The r-process Alliance
Mapping the r-process with stellar abundances

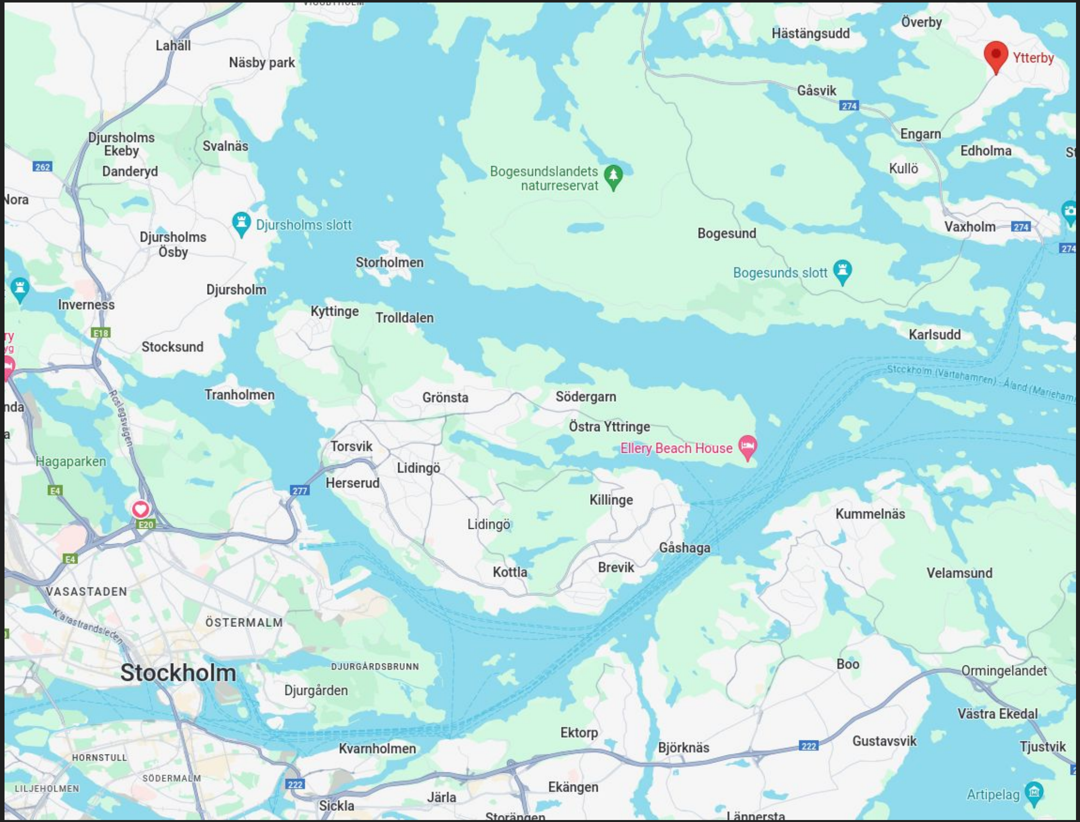
Mila Racca
PhD student

Supervisor: Terese Hansen
Co-supervisor: Karin Lind

19th Russbach School on Nuclear Astrophysics

Oskar Klein centre
Stockholm University

R-Process Alliance


Lahäll
Näsby park
Hästängsudd
Överby
Ytterby
Gåsvik
Engarn
Edholma
Kullö
Djursholms Ekeby
Svalnäs
Danderyd
Bogesundslandets naturreservat
Djursholms slott
Djursholms Ösby
Vaxholm
Bogesund
Storholmen
Bogesunds slott
Djursholm
Inverness
Kyttinge
Trolldalen
Karlsudd
Stocksund
Tranholmen
Grönsta
Södergarn
Östra Yttringe
Ellery Beach House
Torsvik
Lidingö
Herserud
Hagaparken
Killinge
Kummelnäs
Lidingö
Gåshaga
Velamsund
Kottla
Brevik
VASASTADEN
ÖSTERMALM
Stockholm
DJURGÅRDSBRUNN
Djurgården
Boo
Ormingelandet
Västra Ekedal
Ektorp
Björknäs
Gustavsvik
Tjustvik
Kvarnholmen
HORNSTULL
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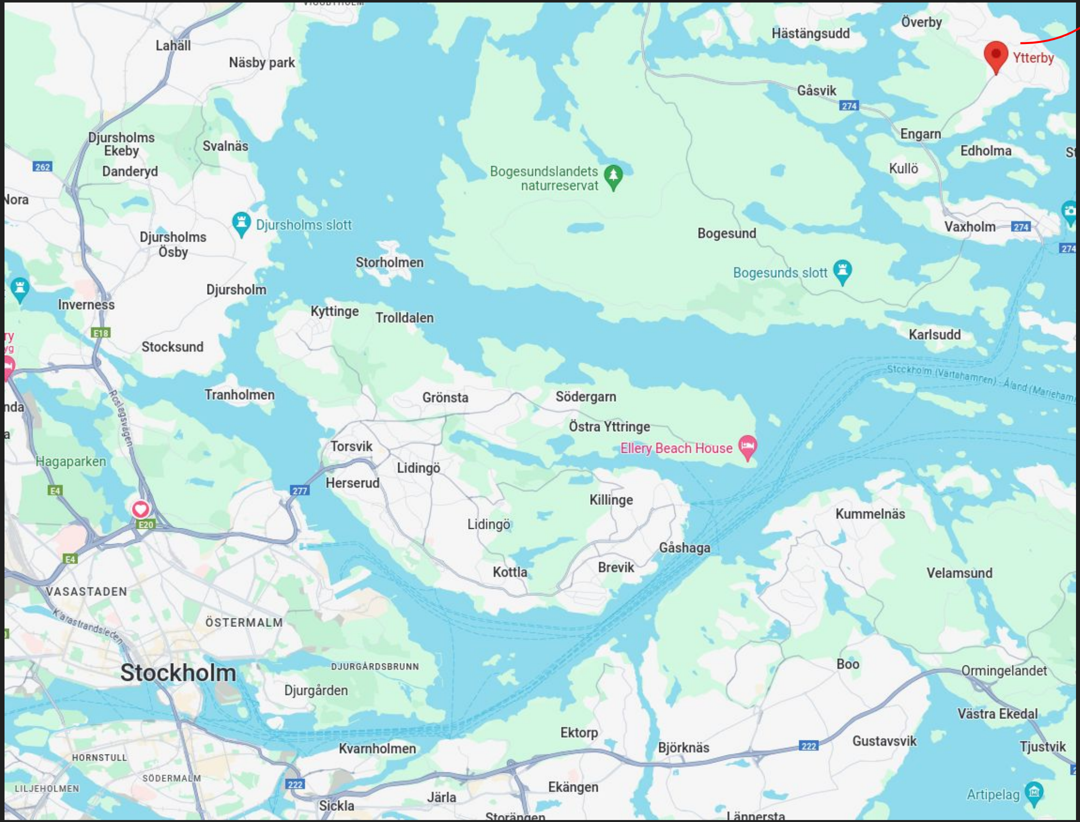
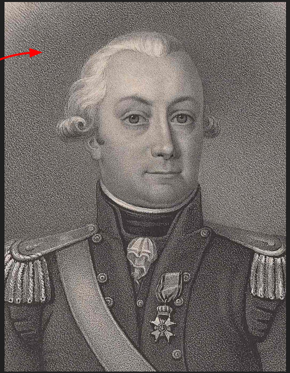
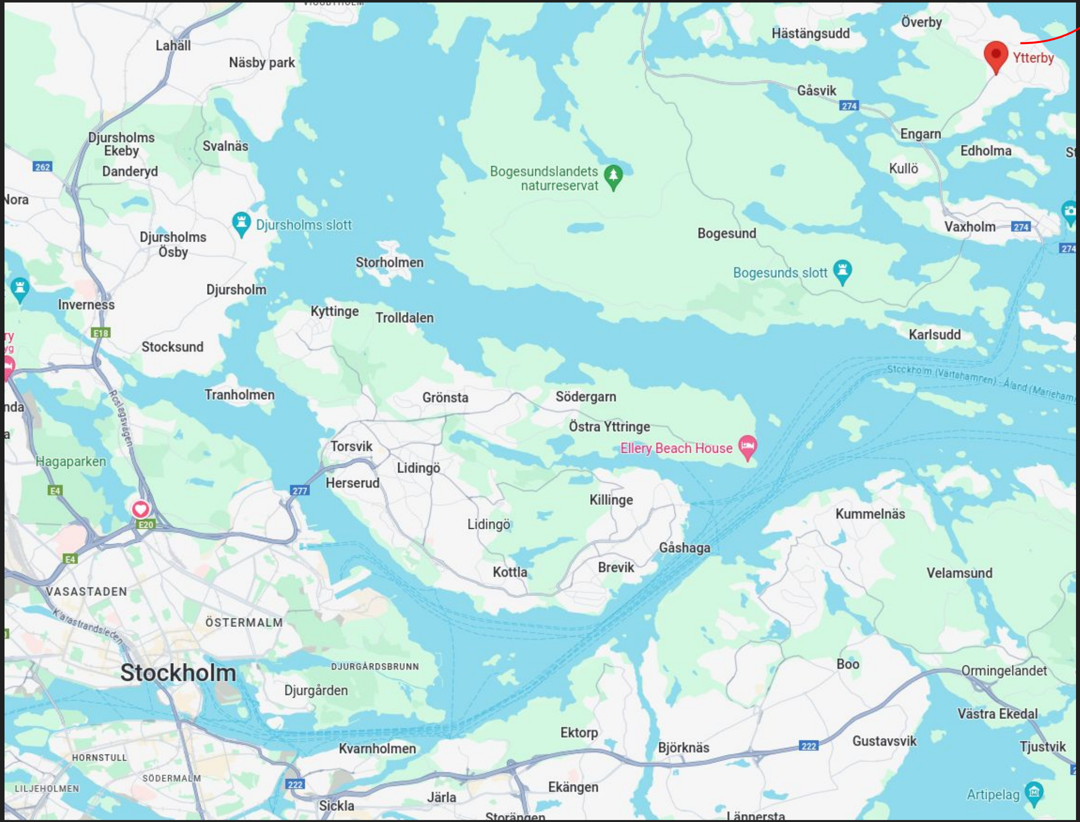
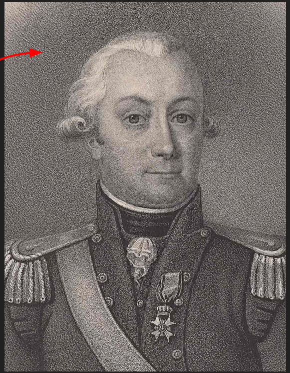
LILJEHOLMEN
Ekängen
Artipelag
Sickla
Järla
Storängen
Lännersta





