Actinide-Rich or Actinide-Poor, Same *r*-Process Progenitor

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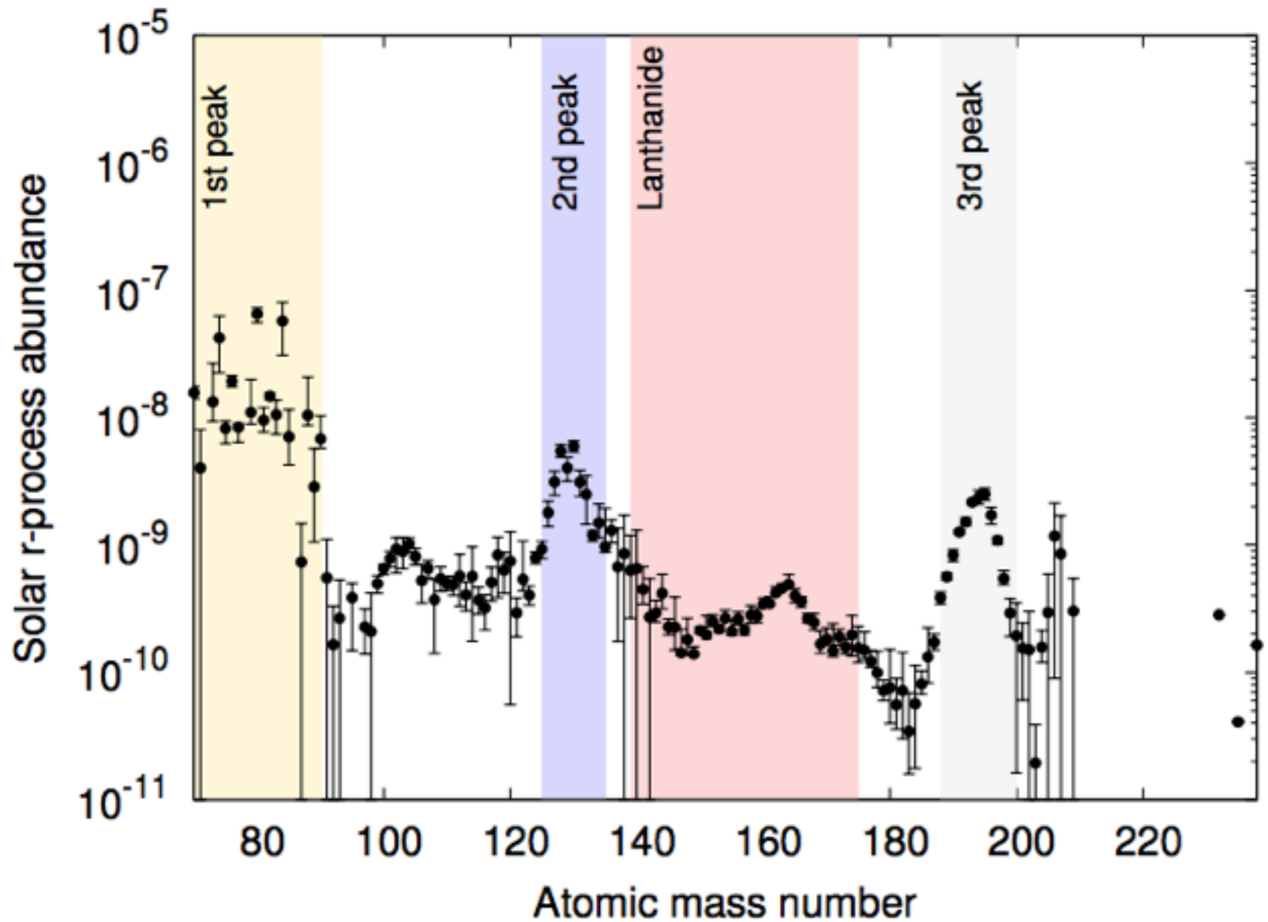
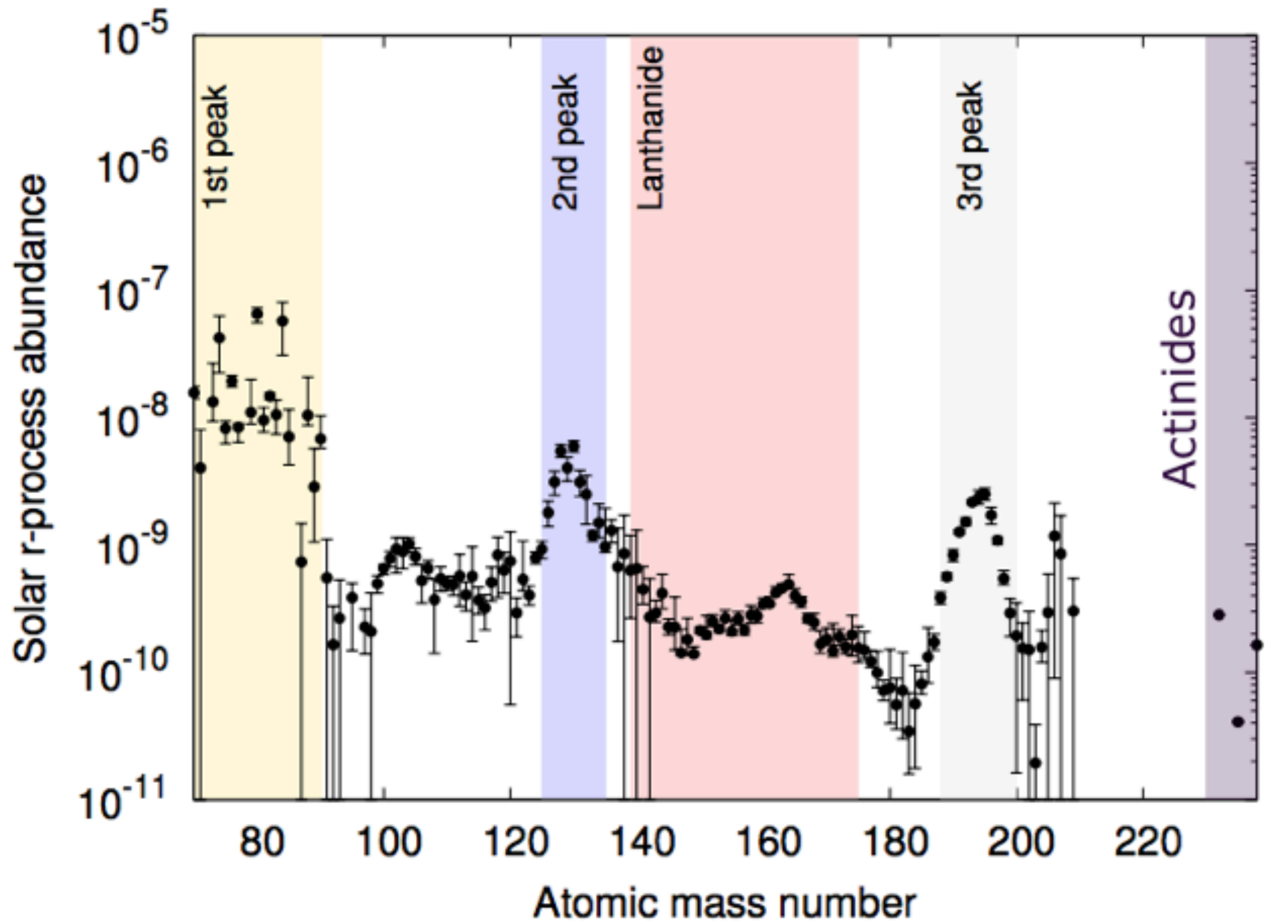
JINA-CEE Frontiers in Nuclear Astrophysics

