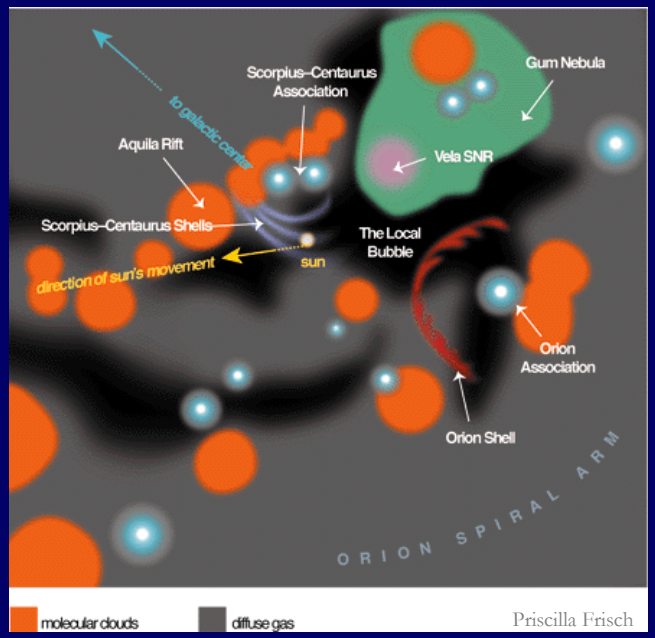
FRIEDRICH-ALEXANDER
UNIVERSITÄT
ERLANGEN-NÜRNBERG

NATURWISSENSCHAFTLICHE
FAKULTÄT

ERLANGEN CENTRE
FOR ASTROPARTICLE
PHYSICS

Present-day oxygen abundance in the solar neighbourhood



Fernanda Nieva

Norbert Przybilla

Early B-type stars: reliable indicators for *present-day* and spatial *(birth-place)* information on chemical abundances

Present-day abundances in the context of stellar and galactic evolution

Early B-type stars (B0-B2)

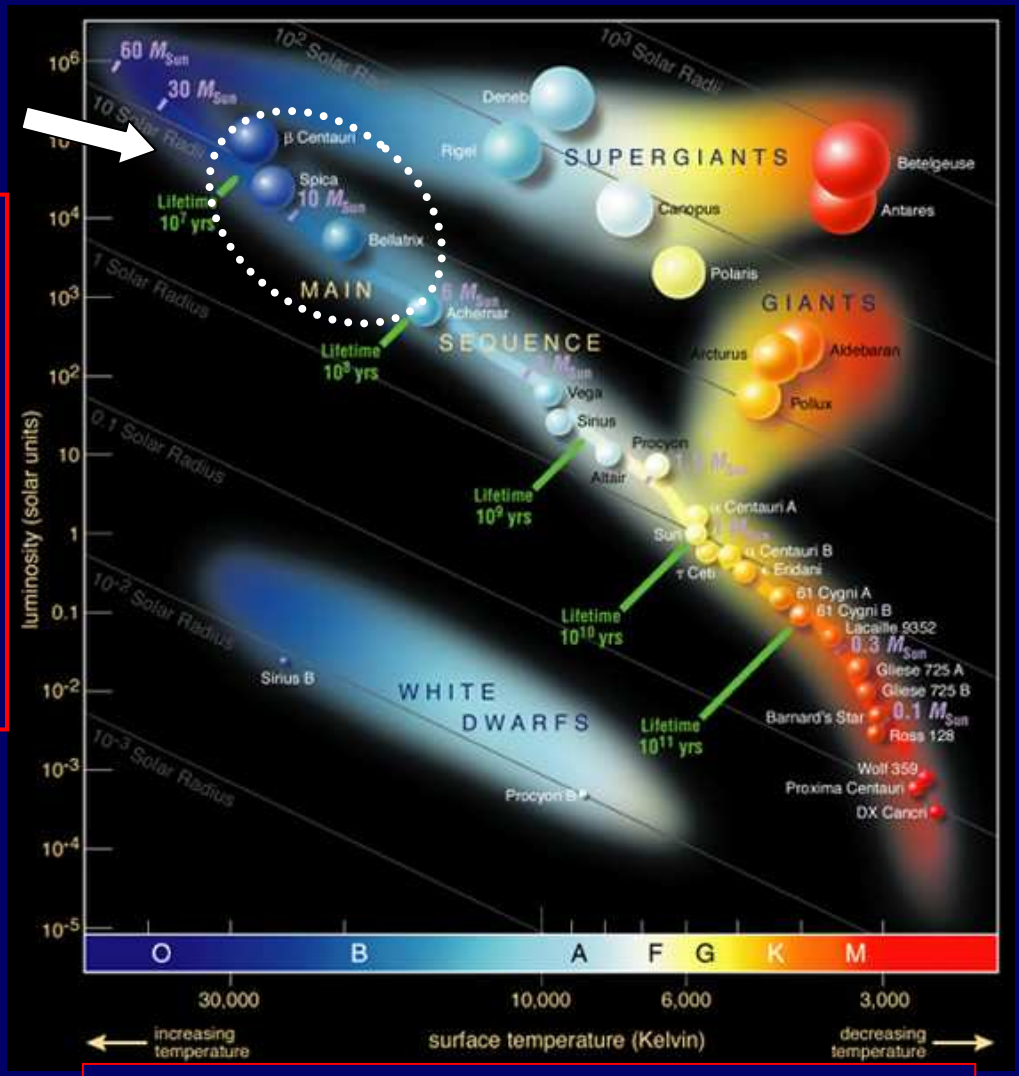
Main Sequence

Young: age ~10^7 yr

Massive: M ~9-20 M_{sun}

Hot: T_{eff} ~20-33 x10^4 K

Luminous: L~10^4-10^5 L_{sun}



absolute chemical composition (independently from e.g. solar values)

Early B-type stars

short lived (~10 Myr)
→ present-day

no migration (pc)
→ birth place

very bright in the optical
→ large distances

simple atmospheres
→ 1D, radiative envelope, no chromosphere

simple optical spectrum
→ ~hundred metal lines

Older stars (e.g. Sun)

long lived (~Gyr)
→ effects of GCE

migration (kpc)
→ away from birth place

fainter in the optical
→ shorter distances

complex atmospheres
→ 3D, convective envelope, chromosphere

complex optical spectrum
→ ~million lines

Early B-type stars	ISM / HII regions
no depletion into dust	depletion into dust

Early B-type stars	Late B-type stars
no diffusion	diffusion

Early B-type stars	O stars, B SGs
weak winds	strong winds

Chemical abundances of early B-type stars

Past decades

large uncertainties
(~factor 2)

large spread
(>factor 10)

metal-poor compared to
older stars like Sun

dubious abundance indicators

Recently

(e.g. Nieva et al./Simon-Diaz et al.)

