

# Clusters: the X-ray perspective

**Silvano Molendi**  
**IASF-Milano/INAF**

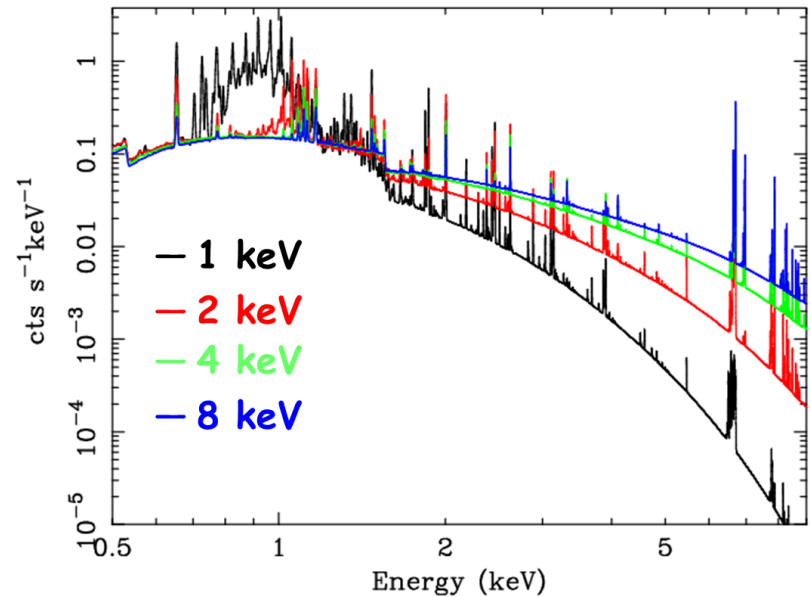
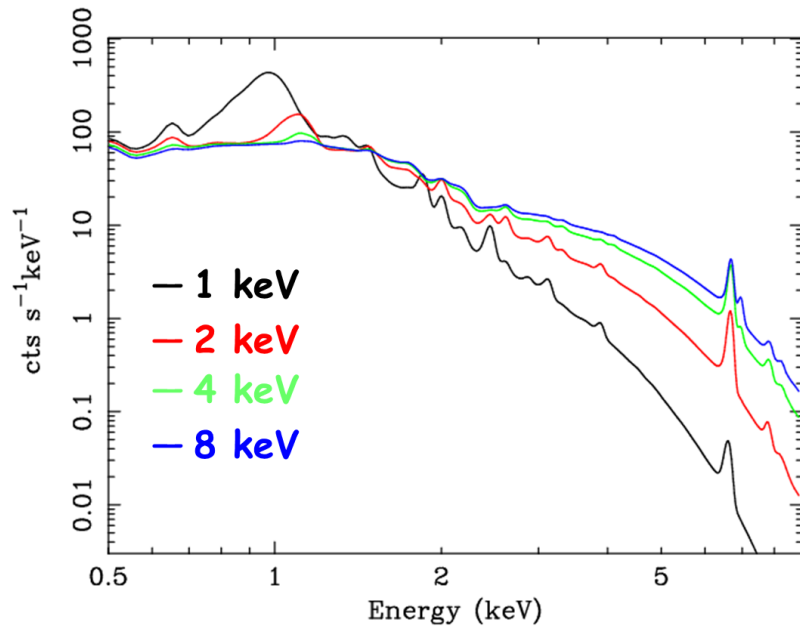
# Preliminary

Key work on clusters in X-rays depends critically on the availability of new missions carrying innovative experiments.

