X-ray Studies of **Supernova Remnants** and **Neutron Stars** ~ from *Suzaku* toward *ASTRO-H*

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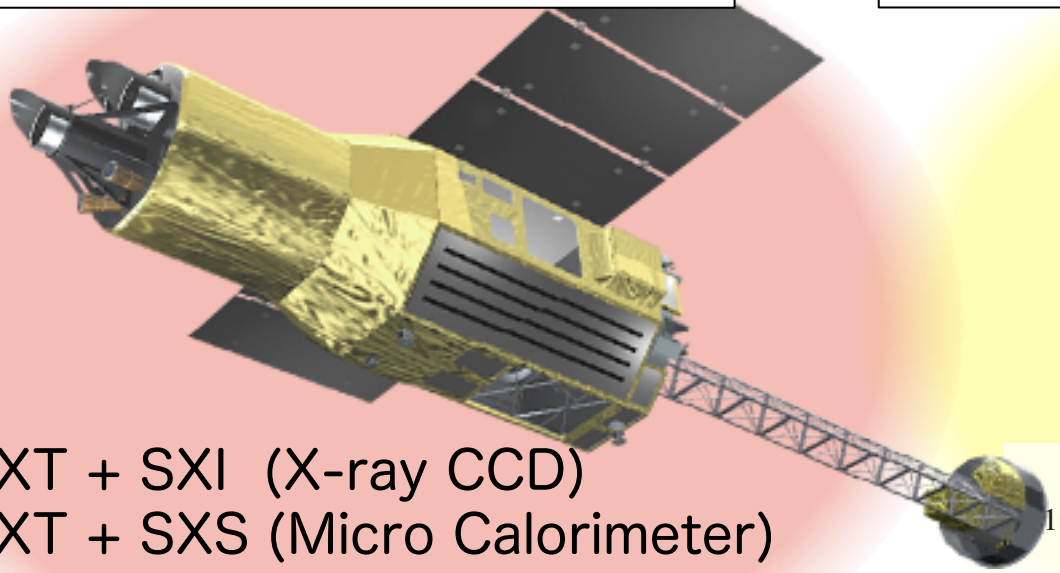
1. *Suzaku* and *ASTRO-H*

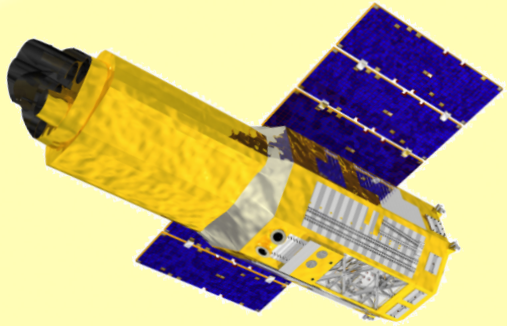
ASTRO-H ～Launch in 2015 年度



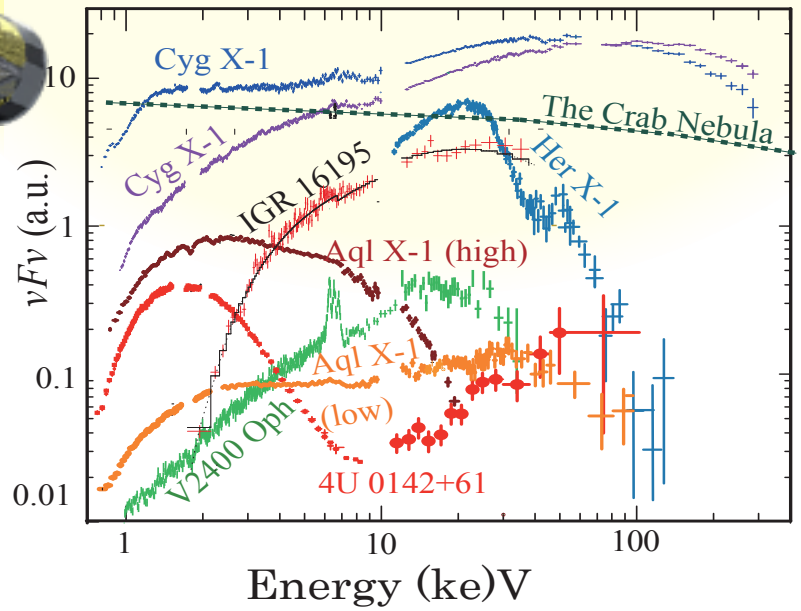
SXT + SXI (X-ray CCD)
SXT + SXS (Micro Calorimeter)
HXT + HXI (Hard X-ray Imager)
SGD (Soft Gamma-ray Detector)

