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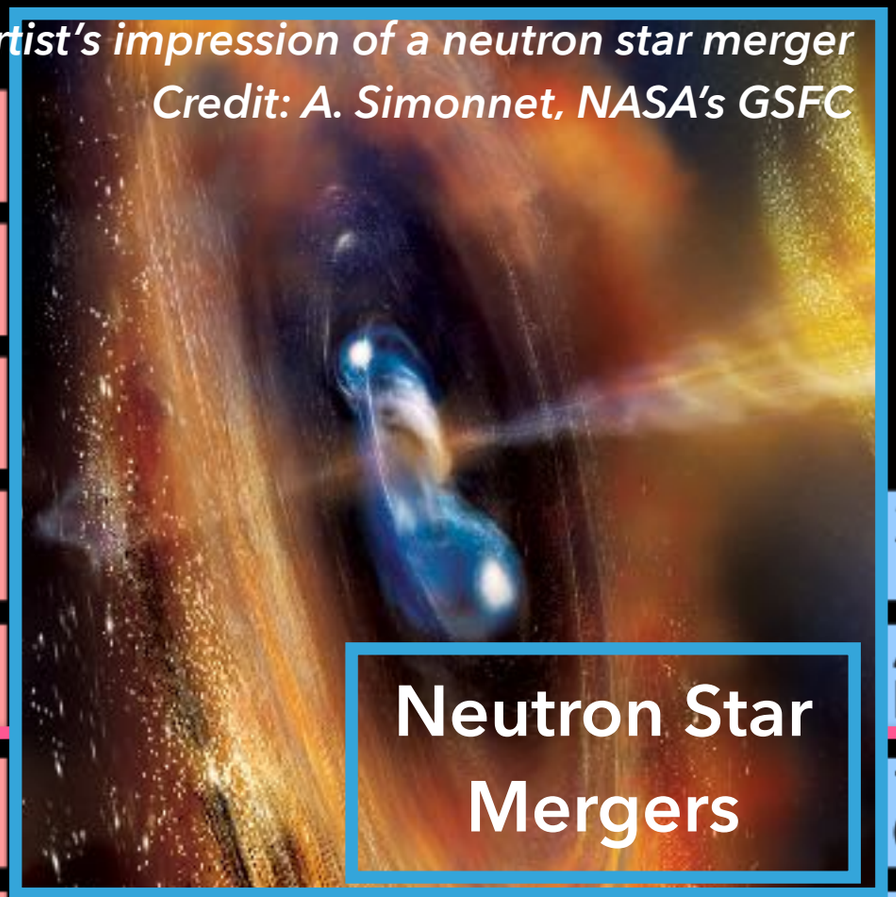
A SEARCH FOR R-PROCESS NUCLEOSYNTHESIS IN GRB SUPERNOVAE