# Key work < 5 yrs

High spectral resolution studies Hitomi

ICM Spectra at CCD resolution ICM Spectra at SXS resolution



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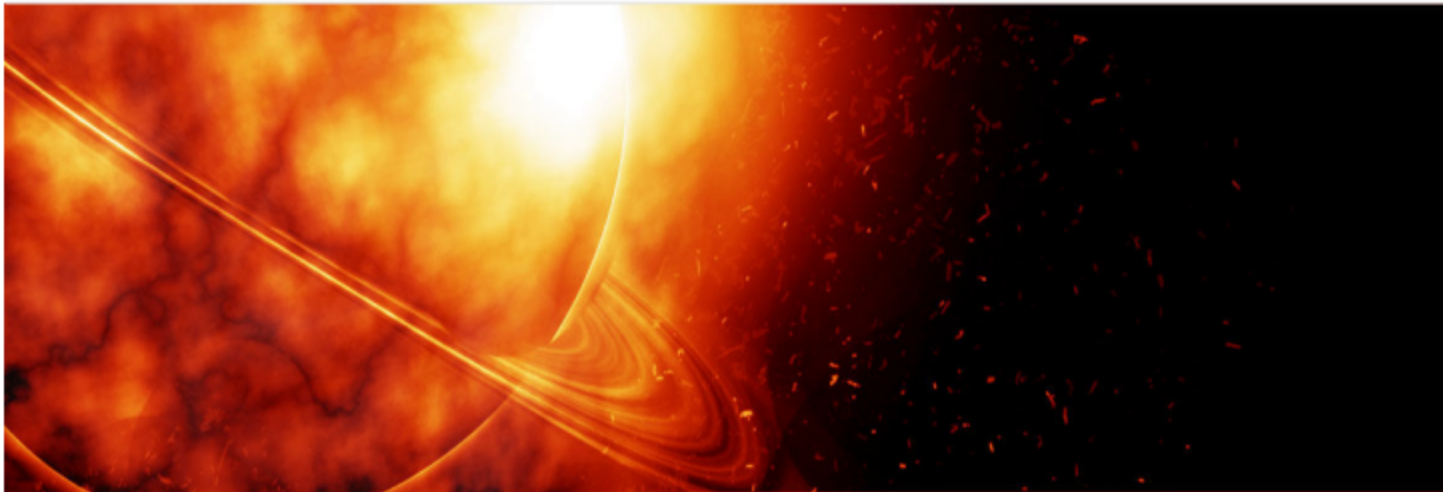
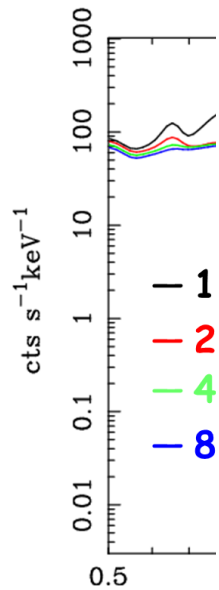
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- Gas Dynamic
- Thermodynamic Structure
- Metal content

# Key work < 5 yrs

High spectral resolution studies Hitomi

ICM S



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2016 > May > 1 > JAXA announced the loss of its Hitomi Space Telescope