- ✓ Wide Band (0.3 – 600 keV)
- ✓ High Sensitivity
- ✓ High energy resolution (FWHM 5eV @ 6 keV)

「すざく」 2005年～

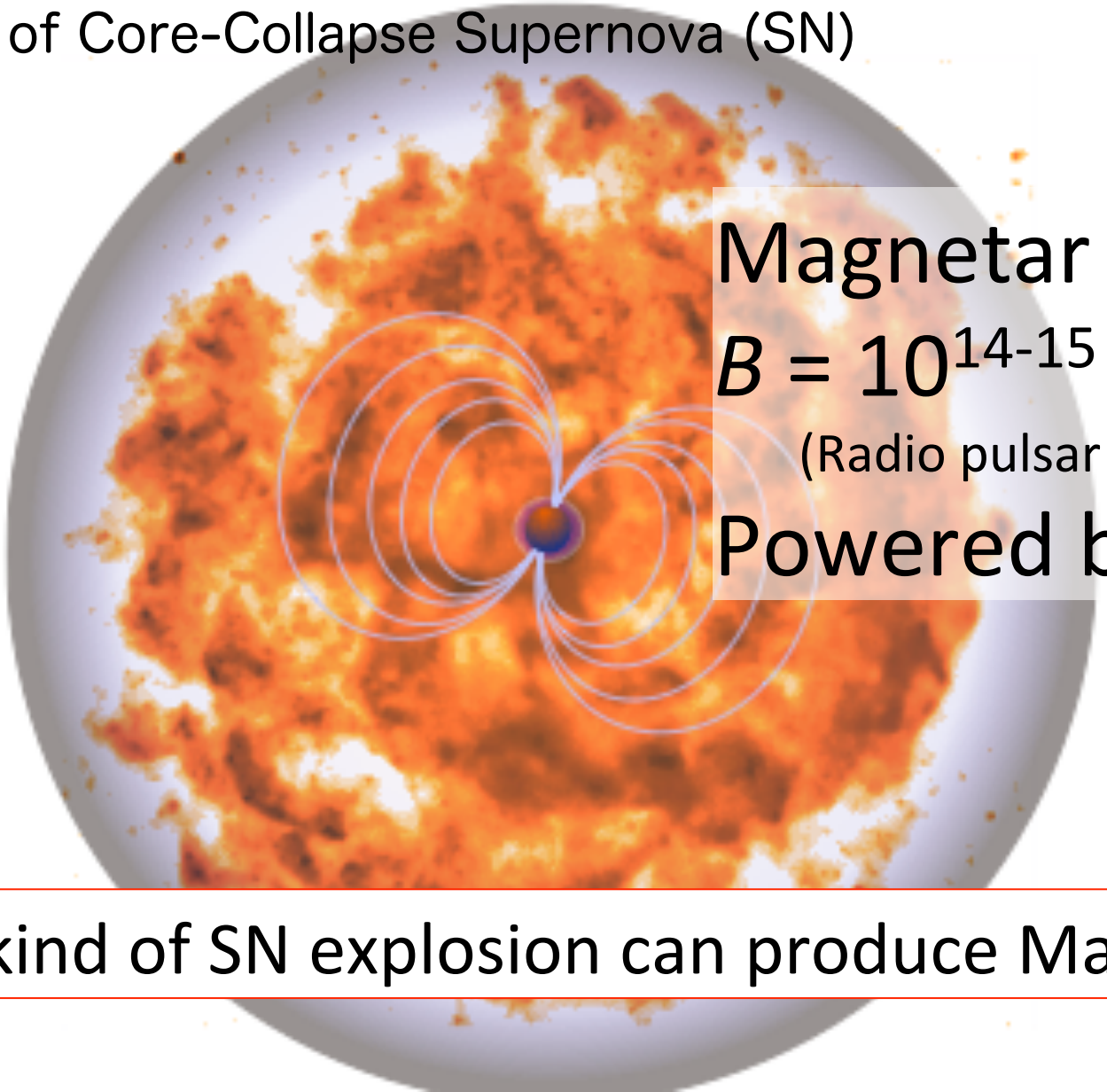


over 10 years !



