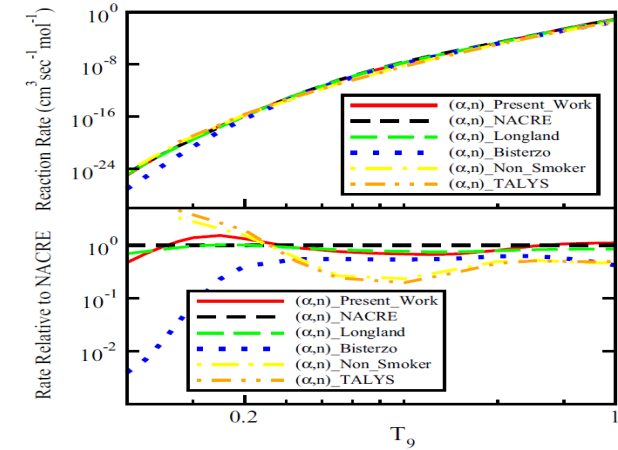
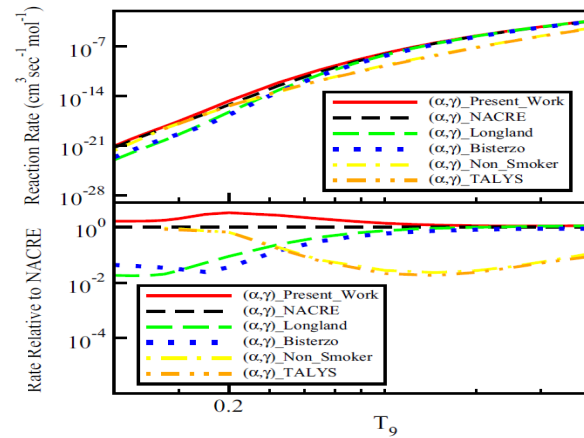
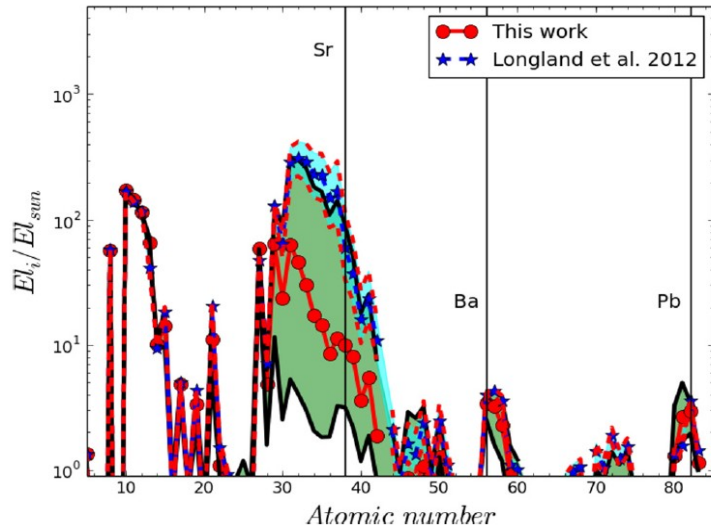


The s-process and the residual method v2.0

$^{22}\text{Ne} + \alpha$ rates: Talwar, ..MP et al. 2016, Phys. Rev. C

Nuclear rates considered:



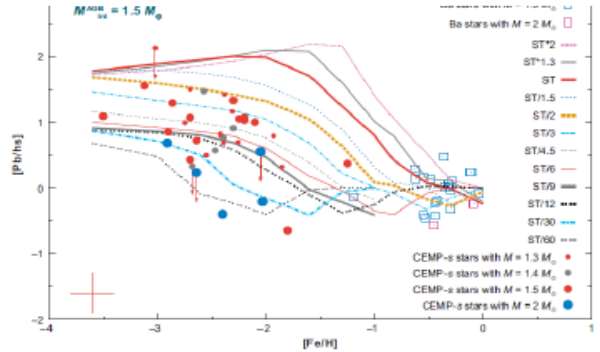
Impact study on the weak s-process
in massive stars:

- ~ 1 dex errorbar in the stellar yields
- Uncertainty variation between Talwar and Longland rates.