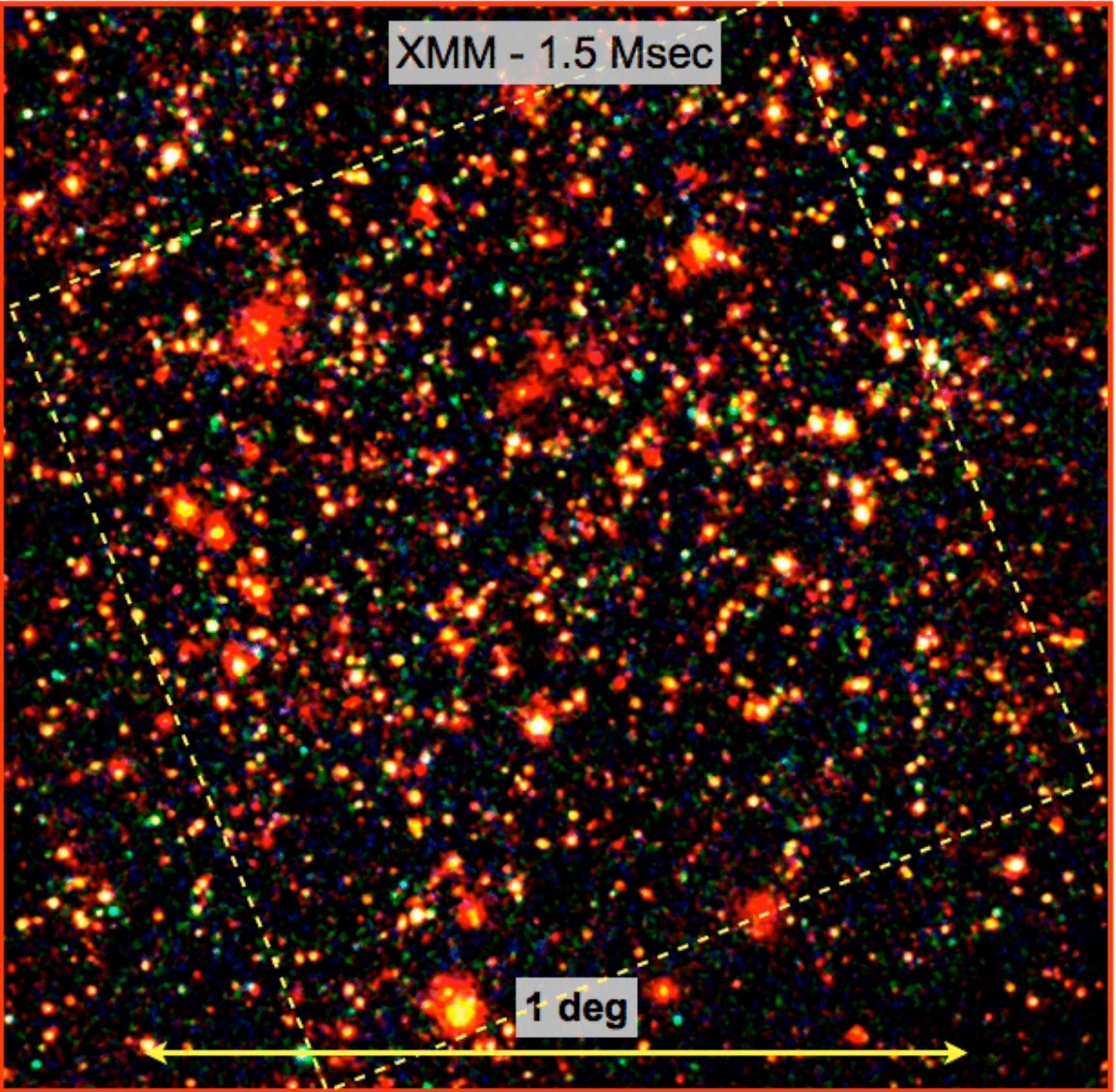
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- Metal content

# Key work < 5 yrs

## X-ray cluster surveys - eROSITA

- Spektr-RG launch currently scheduled for Sep 2017 delayed for years...
- Russian-German mission with limited participation for scientists operating in other countries
- eROSITA will not be the only cluster Survey machine SZ and optical surveys - complementarity
- Paradoxical obstacle for other telescopes with far better wide-field imaging capabilities



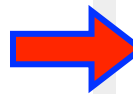
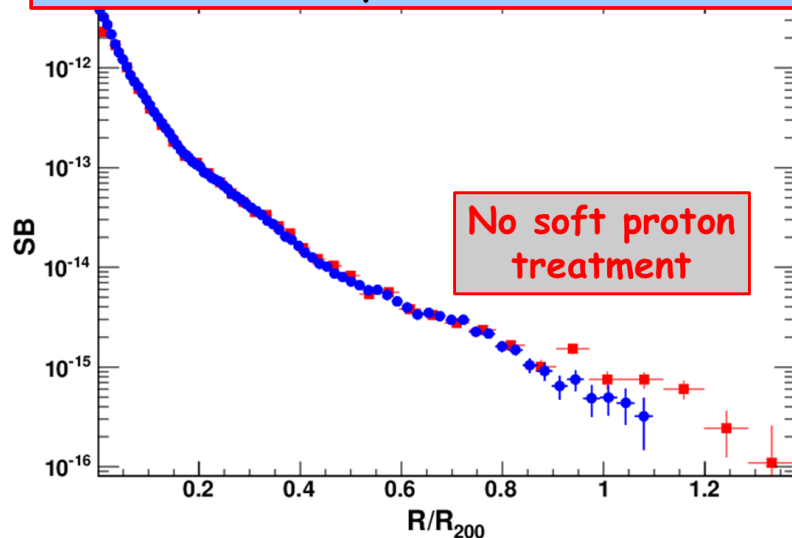
# Key work < 5 yrs

