Conclusion:

Either there is some important physical process affecting all metal-rich giants or the systematic errors possibly affecting the chemical analysis of giant stars are responsible for this.

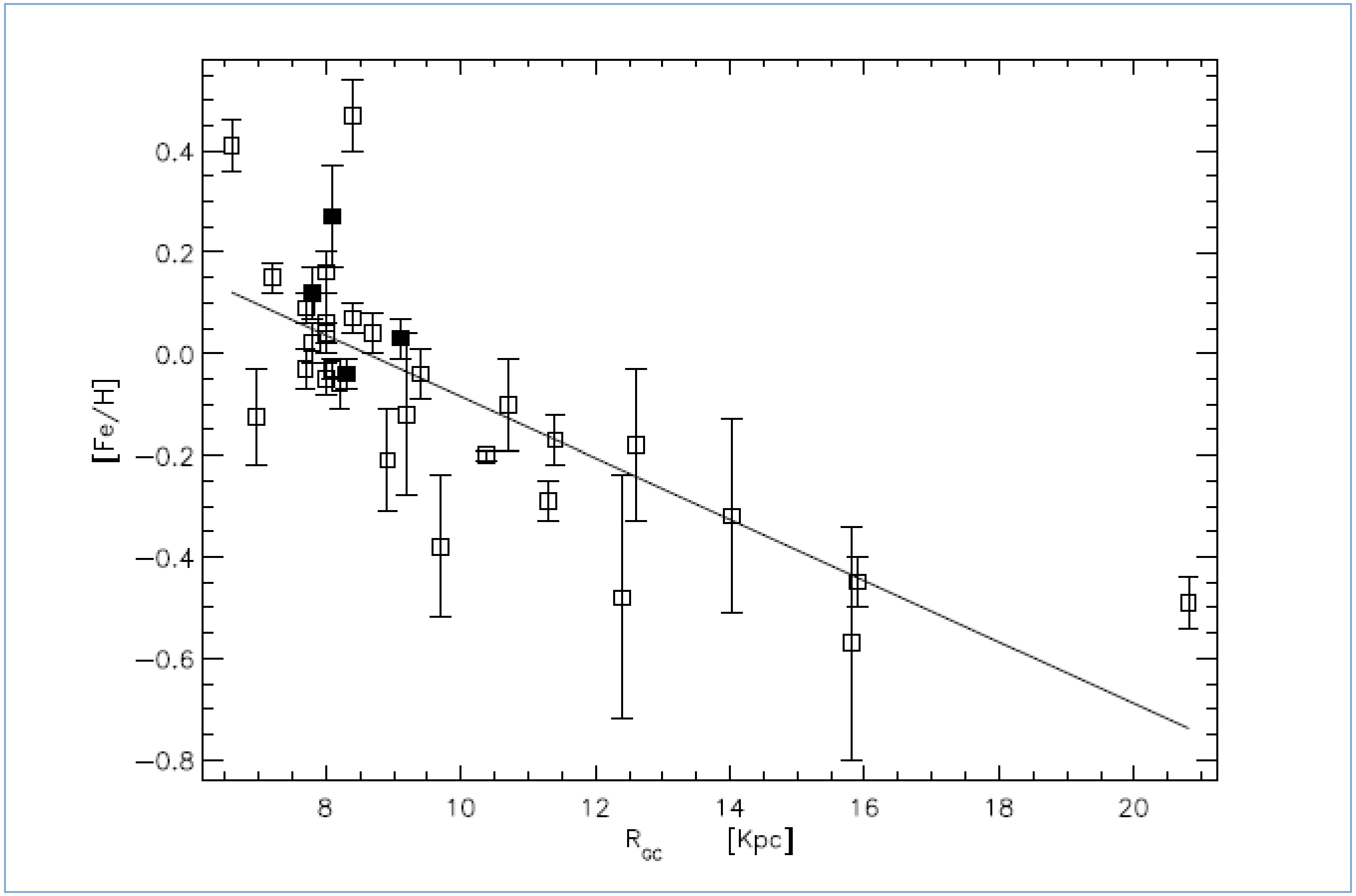
The Bulge is more metal rich than it first looked

The first studies on bulge dwarfs exploiting microlensing (Johnson 2008, Cohen 2008) made the Bulge less metal poor than thought on the basis of giants.

Even study on metal poor dwarfs in the bulge (Bensby et al. 2010)

Can we exclude dwarfs from open clusters surveys?