The *r*-Process Pattern



Hotokezaka+ (2018)

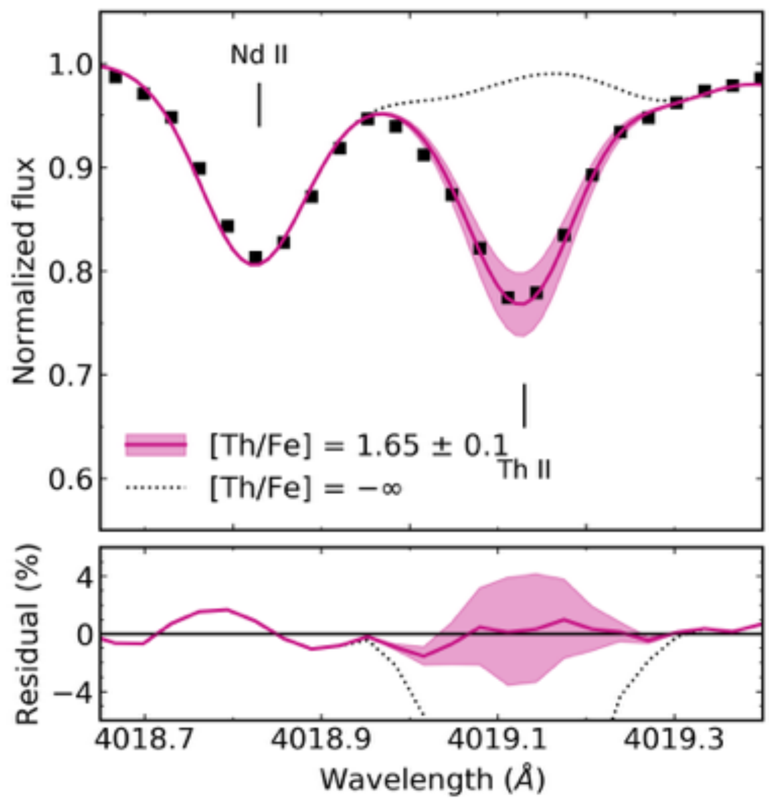
The *r*-Process Pattern



Hotokezaka+ (2018)

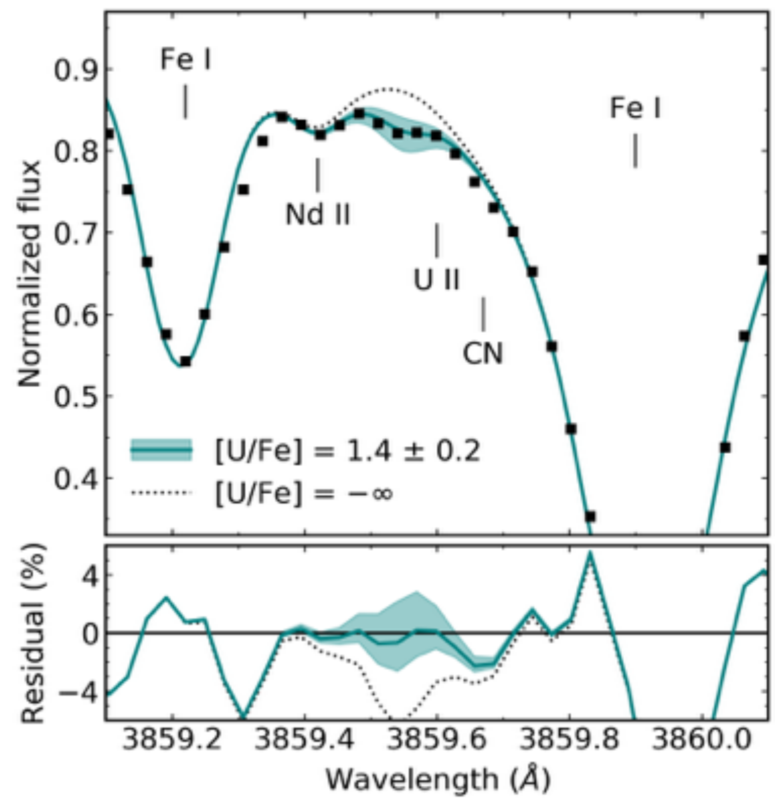
Actinides in *r*-II Stars

Thorium in J2038-0023



Placco, Holmbeck+ (2017)

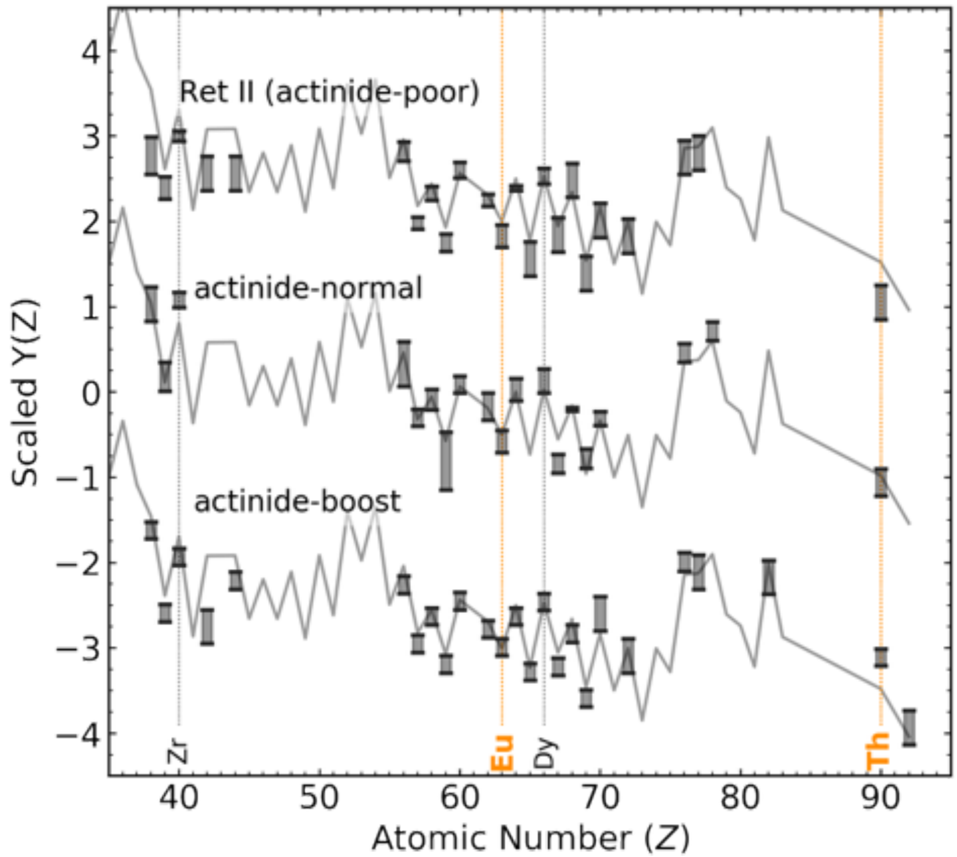
Uranium in J0954+5246



Holmbeck+ (2018)

Actinide Variation

The actinide-to-lanthanide ratio (**Th/Eu**) is not the same in all *r*-process enhanced stars
Actinide variations could be a **hint to key *r*-process characteristics**