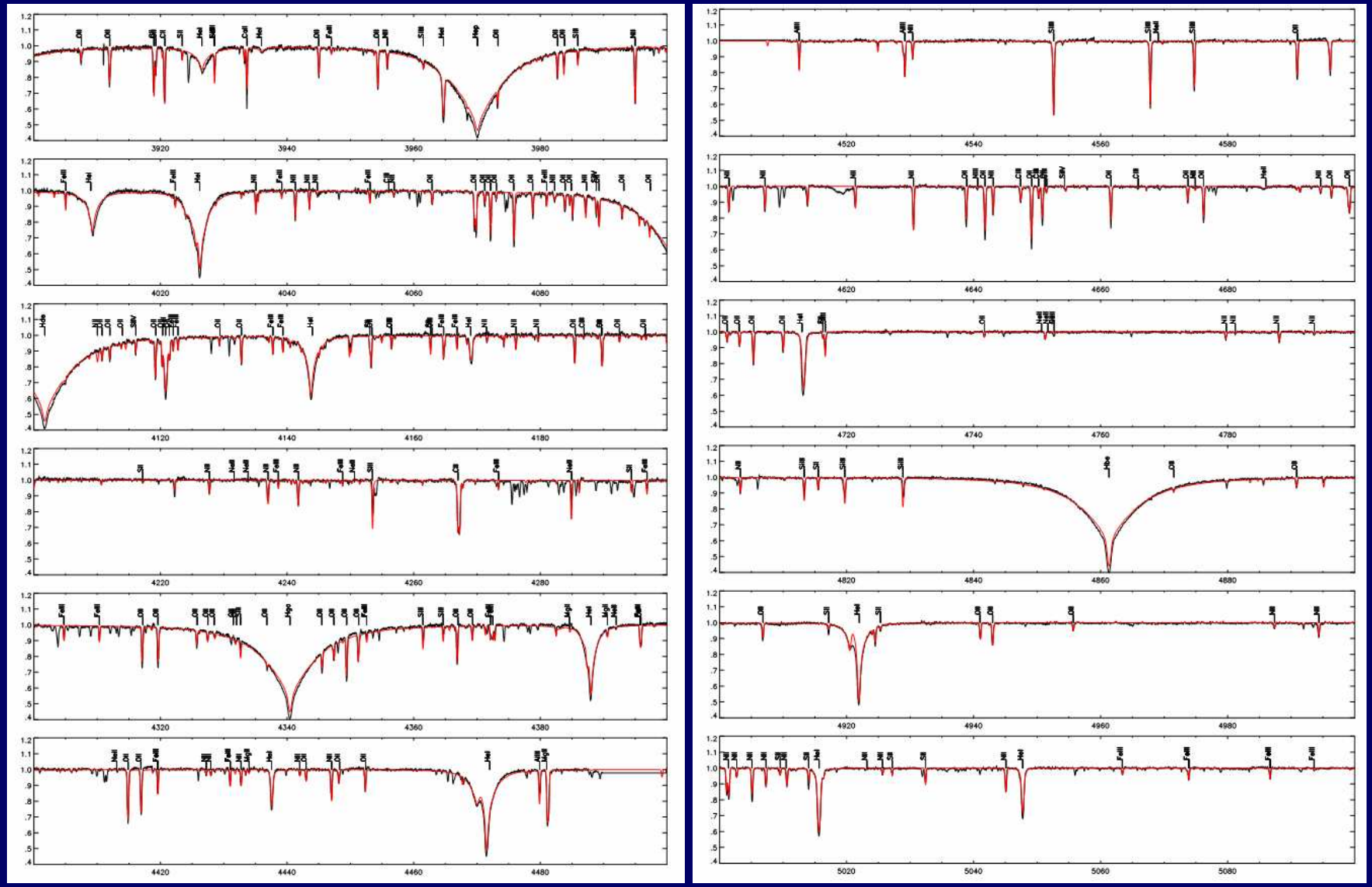
high precision and accuracy
(~ 25%)

small spread
(~10%, ~ISM)