Image Credit: International Gemini Observatory/NOIRLab/NSF/AURA/J. da Silva

The Periodic Table of Elements

Artist's impression of a neutron star merger
Credit: A. Simonnet, NASA's GSFC

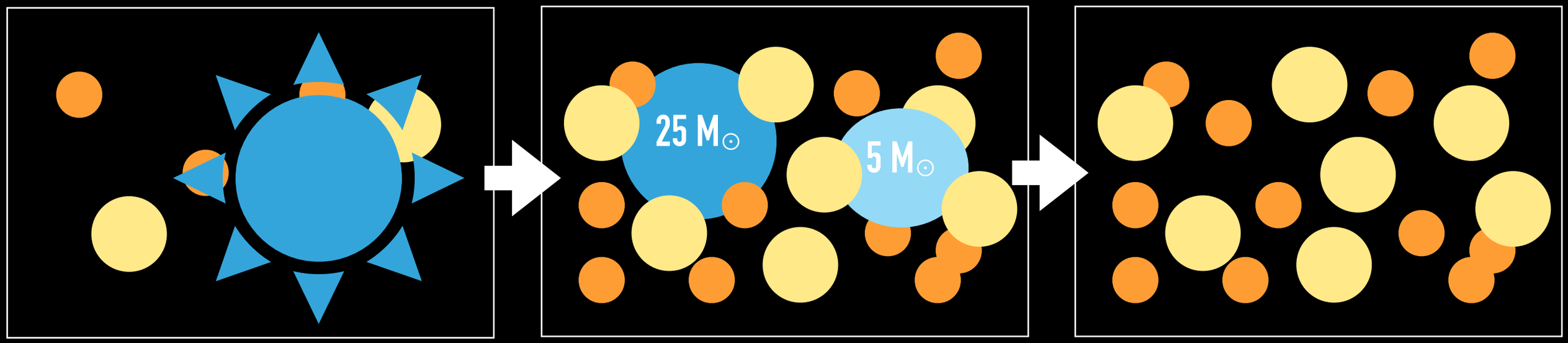


Neutron Star Mergers

Increasing evidence in favor of a "fast" channel tracing star formation

1 H																	2 He
3 Li													8 O	9 F	10 Ne		
11 Na													16 S	17 Cl	18 Ar		
19 K						26 Fe	27 Co						34 Se	35 Br	36 Kr		
37 Rb						44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe	
55 Cs						76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn	
87 Fr	88 Ra	103 Lr	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn	113 Nh	114 Fl	115 Mc	116 Lv	117 Ts	118 Og
		57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb		
		89 Ac	90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No		

An additional, "faster" r-process production channel: Select Core-Collapse Supernovae



T = 0 Gyr

T ~100-500 Myr

T = 13 Gyr

An early metal-poor stellar population

SN gas cools to form new stars, enriched with new r-process material

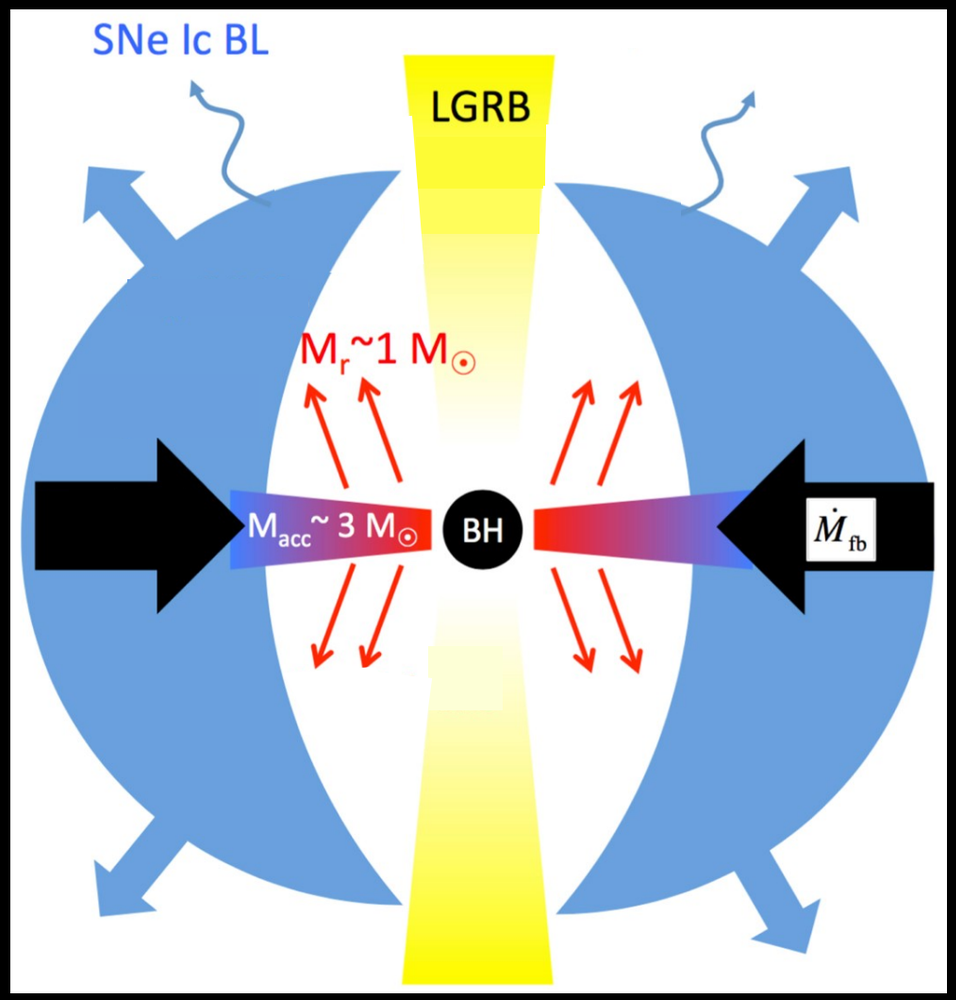
Observations of today's Milky Way dwarfs, GCs show metal-poor stars with r-process enrichment

