



Saitama
University

High Energy
Astrophysics Laboratory

No.3



Feasibility studies to detect r-process nuclear emissions from the binary-neutron-star merger remnants with the HEX-P satellite

Yugo Motogami (Saitama Univ., y.motogami.738@ms.saitama-u.ac.jp)

Yukikatsu Terada[1][2], Satoru Katsuda[1], Hayato Ohsumi[1],

Shin-ichiro Fujimoto[3], Aya Bamba[4], Ryo Yamazaki[5], Kaya Mori[6]

([1] Saitama Univ., [2] ISAS/JAXA, [3] Kumamoto NCT, [4] U.Tokyo, [5] Aoyama Gakuin, [6] Columbia Univ)

Introduction

Open issue

Where is the r-process nucleosynthesis site in space?

one of the most promising r-process site:
neutron star merger (NSM)

Observation of radiation from the r-process nuclei would provide evidence of a nucleosynthesis site!



High sensitive MeV observation is required
**Our Idea: How about high sensitive
Hard X-ray observations?**

**Our objectives: Feasibility study of possible detection
of NSM remnants in the hard X-ray band**

Instruments assumed/HEX-P

The High Energy X-ray Probe (HEX-P):

Next-generation hard X-ray satellite planned in the U.S.

Performance (as of 2023.Aug)