similar abundances than
older stars like Sun

reliable abundance indicators

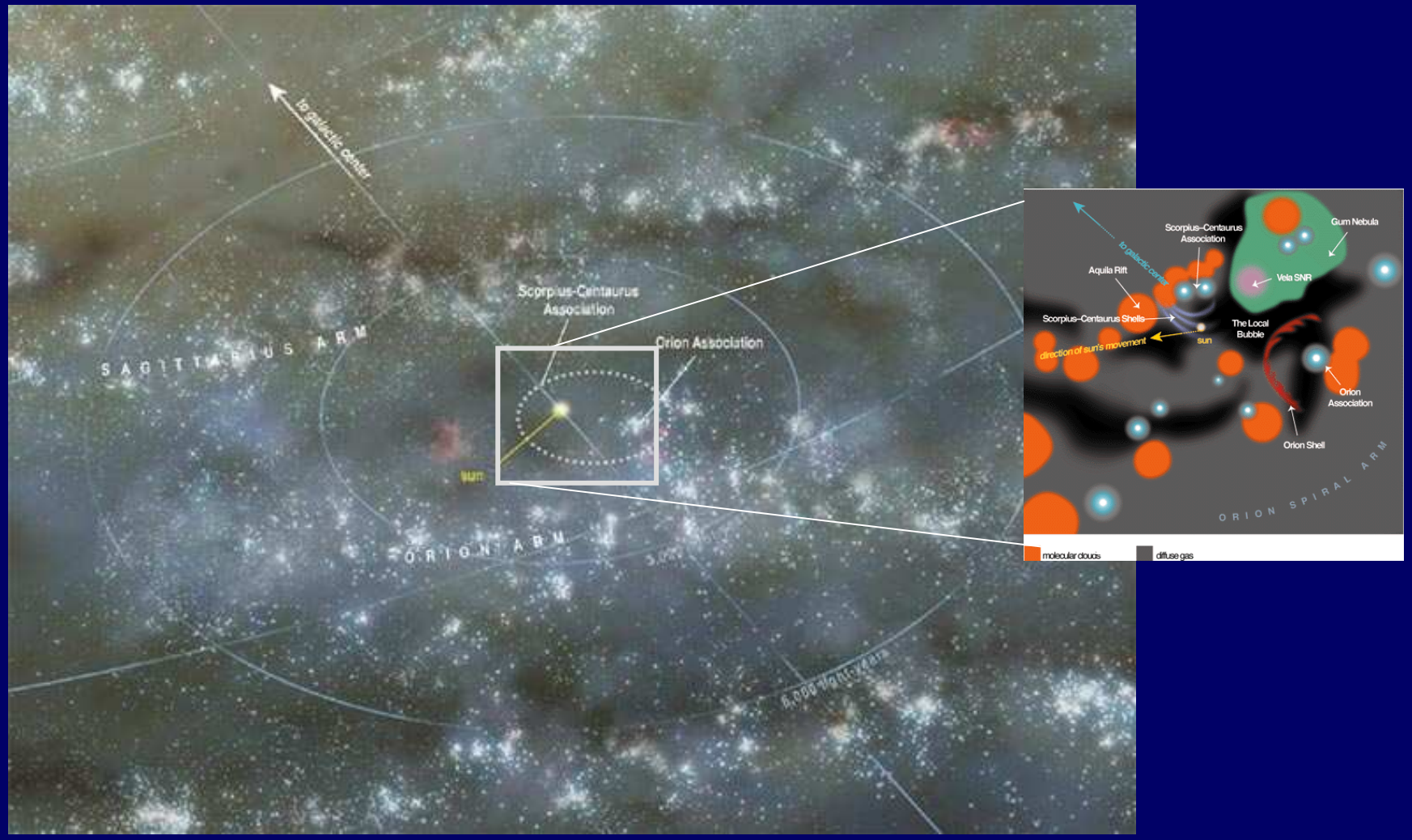
Fits to all modeled lines (3800-5100 Å)



Nieva & Przybilla 2012, A&A, 539, A143

Nieva & Simon-Diaz 2011, A&A, 532, A2

Early-B stars in the solar neighborhood



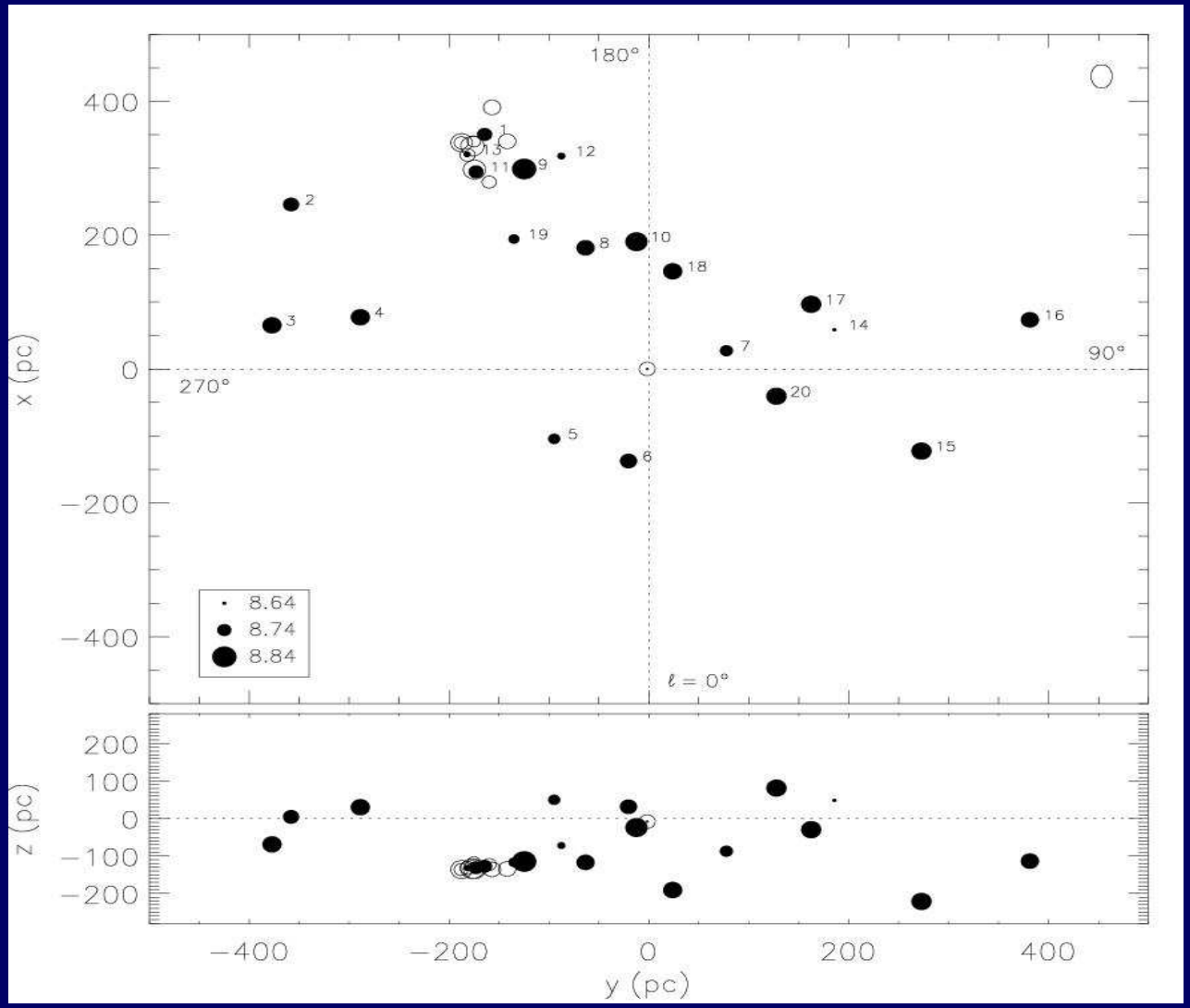
Present-day oxygen abundance in the solar neighbourhood