Carl Axel Arrhenius
1757 – 1824



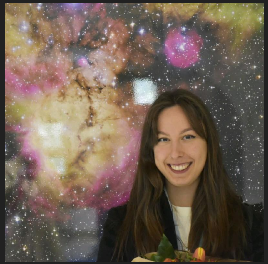


Carl Axel Arrhenius
1757 – 1824

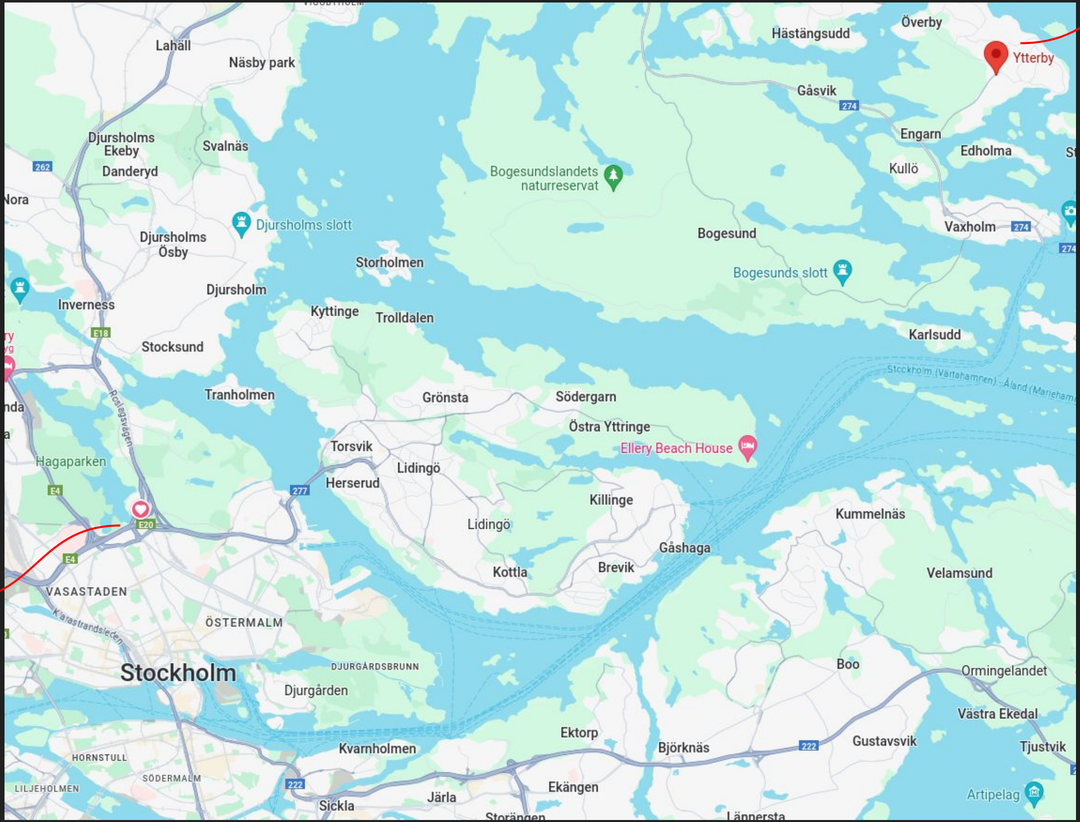
Ytterby mine

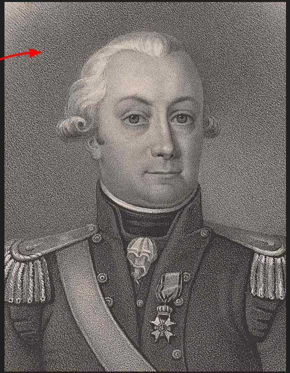
terbium,
dysprosium,
holmium,
erbium,
thulium,
ytterbium,
lutetium.

Where do these elements come from?



2024





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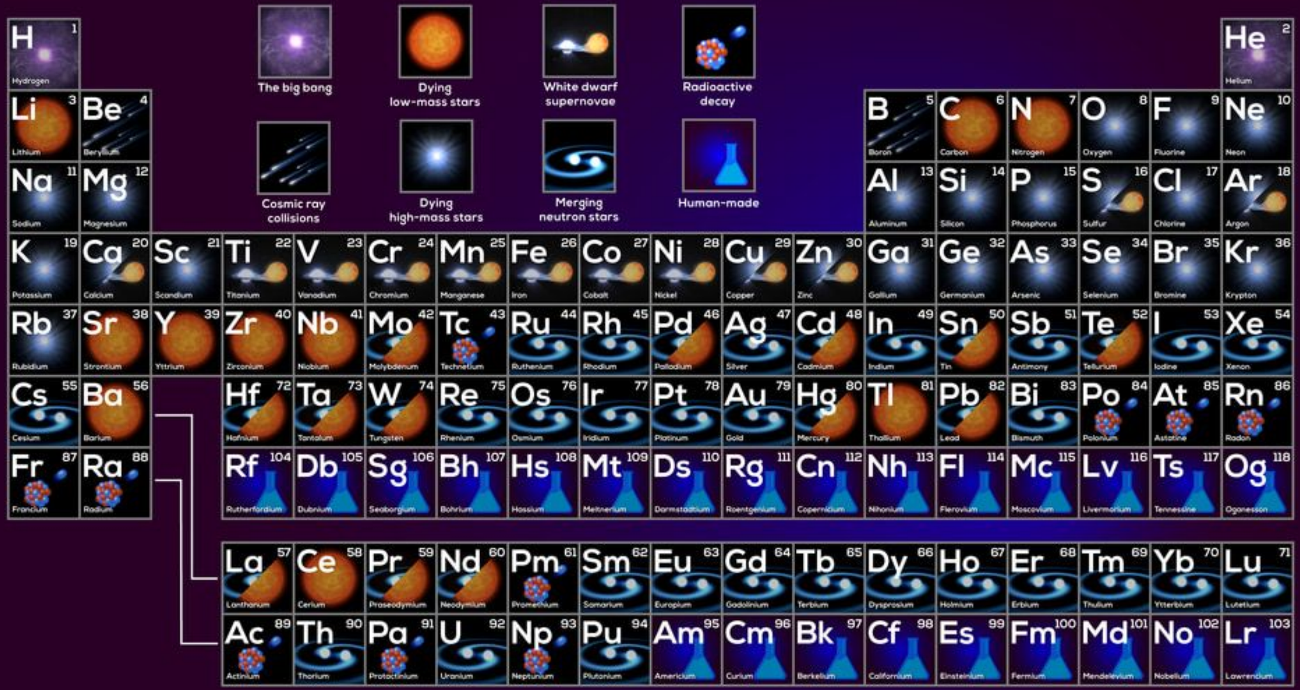
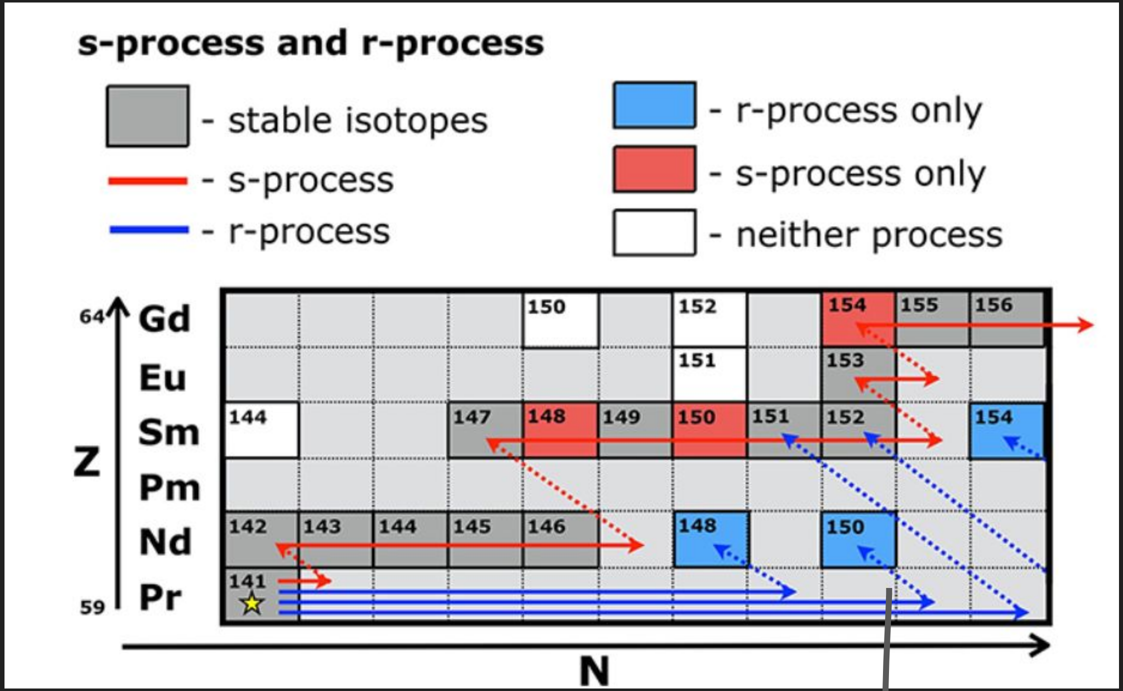
Origins of the Elements