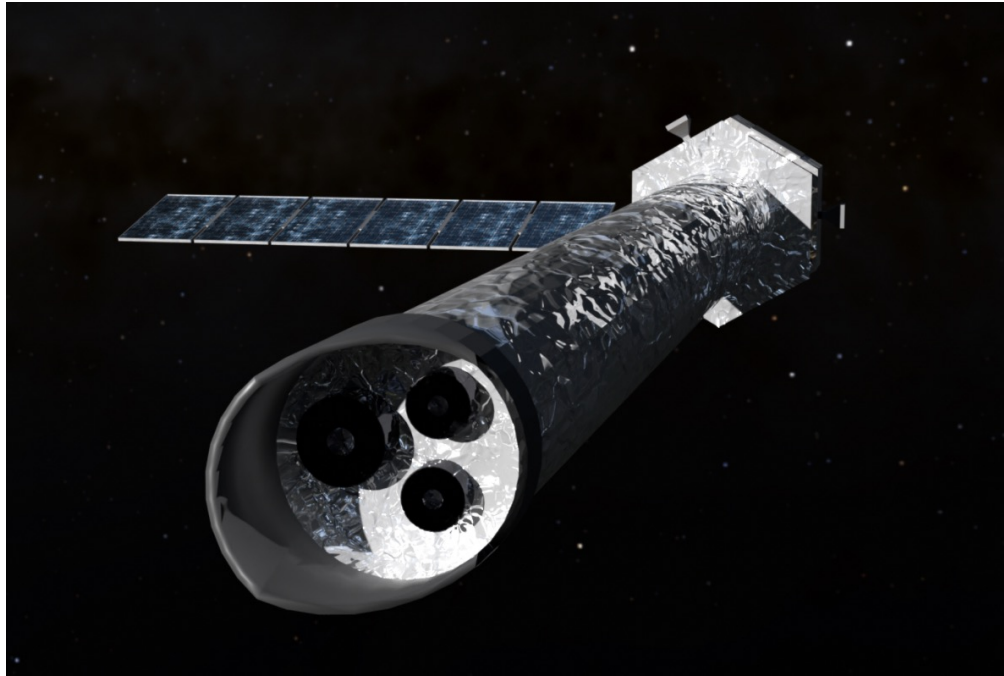


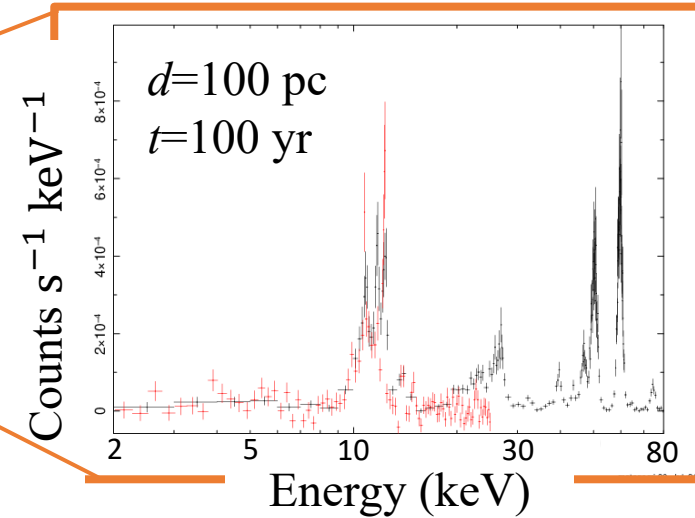
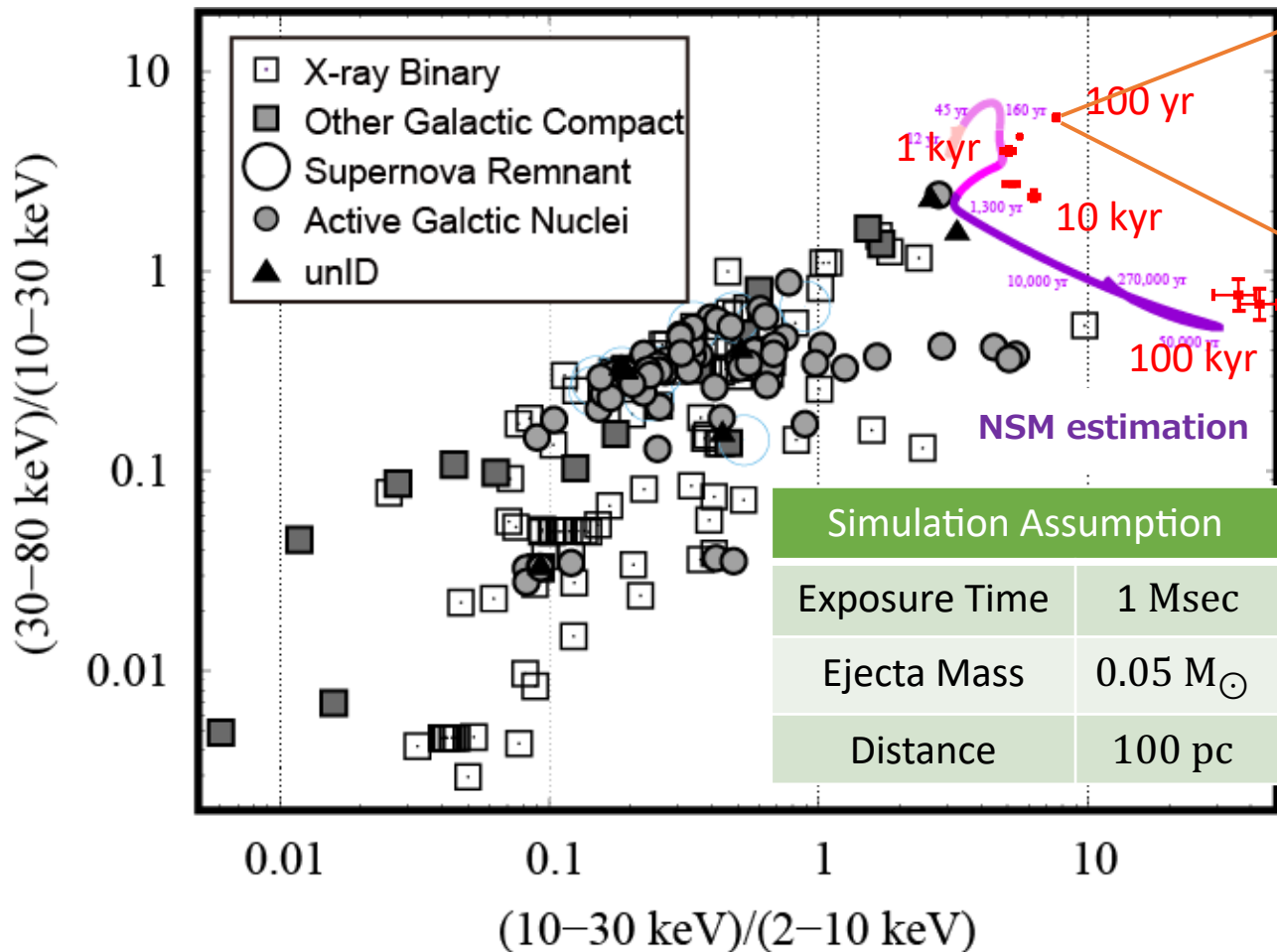
fig1:Imaginary drawing of HEX-P
HEX-P homepage(<https://hexp.org>)

Item	Value
Bandpass	2-80 keV
Effective Area (HET+LET)	4400 cm ² @6 keV
Angular Resolution (FWHM)	2.5-4"
Spectral Resolution (FWHM)	200 eV @ 6 keV 0.8 keV @ 60 keV
Field of View	13.4' × 13.4'

