α Cen and the Abundance of Neon in the Local Universe

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Outline:

- Why is there a problem to start with ?
- Why is there a problem with neon ?
- Is there a solution to the problem ?

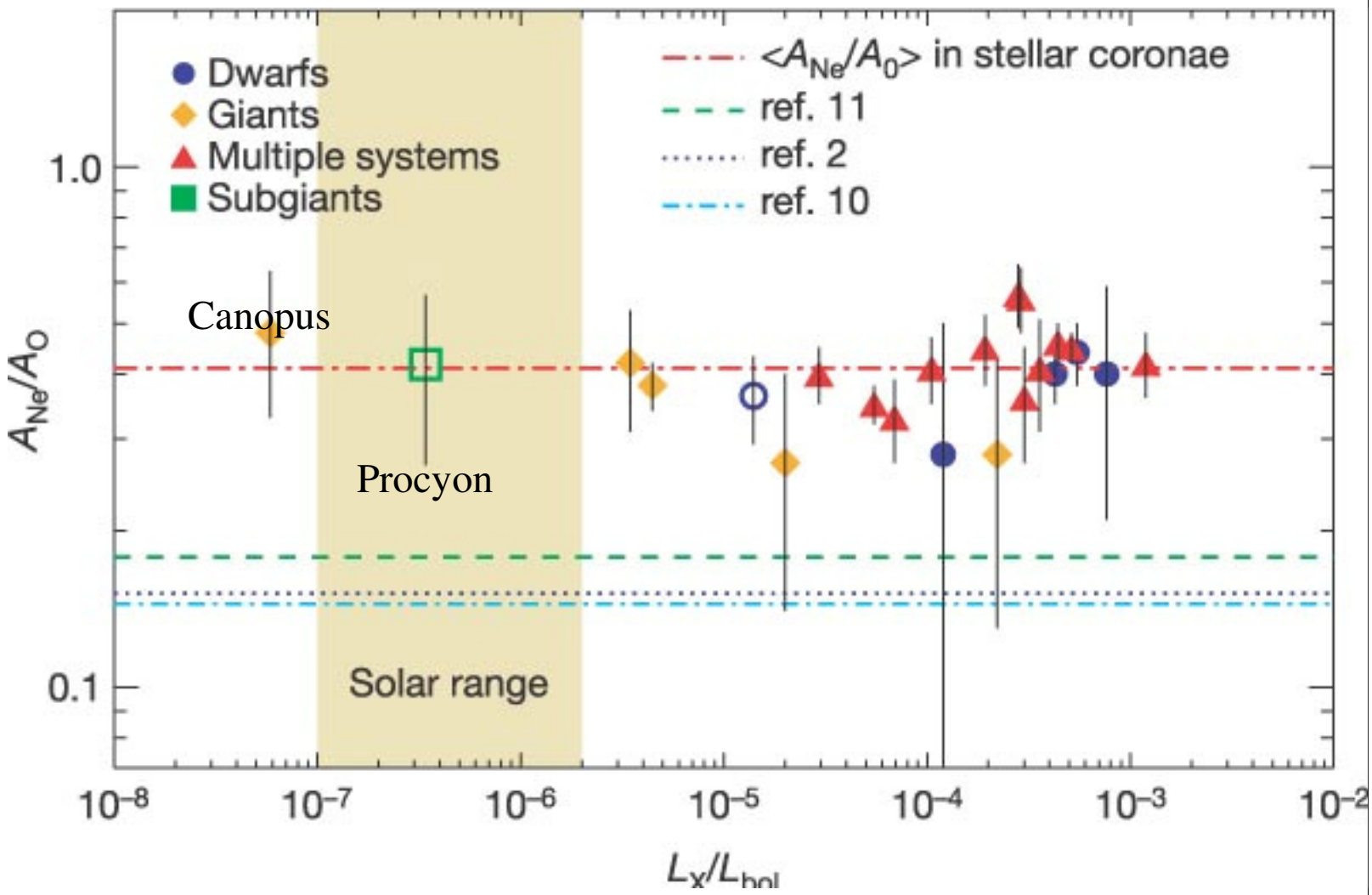
Why is there a problem ?

- 3-D hydrodynamic modelling of solar photospheric convection by M. Asplund and collaborators
- Downward revision of solar oxygen abundance
- Contradiction to helioseismology: Wrong opacity of interior leads to wrong convection zone depth

Why is there a problem with neon?

