# Evidence for *r*-process production by rare supernovae in the low-metallicity environment

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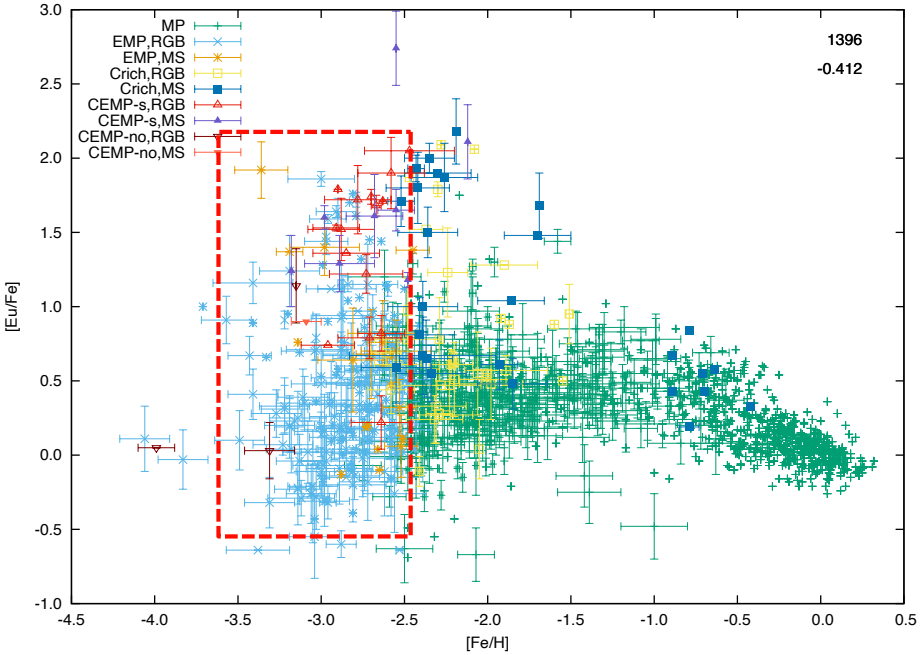
*Galactic chemical evolution suggests*