Early r-process enrichment

Based on Naidu+22, Ji+18, Hansen+17,Kirby+23, + more!

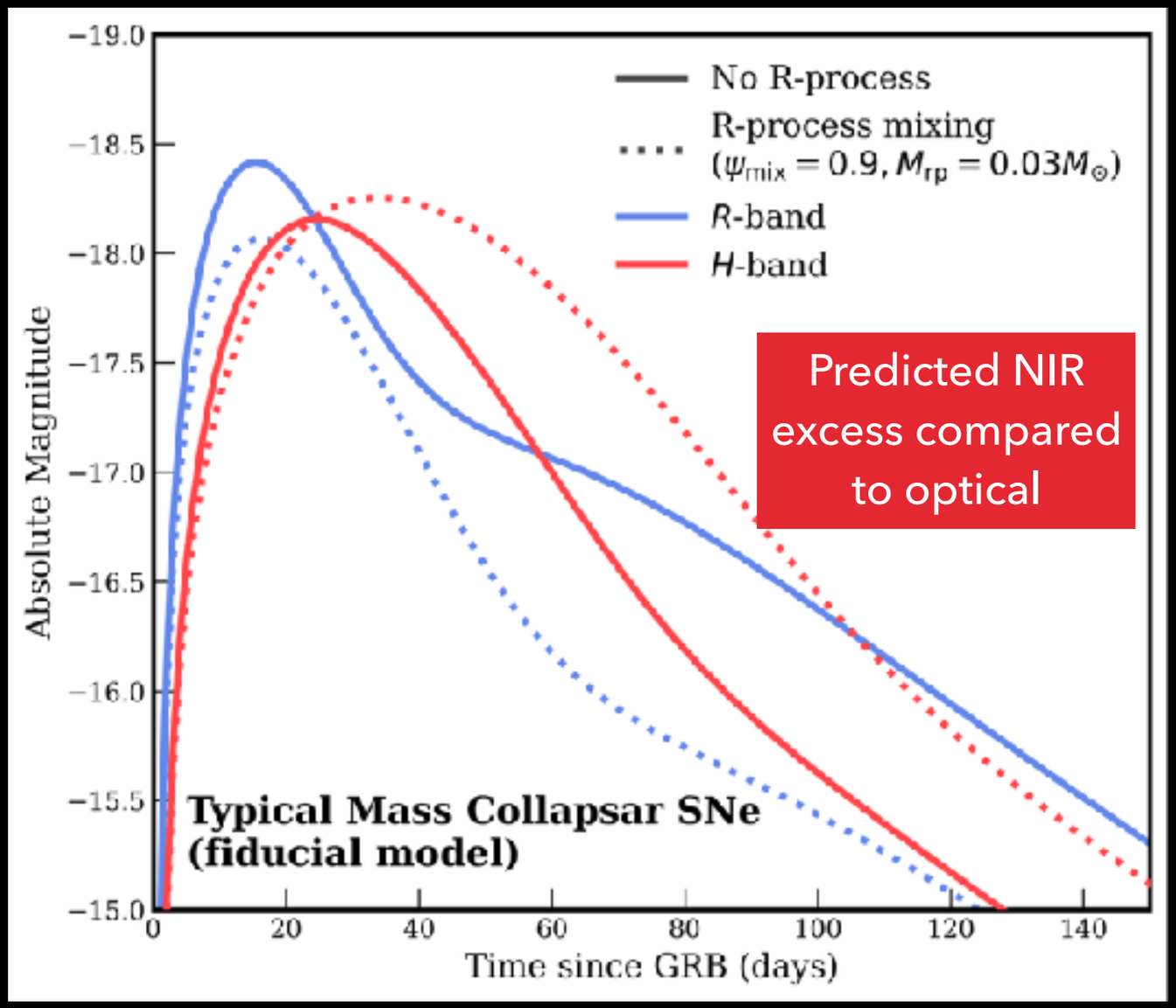
An additional, "faster" r-process production channel: Select Core-Collapse Supernovae

