Multi-Messenger Astronomy with XRISM
XRISM時代のマルチメッセンジャー天文学

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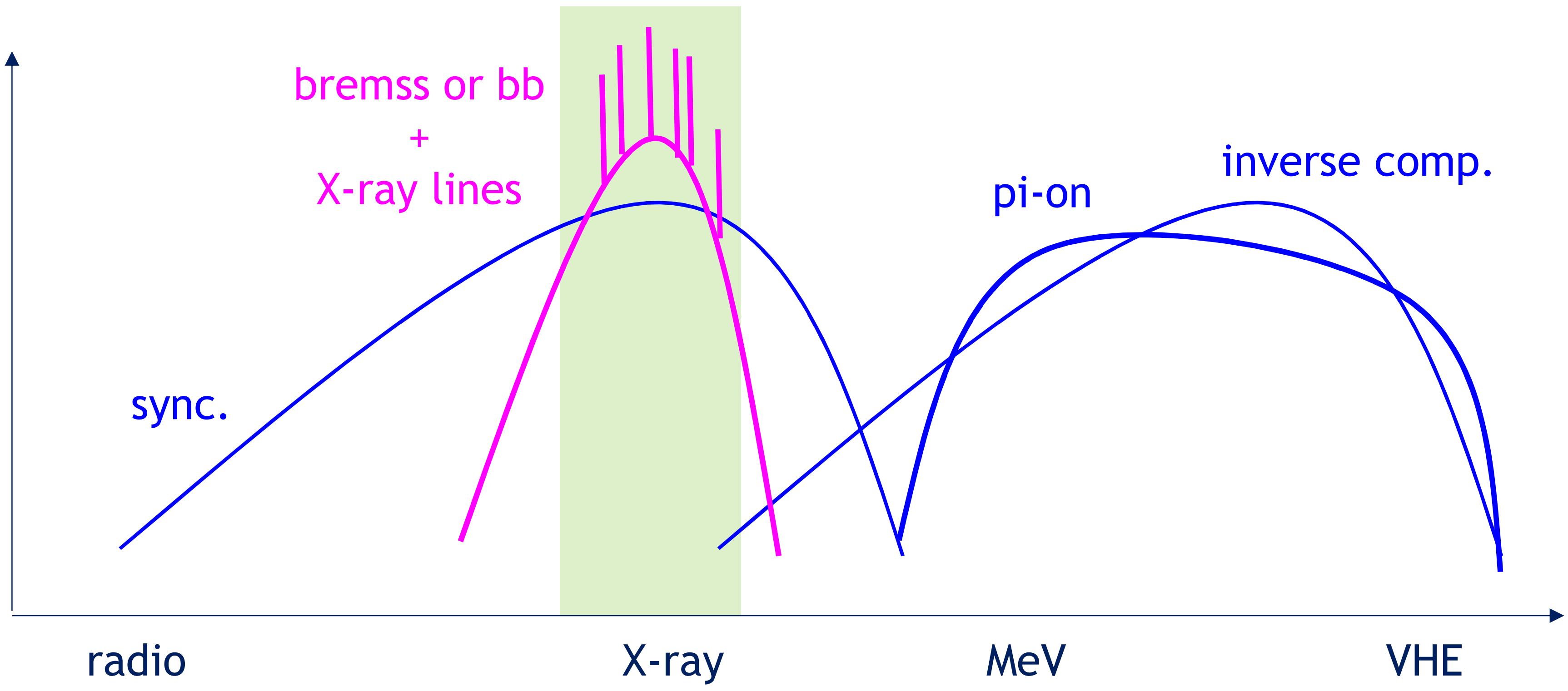
1. X-ray astronomy for multimessenger objects



nonthermal: mainly sync. ->info. of high E electrons

thermal: bremss, bb (10^{6-8} K) ->density, kT,

+ X-ray lines abundance, age, …

X-ray obs. is ideal to get SED and physical info. of multimessenger objects

2.1. XRISM satellite

X-ray CCD “Xtend”
E reso. < 250 eV@6keV@EOL
Area > 300 cm^2 @6keV
band: 0.4-12 keV
FoV: 30x30 $arcmin^2$