29 single stars

Up to 55 lines per star:
2 OI triplets (6155, 7774 Å)
~50 OII lines

OI/II ionization equilibrium
(among other elements)

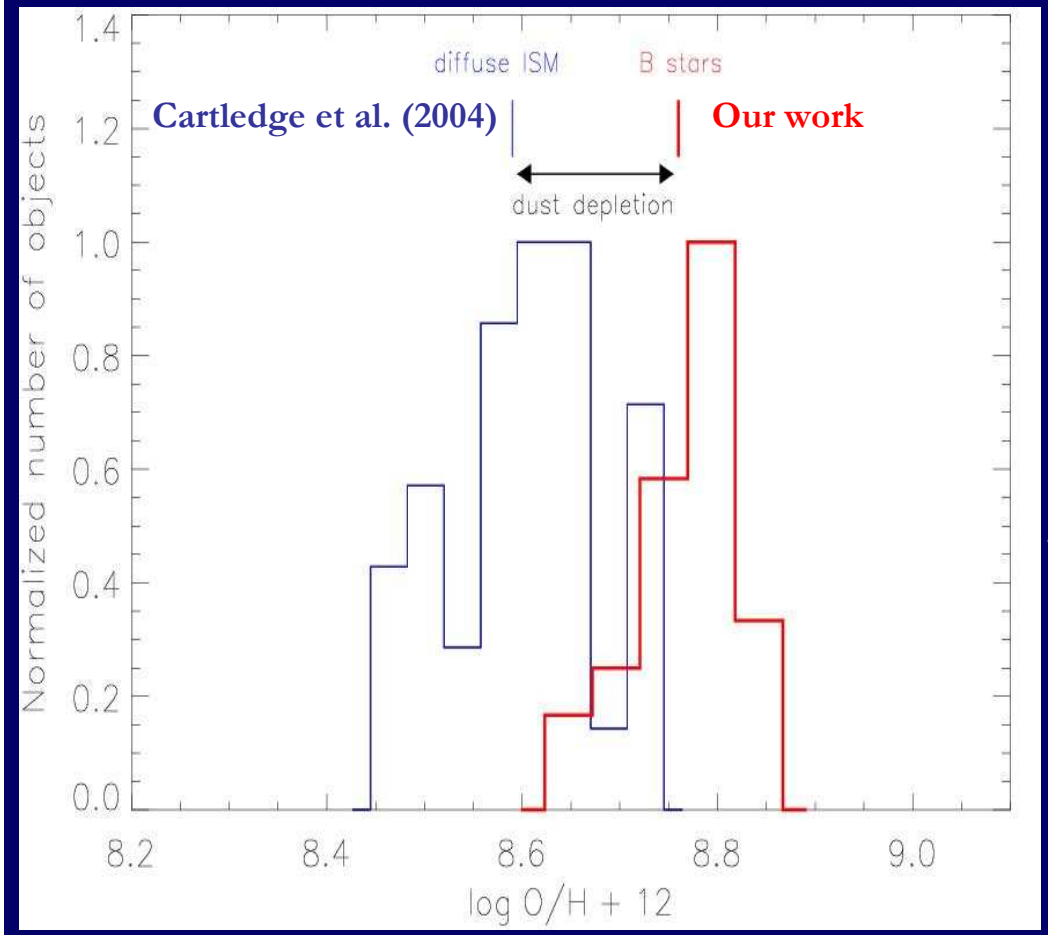
Mapping present-day oxygen in the solar neighborhood