Result (1)/Identification of NSMs in the hard X-ray band using HEX-P (@100 pc)

No.3

- ① Hard X-rays alone can distinguish old remnants (older than 1 kyr) from other objects
- ② Instrument simulation using HEX-P response functions

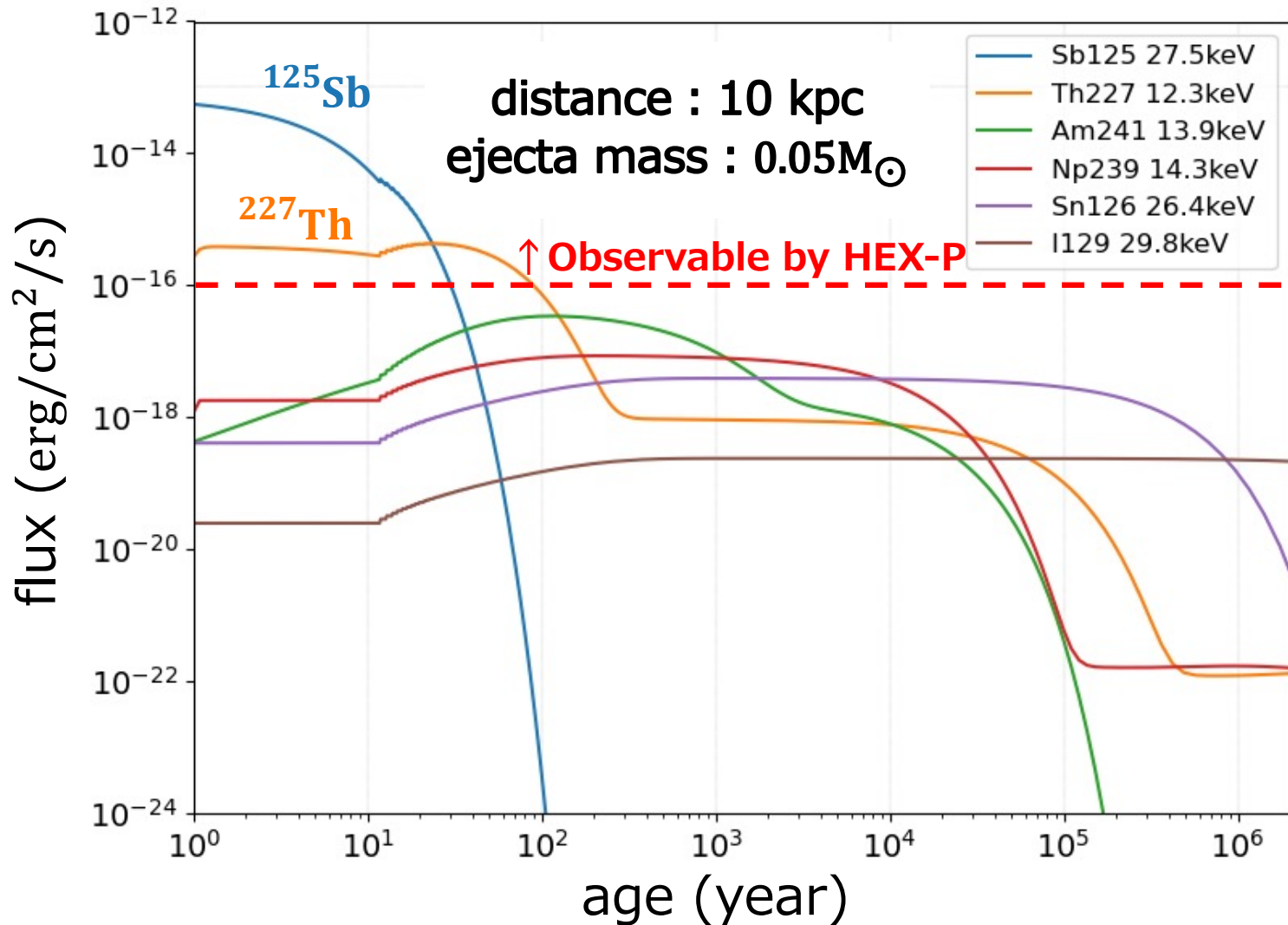


$d=100$ pc
Up to $t=100$ kyr
can be identified
(err : 3σ)