X-ray mirrors “XMA”
HPD < 1.7 arcmin

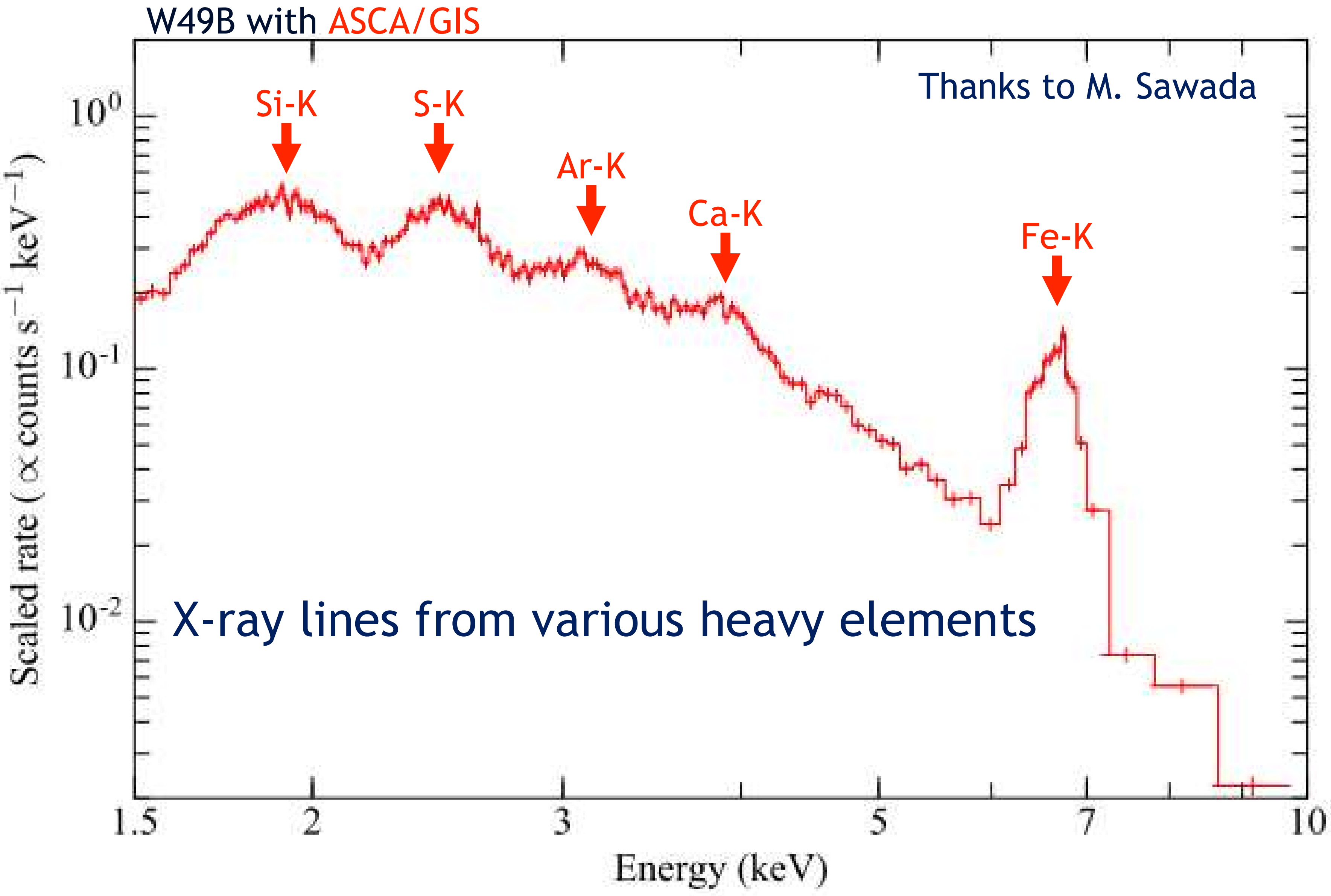
XRISM is good at
pointing objects.
Please check eROSITA talk tomorrow
for survey type missions.

main detector “Resolve”
E resolution < 7 eV !
Area > 210 cm^2 @6keV
band: 0.3-12 keV
FoV 2.9x2.9 $arcmin^2$

(c) XRISM quick reference

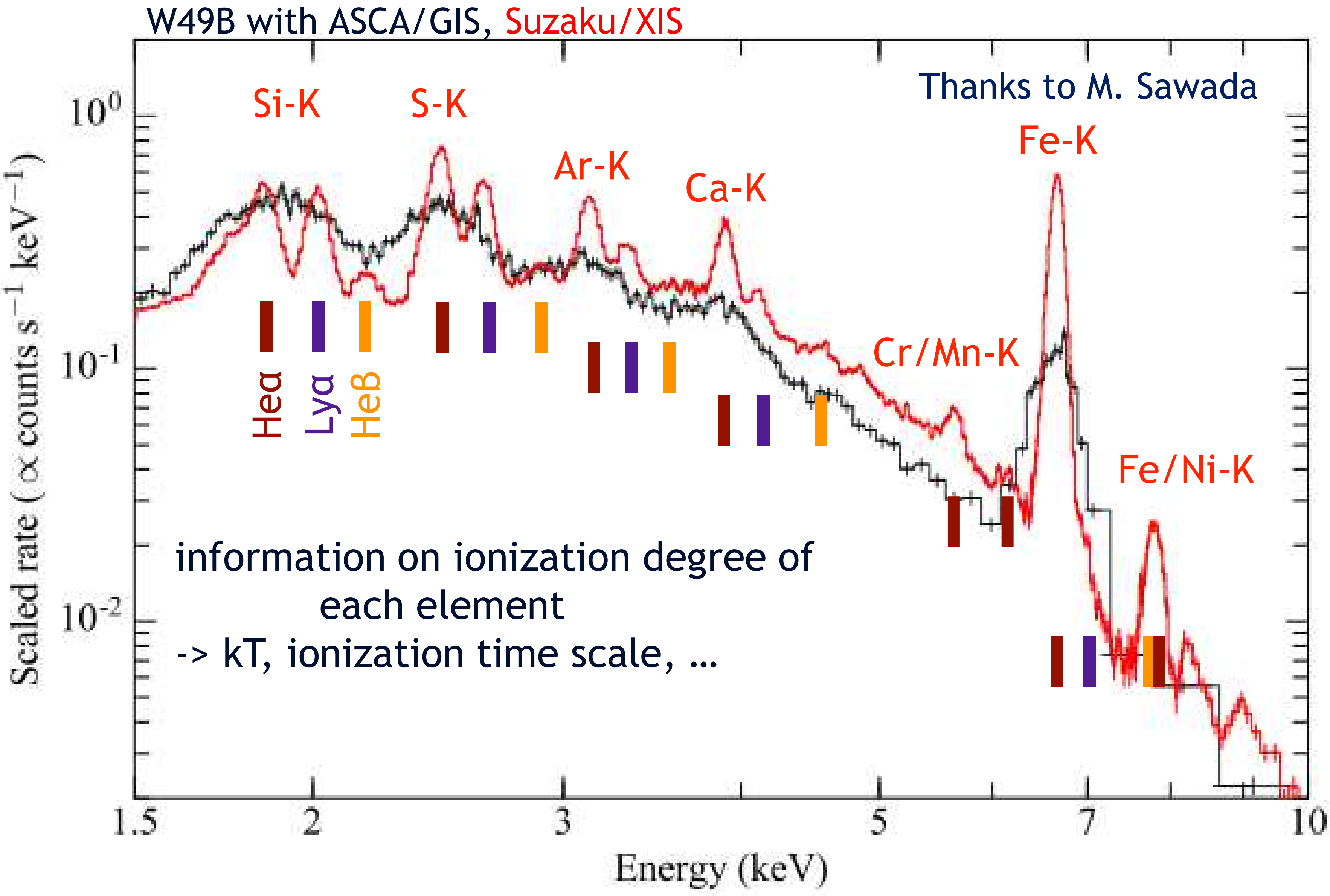
2.2.Evolution of energy resolution of X-ray astronomy