Nuclear experiment effort:
neutron-capture rates, weak rates,
alpha-captures, proton-captures...

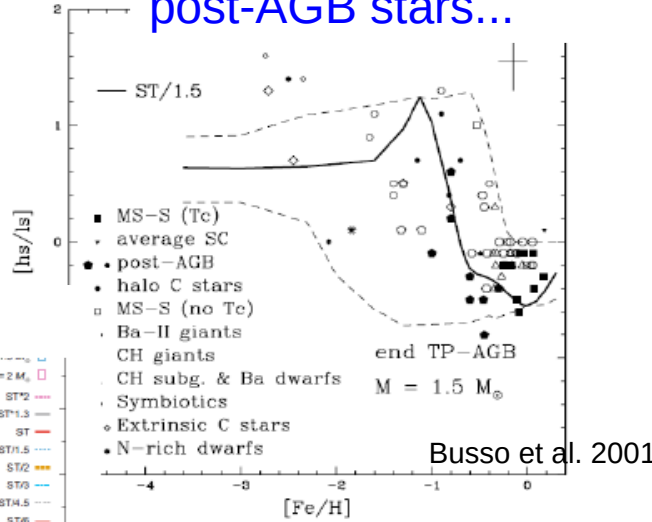
Incredible effort from spectroscopic observations and cosmochemistry

CEMP-s stars

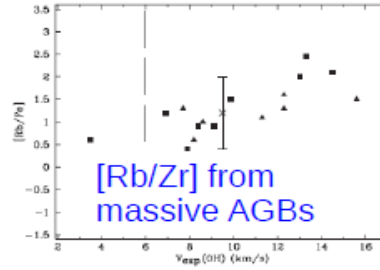


Snedden et al. 2008

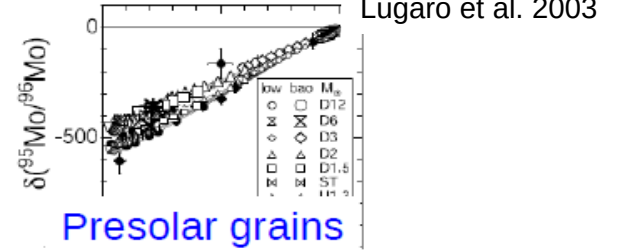
Ba stars, MS-S stars, post-AGB stars...