Nieva & Przybilla 2012, A&A, 539, A143

Our oxygen abundances from B-stars vs. ISM

Chemical homogeneity (~10%) ~ ISM



Nieva & Przybilla 2012, A&A, 539, A143

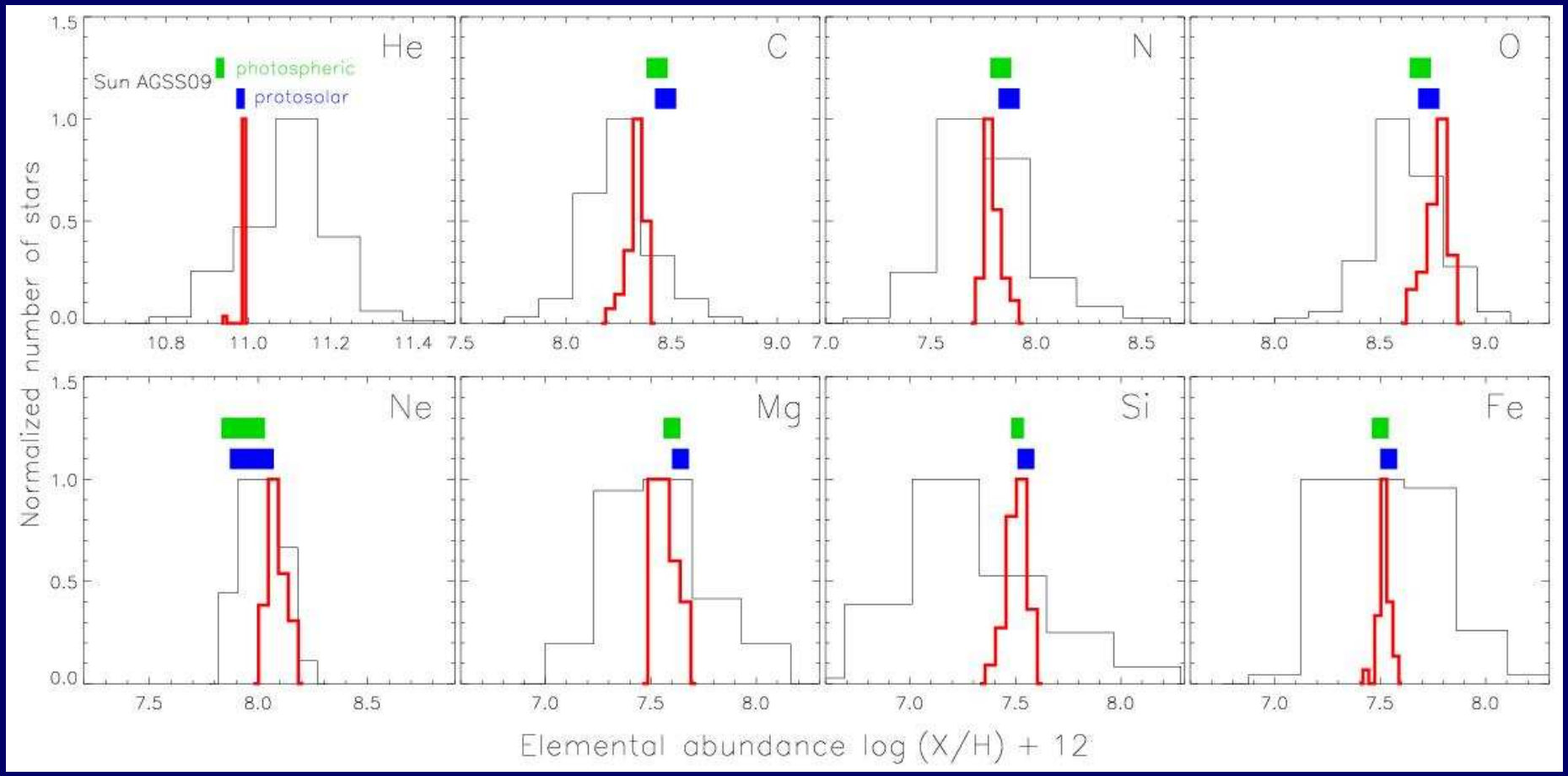
Dust composition in ppm: (B-stars – ISM*/HII)**

	local ISM	Orion nebula
C	123 ± 23	~0
N	~0	...
O	168 ± 67	128 ± 73
Mg	35 ± 4	33 ± 4
Si	29 ± 4	28 ± 4
Fe	33 ± 2	32 ± 3

*Ref. ISM: Sofia et al. (2011), Meyer et al. (1997), Cartledge(2004,2006)

**HII Orion: Esteban et al. (2004), Simon-Diaz & Stasinska (2011)

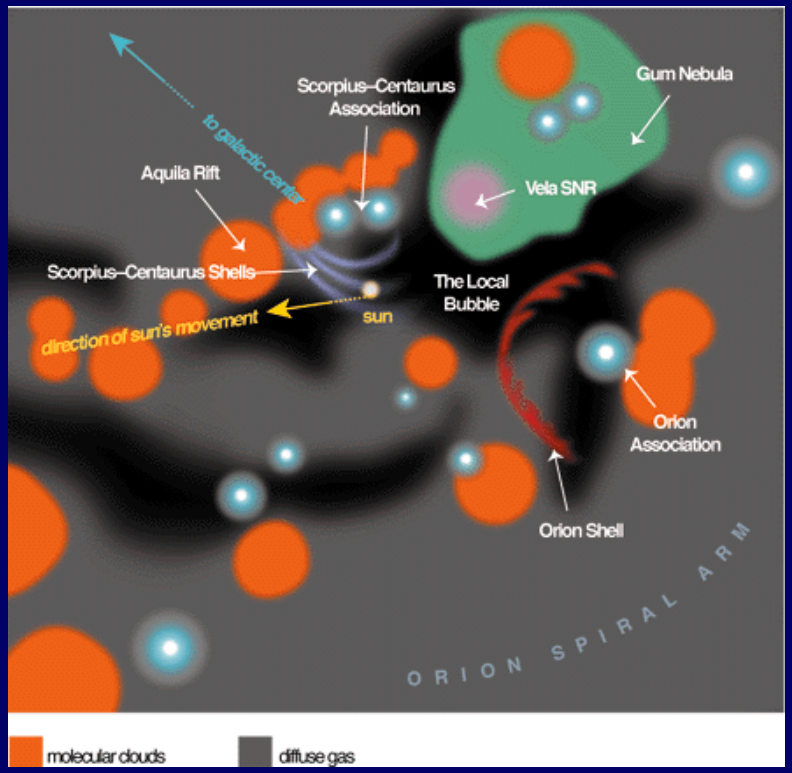
Present-day abundances in the solar neighbourhood



Nieva & Przybilla 2012, A&A, 539, A143

O and Si: same abundances from early B-type stars in Orion by Simon-Diaz (2010) (OII)

O and Mg: same abundances from BA-supergiants in the solar neighbourhood by Firnstein & Przybilla, subm. (OI)



Homogeneity of ISM and stars: natural consequence of turbulent mixing due to the large density variation of the gas!

