Observational test on the origin of r-process from local dwarf spheroidal galaxies

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1. Why dwarf galaxies?

2. Dwarf galaxies cast a vote for a NS merger origin

3. How frequent is a NS merger event?

Details in TT & Shigeyama 2014, A&A 565, L5

A simple/new test on the origin of r-process

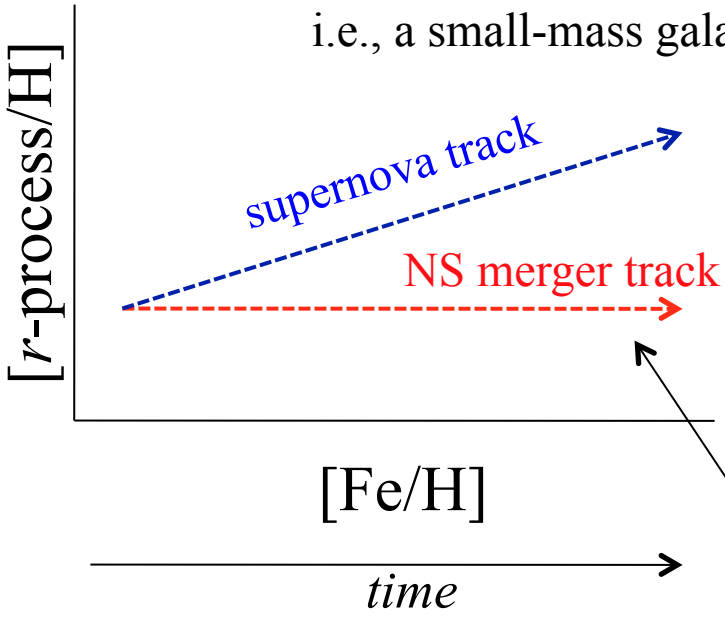
supernovae vs. NS mergers

8-10 $M_\odot$SN case
one per a few SNe

rarity

one per (a few) 1000 CCSNe

If a faint dSph
i.e., a small-mass galaxy



no NS Merger event in small galaxies is expected.

For instance, a dSph galaxy with 10^5 $M_\odot$

a Salpeter IMF

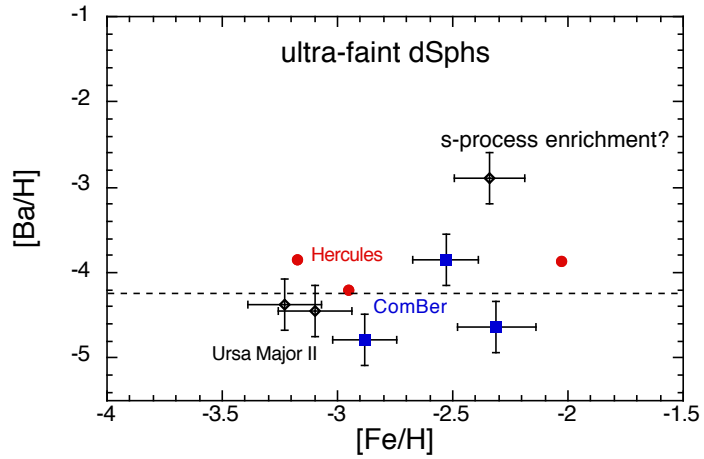
~500 CCSNe in total

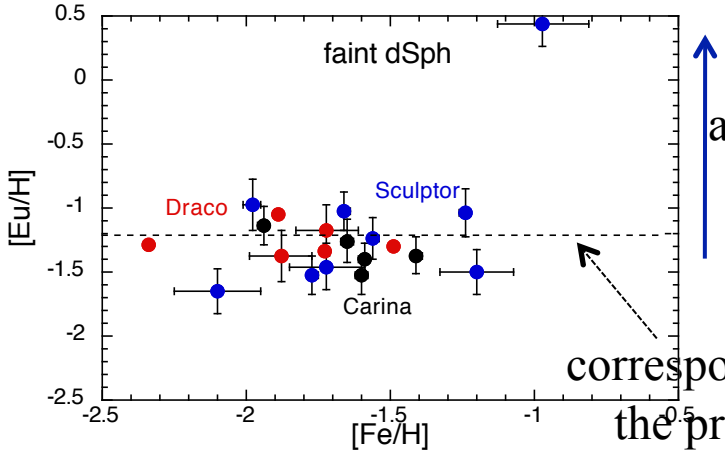
No increase in [r-process/H] is predicted

Note: dSph=dwarf spheroidal galaxy

r-process feature in dSphs claims a NS merger origin

I. faint (small-mass) dSphs



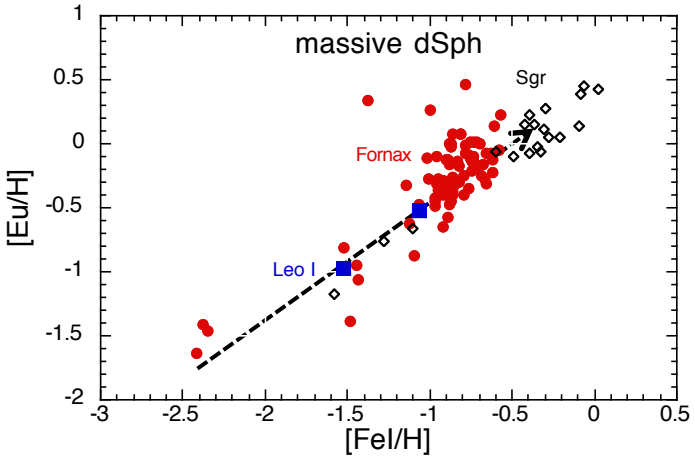


a jump of [Eu/H] by NSM?

corresponding to the pre-enriched level

No increase in *r*-process abundance together with its sudden increase in Sculptor strongly suggests a NS merger is a *r*-process origin.