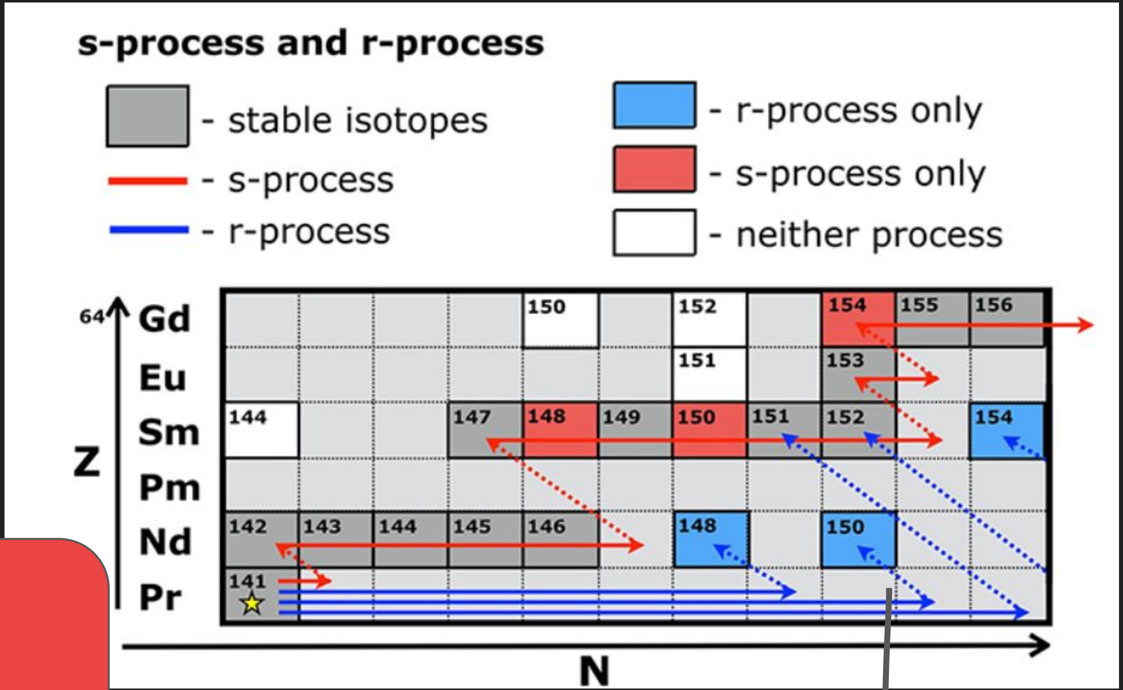
This periodic table depicts the primary source on Earth for each element. In cases where two sources contribute fairly equally, both appear.

Neutron capture processes



$$n \rightarrow p + e^{-} + \bar{\nu}$$

Neutron capture processes



s-process:

$\tau_n >> \tau_\beta$

$n_n < \sim 10^8\ /cm^3$

$$n \rightarrow p + e^- + \bar{\nu}$$

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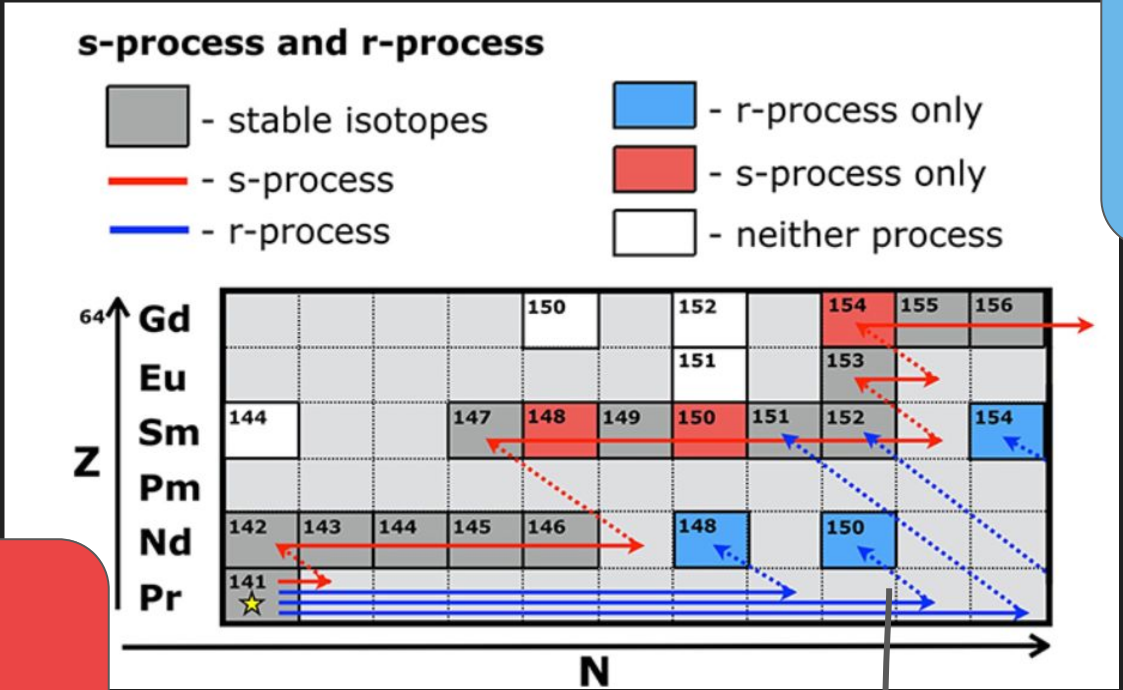

r-process:

$\tau_n << \tau_\beta$

$n_n >> 10^8 - 10^{28}$ /cm^3

s-process:

$\tau_n >> \tau_\beta$

$n_n < \sim 10^8$ /cm^3

$$n \rightarrow p + e^- + \bar{\nu}$$

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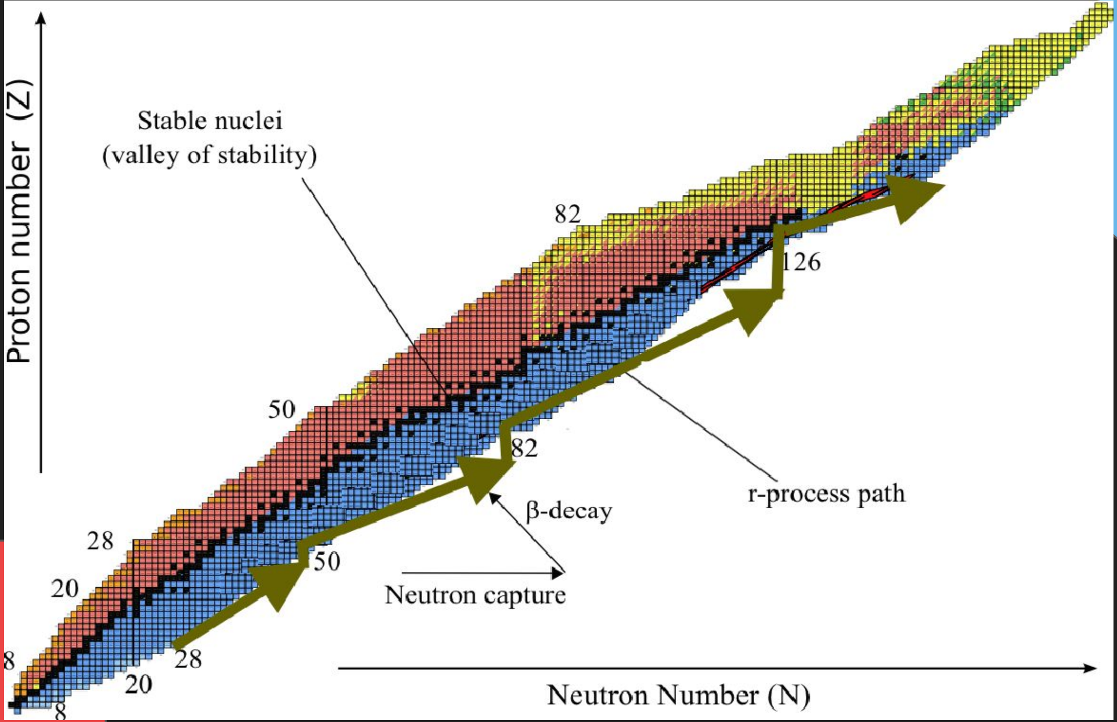

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Astrophysical sites of r-process