2. Supernova Remnants and Neutron Stars

Products of Core-Collapse Supernova (SN)



Magnetar

$B = 10^{14\text{-}15}$ G

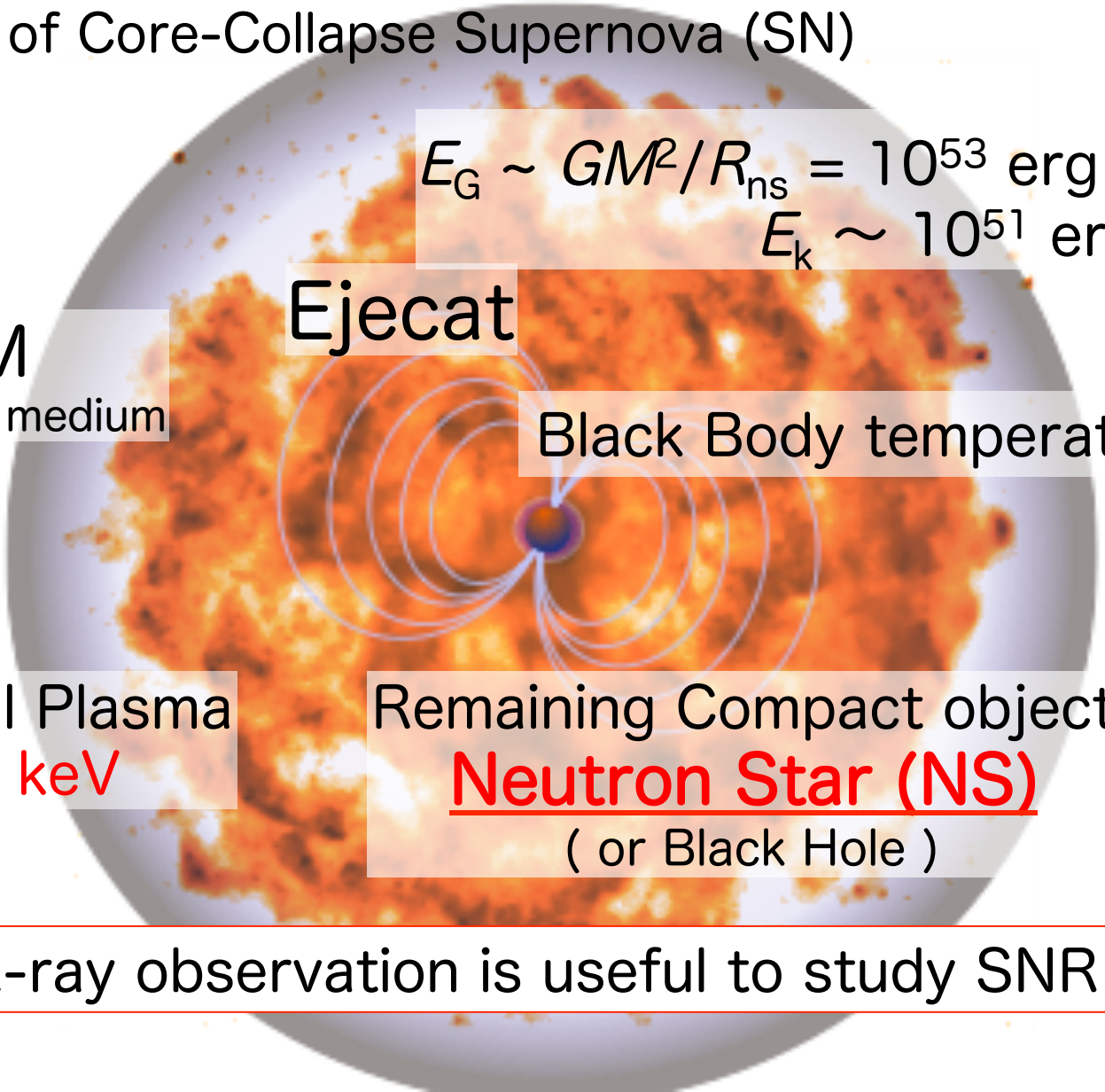
(Radio pulsar 10^{12} G)

Powered by B

What kind of SN explosion can produce Magnetar ?