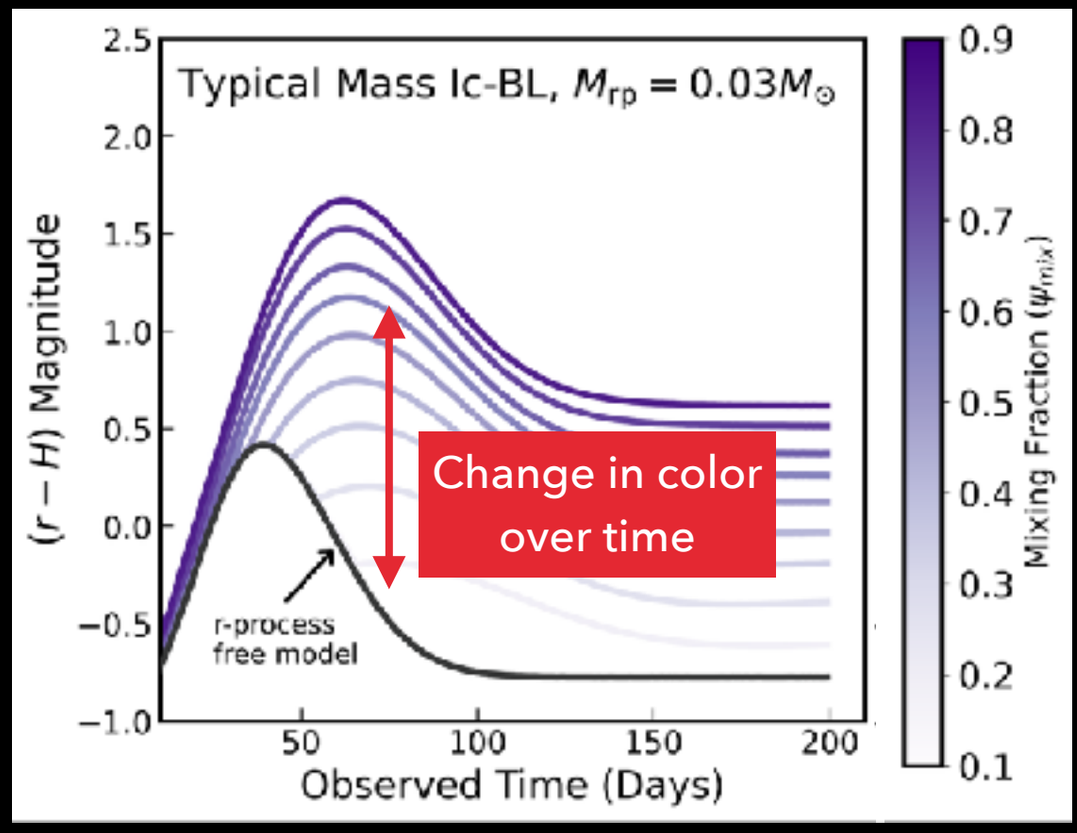
Collapsar Supernovae



e.g., Siegel+19, Zenati+20

Leveraging photometric colors in searching for r-process in LGRB Collapsar SNe

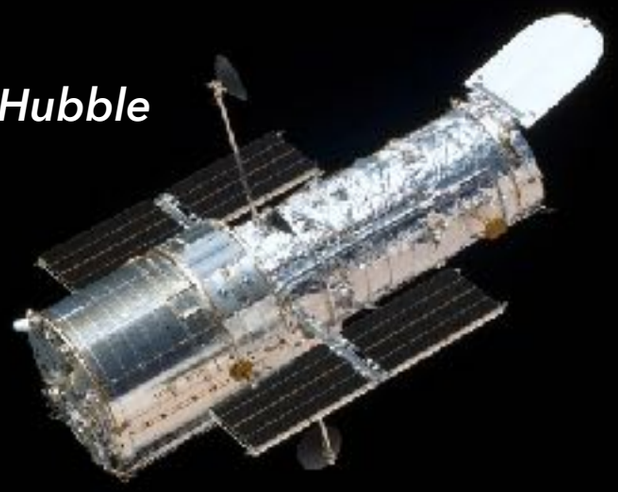