$d=10$ kpc : **cannot be identified**

fig2: Identification of NSM using HEX-P @100 pc

Result (2)/ Line identification with HEX-P (@10 kpc)^{No.3}



1 Msec, 1 sigma sensitivity
of HEX-P
(@10-30 keV)
About 10^{-16} erg/cm²/s

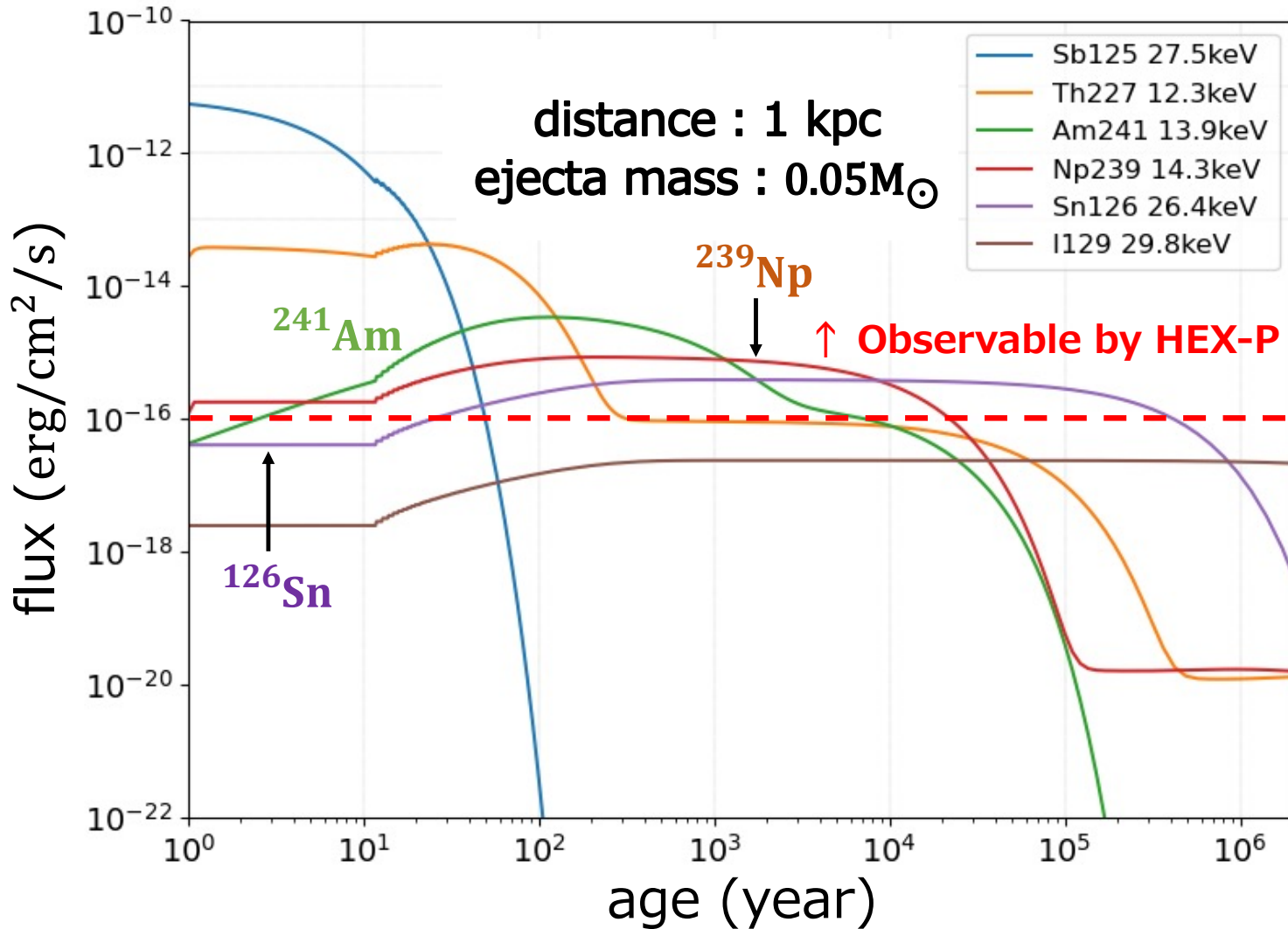
**Observable emission
lines @10 kpc**

$^{125}\text{Sb} : t \leq 100 \text{ yr}$

$^{227}\text{Th} : t \leq 100 \text{ yr}$

fig3: Time variation of strong emission flux from NSM in hard X-ray band @10 kpc

Result (2)/ Line identification with HEX-P (@1 kpc)



Newly observable emission lines @1 kpc

^{241}Am : 10 kyr

^{239}Np : 10 kyr

^{126}Sn : 500 kyr

^{239}Np can be used as a standard candle during 10^2 - 10^4 yr!