- Neon abundance not constrained by photospheric lines
- Increased neon abundance can compensate the opacity reduction due to decrease of oxygen abundance
- Consistency of helioseismology and 3D hydromodels

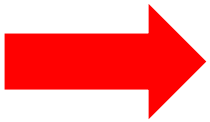
Drake & Testa (2005)



Suggestion: **Increased neon abundance typical for local cosmos**

Criticisms/Problems of/with enhanced neon abundance:

- **Most of analyzed stars are active stars , not comparable to Sun**
- **Sun does not show increased neon abundance (Young 2005, Schmelz et al. 2005)**
- **Abundance determination method may lead to systematic errors**



- **Determine Ne/O abundance for low activity star α Cen**
- **Investigate influence of DEM distribution on abundance**

How to do line based abundance determination ? (I)

$$F_{Lyman\ \alpha,Mg} = A_{Mg} \int_0^\infty dT\, DEM(T)\, P_{Mg,Ly\alpha}(T)$$

$$F_{Lyman\ \alpha,Si} = A_{Si} \int_0^\infty dT\, DEM(T)\, P_{Si,Ly\alpha}(T)$$

→ Model DEM distribution

OR

$$\frac{F_{Lyman\ \alpha,Mg}}{F_{Lyman\ \alpha,Si}} = \frac{A_{Mg}}{A_{Si}} \frac{\int_0^\infty dT\, DEM(T)\, P_{Mg,Ly\alpha}(T)}{\int_0^\infty dT\, DEM(T)\, P_{Si,Ly\alpha}(T)} \neq 1$$

measurable

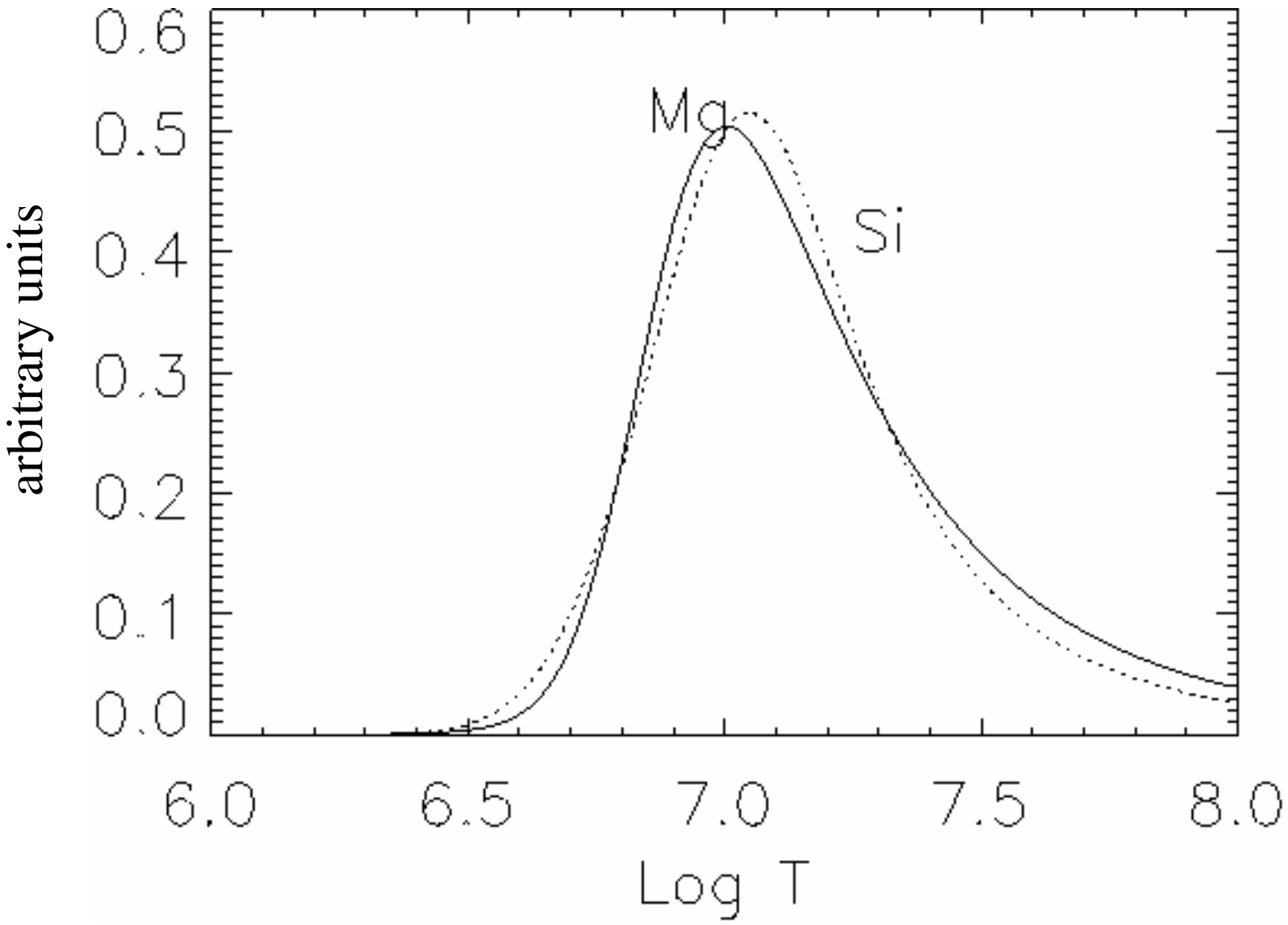
How to do line based abundance determination ? (II)