Chemical gradient of the disk: Galactic chemical evolution.



Preliminary results on NGC 6253: Montalto et al., in preparation

1 dwarf: [Fe/H]~0.35 dex.
2 red clump: [Fe/H]~0.2 dex

Is it fair to compare giants with dwarfs?

however ......

IC 4756 and NGC 5822:

Cluster	Source	[Fe/H]	[Na/H]	[Al/H]	[Si/H]	Ref.
IC 4756	3 dwarfs	0.01 $\sigma = 0.04$	$-0.15\sigma = 0.04$	$-0.09\sigma = 0.05$	$-0.04\sigma = 0.04$	1
IC 4756	1 dwarf	0.03 –				4
IC 4756	3 giants	0.08 $\sigma = 0.02$	$0.19\sigma = 0.04$	$-0.03\sigma = 0.05$	0.10 $\sigma = 0.01$	1, 2
IC 4756	7 giants	0.0 ± 0.1 *				3
IC 4756	4 giants	-0.05 ± 0.04				4
IC 4756	1 giant			0.20	0.16 ± 0.25	4
IC 4756	6 giants	$-0.15\sigma = 0.04$	$0.73\sigma = 0.06$ *	0.44 $\sigma = 0.08$ *	0.19 $\sigma = 0.06$	5
NGC 5822	2 dwarfs	$0.05\sigma = 0.03$	$-0.15\sigma = 0.04$	−0.05 –	$0.01\sigma = 0.02$	1
NGC 5822	3 giants	$0.15\sigma = 0.08$	$0.21\sigma = 0.04$	$0.02\sigma = 0.01$	$0.14\sigma = 0.08$	1, 2
NGC 5822	3 giants	$0.12\sigma = 0.1$				4
NGC 5822	1 giant		0.28 ± 0.07	0.12 ± 0.12	0.25 ± 0.25	4
		[Ca/H]	[Ti/H]	[Cr/H]	[Ni/H]	
IC 4756	3 dwarfs	$0.05\sigma = 0.05$	$-0.04\sigma = 0.05$	$0.00\sigma = 0.05$	$-0.06\sigma = 0.03$	1
IC 4756	3 giants	$0.06\sigma = 0.03$	$0.11\sigma = 0.03$	$0.08\sigma = 0.03$	$0.04\sigma = 0.01$	1, 2
IC 4756	1 giant	-0.06 ± 0.29	-0.28 ± 0.29		0.04 ± 0.16	4
IC 4756	6 giants	$-0.08\sigma = 0.08$			$-0.07\sigma = 0.05$	5
NGC 5822	2 dwarfs	$0.08\sigma = 0.02$	$0.00\sigma = 0.02$	$0.07\sigma = 0.04$	−0.03 $\sigma = 0.03$	1
NGC 5822	3 giants	$0.11\sigma = 0.07$	$0.18\sigma = 0.11$	$0.18\sigma = 0.08$	0.07 $\sigma = 0.14$	1, 2
NGC 5822	1 giant	-0.05 ± 0.23	0.20 ± 0.24	0.26 ± 0.29	0.25 ± 0.26	4

References. (1) ; (2) Santos et al. (2009); (3) Gilroy (1989); (4) Luck (1994); (5) Jacobson et al. (2007).
Pace et al (2009)

More differences

Na & Al overabundant in giants:

IC 4756, NGC 6939 and NGC 714 (Jacobson et al. 2007)
NGC 6475 (Villanova et al. 2009)
Collinder 261 (Friel et al. 2003)
Berkeley 17 (Friel et al. 2005)
Saurer 1 and Berkeley 29 (Carraro et al. 2004)

Only Na:

IC 4651 (Pasquini et al. 2004)
NGC 7789 & M 67 (Tautvaišien˙e et al. 2000, 2005; Randich et al. 2006)
NGC 1817 and NGC 2141 (Jacobson et al. 2009)

either direct comparison, or [Na-Al/Fe] > 0.1 dex in evolved stars

Summary and conclusion

- Open cluster data suggest abundance difference between giant and dwarfs.
- Such difference strongly depends on metallicity, and on the line list and the procedure adopted. It is therefore probably spurious in nature.
- It is necessary to tackle this issue thoroughly, since it has important repercussions on planet formation theory and Galactic chemical enrichment.
- We need chemical studies of both dwarfs and giants in a number of open clusters at all [Fe/H]