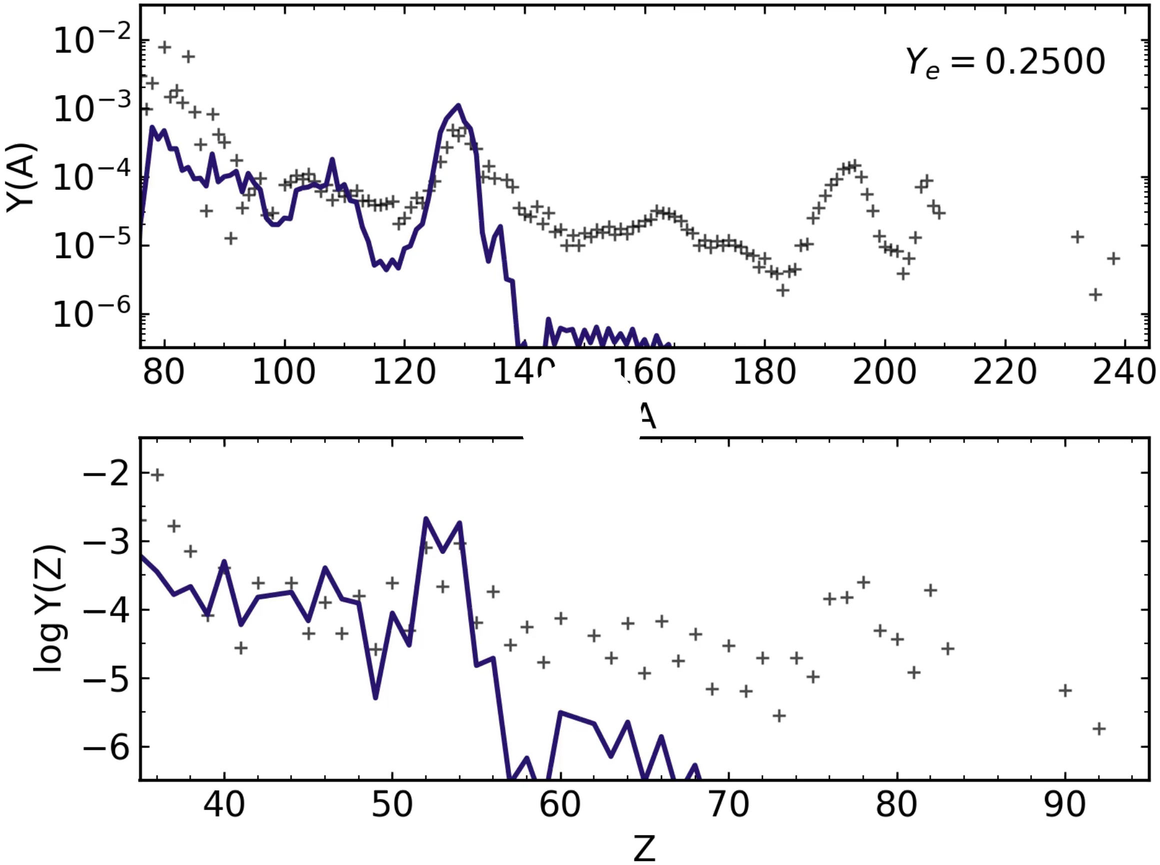


Holmbeck+ (2019b)

Actinide Production and Y_e

Th and U are produced by the ***r*-process**

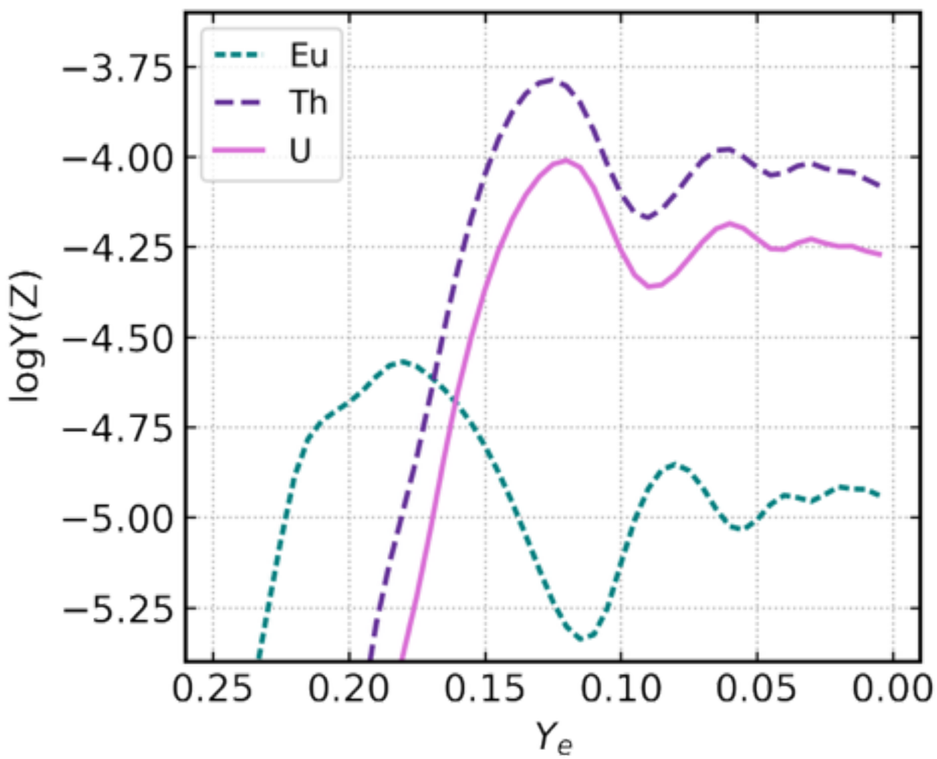
The **electron fraction, Y_e,** is a key parameter determining the extent of an *r*-process event



$Y_e = [1+(n/p)]^{-1}$

Actinide Production and Y_e

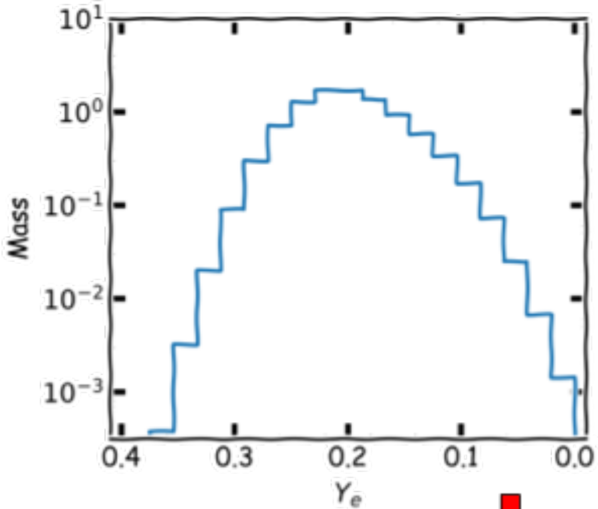
Th and U **overproduced** at very low Y_e



Holmbeck+ (2019a)