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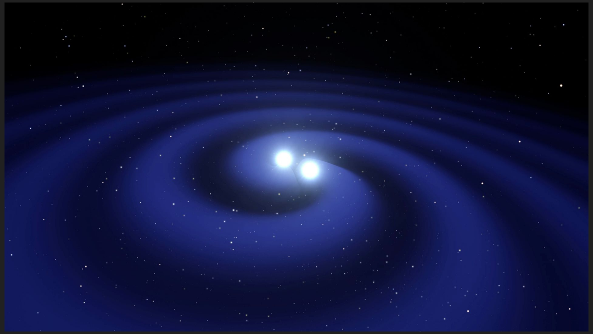
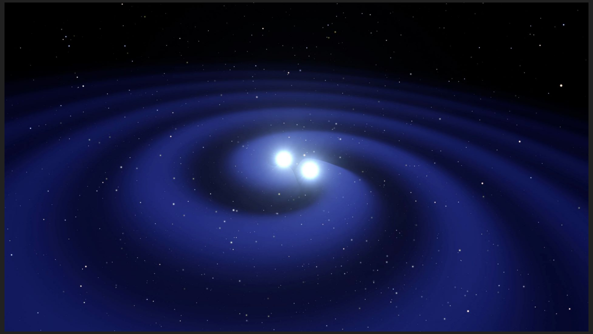


Neutron star mergers

Astrophysical sites of r-process



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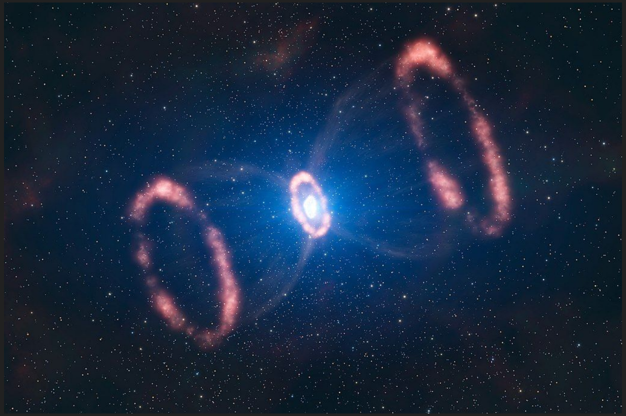
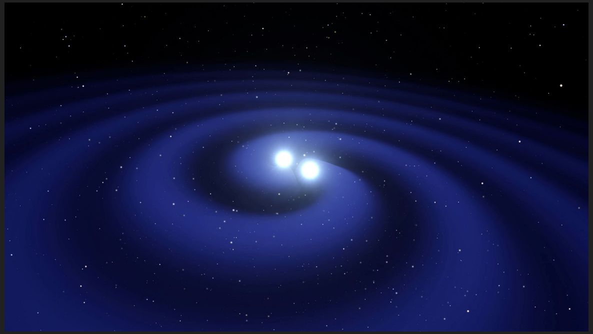


Core collapse supernovae

Astrophysical sites of r-process

Collapsars



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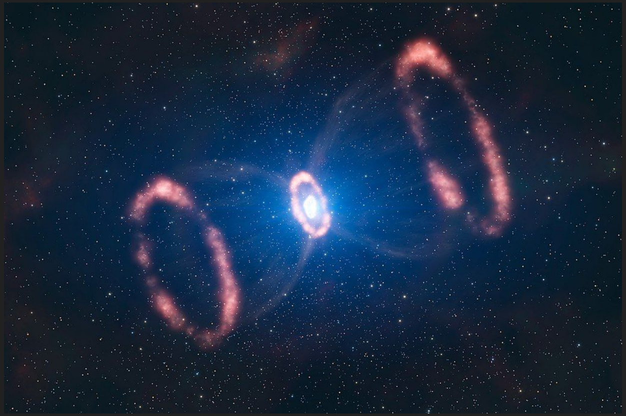

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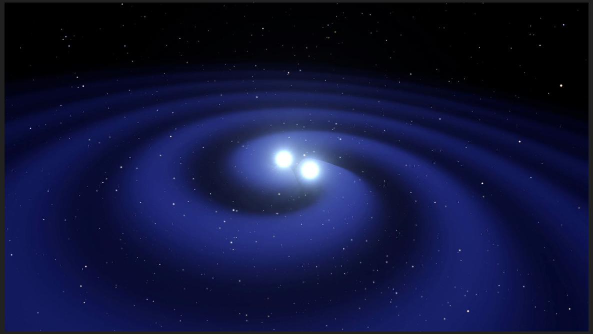
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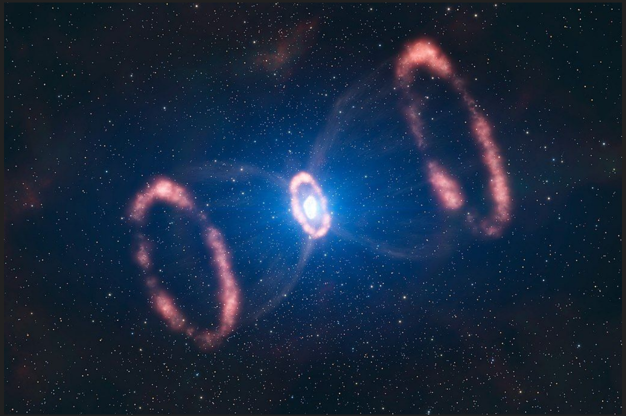
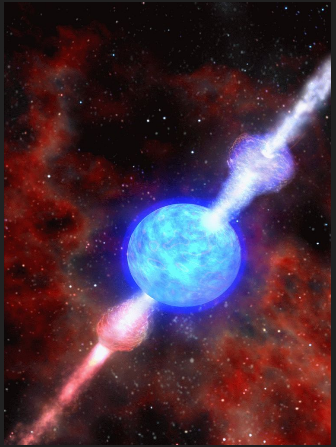
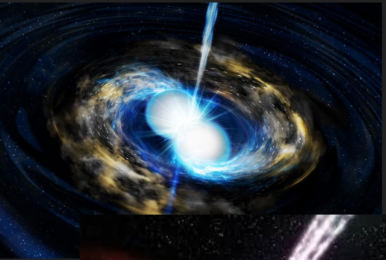

Core collapse supernovae


Jet-supernovae

Nuclear astrophysics with Stellar Abundances

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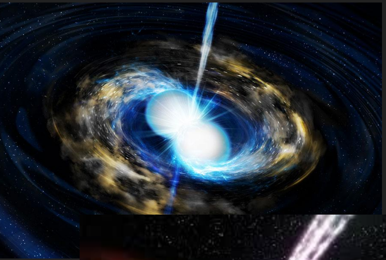

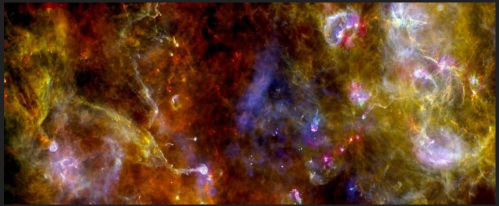

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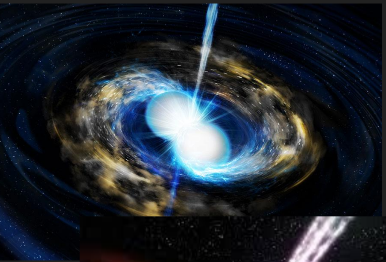

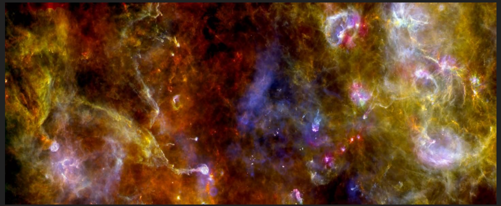

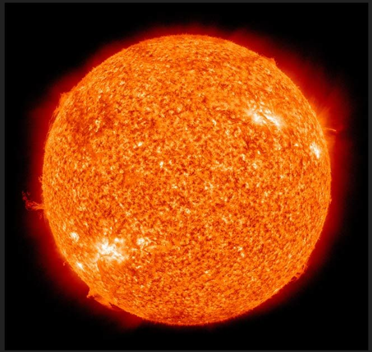

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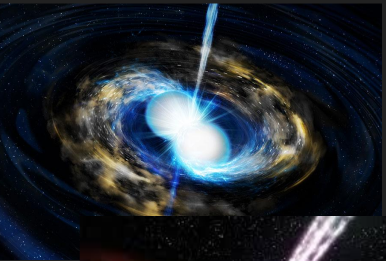

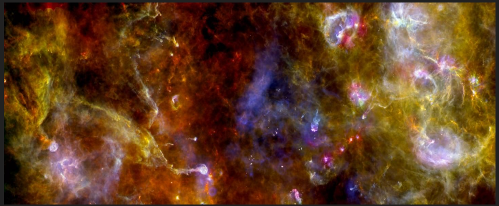

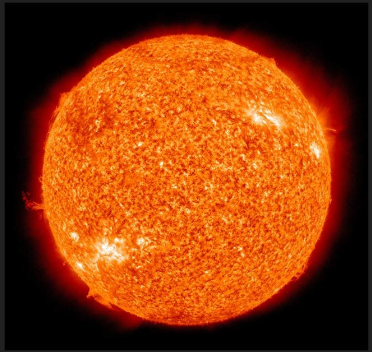

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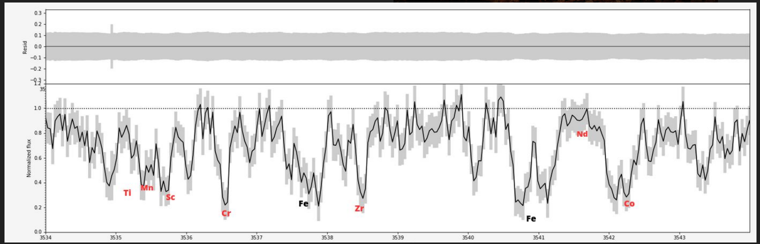