2. Supernova Remnants and Neutron Stars

Products of Core-Collapse Supernova (SN)



$E_G \sim GM^2/R_{ns} = 10^{53}$ erg ➔ E_ν

$E_k \sim 10^{51}$ erg ?

Ejecat

ISM

Interstellar medium

Black Body temperature ~ keV

Thermal Plasma

~ keV

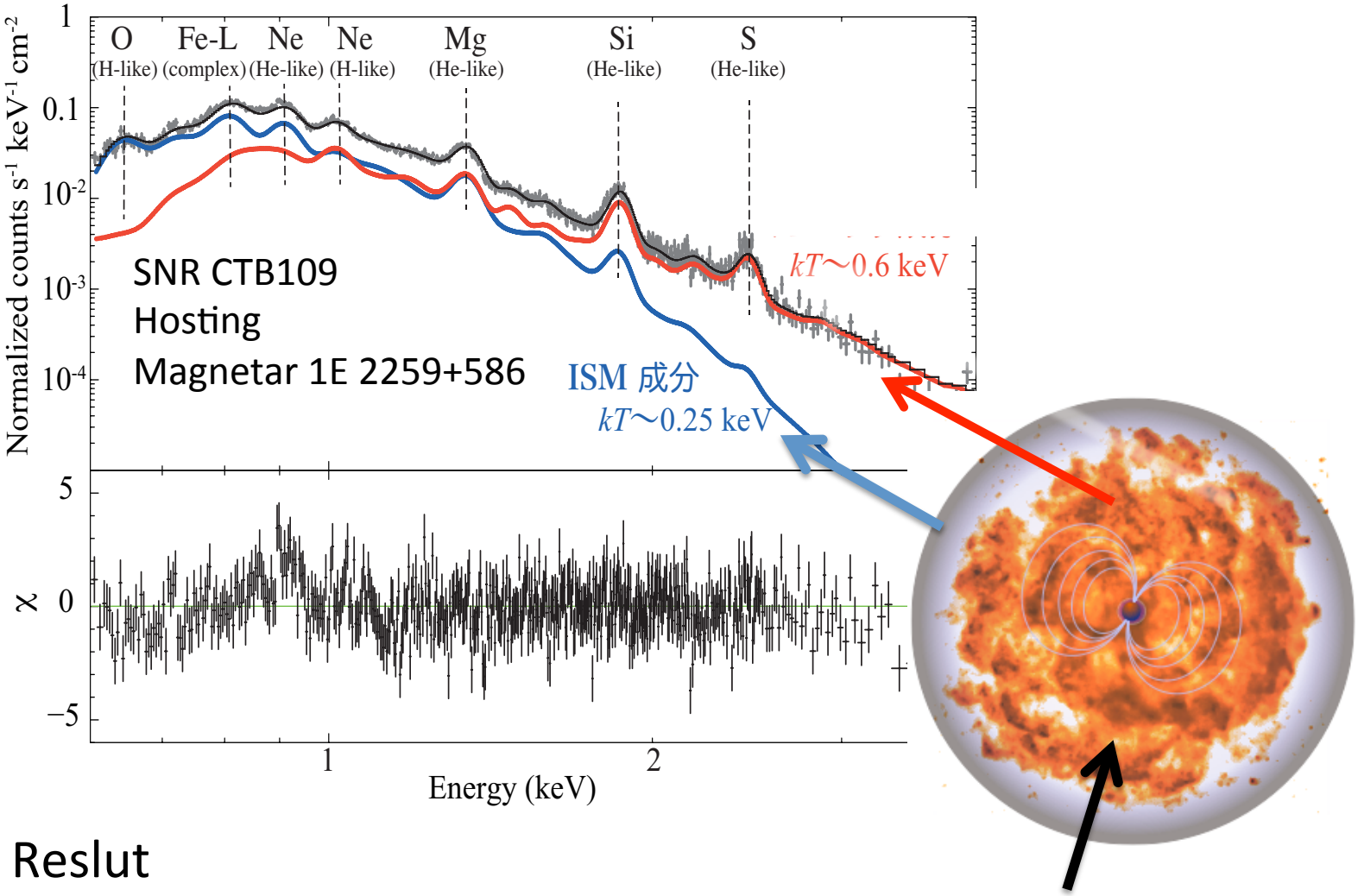
Remaining Compact object

Neutron Star (NS)

(or Black Hole)