Best spectrum of X-ray astronomy in 1990s



2.2.Evolution of energy resolution of X-ray astronomy

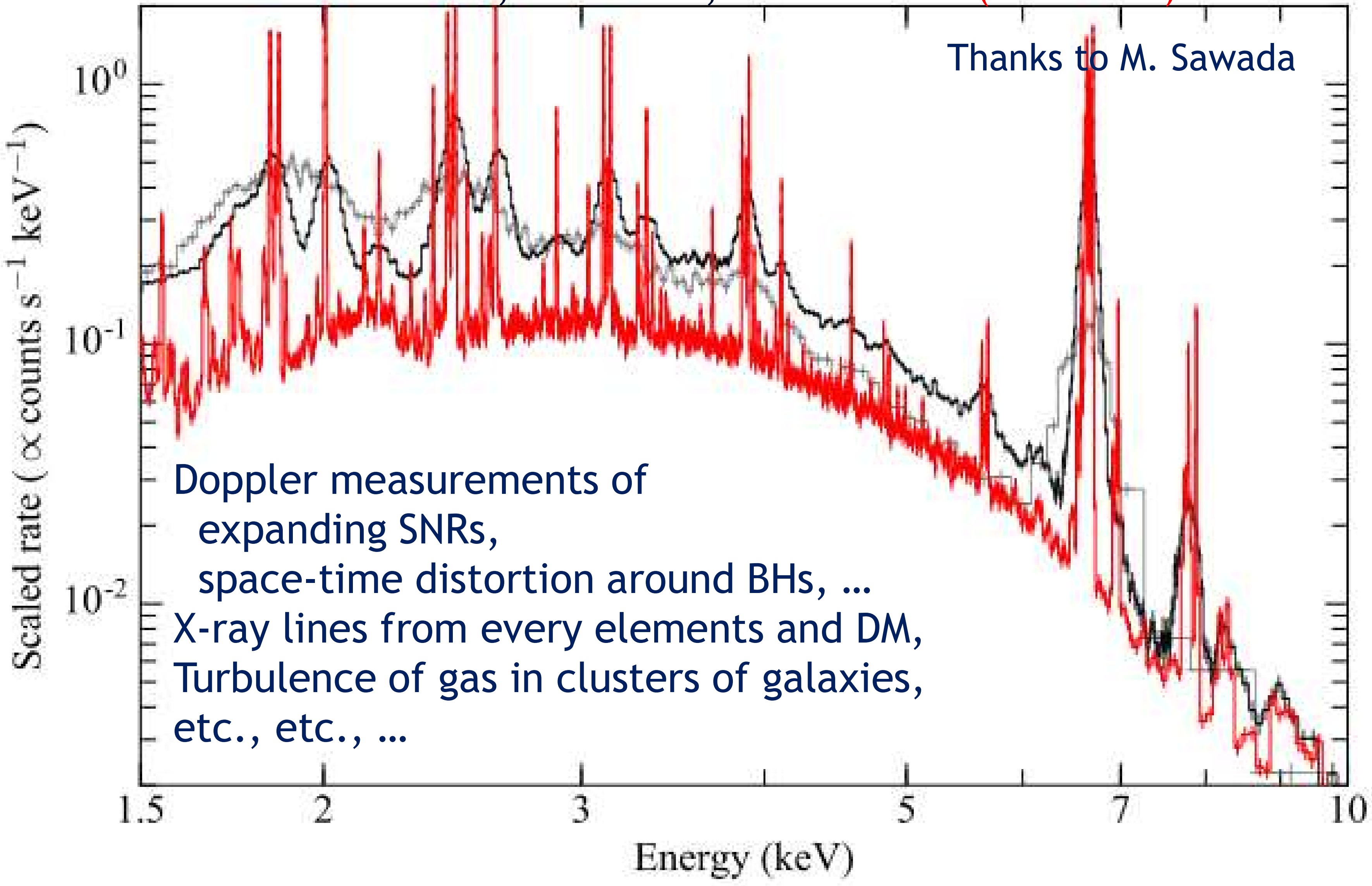
Best spectrum of X-ray astronomy in 2000s



2.2.Evolution of energy resolution of X-ray astronomy

Best spectrum of X-ray astronomy in 2020s

W49B with ASCA/GIS, Suzaku/XIS, XRISM/resolve (simulation)



3. Science cases with XRISM

3.1. The Assembly of Clusters of Galaxies

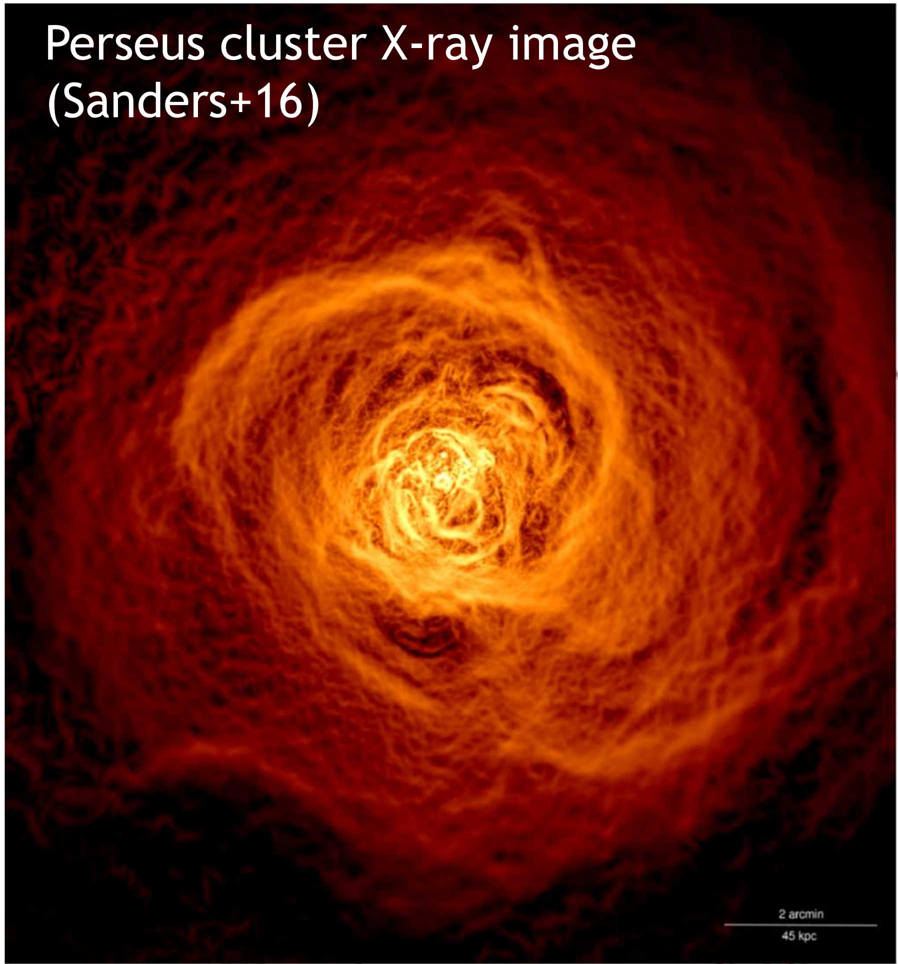
What energy source keeps galaxy cluster gas
from gravitationally collapsing?