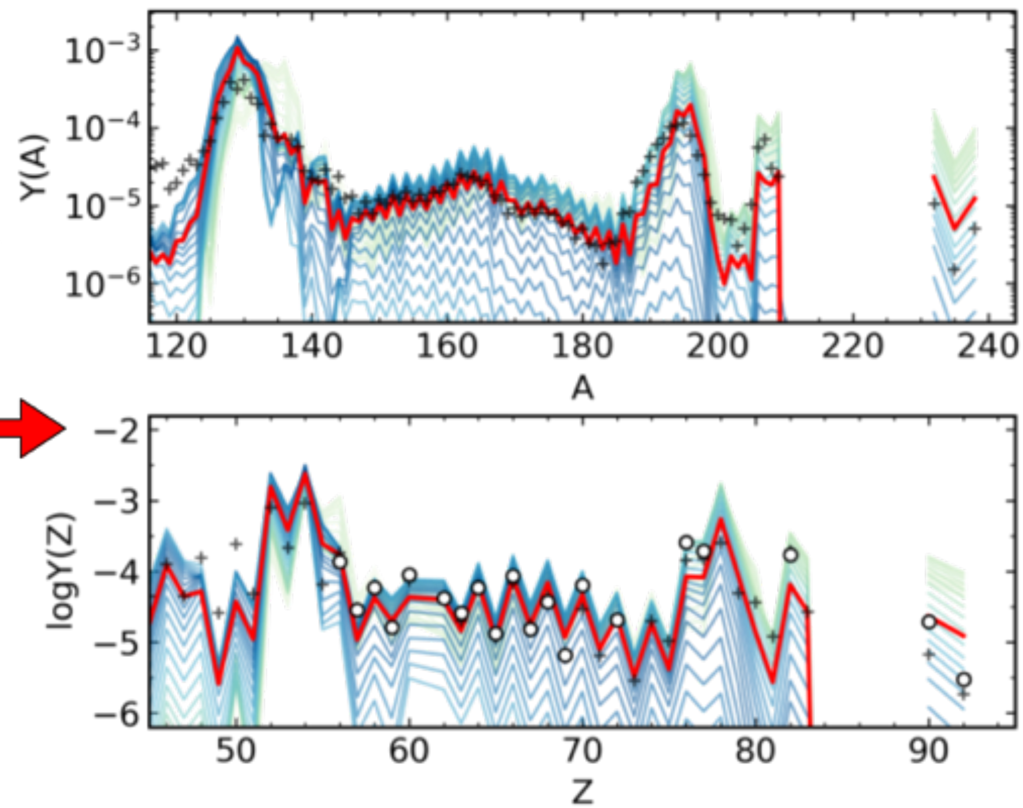
Actinide Boost Stars

Abundances of stars enhanced with Th and U can be reproduced by a **combination** of Y_e



Bovard+ (2017); Lippuner+ (2017)

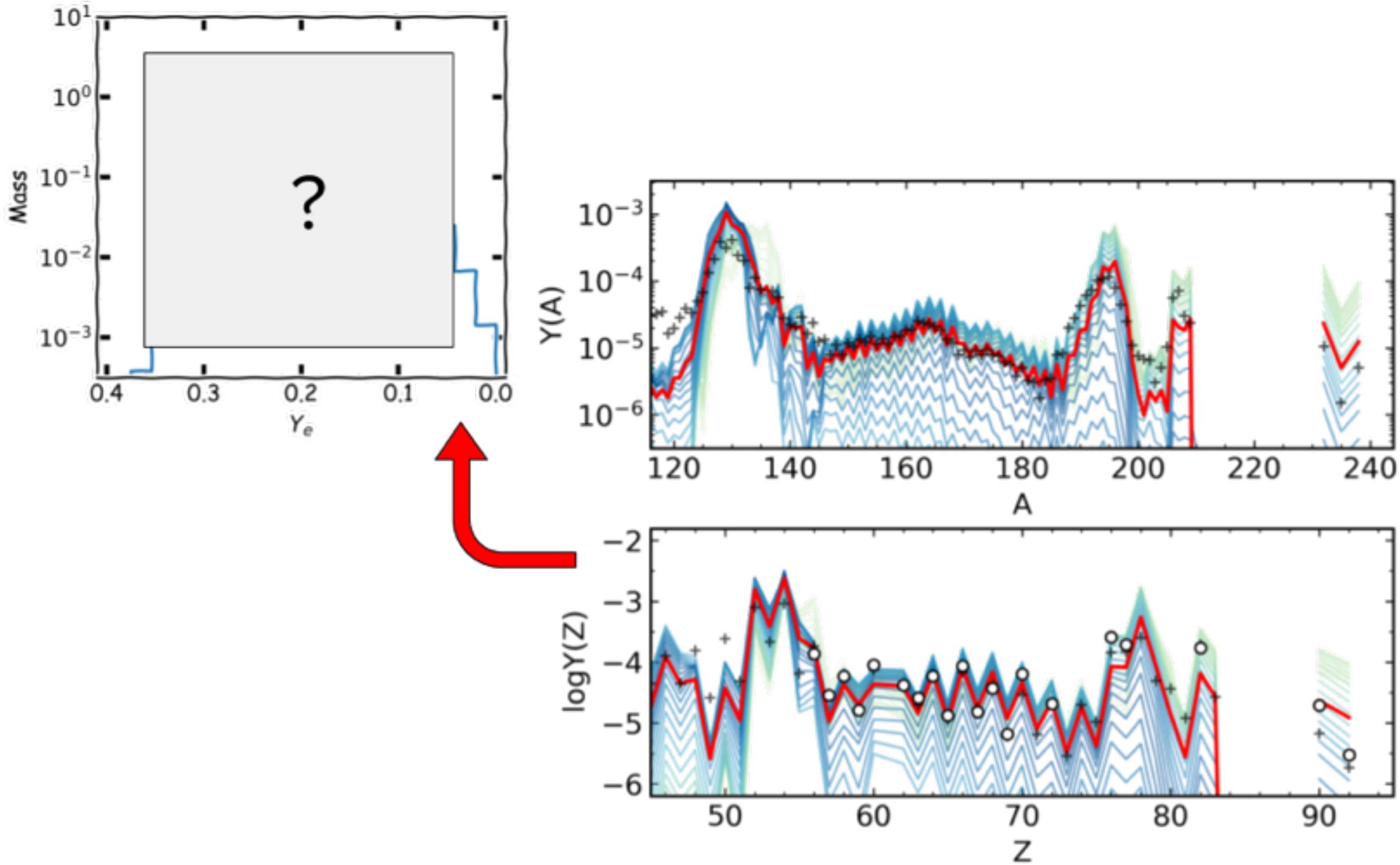
GW170817: Rosswog+ (2017)
and Tanaka+ (2017)



Holmbeck+ (2019a)

Going backwards

What would the abundances themselves suggest for this ejecta distribution?