*supernovae must contribute to the r-process enrichment*

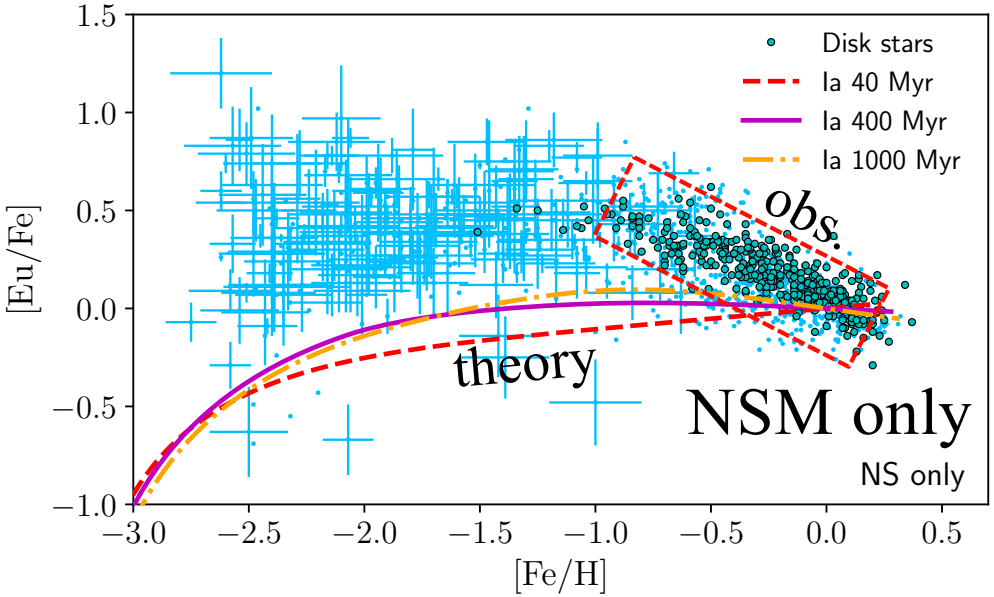
Halo

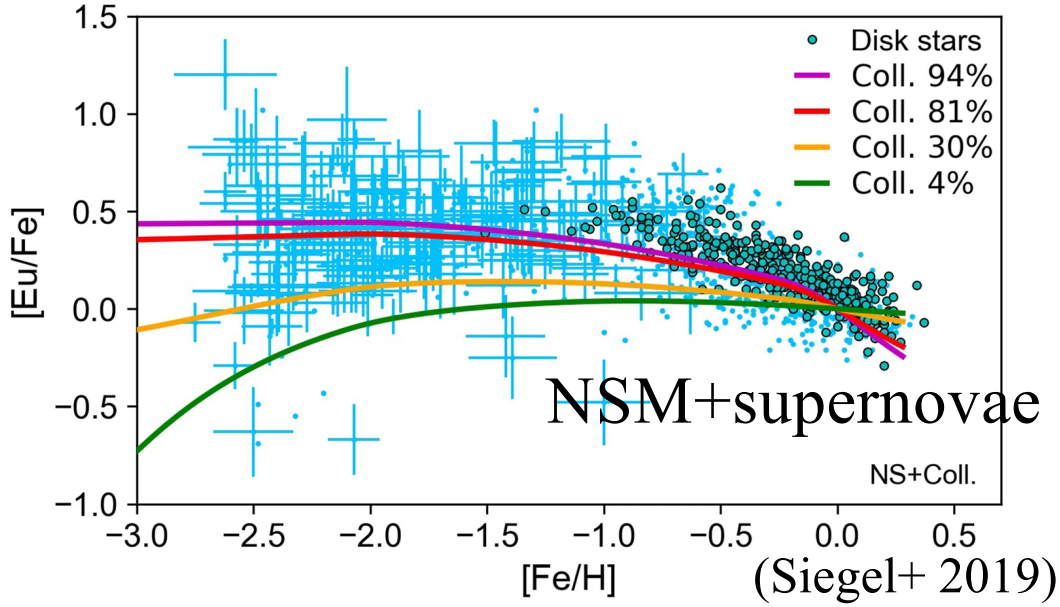



(from SAGA database)

Extremely metal-poor stars are enriched by *r*-process elements

Disk




(Siegel+ 2019)

# Candidates of *r*-process core-collapse SNe

## 1. **Magnetorotational SNe**

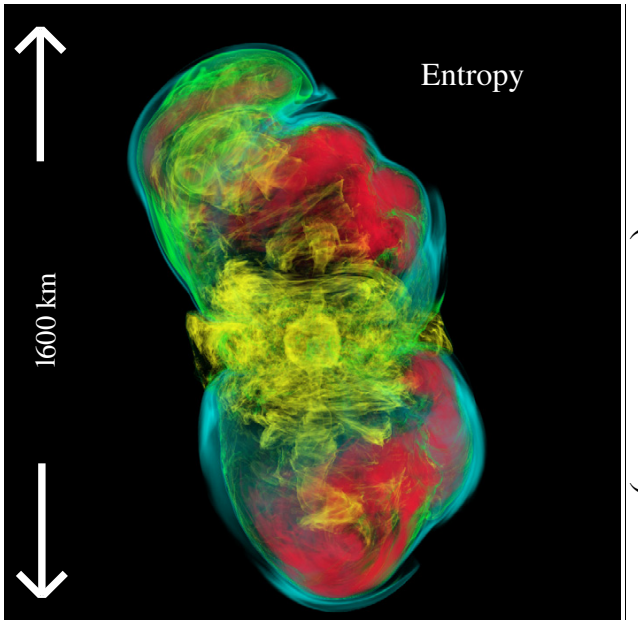
✓ An explosion triggered by fast rotation and high magnetic fields

(e.g., Takiwaki+09, Kuroda+20)

✓ *r*-process nucleosynthesis

(e.g., Winteler+12, Nishimura+15)

✓ associated with superluminous SNe (?)