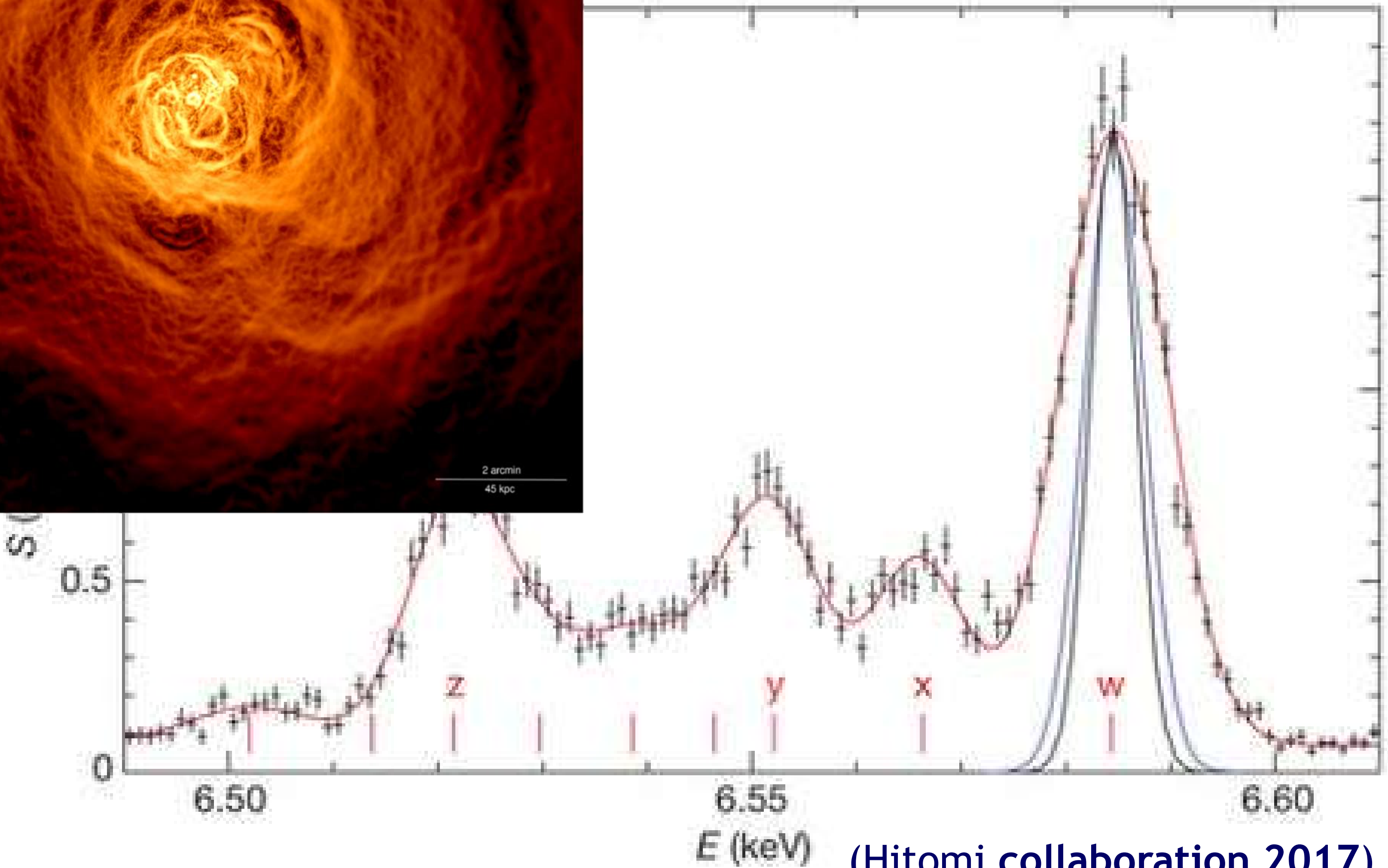
- heat transfer from thermal plasma ?
- from galaxies moving in the cluster ?
- from jets of the AGN in the central galaxy ?

We can resolve them with

- kT distribution in the cluster
- kinetic motion of plasma with Doppler broadening/shift

Turbulent velocity = 164 km/s
- mapping ?
- other elements ? (-> kT)
- other clusters ?