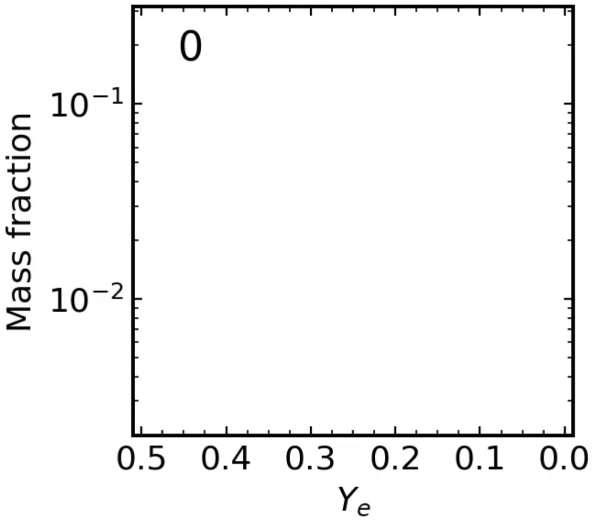


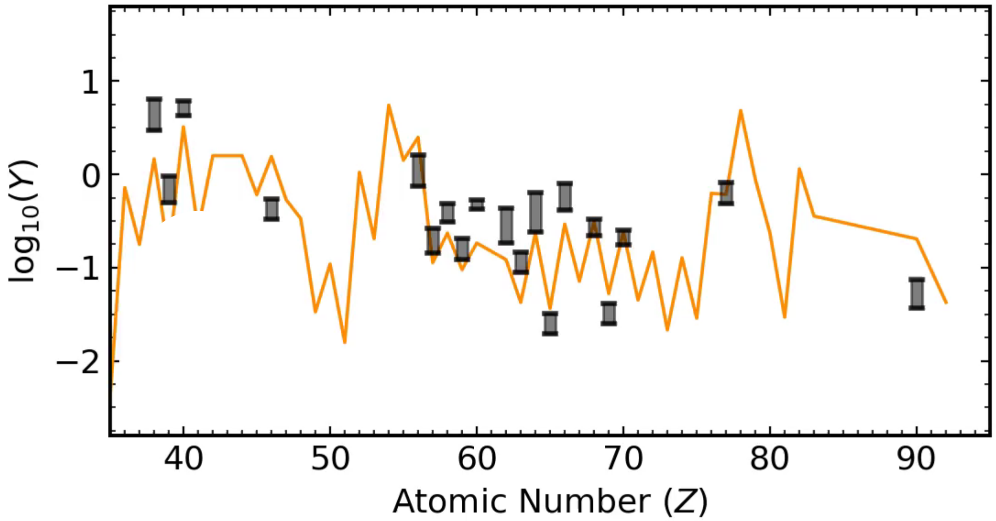
Holmbeck+ (2019a)

Actinide-Dilution with Matching Model

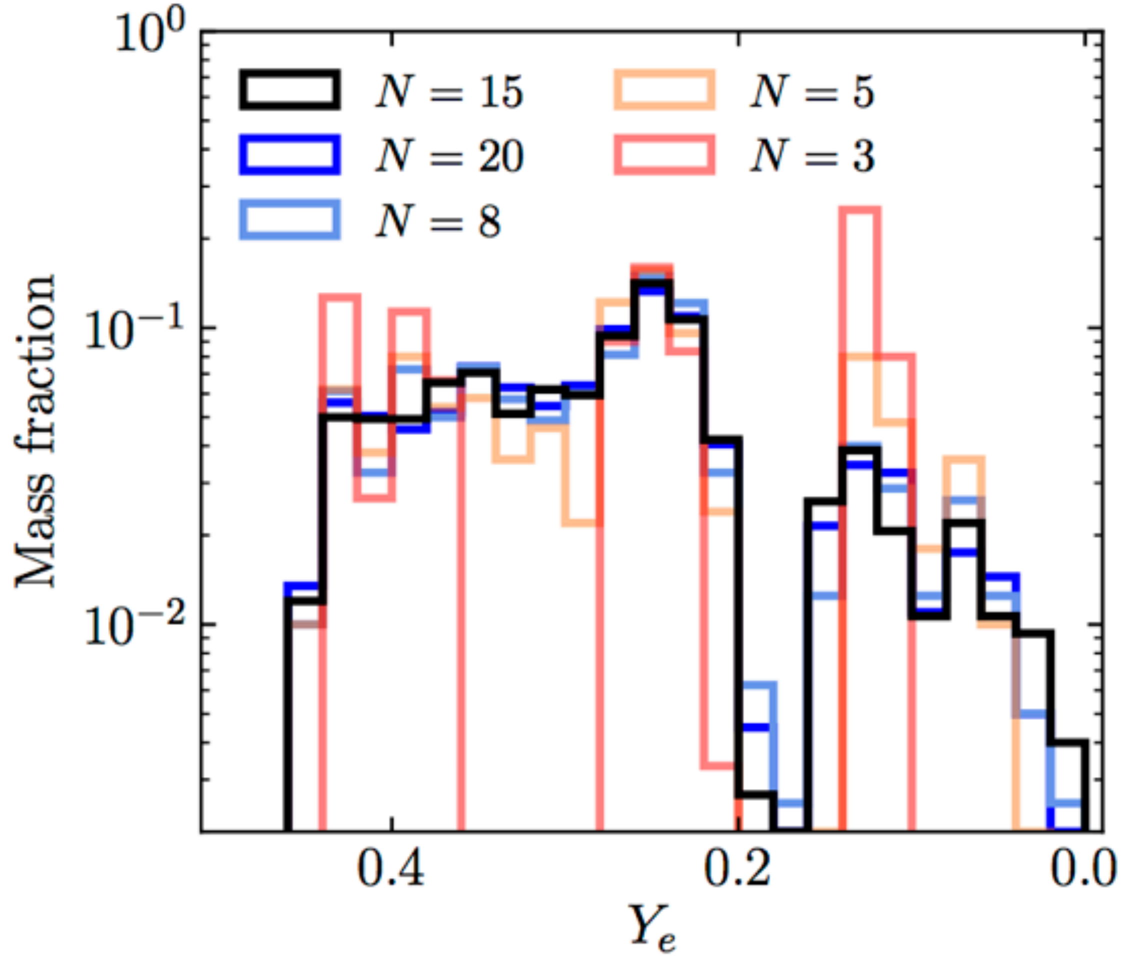
Builds **empirical** mass ejecta distributions as a function of Y_e (0.005-0.450)