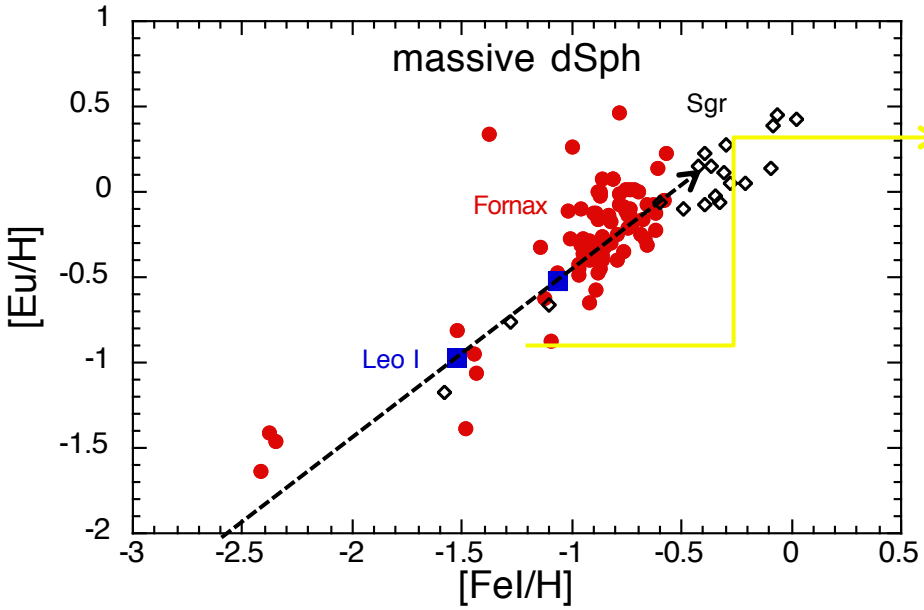
II. massive dSphs



An increasing Eu/H trend is quite reasonable since NSMs happened ~1000 times in total in the Fornax dSph.

NSM rate deduced from dSph galaxies I

Massive dSph argument



a slope is determined by the ratio of the production rates between Fe and Eu

slope =

$$\frac{\text{NSM Eu yield}\times\text{NSM rate}}{\text{supernova Fe yield}\times\text{supernova rate}}$$

$M_{\rm Fe}=0.1M_{\odot}$

$M_{\rm NSM,ejecta}=0.01M_{\odot}$

NSM rate = one per 1000 CCSNe

Galactic CCSNe rate of 2.3±0.48 SNe per century (Li et al. 2011)

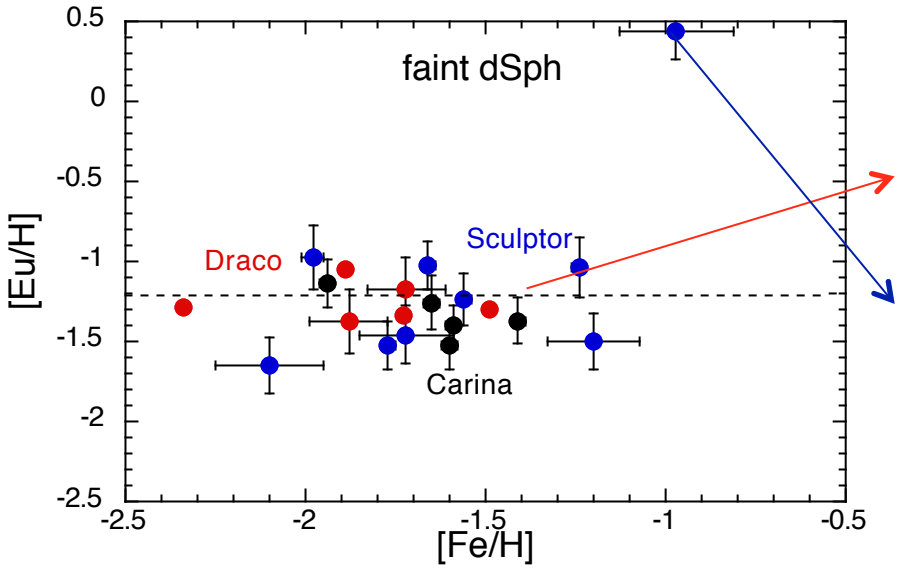
23 $\rm Myr^{-1}$ in the Galaxy

Note!

Its estimate subject to uncertainties in the yield and ejecta mass

NSM rate deduced from dSph galaxies II

independent assessment from faint dSphs



no NSM event in **Draco**

one NSM event in **Sculptor**

Using the total mass and a canonical initial mass function,
we can deduce **the total number of CCSNe** that occurred
in the past for individual dSphs.

Sculptor

Draco

one per 10,000 CCSNe ≤ **NSM rate** < one per 1500 CCSNe

from Sculptor

from Draco

NSM event number – galaxy mass correlation in Local Universe