(Mosta+ 2014)

## 2. **Collapsars**

torus around BH

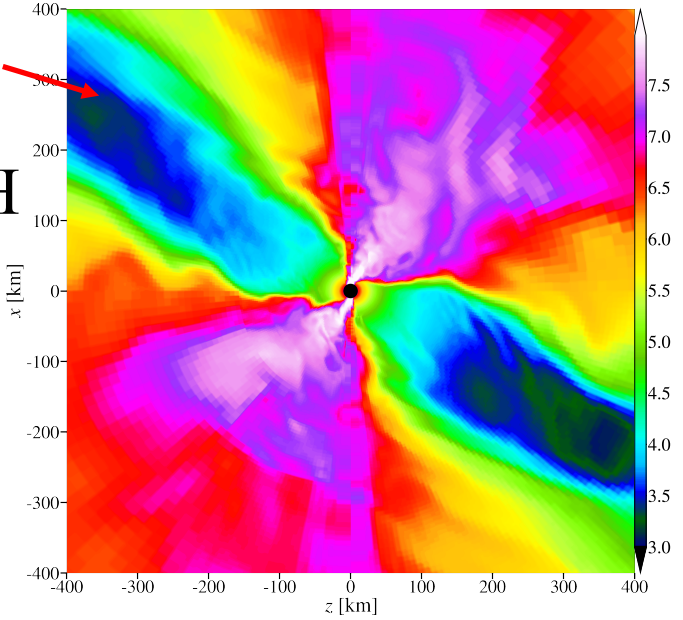
✓ Powered by energy from the rotating BH

(MacFadyen & Woosley 99)

✓ *r*-process nucleosynthesis

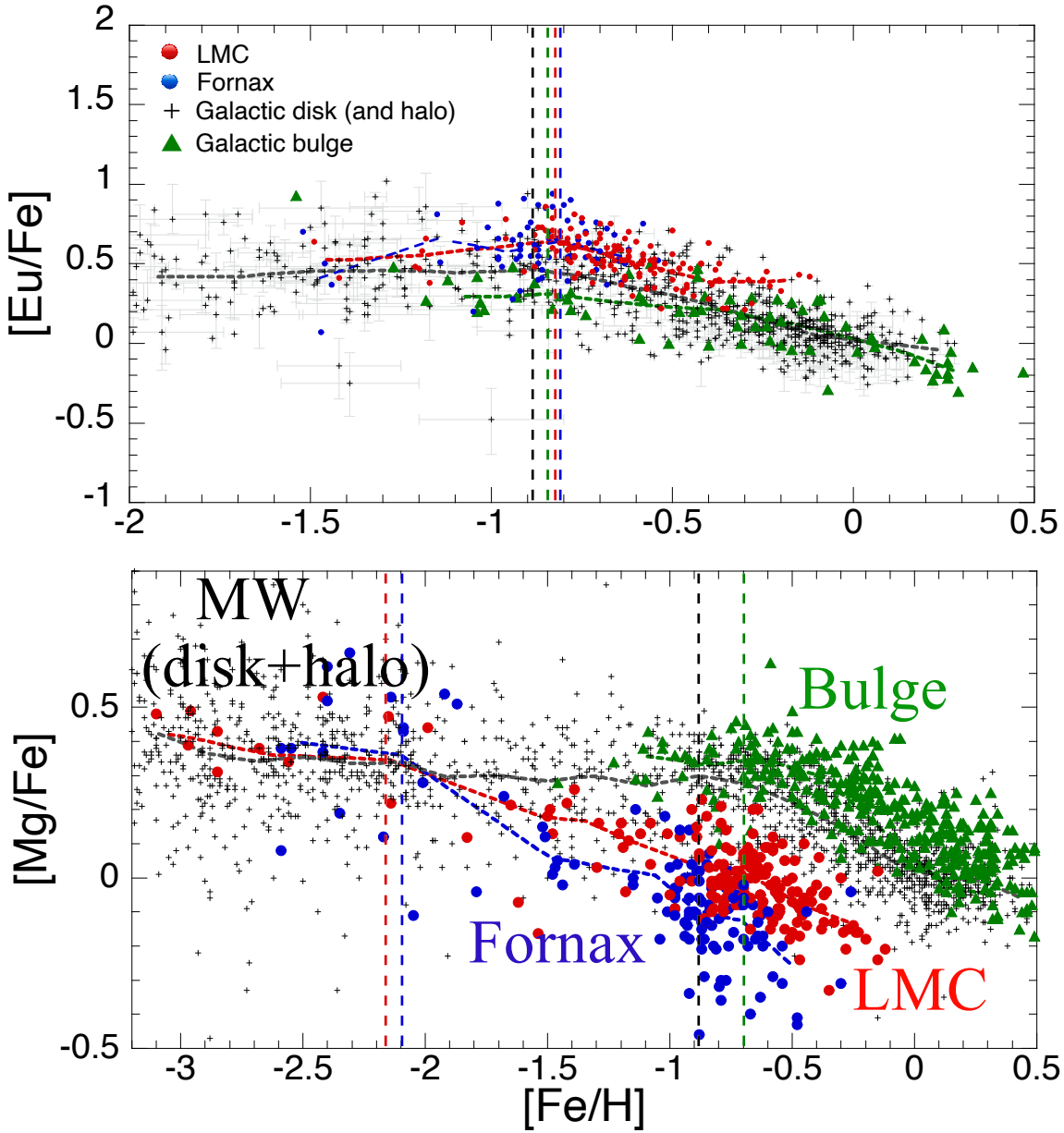
(Siegel+ 18)