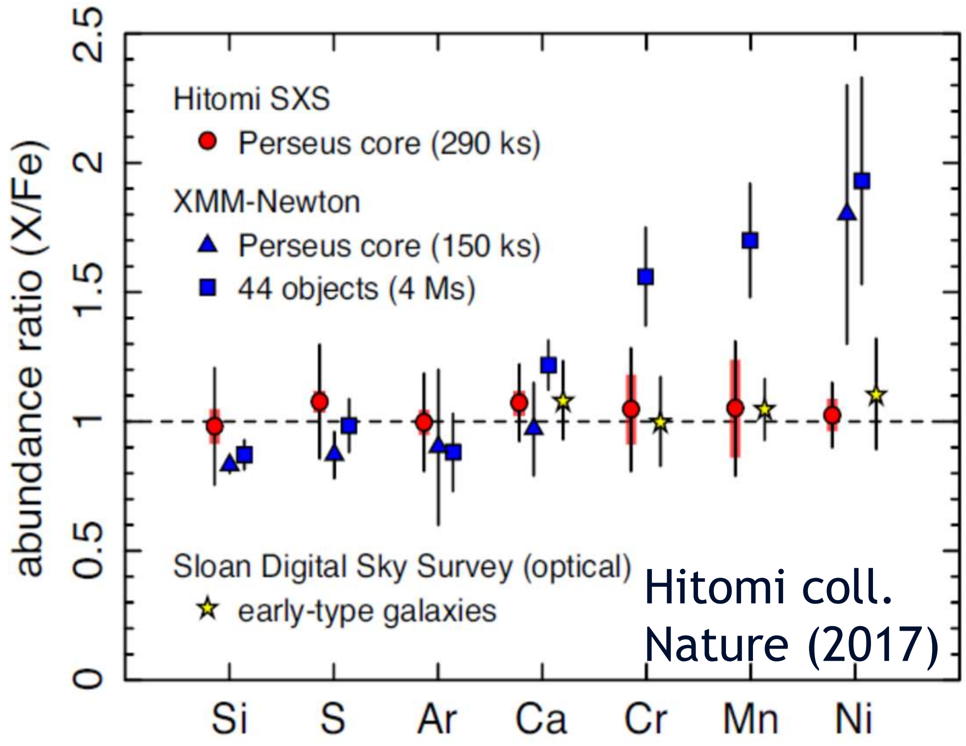


(Hitomi **collaboration 2017**)

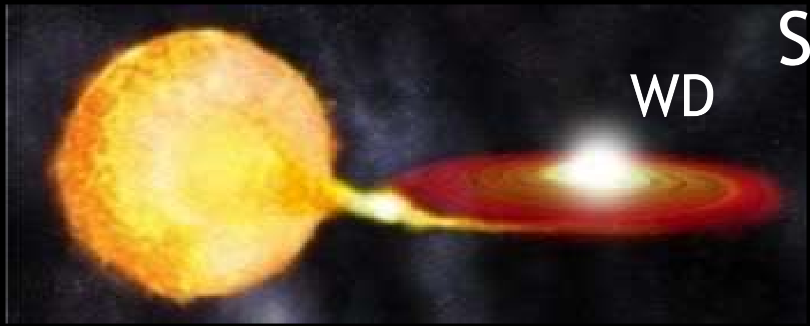
3.2. The Chemical Makeup of the Universe

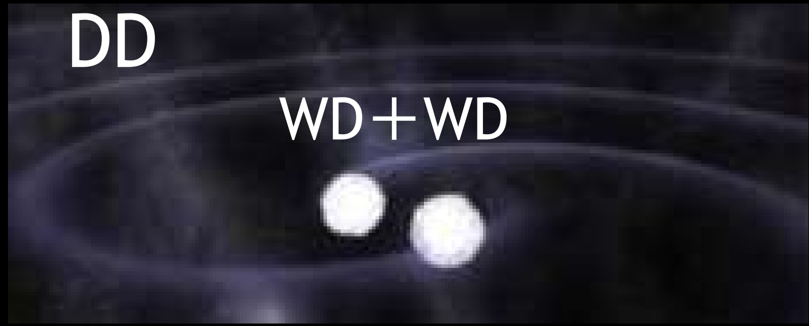
How much, and how heavy elements are distributed
from supernovae to interstellar metium ?

- measurements of iron-family elements such as Cr, Mn from Ia SNRs
- measurements of odd-elements from cc SNRs
- measurements of emission lines from Crab-like SNRs
- measurements of abundance pattern in cluster of galaxies …



Origin of Ia ?