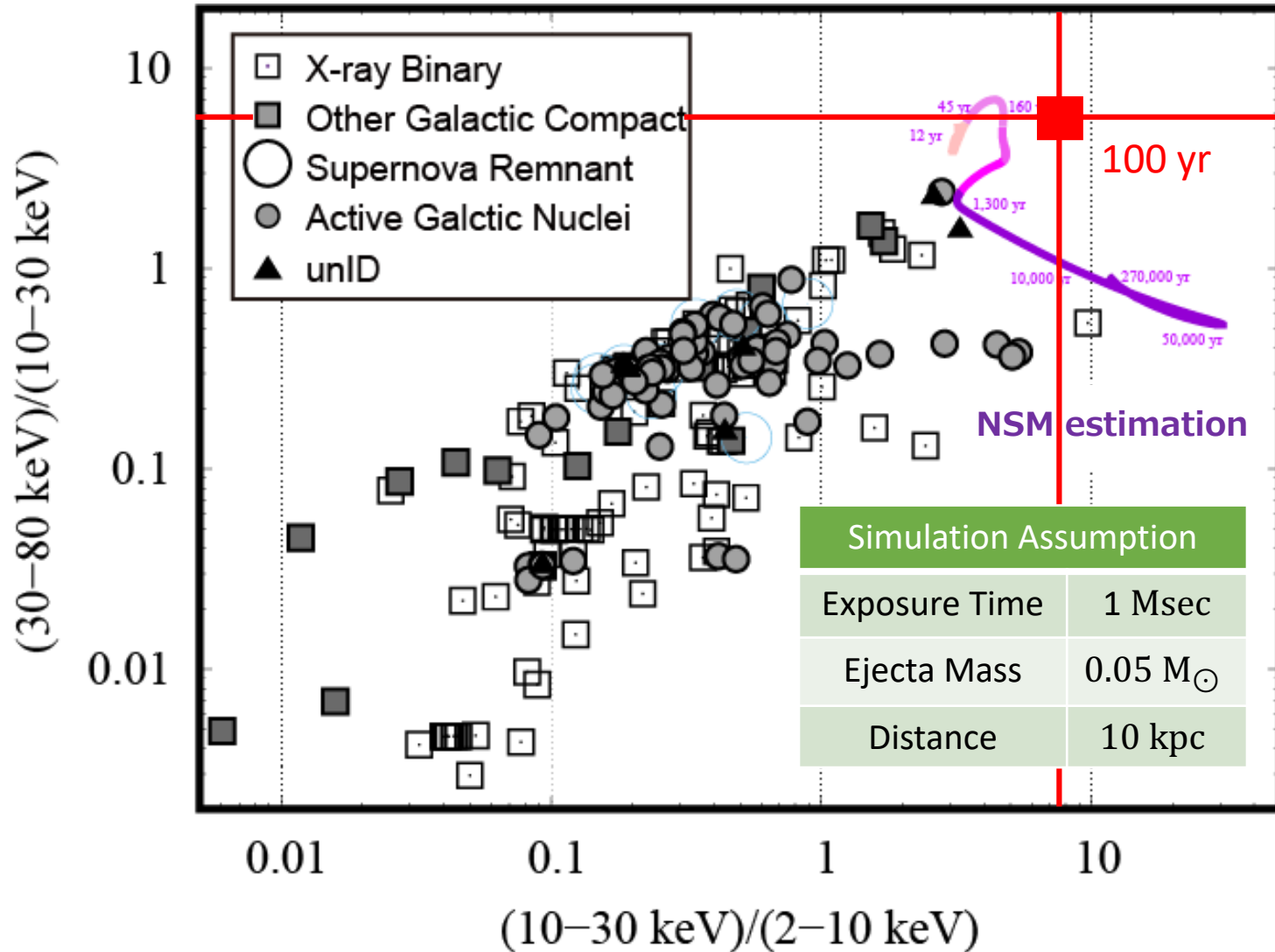
Please come to our poster and discuss!!

fig4: Time variation of strong emission flux from NSM in hard X-ray band @1 kpc

backup

Result (1)/Identification of NSMs in the hard X-ray band using HEX-P (@10 kpc)

ポスター番号



Assuming a galactic center



d=10 kpc
 Even at t=100 yr
cannot be identified

fig2: Identification of NSM using HEX-P @10 kpc