X-ray observation is useful to study SNR and NS

3. X-ray Spectra “*Suzaku*” ➔ “ASTRO-H”

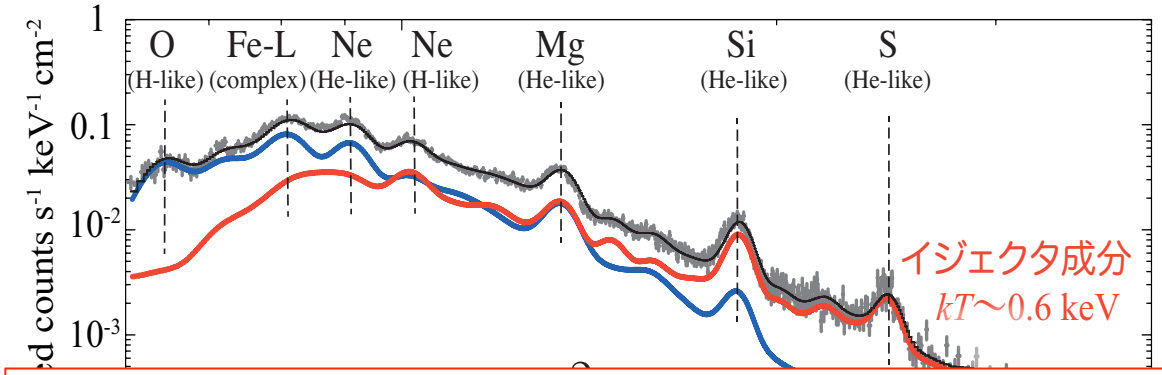


Suzaku Reslut

The progenitor of the magnetar was very massive (> 20 $M_\odot$).

However, explosion energy was typical (10^{51} erg).

3. X-ray Spectra “*Suzaku*” ➔ “*ASTRO-H*”

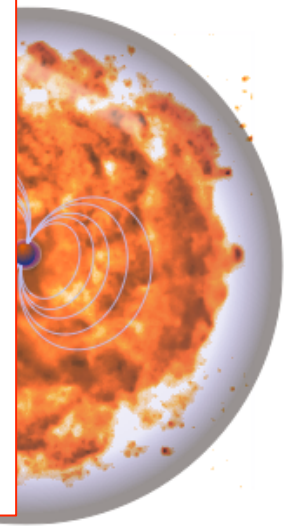


Why not a Black hole

We cannot find E ～10^{52} erg expected to produce NS.