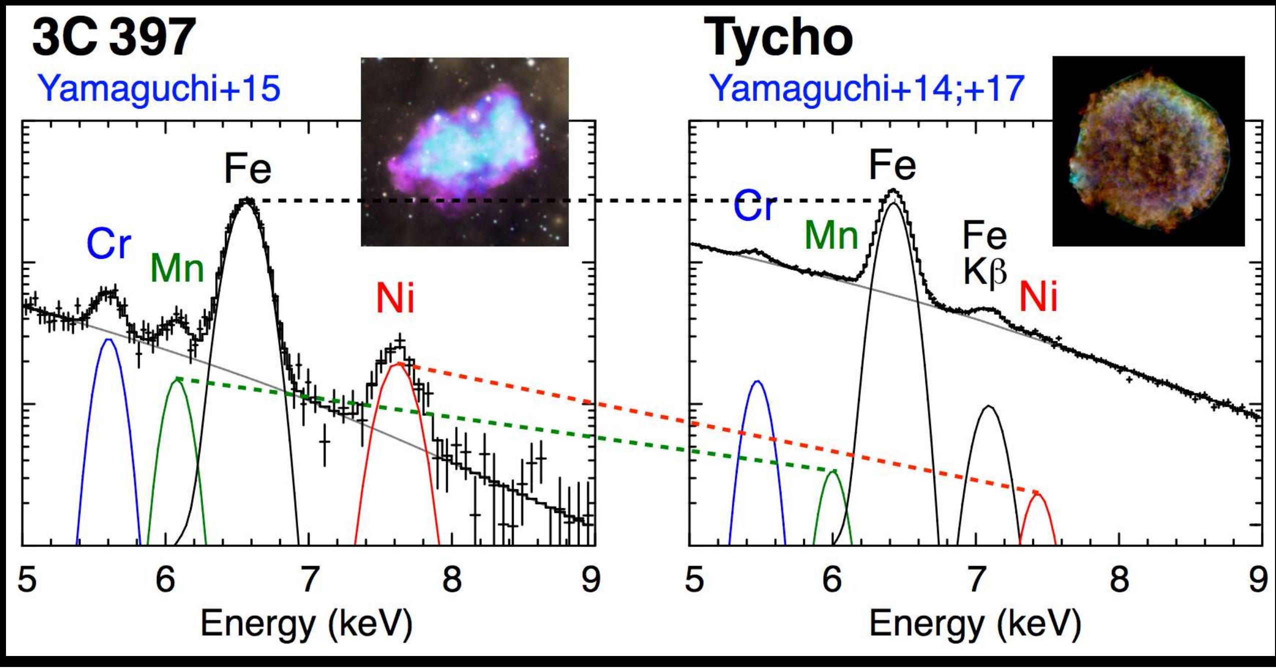




~M_{ch}, high density core($\rho \geq$ 2e8 g/cm^3) sub M_{ch}, low density core

high density core = more electron capture

-> more Ni, Mn are produced



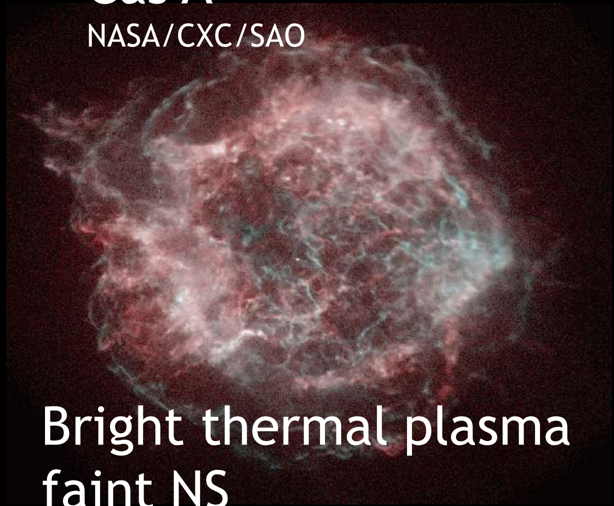
3C397 needs M_{ch}

strong diagnostics for SD/DD

Good connection with multimessenger astrophysics

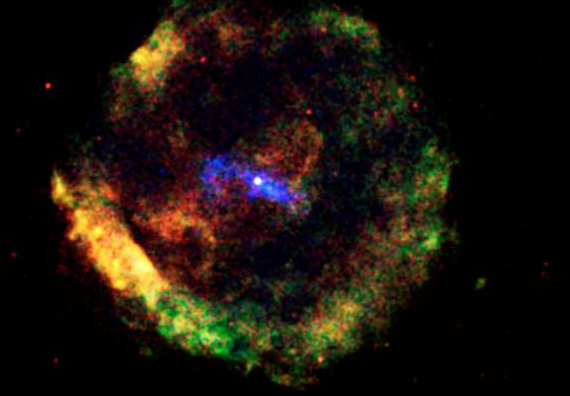
Variety of CC SNRs

Cas A
NASA/CXC/SAO



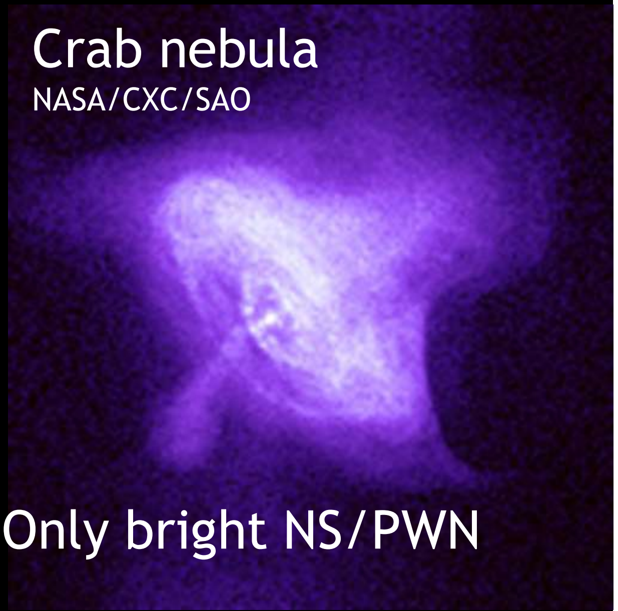
Bright thermal plasma
faint NS

G11.2-0.3
NASA/CXC/Eureka Scientific/Roberts+



Between the two

Crab nebula
NASA/CXC/SAO

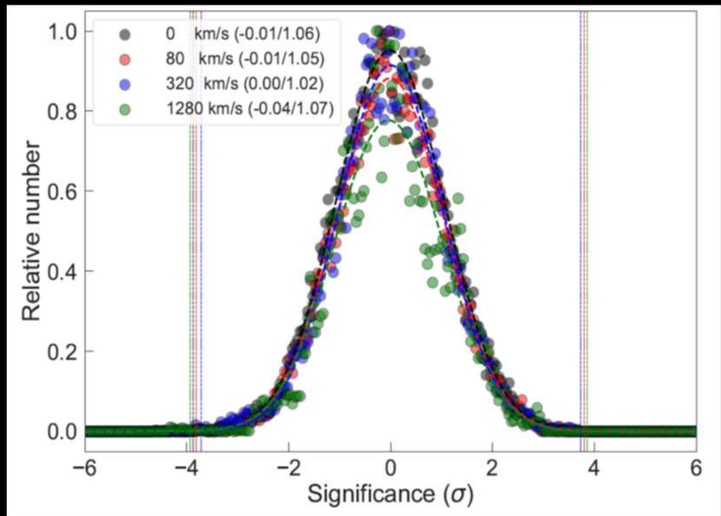


Only bright NS/PWN