Busso et al. 2001

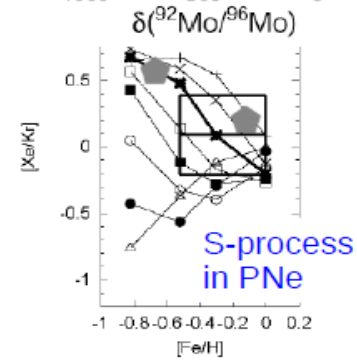


Garcia-Hernandez et al. 2006

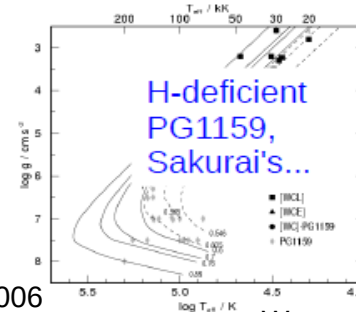


Lugaro et al. 2003

Presolar grains



MP et al. 2006



Werner & Herwig 2006



-3

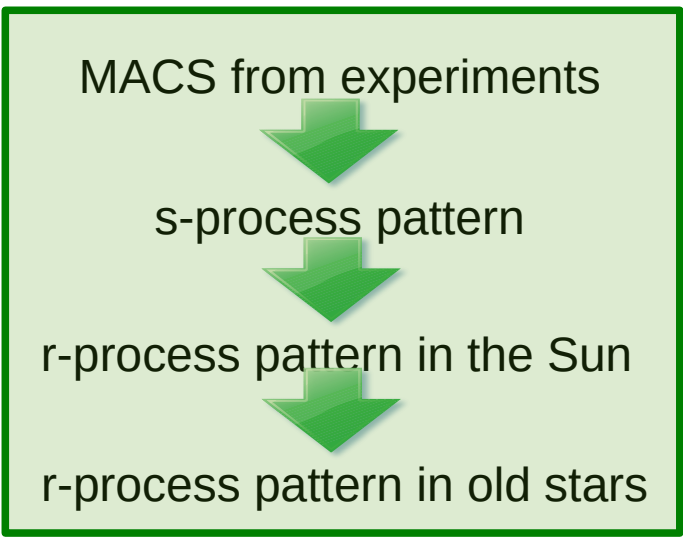
[Fe/H]

Solar system distribution

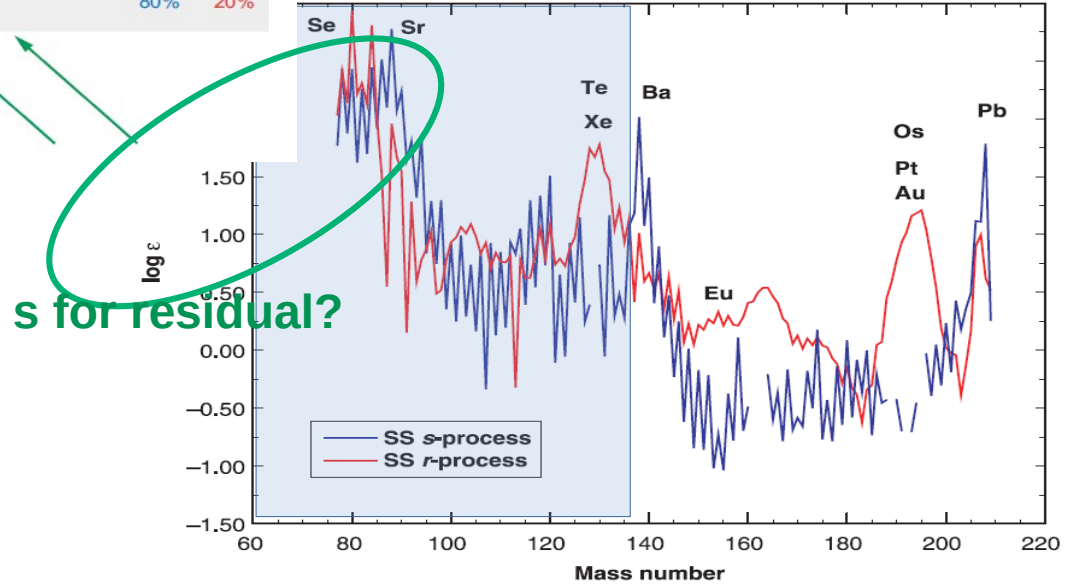
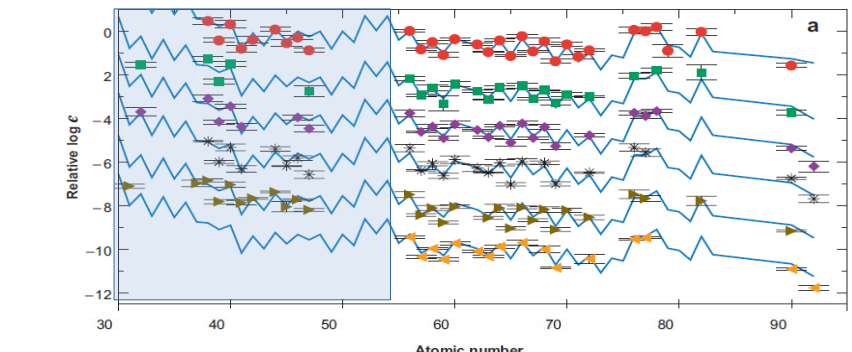
e.g., Bisterzo et al. 2014