↓

Remaining questions for *Astro-H*

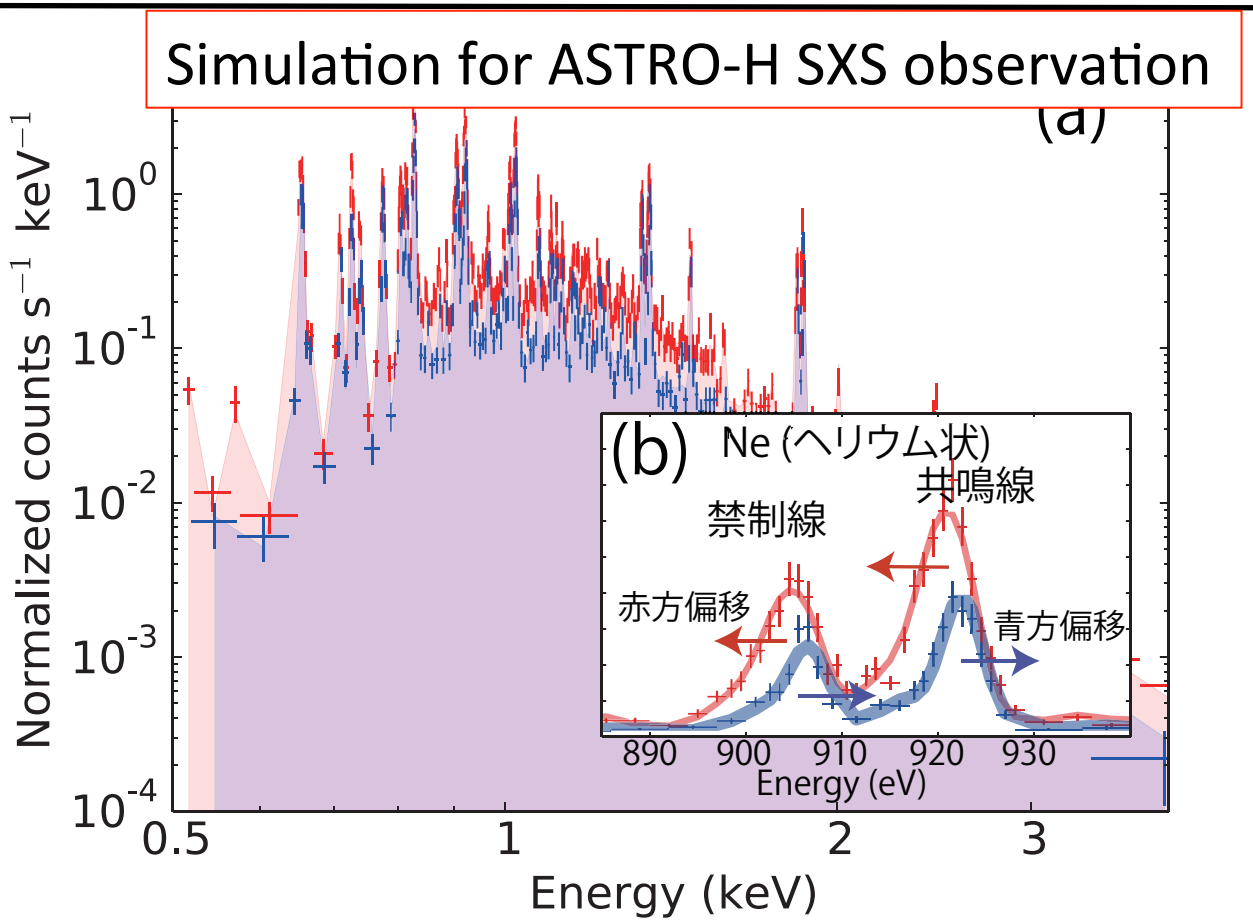


Suzaku Reslut

The progenitor of the magnetar was very massive (> 20 $M_{\odot}$).

However, explosion energy is estimated as typical (10^{51} erg).