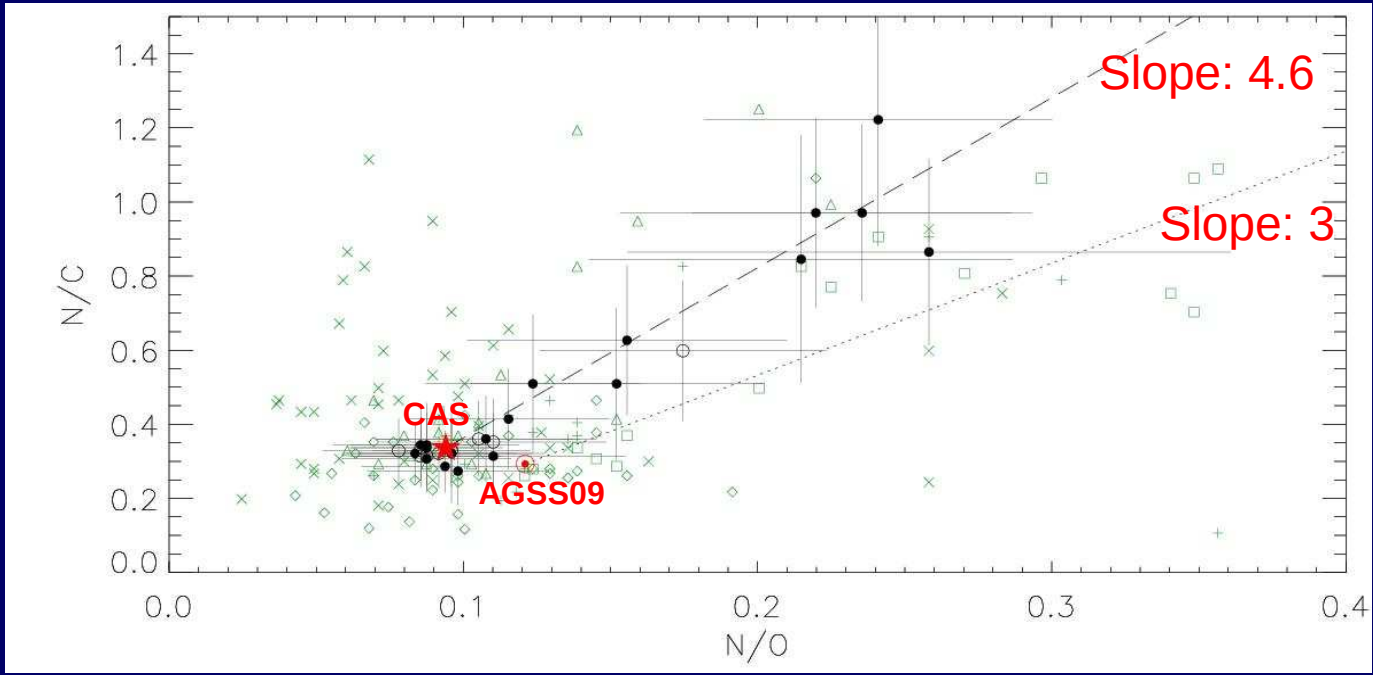
→ generated by complex interactions of momentum injection by stellar winds, supernova shocks, magnetic fields and self-gravity

Our results put constraints on:

injection and mixing timescales of metals in the local ISM

Critical test for stellar evolution

Observational constraints on the (magneto-)hydrodynamic mixing of CNO-burning products in massive stars



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In the Main Sequence, **the slope depends only on the initial abundance**, regardless on any other ingredient of the models (mass, rotational velocity, etc.)

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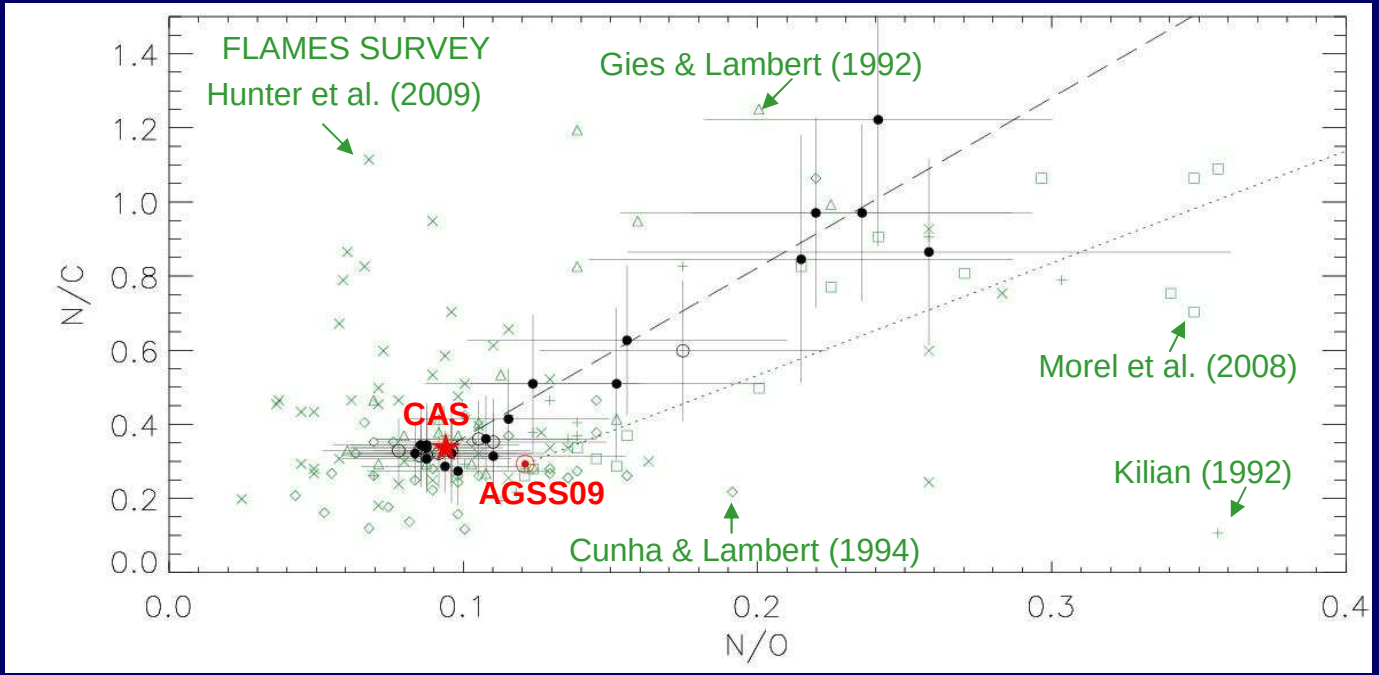