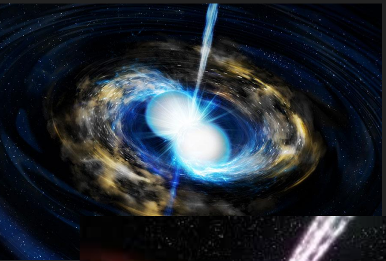

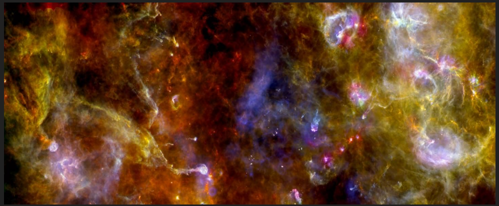

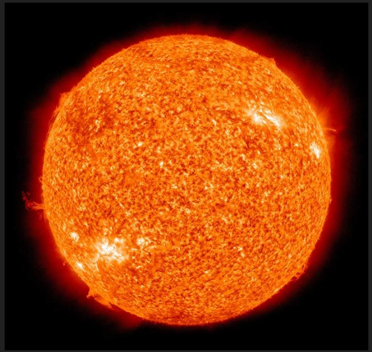

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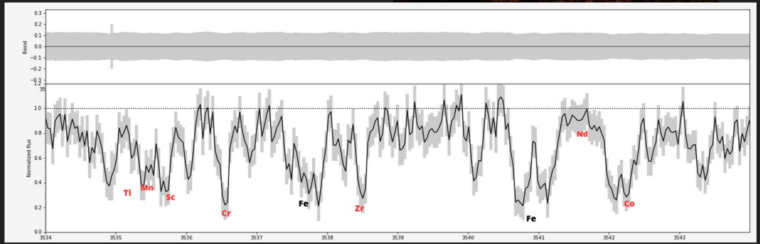

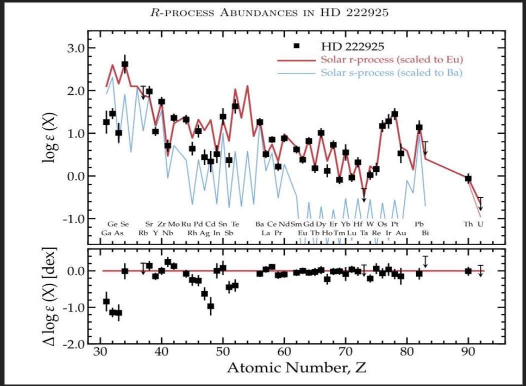

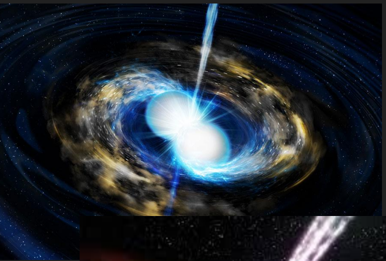

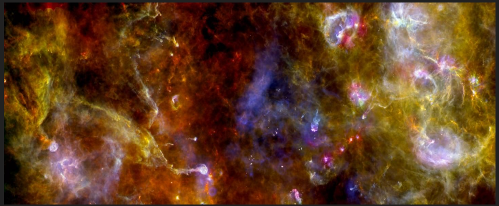

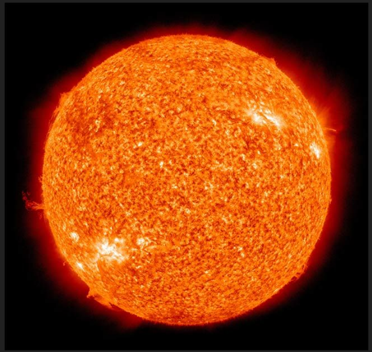

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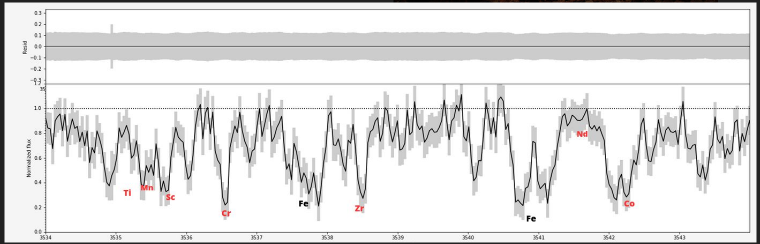

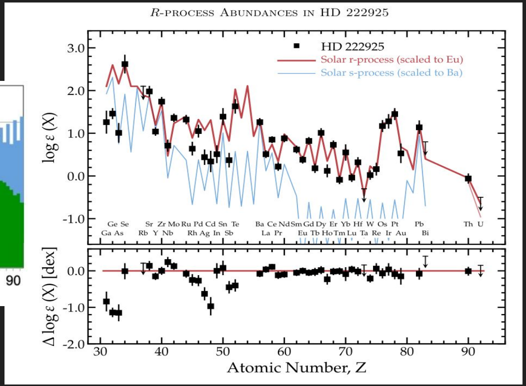

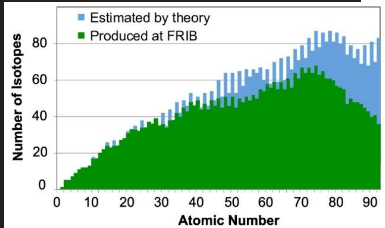

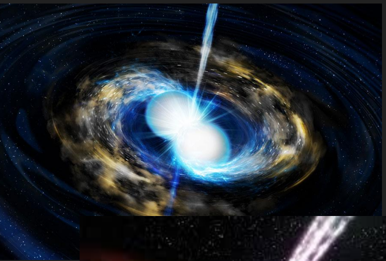

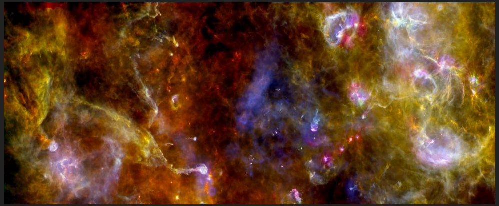

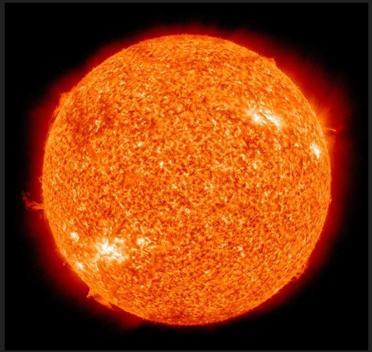

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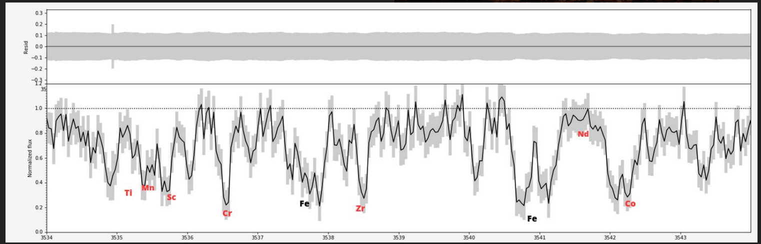

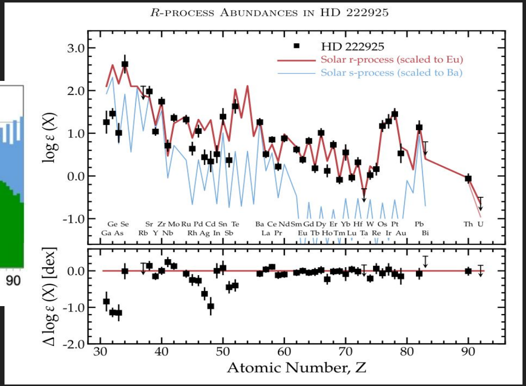

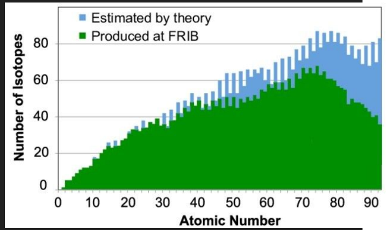

RPA

R-Process Alliance

R-Process Alliance: Target selection

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Bright, $V < 13.5 \rightarrow$ can observe many stars in short time