✓ associated with long GRBs (?)




(Gottlieb+2022)

# *What causes the [Eu/Fe]-knee feature??*




The [Eu/Fe]-knee locus **solely depends on the metallicity** ([Fe/H] ~ -0.7)

The [Eu/Fe] knee was not caused by an onset of the Fe release from SNe Ia

*Instead,*

"**A metallicity threshold** beyond which *r*-process SNe cease to emerge" is implied

(TT 2024)

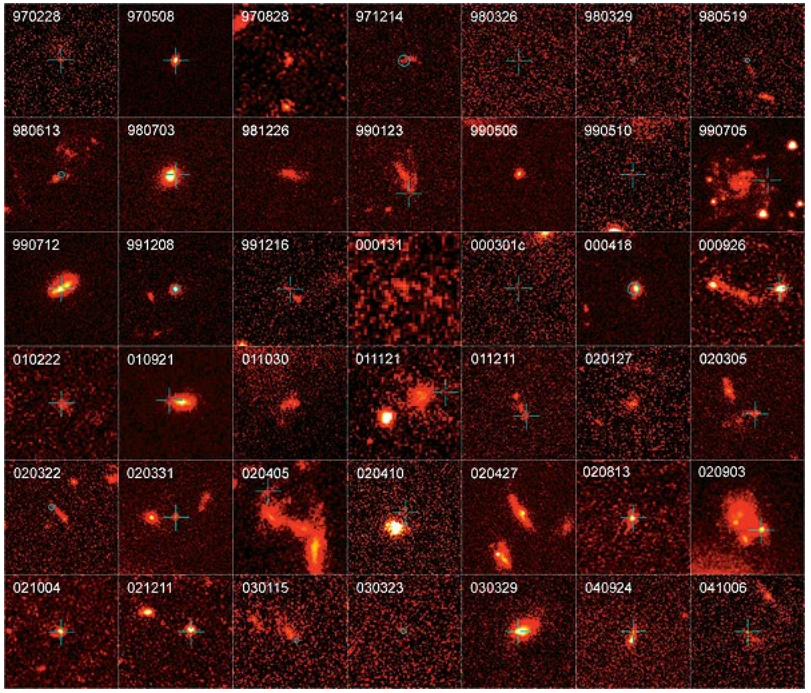
## *If r-process SNe = collapsars,*

✓Long GRBs (≈ Collapsars) favor a low-metallicity environment

host galaxies = faint, irregular galaxies
"low-metallicity galaxies"
$Z < 1/3\ Z_{\odot}$

✓Theoretically, a metallicity threshold should exist that retains enough angular momentum as $Z < 0.3\ Z_{\odot}$

(Woosley & Heger 2006)




(Fruchter+ 2006)

## *If r-process SNe = magneto-rotational SNe,*

Superluminous SNe, possibly identified with magnetorotational SNe, emerge in low-metallicity galaxies (e.g., Lunnan+ 2014).

# *Modeling of chemical evolution for MW and LMC*