Observed reddening analogous to a kilonova

Models from Barnes & Metzger 2022

Hubble



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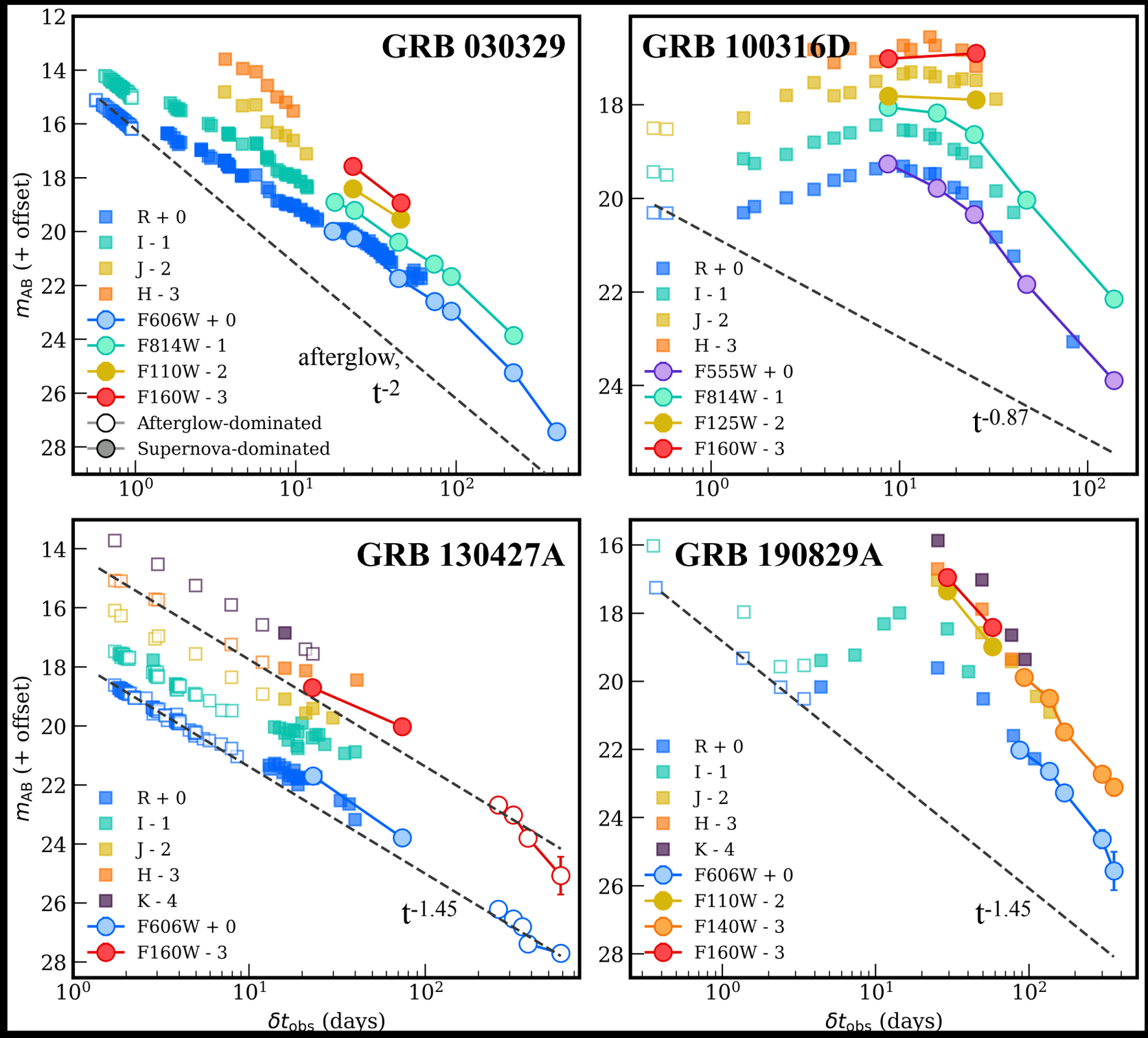