What makes the difference ? -> diagnostics with abundance

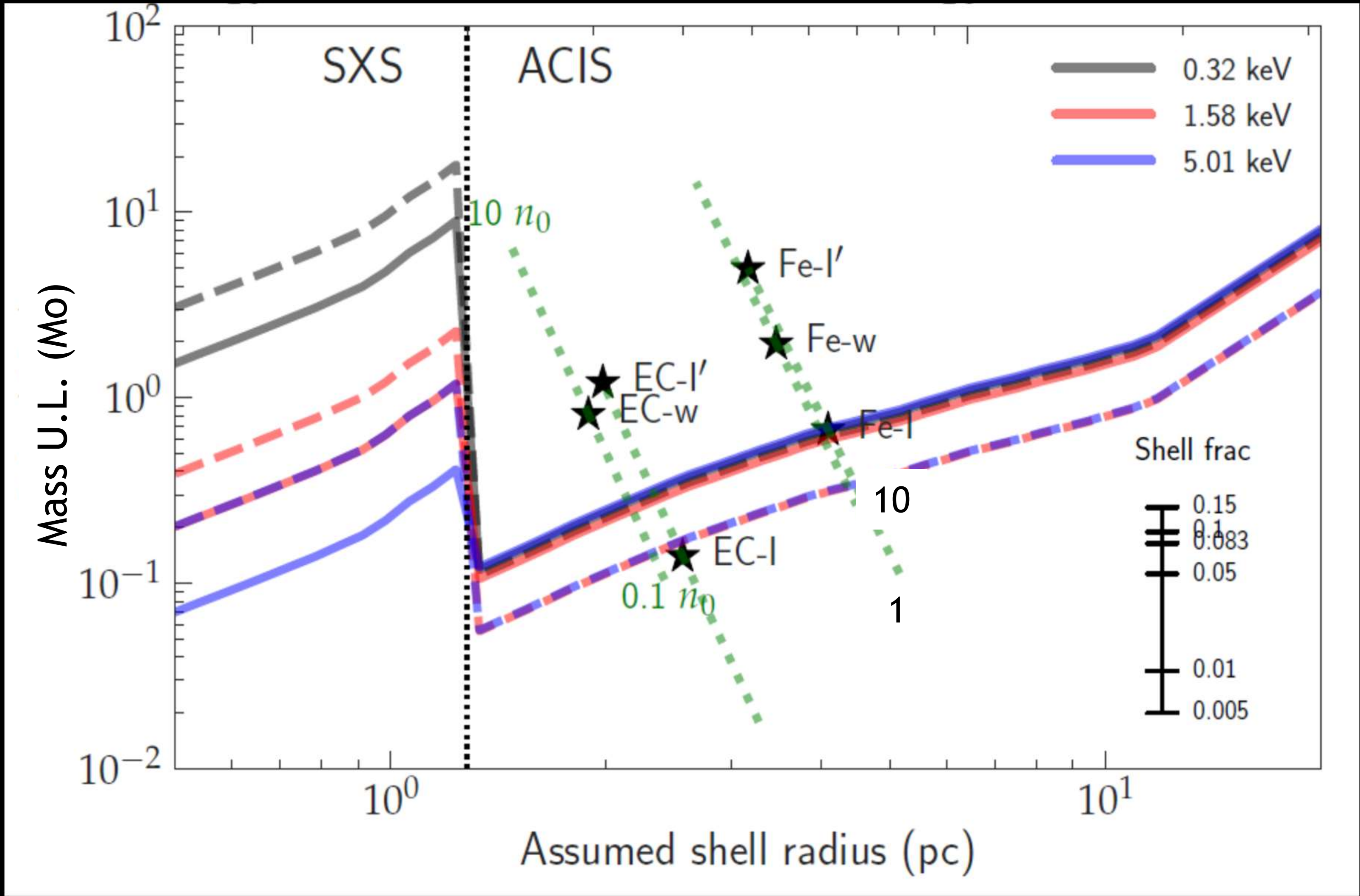
Blind line search from Crab nebula
-> No significant line detected

(Hitomi coll. 2017)



Crab Thermal line search with Calorimeter onboard Hitomi
plasma mass < 1Mo
-> electron capture SN ?

(Hitomi coll. 2017)



3.3. The Extremes of Spacetime

Detecting space-time distortion with emission lines
from accretion disks.
The structure of accretion disk is not so simple,
so we need detailed spectroscopy.

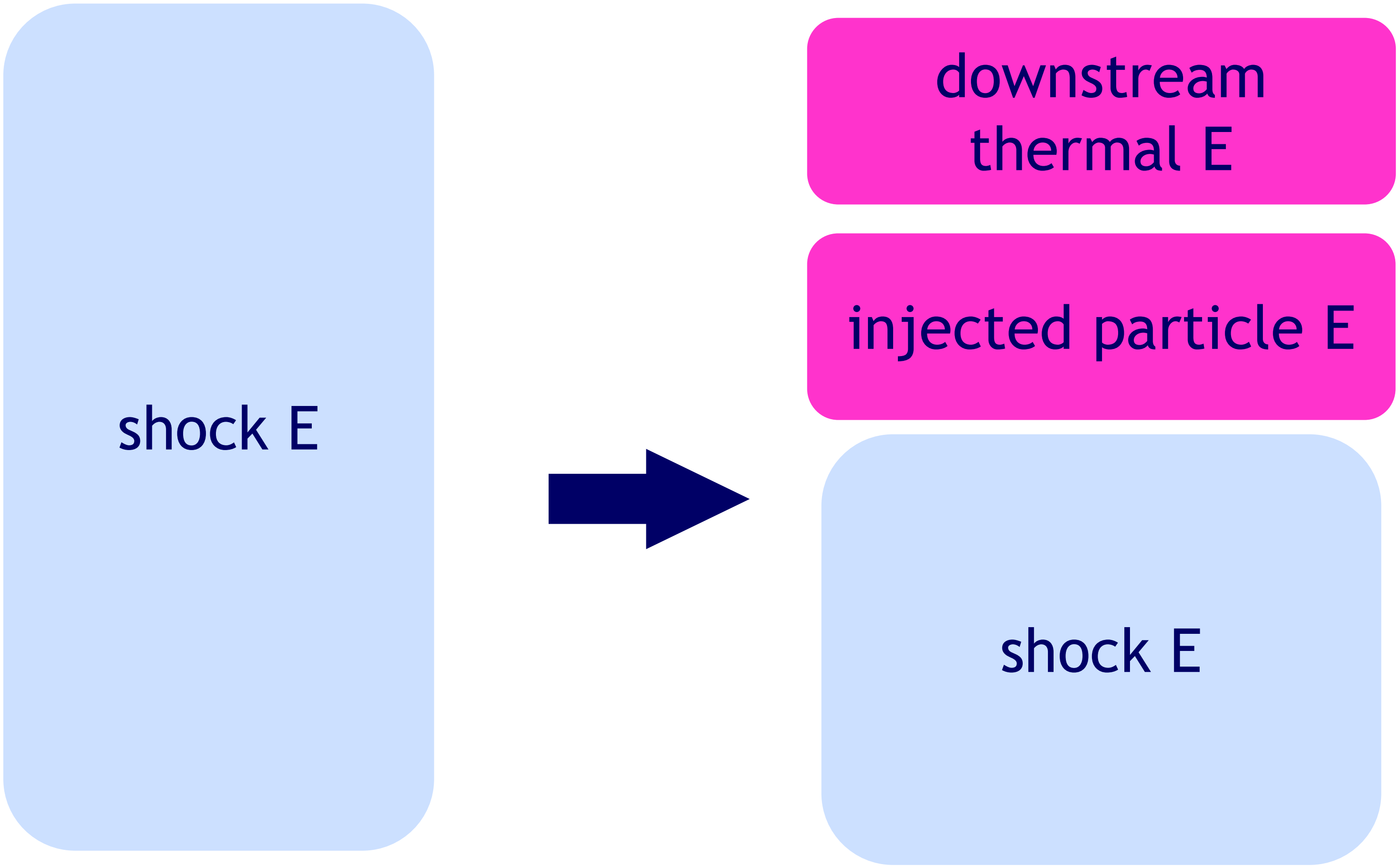
- clumpy and partially ionized absorbers
- dusty torus
- disk wind
- jets
- Compton clouds
- reflection …