Residual method: $1 = s + r$

Element	N = 82					Elemental breakdown		
						r	s	
Nd	142 s					42%	58%	
Pr	141 s,r 100%					51%	49%	
Ce	140 s,r 88.5%					142 r 11.2%	19%	81%
La	139 s,r 99.9%					25%	75%	
Ba	134	135	136	137	138	15%	85%	
	s	s,r	s	s,r	s,r			
	2.4%	6.6%	7.9%	11.2%	71.7%			
Cs	133 s,r 100%					85%	15%	
Xe	128	129	130	131	132	80%	20%	
	s	s,r	s	s,r	r			
	1.9%	26.4%	4.1%	21.2%	26.9%			
								134
								r
								10.4%
								136
					r			
					8.9%			



Sneden & Cowan 2003

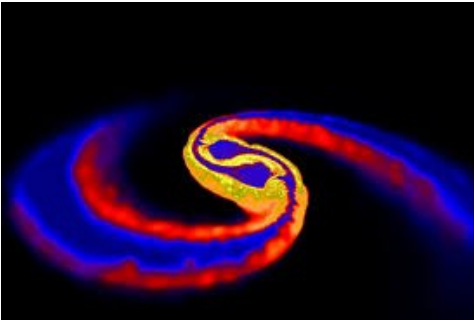


Sneden, Cowan and Gallino 2008

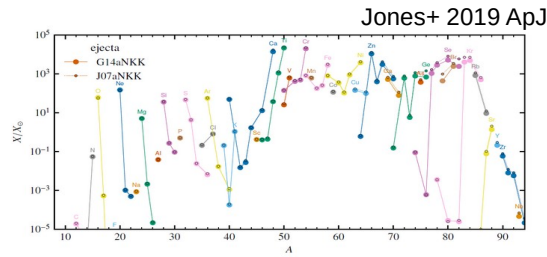
Things are more complicated:
residual method should be upgraded to take this into account

- Refined diagnostic for the stellar layers where elements are made in these stars.
- Residual method: $\text{solar} - s = r + \text{CCSNe} + \text{ECSNe} + i + \dots$

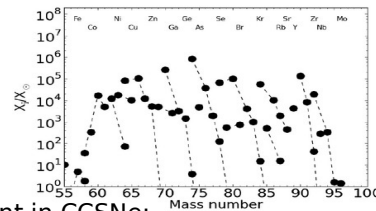
Rosswog et al. NS-NS merger simulation



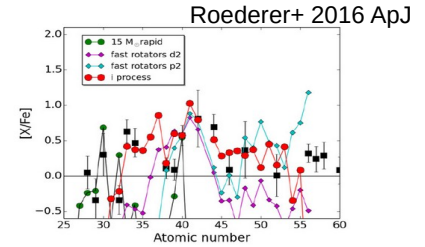
One of the possible r-process sources



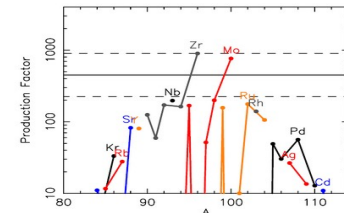
EC-SNe: e.g. Jones et al. 2019 ApJ
Wanajo et al. 2011 ApJL, etc



α -rich freezeout in CCSNe:
e.g. Woosley & Hoffman 1992 ApJ, MP et al. 2016 ApJS



Intermediate neutron-capture process
(i-process)



Neutrino-winds components in CCSNe:
e.g. Fröhlich et al. 2006 PhRvL and ApJ,
Roberts et al. 2010 ApJ, etc.