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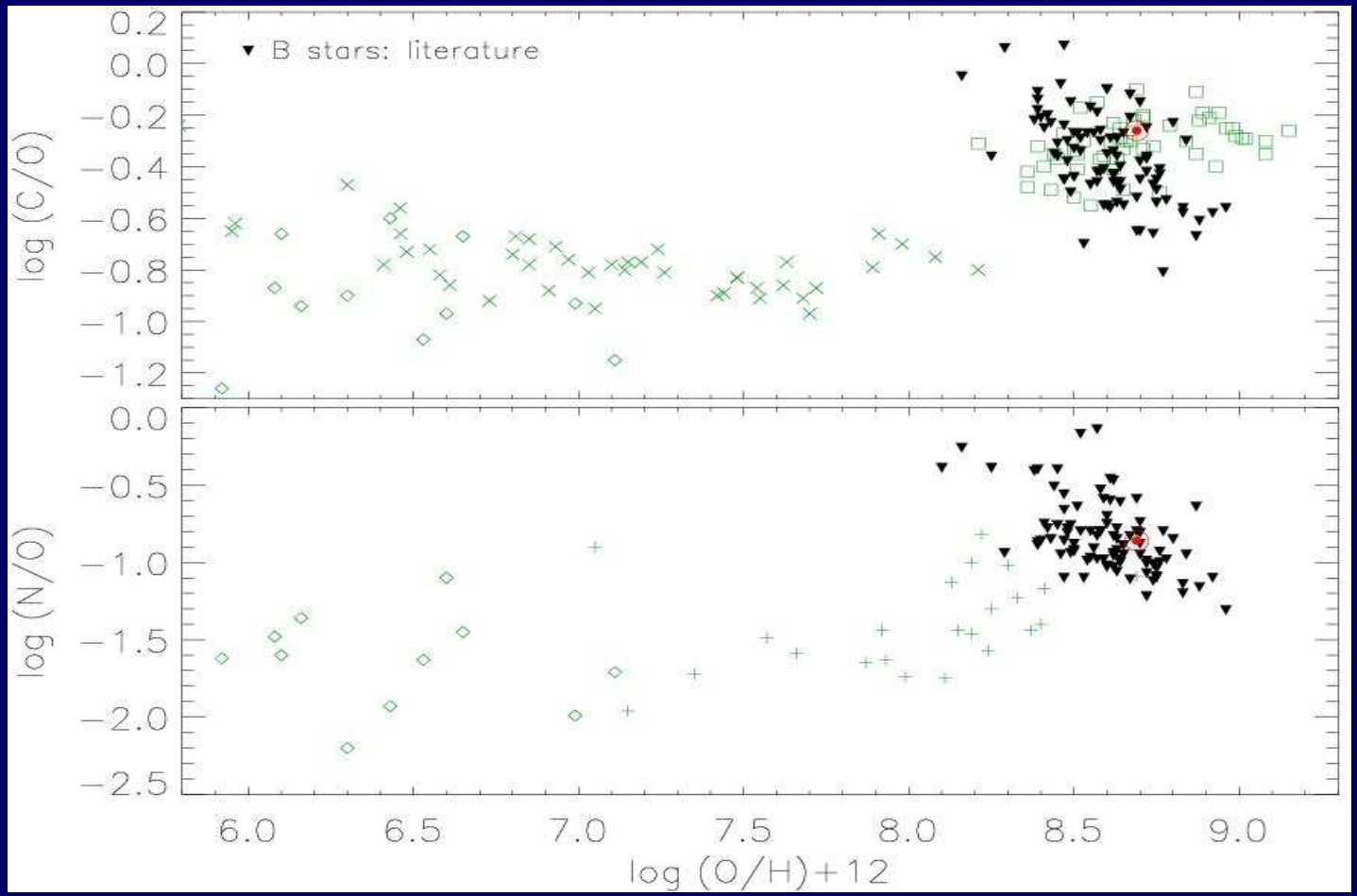
Galactic Chemical Evolution

OB stars: end point of GCE models



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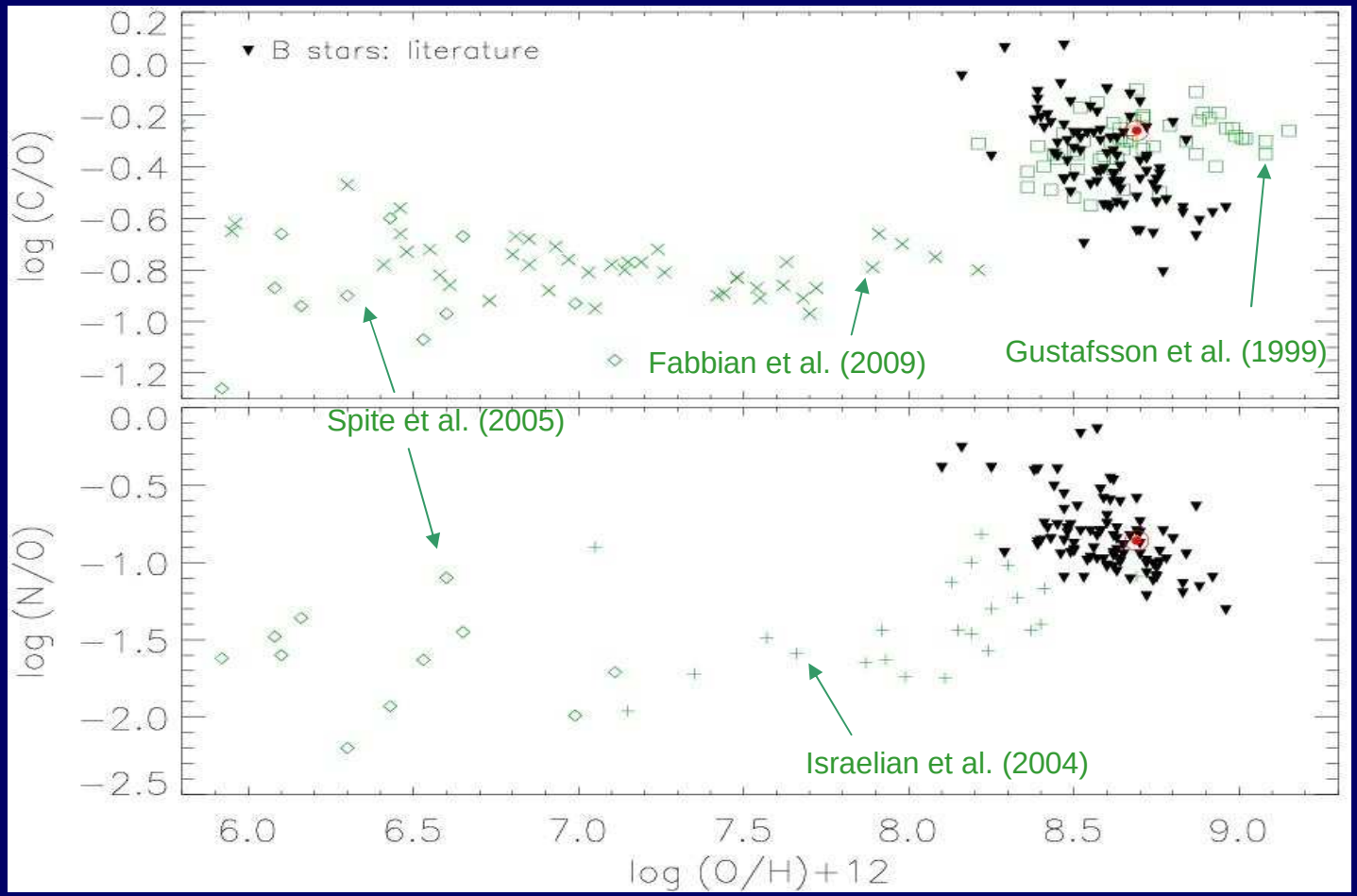