Searching for r-process signatures in GRB-SNe

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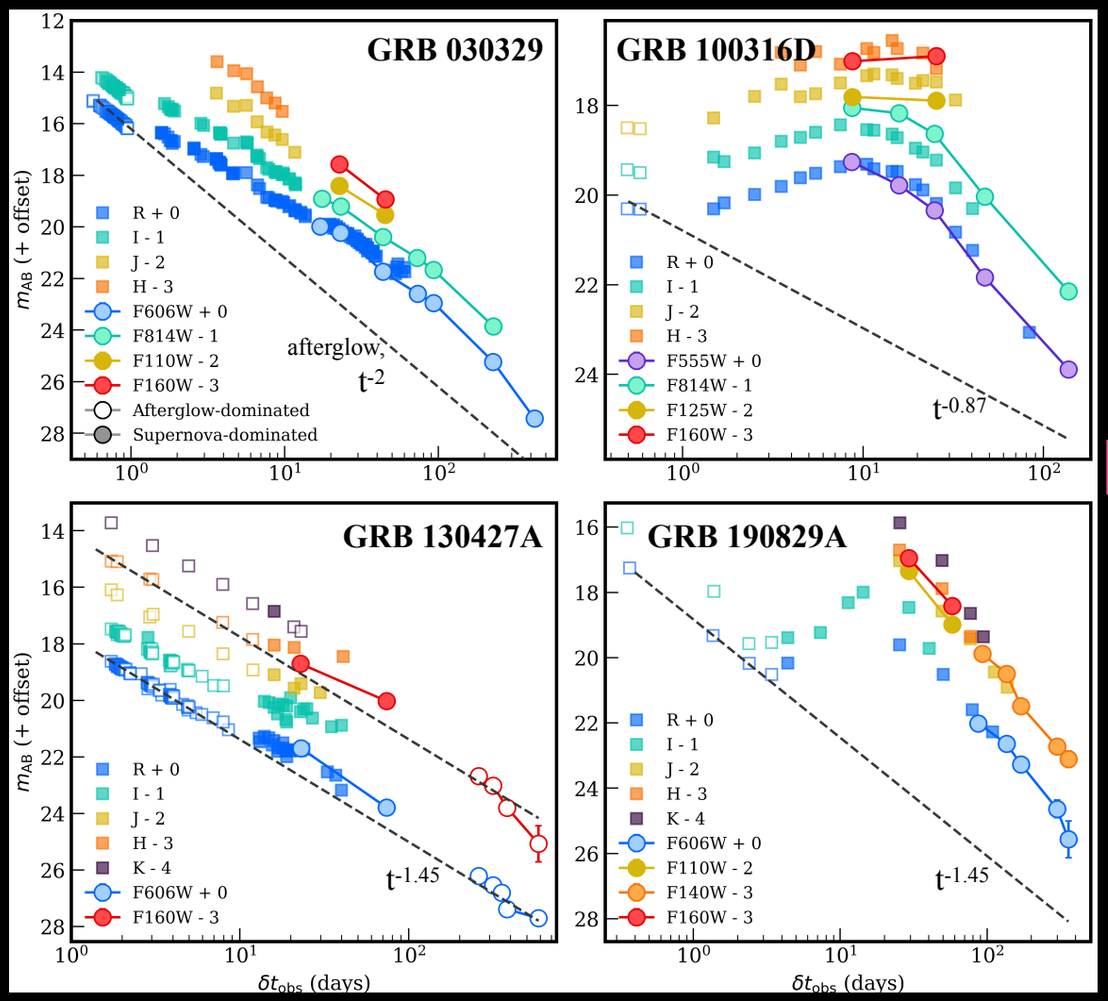