$$\frac{\sum_i A_i F_{i,Mg}}{\sum_j B_j F_{j,Si}} = \frac{A_{Mg}}{A_{Si}} \quad \frac{\int_0^\infty dT\, DEM(T) \sum_i A_i P_{i,Mg}(T)}{\int_0^\infty dT\, DEM(T) \sum_j B_j P_{j,Si}(T)}$$

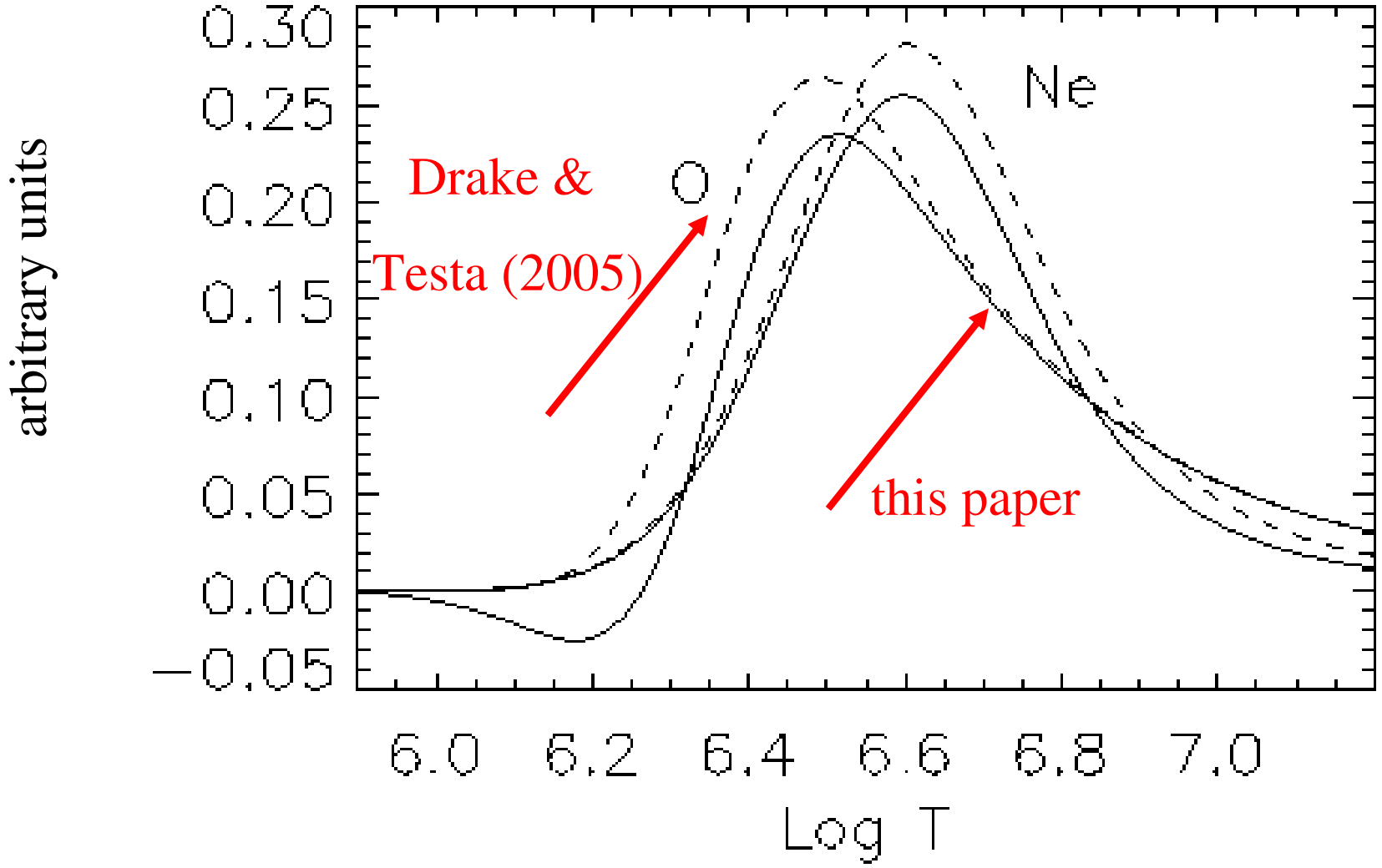
= 1 in a „best fit“ sense

→ Determine best fit coefficients A_i and B_j !!

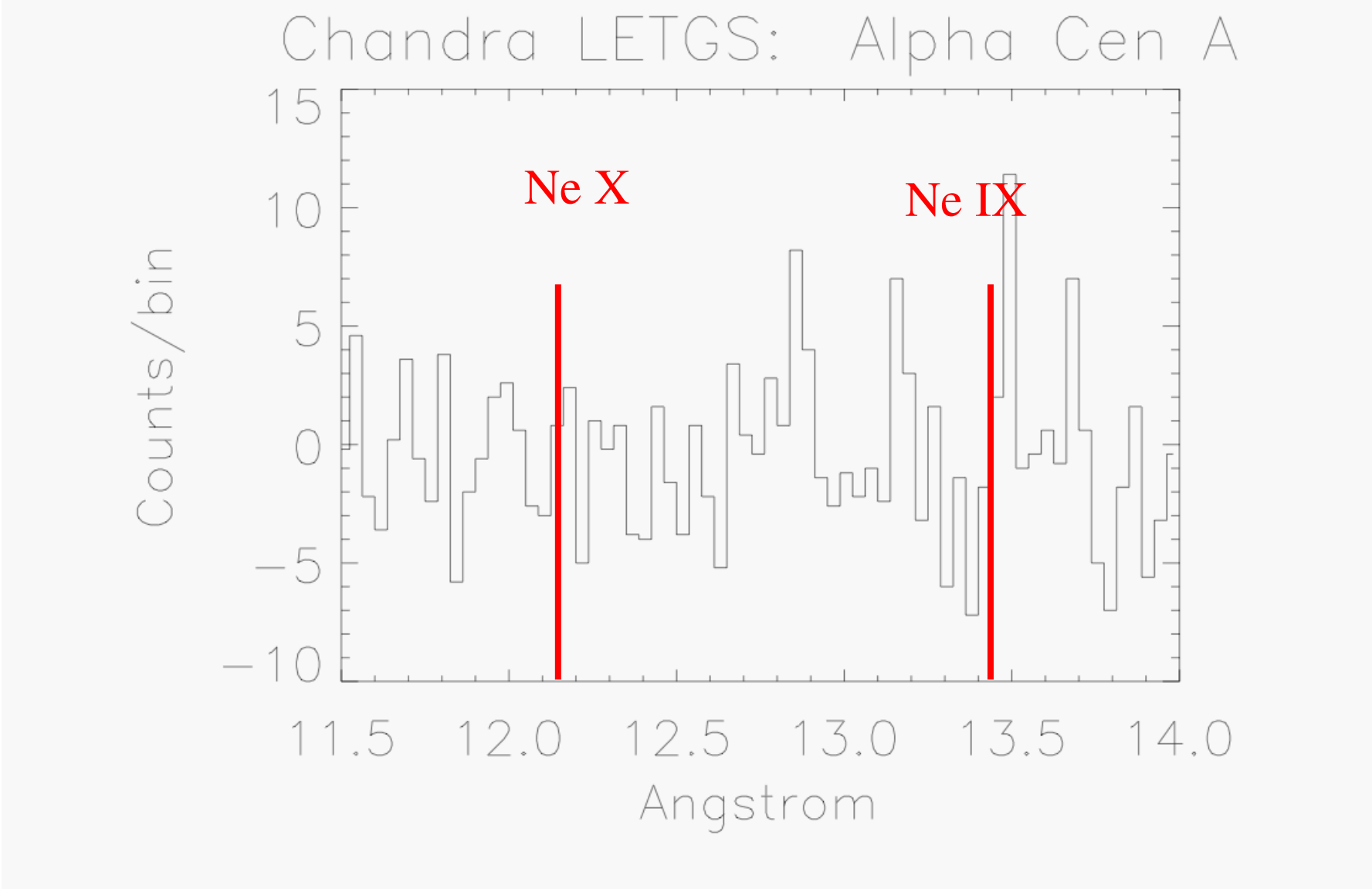
Optimal linear combination of Mg and Si lines:



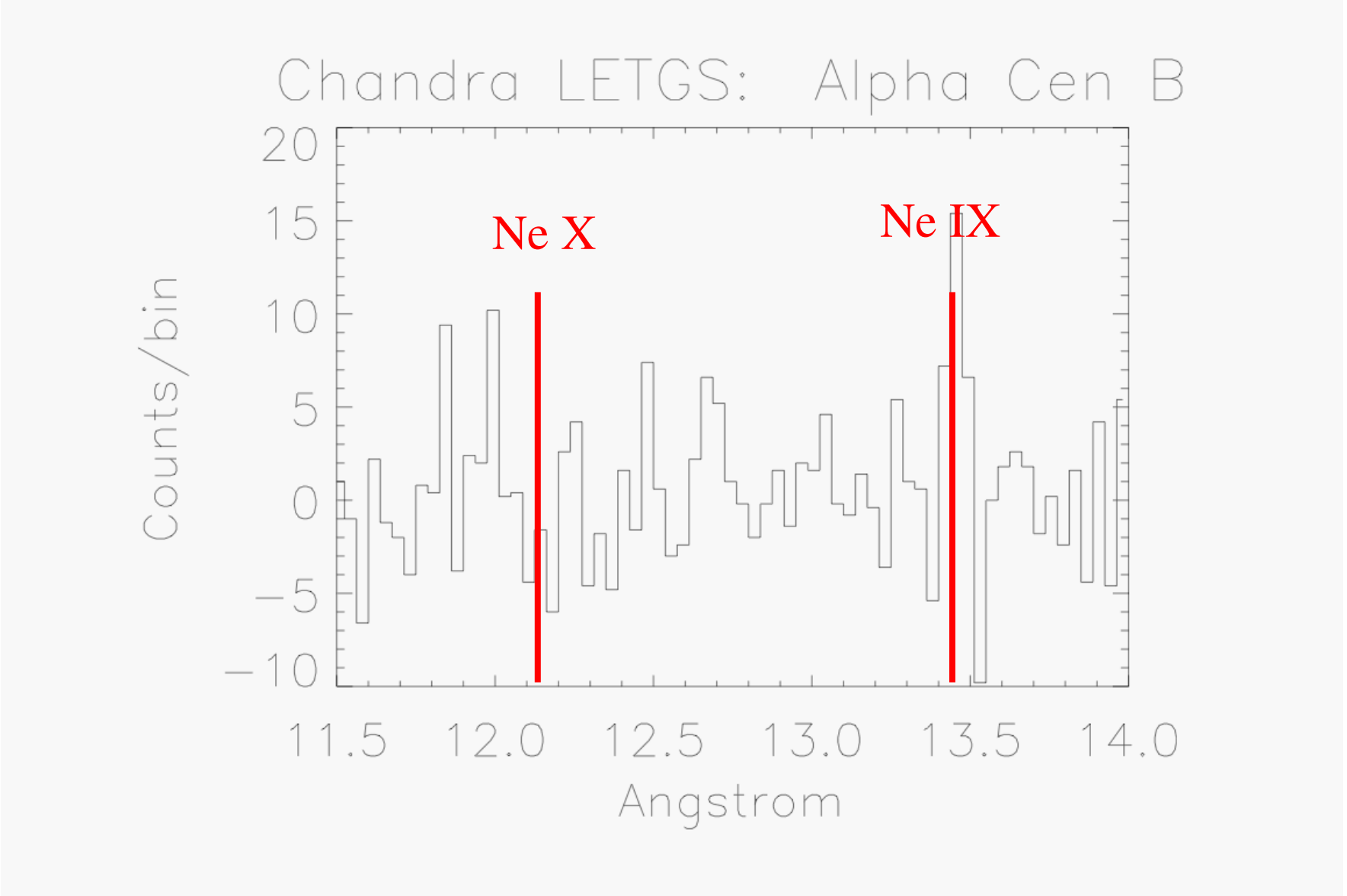
Optimal linear combination of O and Ne lines:



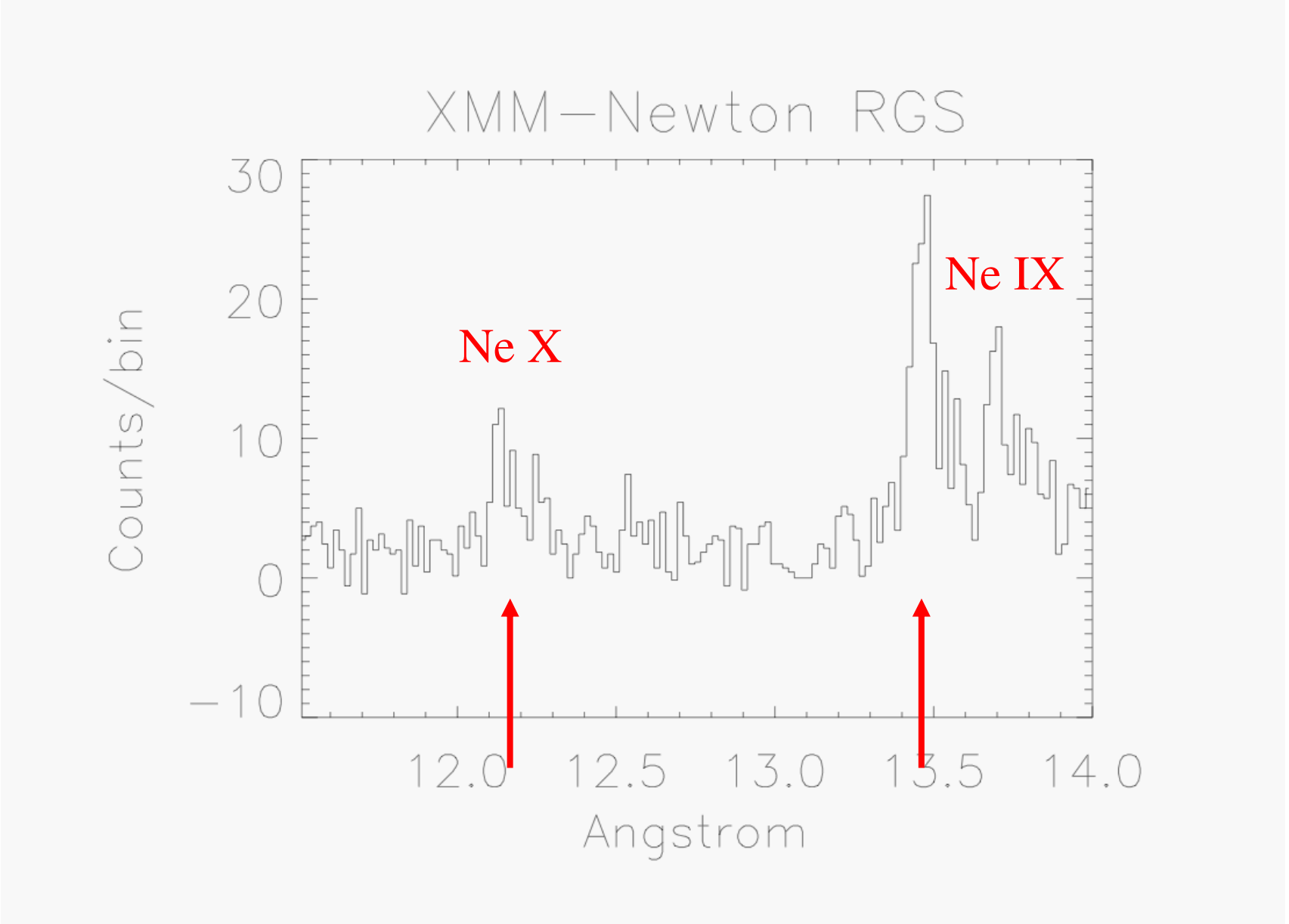
Neon lines in α Cen -- Chandra LETGS



Neon lines in α Cen -- Chandra LETGS

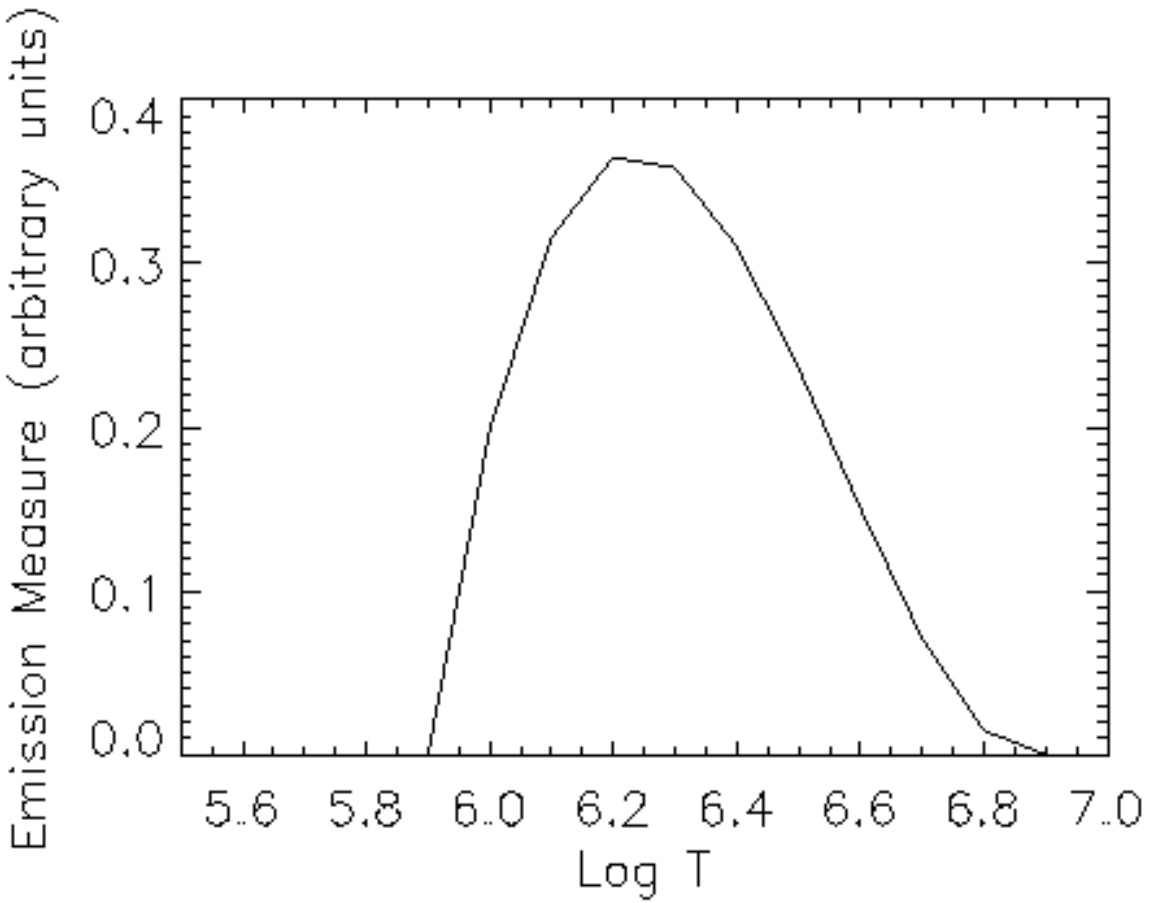


Neon lines in α Cen -- XMM-Newton RGS



Emission measure distribution in α Cen

$$EM = (\log T - a)(b - \log T)((\log T)^2 + c \log T + d)$$



Satisfies:

LyαLyβ C line ratios

LyαHe r O line ratios

LyαHe r Ne line ratios

Ca line ratios

and upper limits for

LyαHe r C line ratios

Fe line ratios

Results for α Cen B

Anders & Grevesse: $\frac{A_{Ne}}{A_O} = 10^{8.08-8.83} = 0.18$

Optimal line ratio method:

α Cen: $\frac{A_{Ne}}{A_O} = 0.31 \pm 0.02$

DEM modelling:

α Cen: Ne IX $\frac{A_{Ne}}{A_O} = 0.31 \pm 0.04$

Ne X $\frac{A_{Ne}}{A_O} = 0.39 \pm 0.07$

Results for α Cen B: Sanity check

Anders & Grevesse: $\frac{A_N}{A_O} = 10^{7.92-8.83} = 0.12$

Optimal line ratio method:

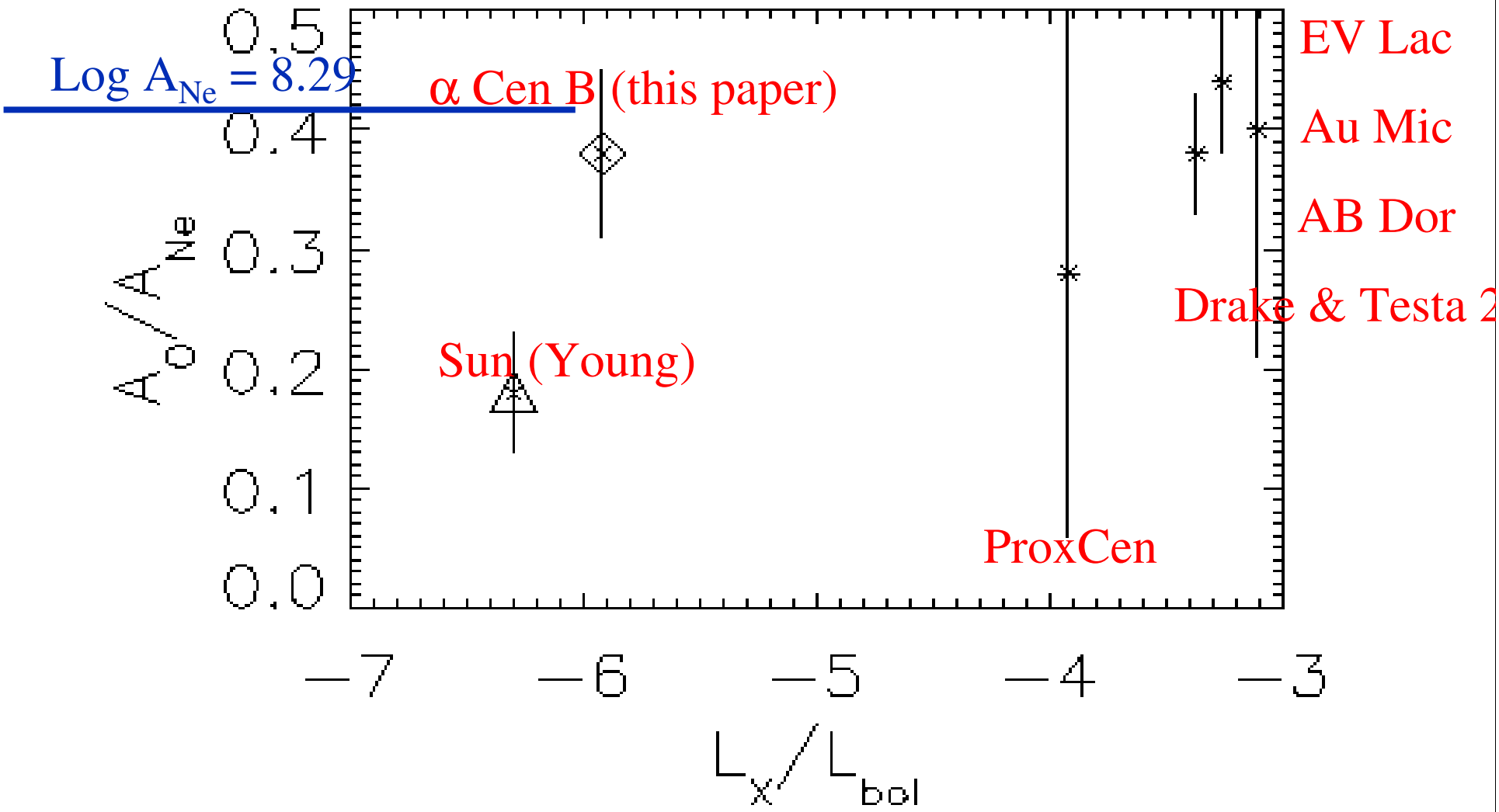
α Cen: $\frac{A_N}{A_O} = 0.13 \pm 0.01$

DEM modelling:

α Cen: N VI $\frac{A_N}{A_O} = 0.16 \pm 0.02$

N VII $\frac{A_N}{A_O} = 0.11 \pm 0.02$

Neon/oxygen abundances for dwarf stars



Conclusions:

Bahcall, Basu, Serenelli, 2005, ApJ, 631,1281:

„What is the neon abundance of the Sun ?“

„Models in which the neon abundance … is $\log A_{Ne} = 8.29 \pm 0.05$ (on a scale where $\log N_H = 12$) are consistent with the helioseismological measurements even though the other heavy-element abundances are in agreement with the determinations by Asplund et al.“

Seems to work at least for α Cen B !!

Why does this scheme not work for the Sun ?