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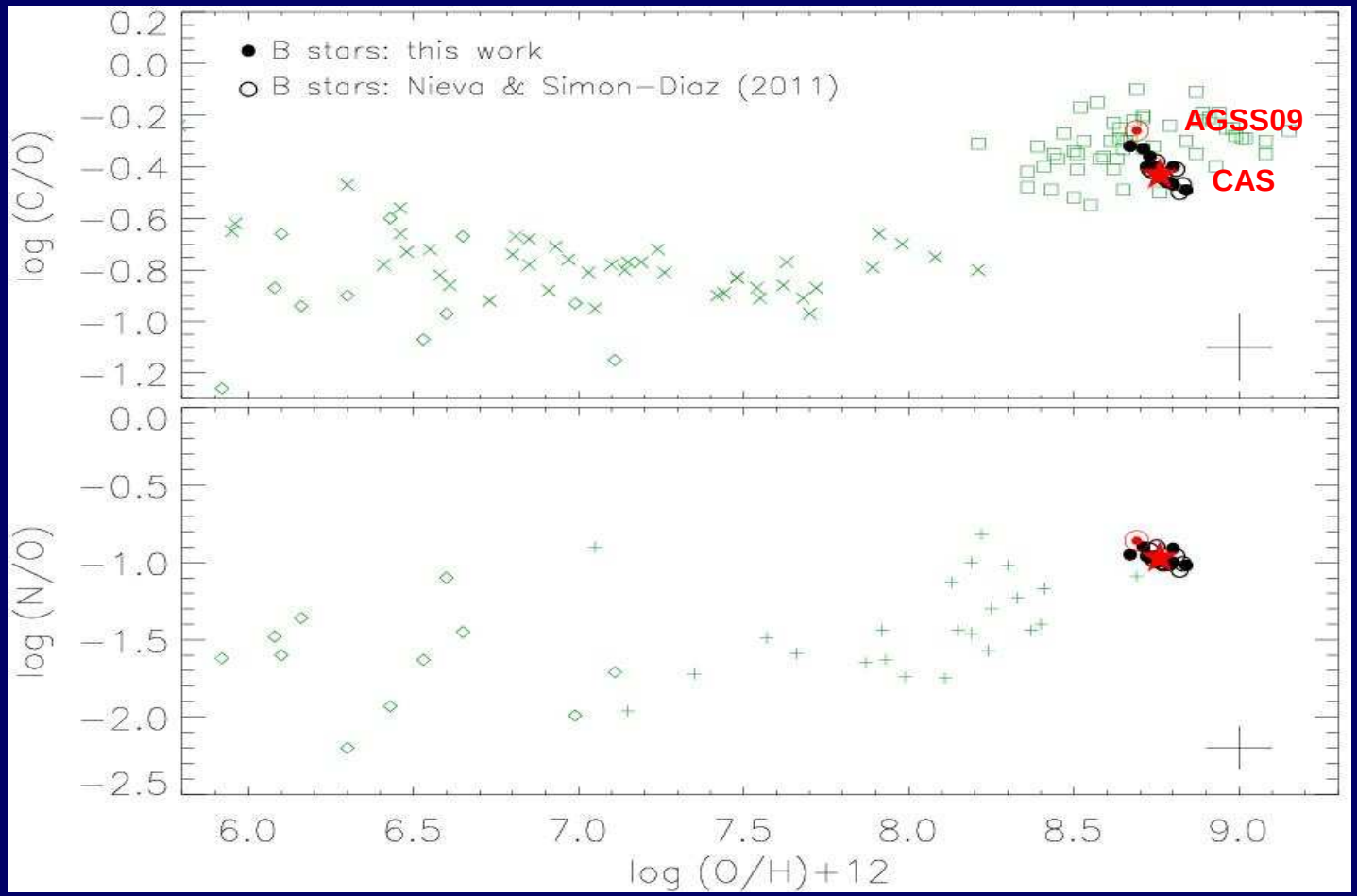

Nieva & Przybilla 2012, A&A, 539, A143

Present-day oxygen abundance in the solar neighbourhood

$$\varepsilon(O)_{CAS} = 8.76 \pm 0.05$$