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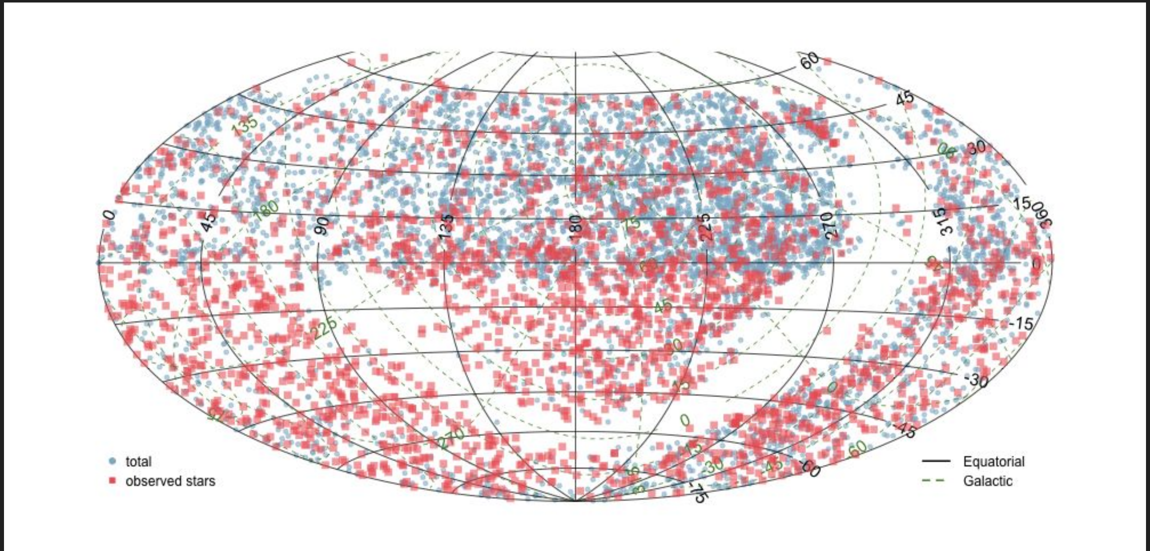
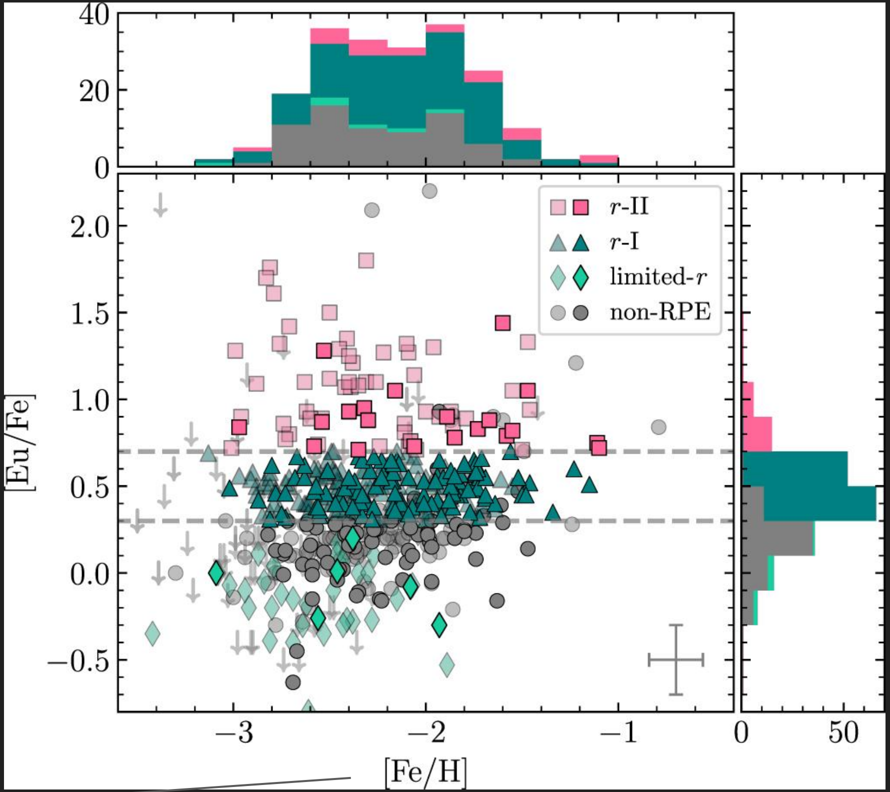


Credit: Vini Placco

: Classification

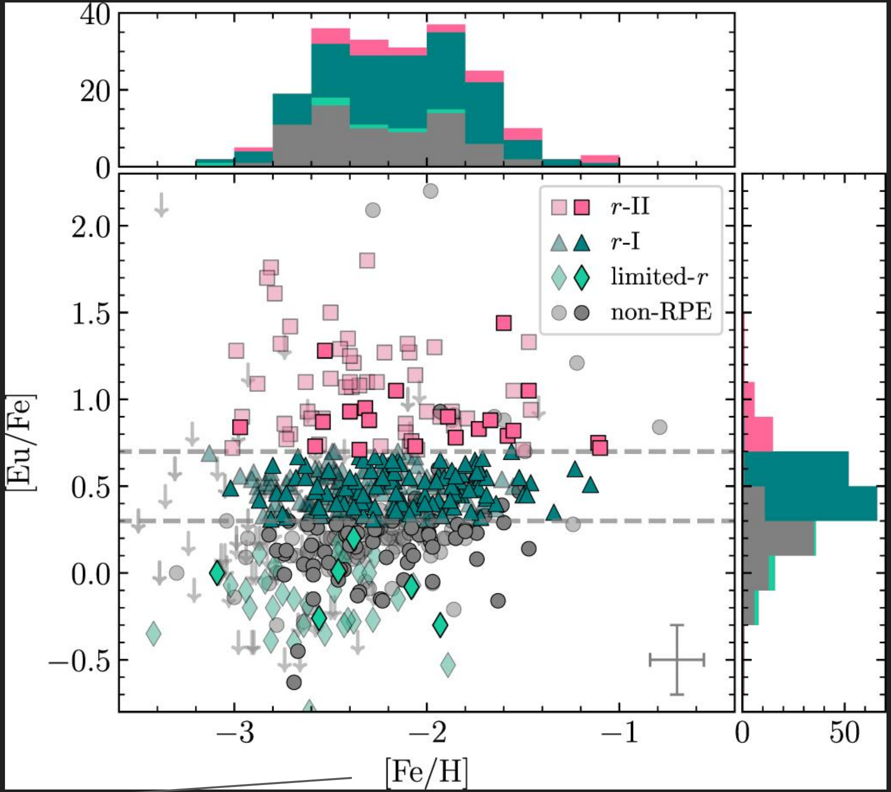


Holmbeck et al. (2020)

$[Fe/H] = \log_{10}(N_{Fe}/N_H)_{star} - \log_{10}(N_{Fe}/N_H)_{Sun}$

: Classification

r-II stars have **[Eu/Fe]≥+0.7** 72



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R-Process Alliance

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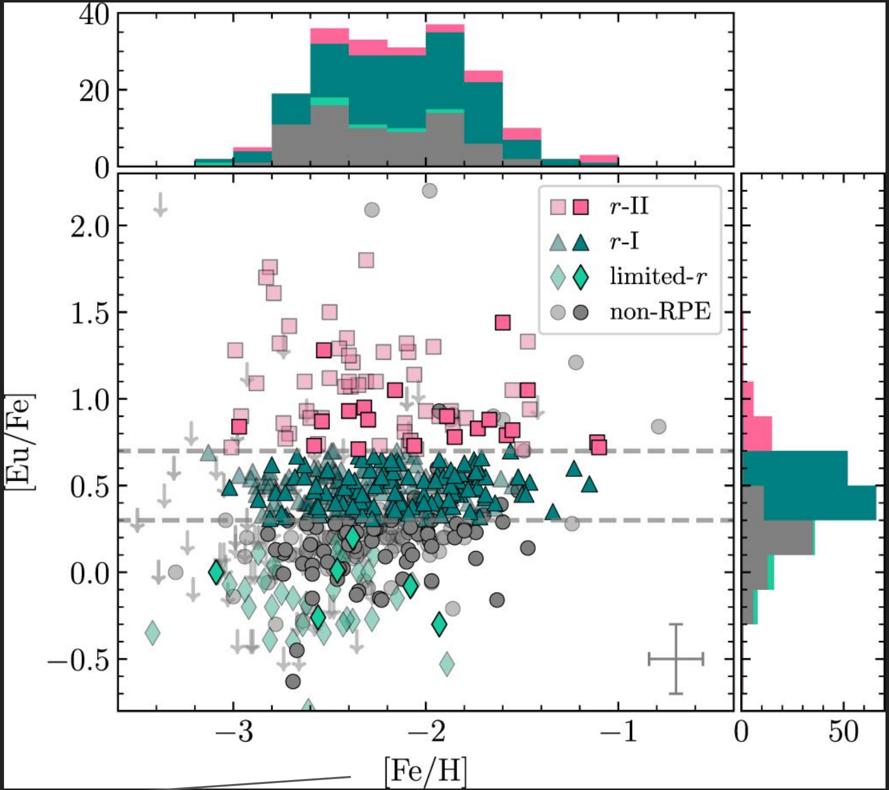

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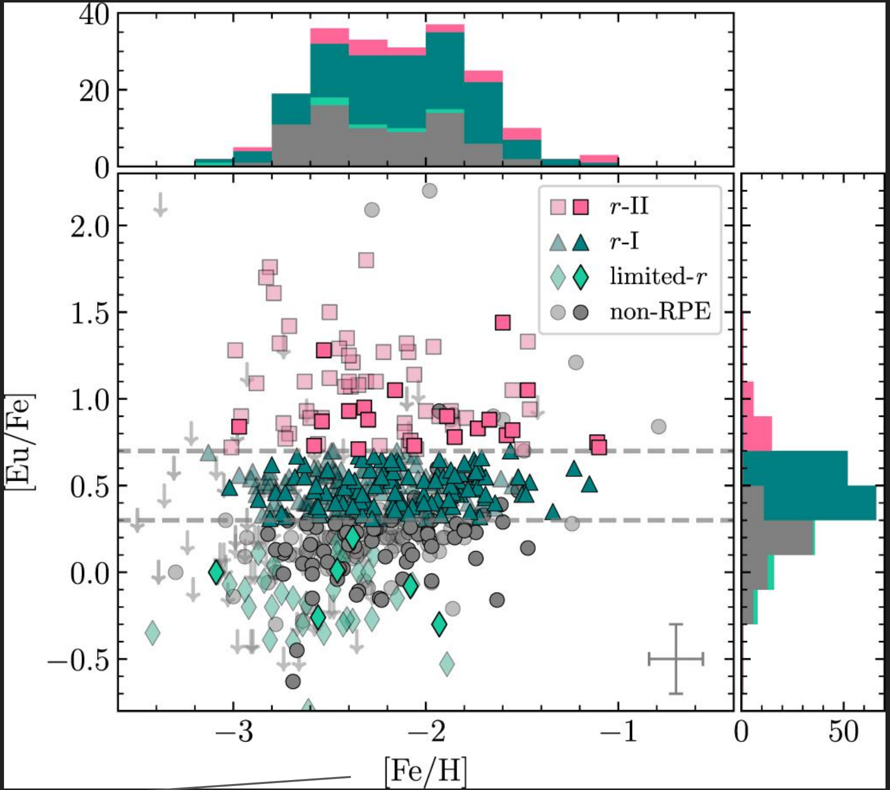