To explain entire pattern using **Zr**, **Dy**, and **Th only**



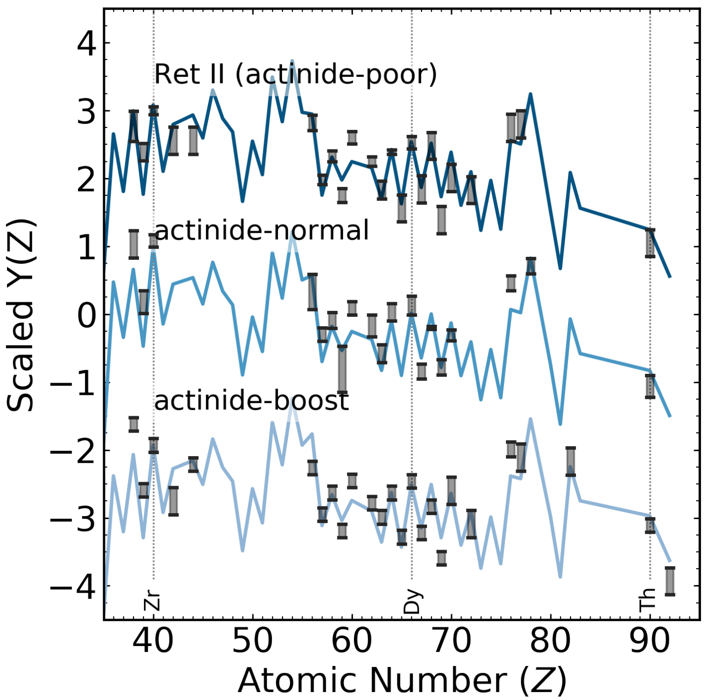


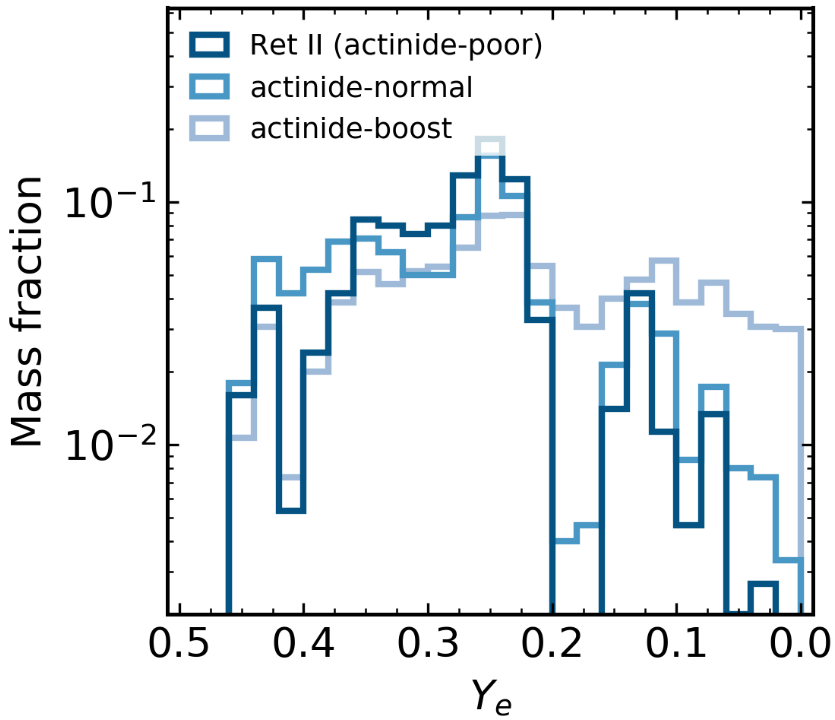
ADM



Empirical ejecta mass distributions

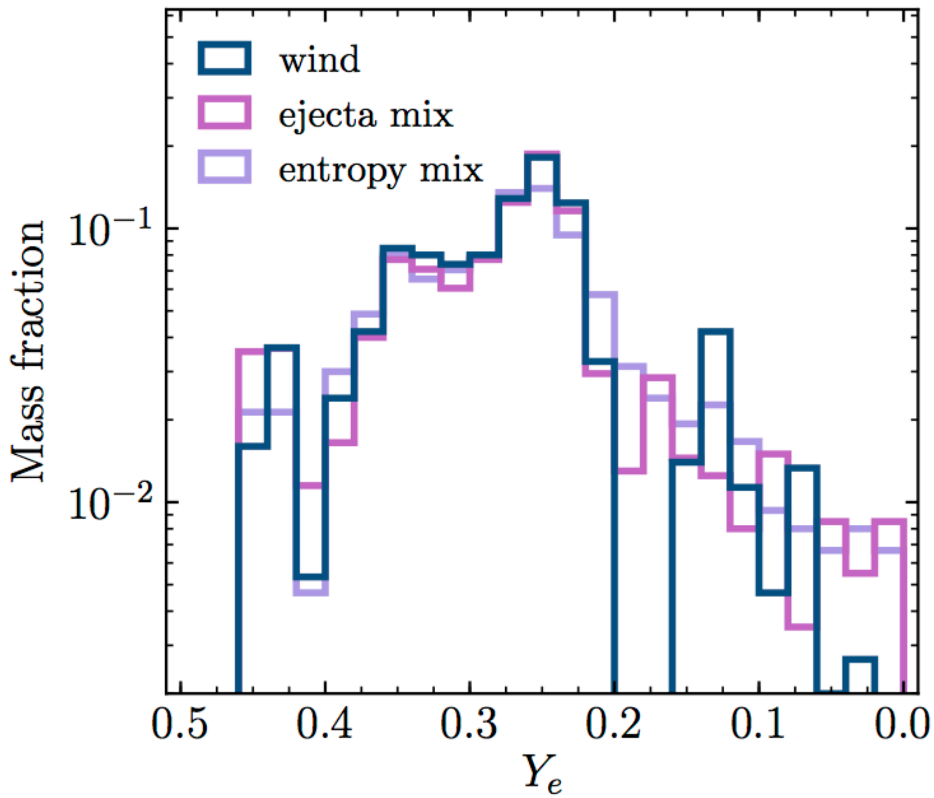
Distributions differ in **very low-Y_e** region





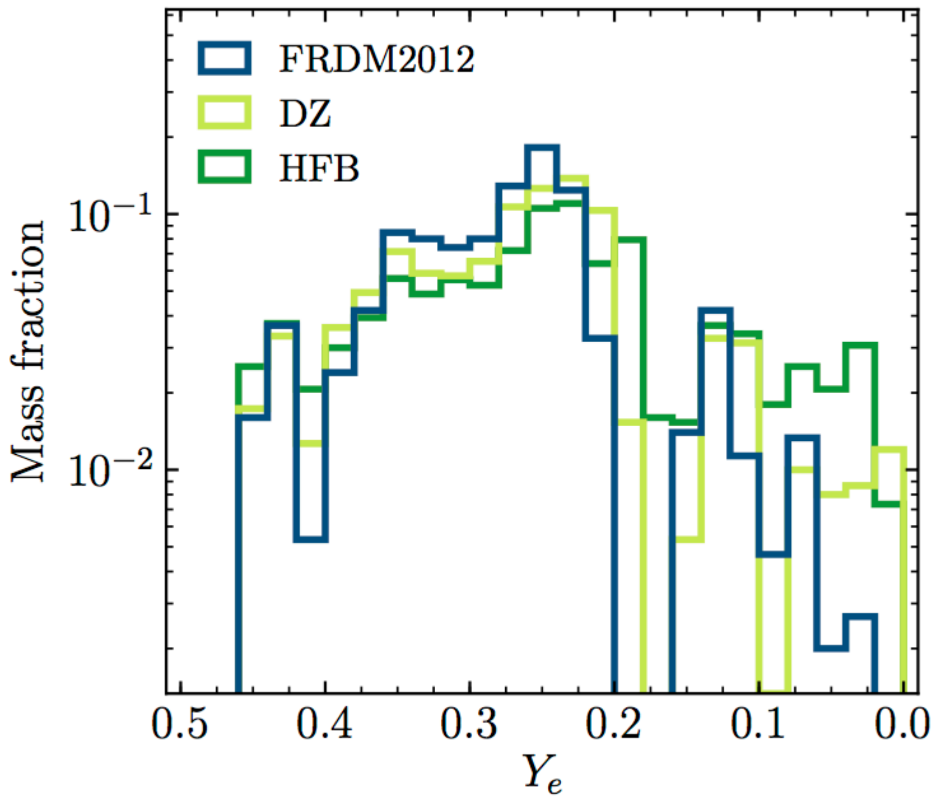
Holmbeck+ (2019b)

Astrophysical Variations



Holmbeck+ (2019b)