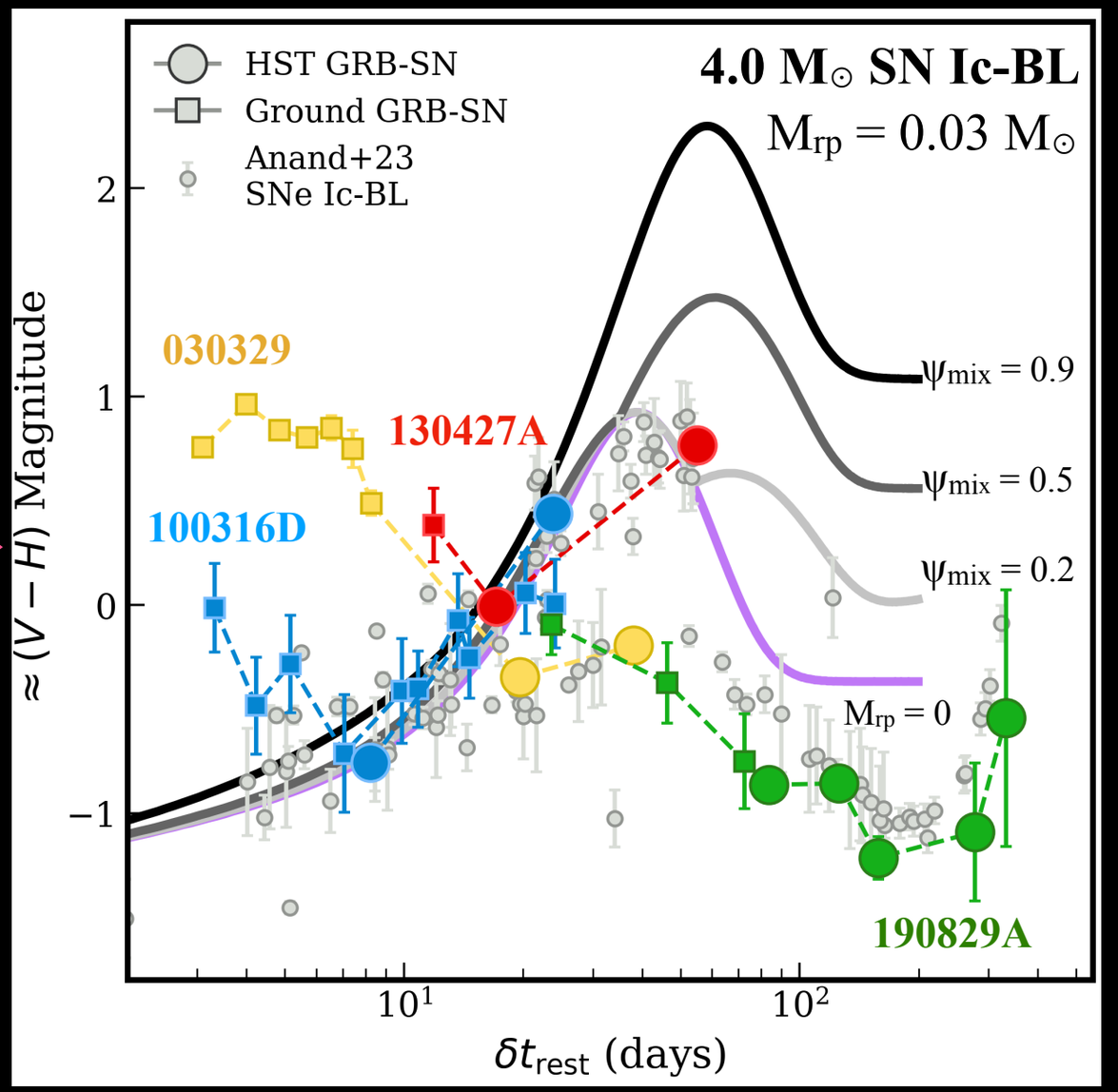

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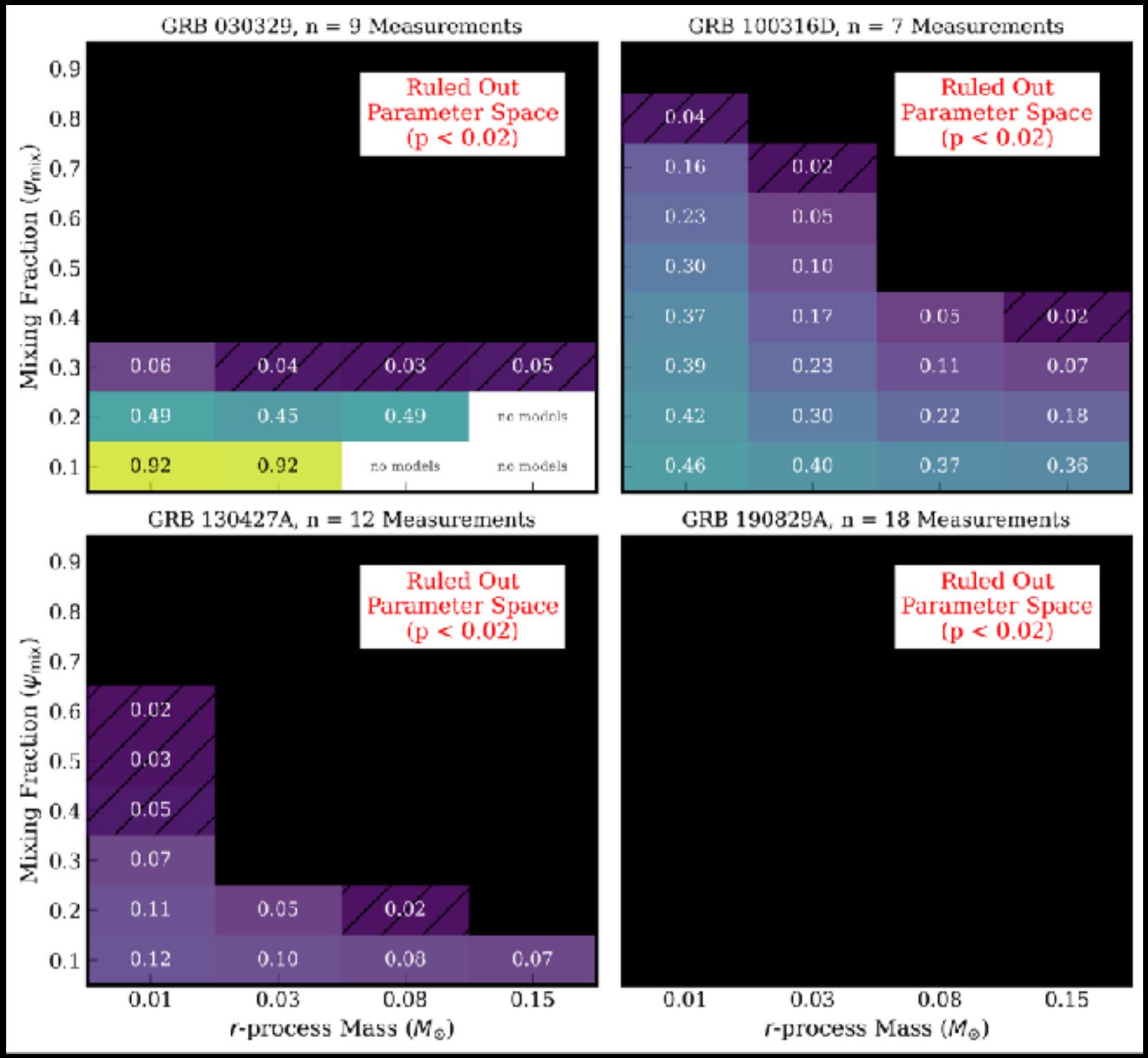
Calculating p-values for model parameter space

190829A not consistent with any enrichment models

030329, 100316D, 130427A consistent with models, mostly lower mixing and mass



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Conclusions

I. Observations of GRB 100316D are consistent with models for enrichment and GRB 190829A favor no enrichment. We caution that our analysis is based on a fiducial set of semi-analytic models that is unable to account for ≳ 30% of our observations.

II. Overall, we observe color diversity within the four GRB– SNe in our sample. Future observations of GRB-SNe are necessary probe r-process enrichment in these favored candidates.

III. Well-localized GRB missions are vital for multiple subfields of astronomy and are necessary to unearth a new source of r-process enrichment.

For more see **arXiv:2312.04630**

Thanks to Wen-fai Fong + the Fong Group and Andrew Levan

Image Credit: International Gemini Observatory/NOIRLab/NSF/AURA/J. da Silva