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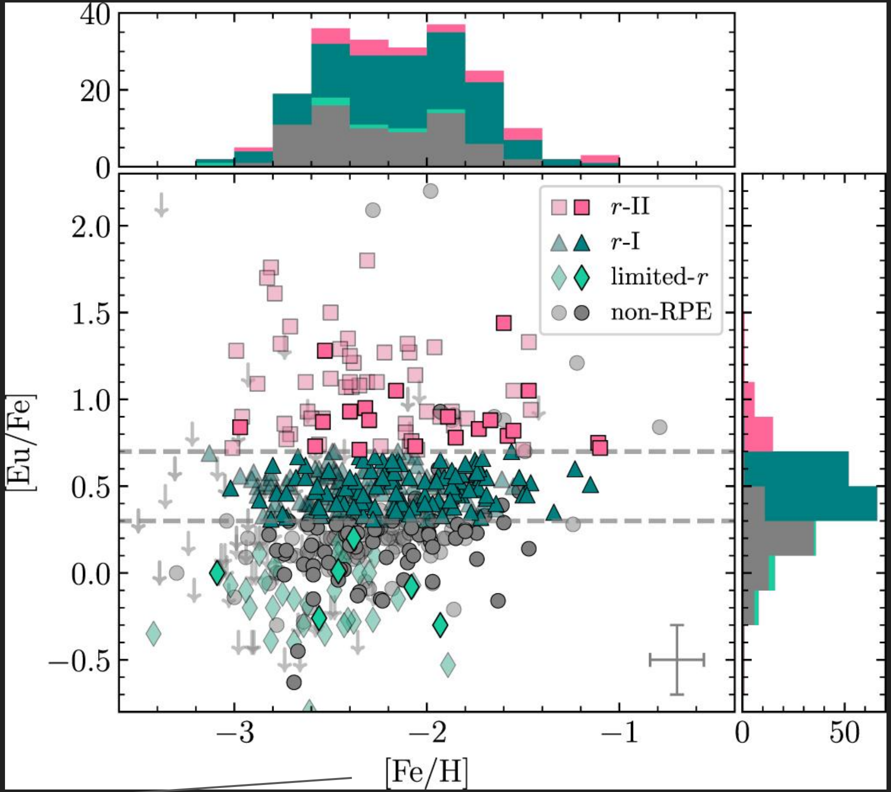

Holmbeck et al. (2020)

: analysis of the stellar portraits

R-Process Alliance

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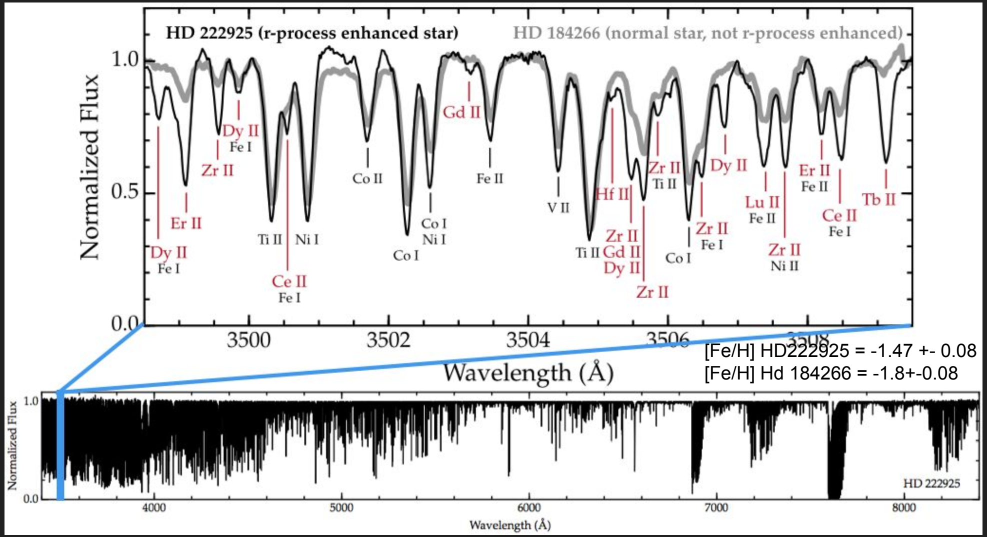
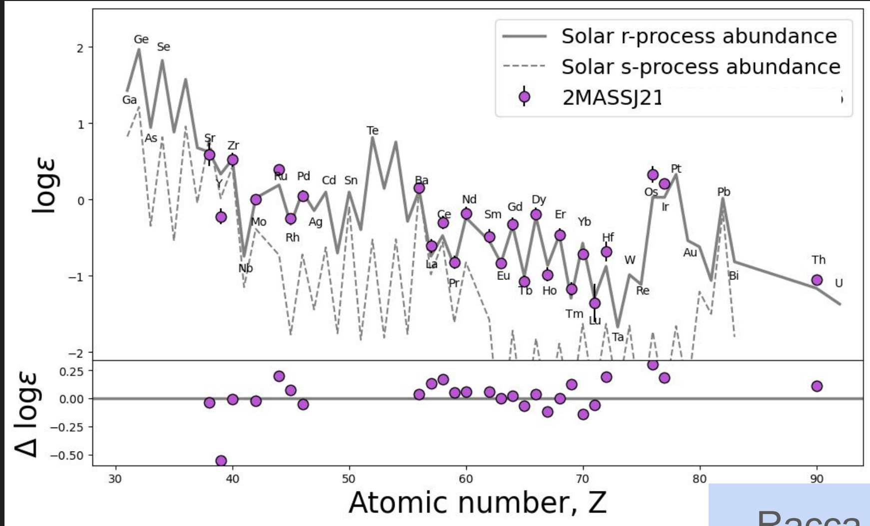
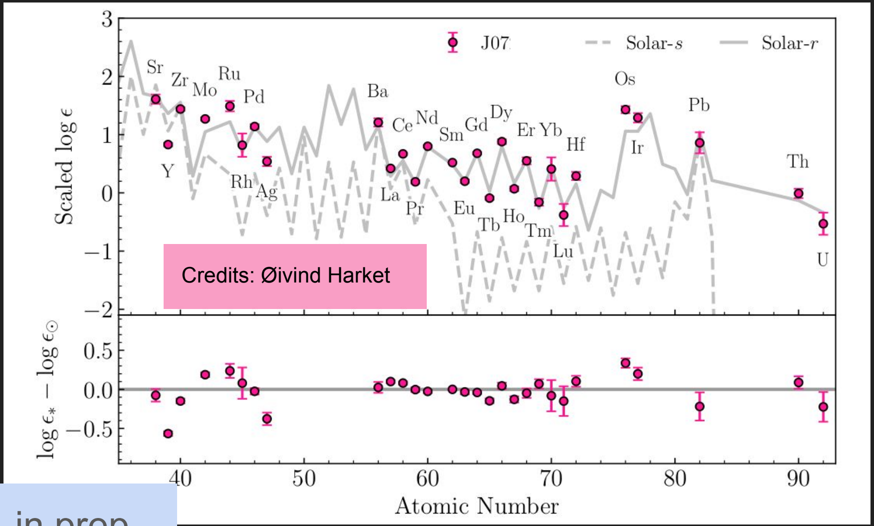


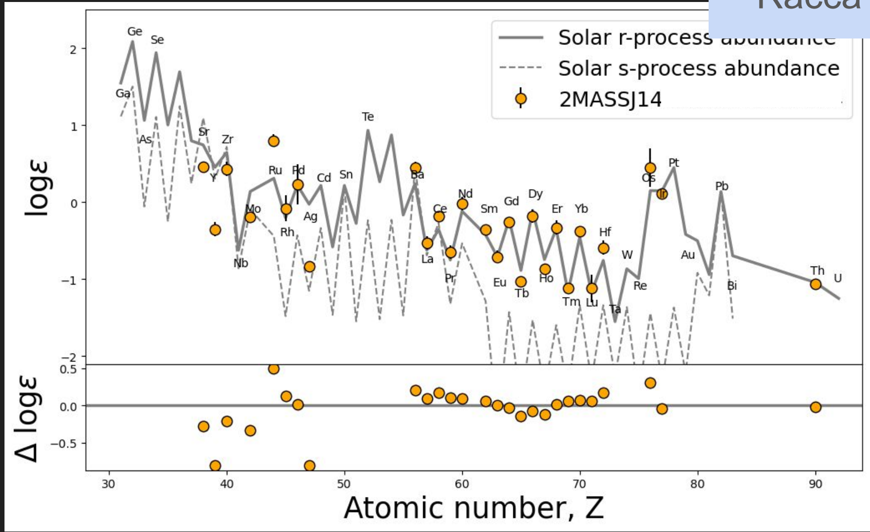
Roederer et al. (2018)