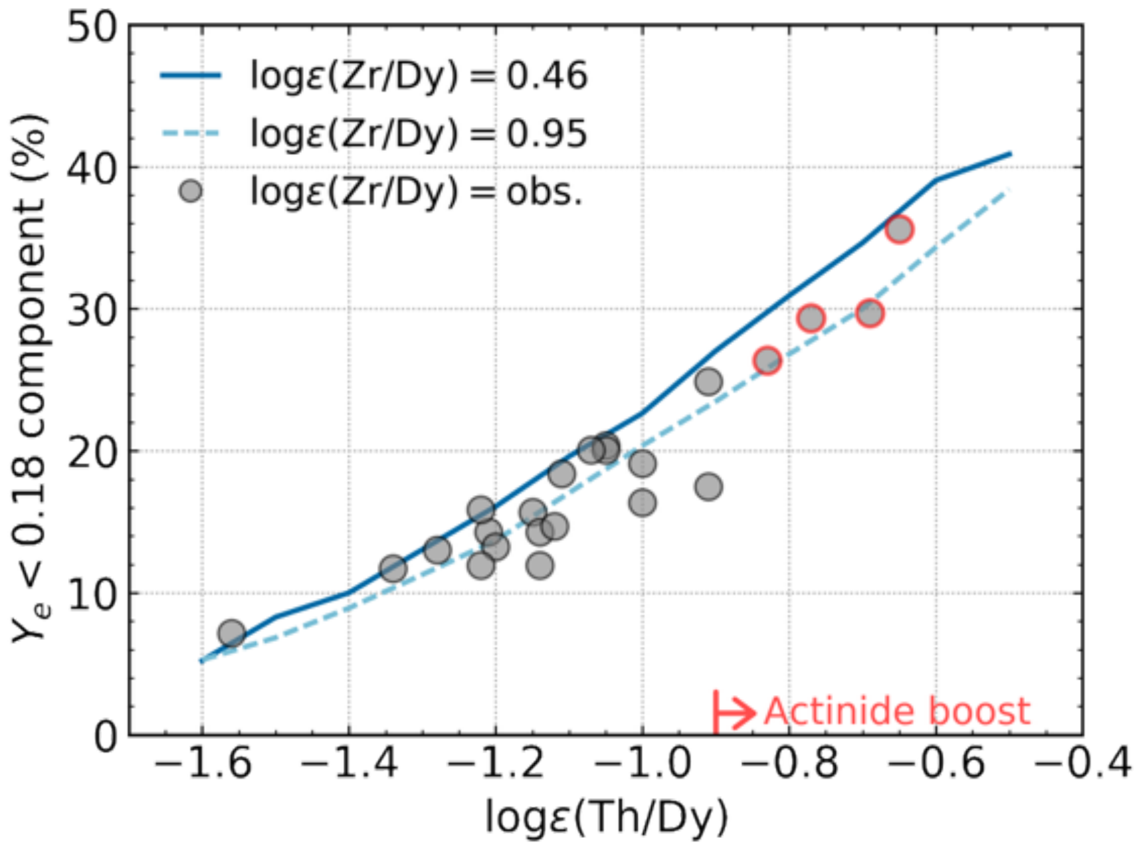
Nuclear Physics Variations



Holmbeck+ (2019b)

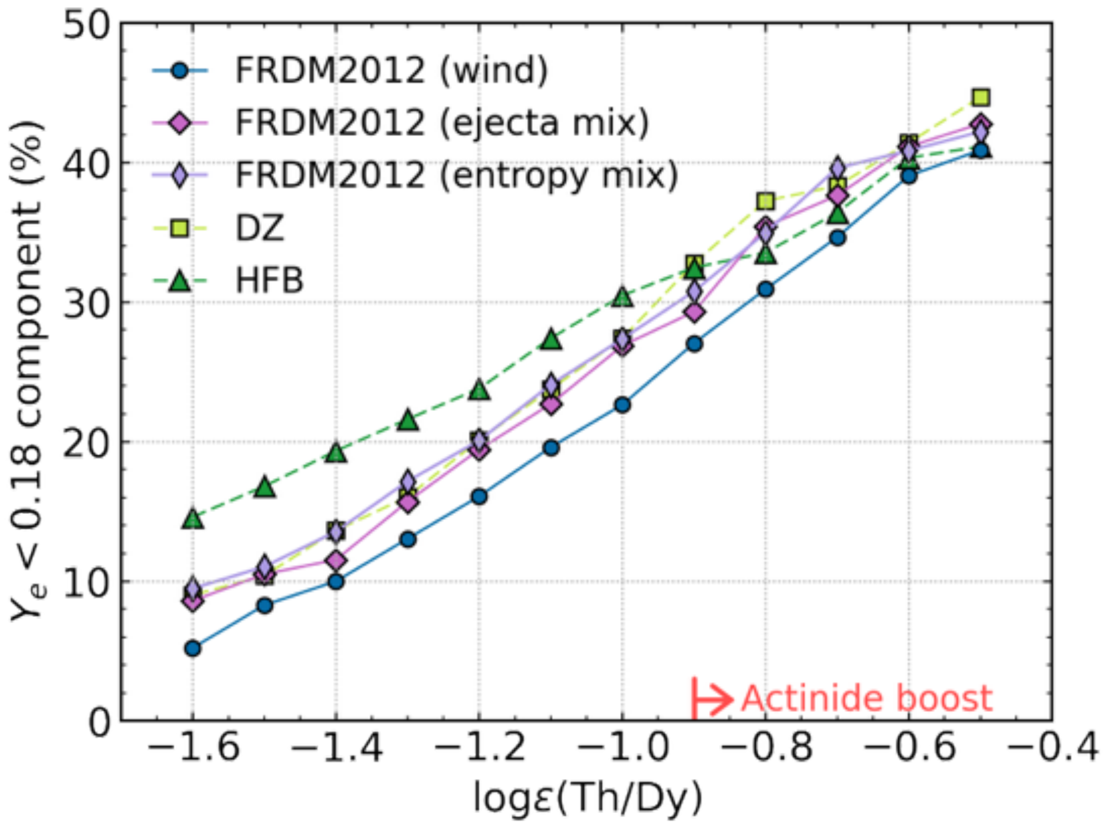
The low-Y_e component

No discrete difference between actinide-rich and actinide-poor



Holmbeck+ (2019b)

Nuclear and Astrophysical Variations



Holmbeck+ (2019b)

Actinide-boost stars **do not necessarily** call for a separate *r*-process progenitor