4. X-ray Spectra “*Suzaku*” ➔ “*ASTRO-H*”

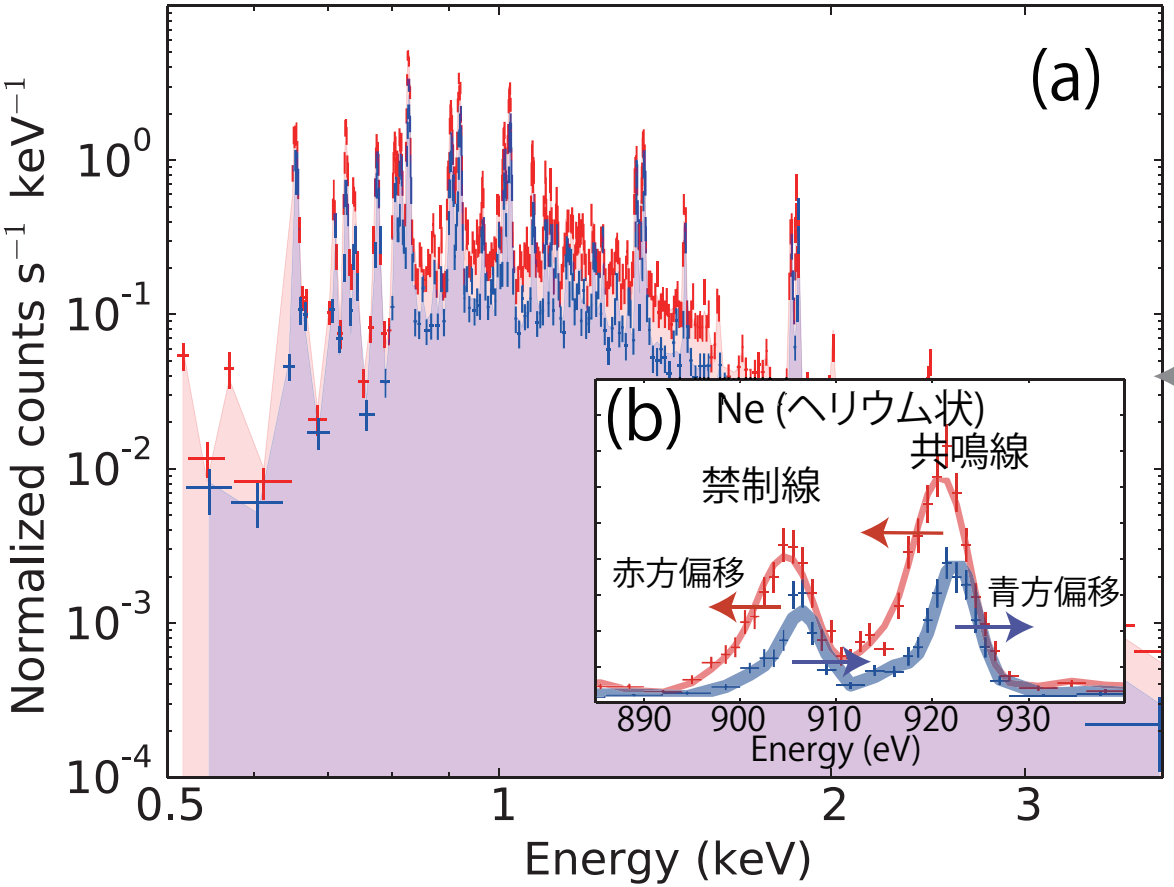


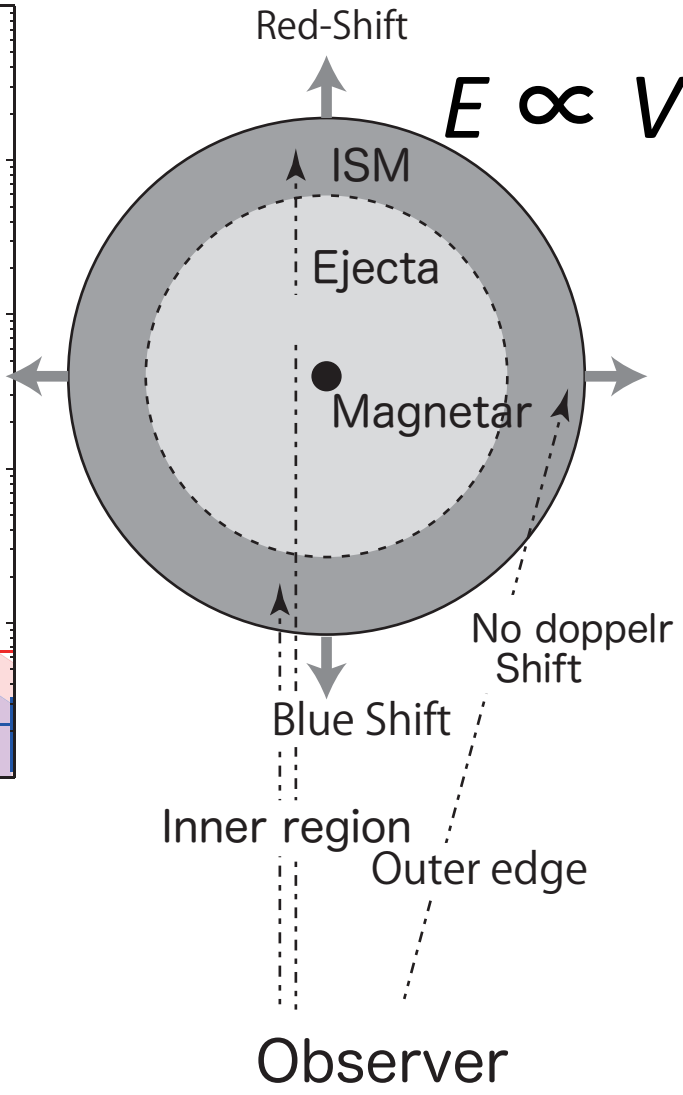
Many lines are resolved by high Energy resolution of SXS

Resonance, Intercombination, and forbidden lines can be separated.

Doppler effect can allow us to measure the shock velocity directly.

5. Direct measurement of expansion energy





~ 10^{52} erg is indeed divided into E_k

Strong shock, (Non-equiriblium)

$T_p >> T_e$, we could not measure T_p.

SXS can measure V with Doppler effect.

6. Summary

- We analyzed Suzaku data of SNR CTB109 hosting Magnetar.
- The progenitor mass is estimated as much larger than 20 $M_{\odot}$
- We do not observe huge explosion energy to leave NS.
- Expected energy will be possibly found with ASTRO-H SXS.