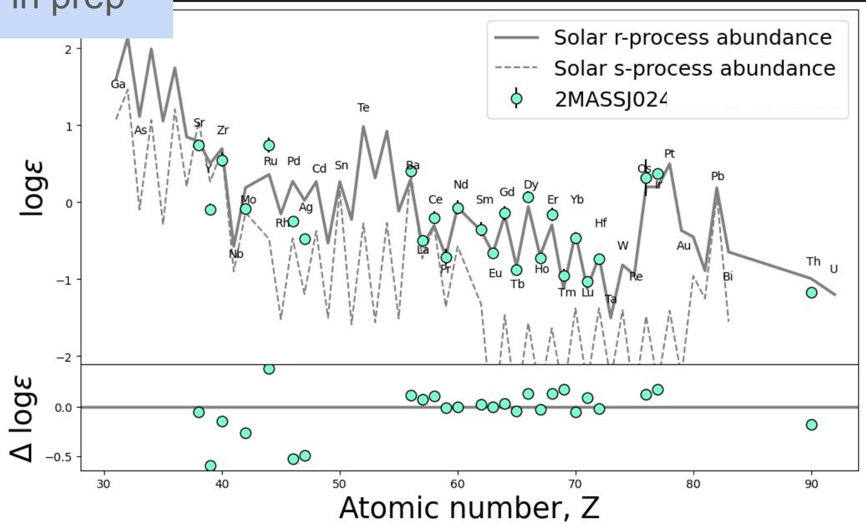
R=80000, S/N=100

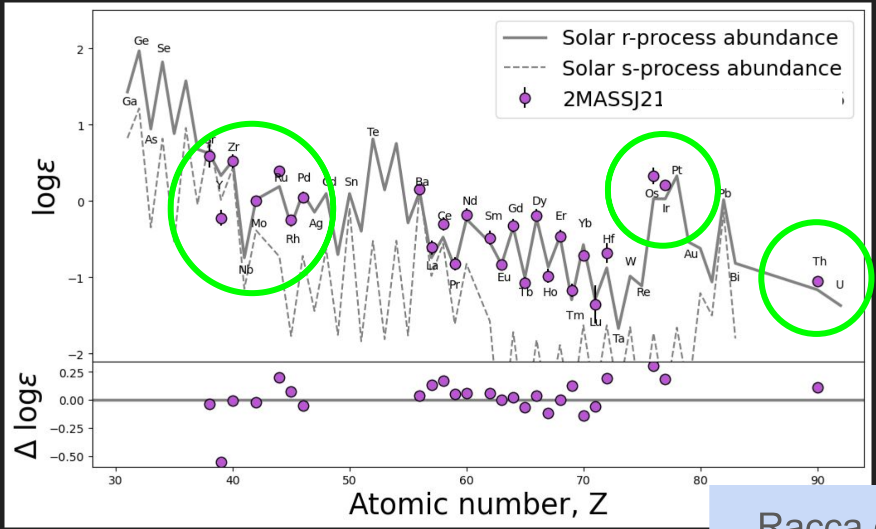


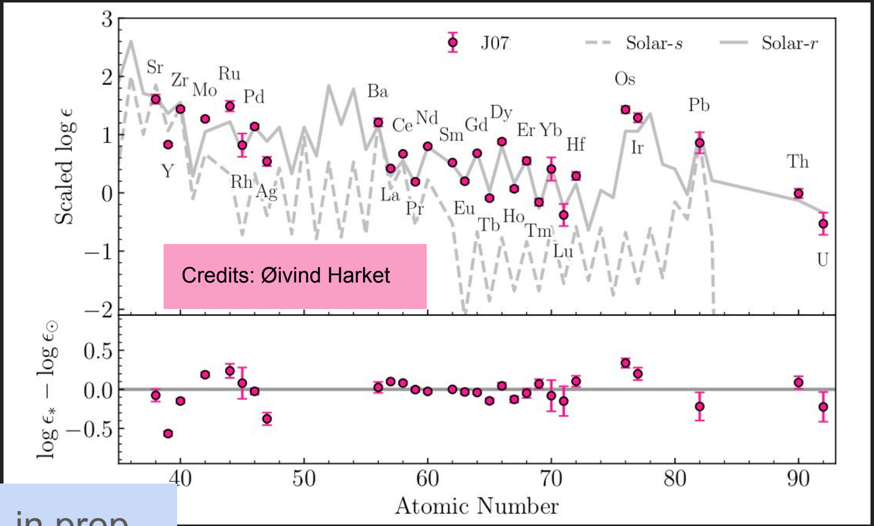


Racca et al. in prep









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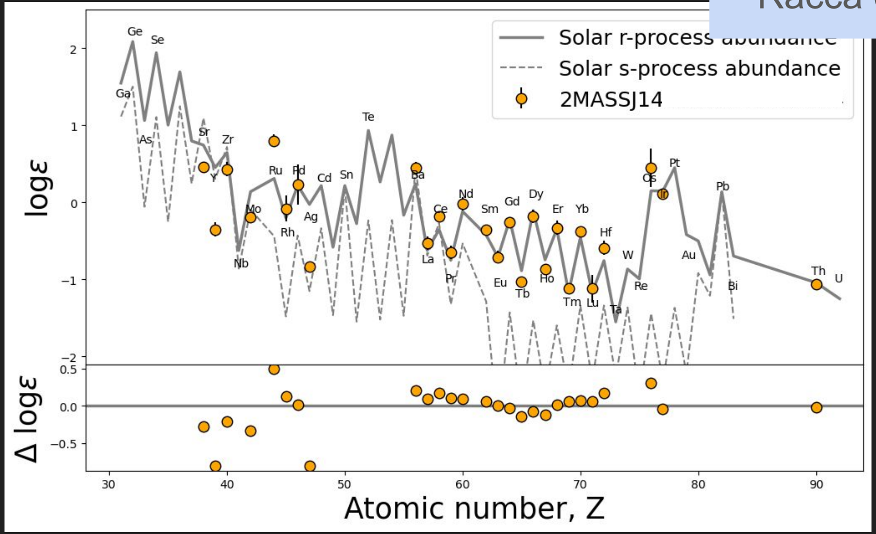
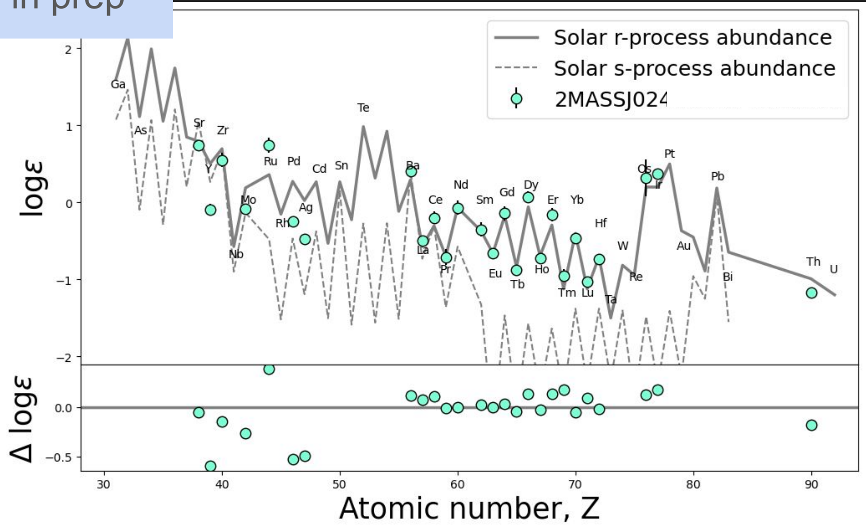
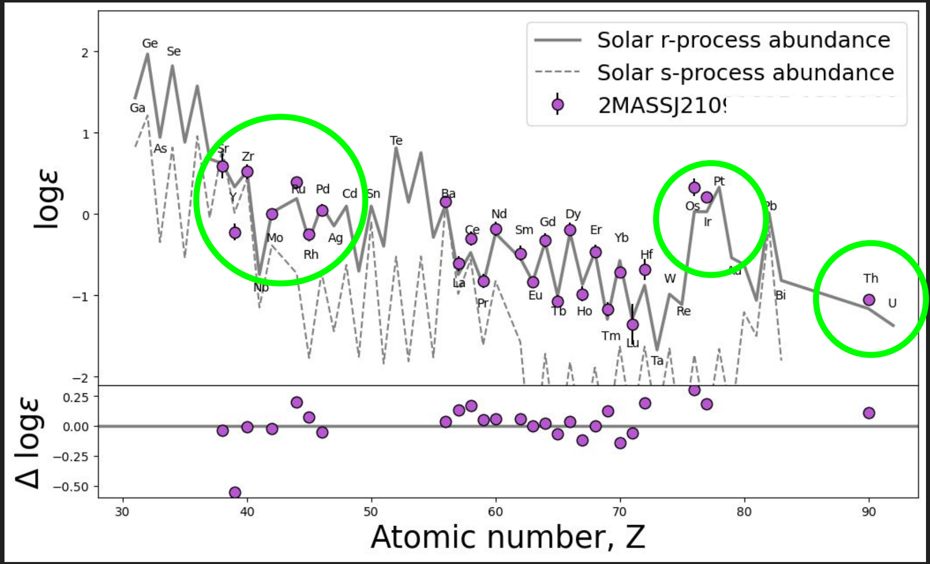




Conclusions

First homogeneous analysis of a large sample of r-II stars to trace the origins and the evolution of the r-elements in the Milky Way



$$A(X) = \log_{10}\frac{N_X}{N_H} + 12$$

$$[X/H] = A_\star(X) - A_\odot(X)$$

R-Process Alliance

email: mila.racca@astro.su.se