Most of these components are time variable.

-> Time critical observations are very important !

idea to measure the input energy from the shock to CRs

From Rankine Hugoniot relation

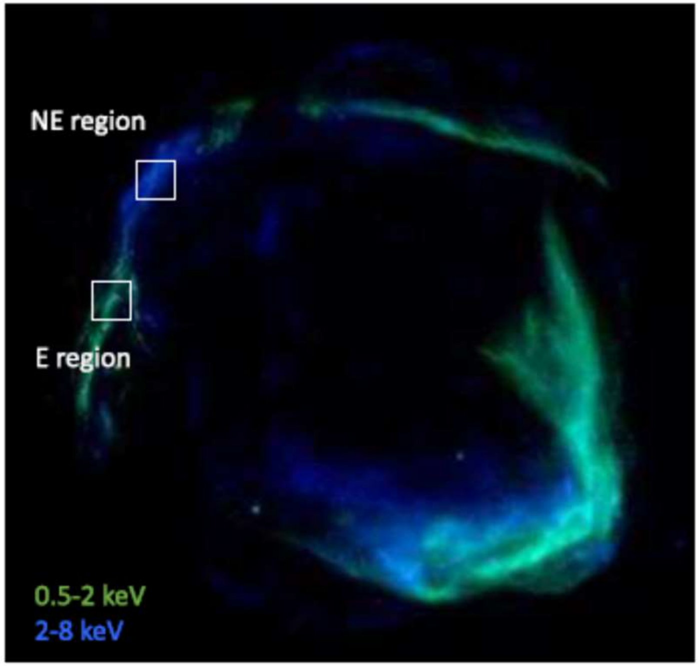


efficient particle acceleration steal energy
from the thermal energy of downstream plasma

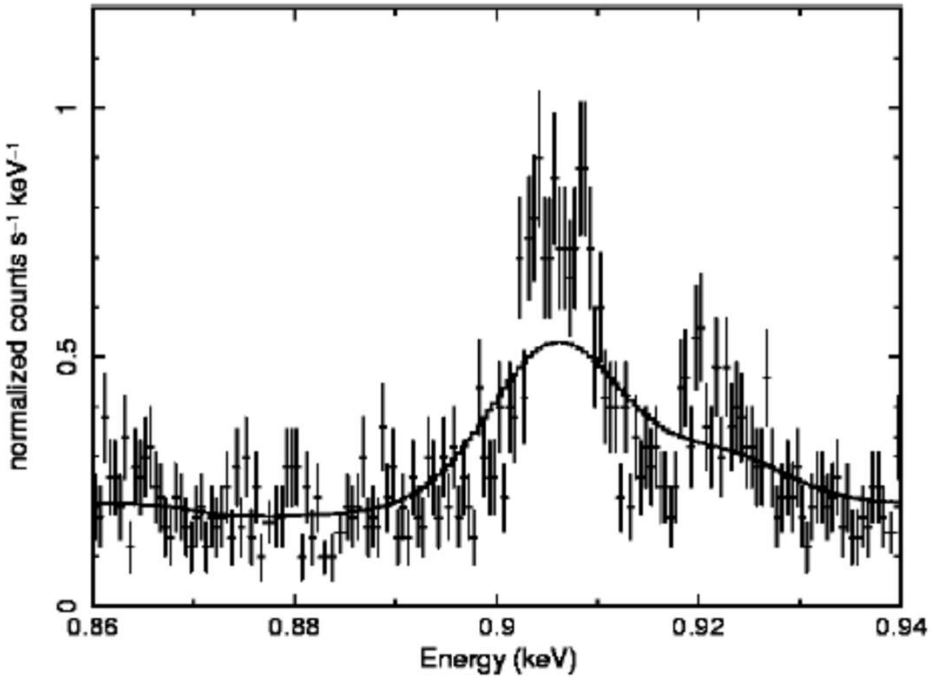
We need to know both shock velocity and thermal condition

The efficient acceleration makes lower ion temperature in the downstream

RCW86



Simulation of XRISM spectrum



Strong acc. -> low ion kT
-> small thermal broadening
(See also Shimoda+22)

4. On the Guest observer program. – Let's propose together !

- Half year starting Dec.: Performance verification phase
  Data will be opened 1 year after the observation.
- After the PV phase,
  most of observations are for guest observers.

Proposal for targets with known position:

We open GO program every year.

Japanese slot is ~50%.

Please propose ToO for targets with known position.

We can aim the target within 48 hrs from the alert.

The team members are happy to collaborate with you.

We are waiting for your contacts.

Proposal for target without known position:

Please propose them as generic ToO.

The data will be public as soon as observation.

5. Summary

- X-ray observations works as an important piece in multimessenger astrophysics.

- We are happy to announce that
  XRISM has been launched successfully,
  and will make the first light soon !

- As for the Guest observations and ToO, we are happy to help you.