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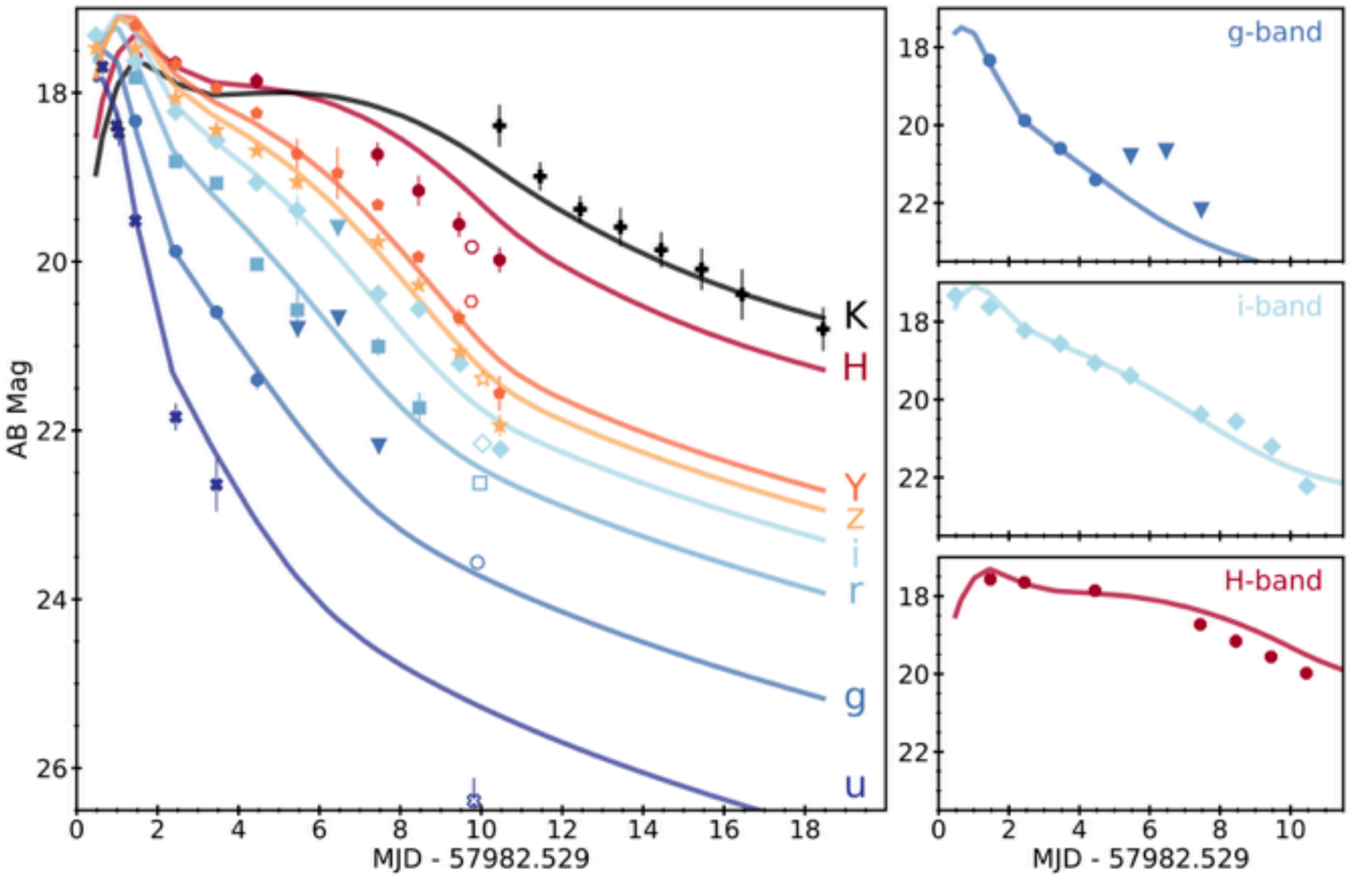
Is this source an NSM?

GW170817 lightcurve

Lanthanide-poor blue ejecta + Lanthanide-rich red ejecta



Cowperthwaite+ (2017)

Two ejecta components

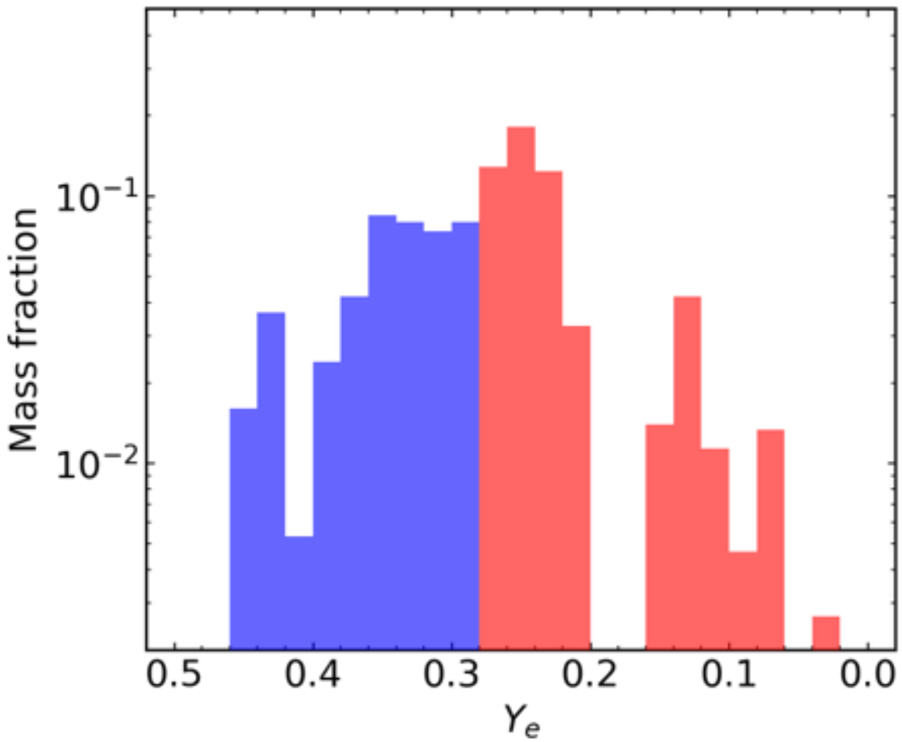
Stellar Abundances

$X_{\rm lan} = 10^{-3.8}$

$X_{\rm lan} = 10^{-0.8}$

$m_{\rm red} / m_{\rm blue} = 1.7$

Holmbeck+ (2019b)



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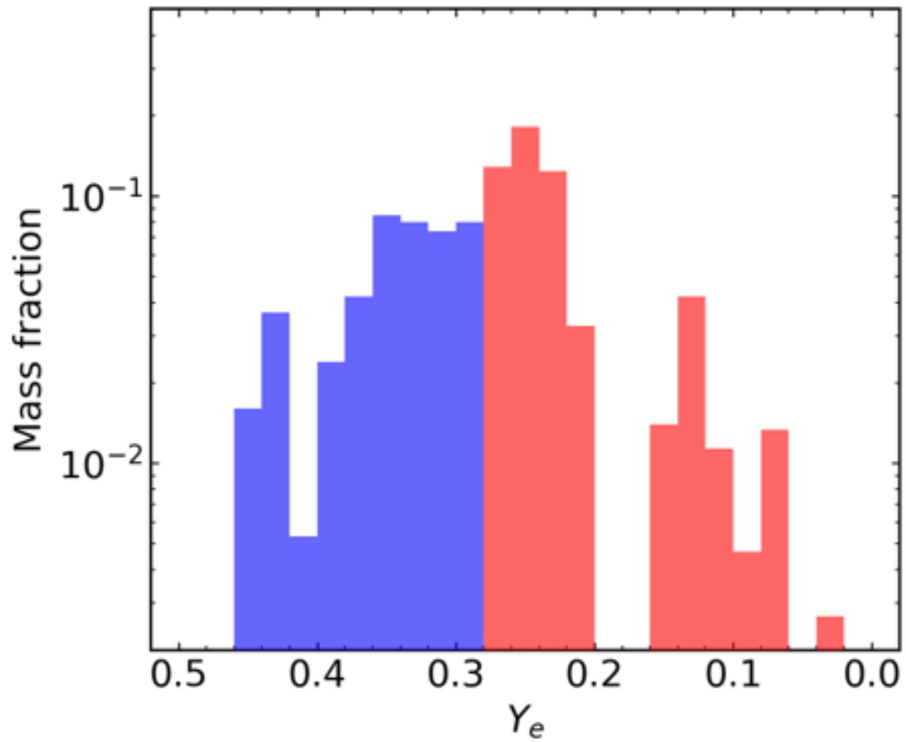

GW170817

$X_{lan} = 10^{-4}$

$X_{lan} = 10^{-1.5}$

$m_{red} / m_{blue} = 1.6$

Kasen+ (2017)

Results derived from *r*-enhanced stars are consistent with the GW170817 kilonova

Results derived from *r*-enhanced stars are consistent with the GW170817 kilonova

Further evidence supporting that an NSM produced the material in *r*-enhanced stars like Ret II

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