Significant improvement of exploitation of existing instrumentation

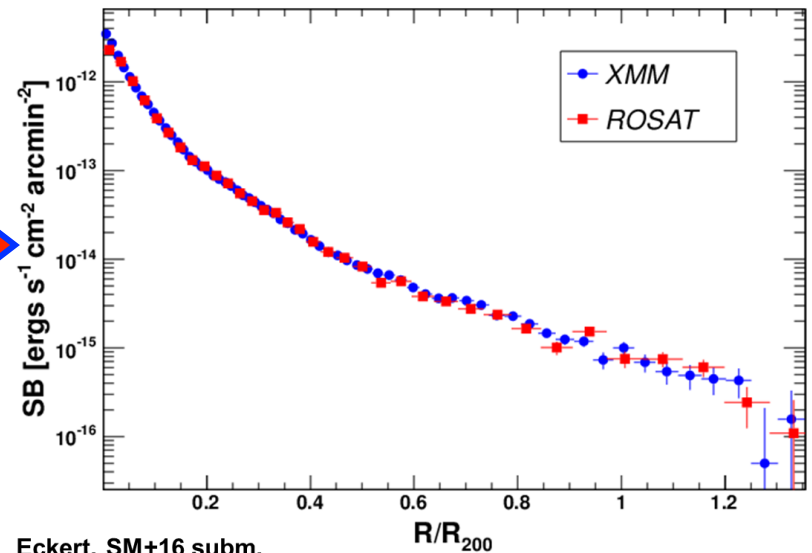
Example: long term (few years) project at IASF/ Milano to investigate XMM EPIC background

1<sup>st</sup> Result Bkg spatial characterization good to 5%

SB radial profile for A2142



SB radial profile for A2142



Eckert, SM+16 subm.

# EPIC 2.0

To reduce systematic errors must achieve a deeper understanding of instrumental bkg  
Analysis of full EPIC archive

Significant resources required



EXTraS (Exploring the X-ray  
Transient and variable Sky)  
A project within the EU-FP7  
framework



Arembes (ATHENA Radiation  
Environment Models and X-Ray  
Background Effects Simulators)  
R&D Activity within ATHENA

Work in progress  
For the time being analysis of MOS2



# Key work 5 - 10 yrs

## High spectral resolution studies after Hitomi?

### NASA-JAXA Science Cooperation Remains Solid Despite Hitomi Setback

Marcia S. Smith

Posted: 12-Jun-2016

Updated: 12-Jun-2016 02:19 PM

Japan Aerospace Exploration Agency (JAXA) and NASA officials highlighted their decades of cooperation in space science and opportunities for the future at a day-long symposium on Friday. The long-planned meeting sponsored by the Japan Society for the Promotion of Science also provided an opportunity for the head of Japan's Institute of Space and Astronautical Science (ISAS), part of JAXA, to explain the recent failure of the Astro-H (Hitomi) x-ray astronomy satellite, a joint JAXA-NASA mission.

ISAS Director General Saku Tsuneta said the Hitomi failure was the result of two different design problems and one improper operational procedure all related to the attitude control/safe-hold system. He said the failure was "embarrassing, but a fact" and his priorities now are to fix the problems, recover Hitomi science, and maintain partnerships with NASA and other space agencies. In response to a question, he stressed that although an individual made a mistake, that person should not be blamed because the system should not have been designed such that a single human error could have catastrophic consequences.

An English-language powerpoint summary of the [failure investigation report](#) is available on JAXA's website.

Hitomi failed before the operational science period began, but Tsuneta said some data were obtained on the Perseus cluster during initial operations and the cryogenic soft x-ray spectrometer (SXS) worked perfectly. SXS was developed jointly by ISAS and NASA's Goddard Space Flight Center (GSFC).

Tsuneta and Geoff Yoder, acting Associate Administrator for NASA's Science Mission Directorate (SMD), said they had just held preliminary discussions on options for getting the science data that Hitomi was intended to collect, but it is too early for decisions to be made. Tsuneta was remorseful about Hitomi's loss. "JAXA led Hitomi on behalf of the global science community. That is why this particular disaster is a severe blow to astrophysics. ... JAXA has to start something to recover the science of SXS, but this is the result of very deep cooperation between NASA and JAXA. One nation cannot do [it alone]. So I hope JAXA and NASA can work together to make it happen."

NASA/GSFC's Richard Kelley, the U.S. principal investigator for SXS, discussed the Perseus cluster observations later in the day and noted that if a decision is made to perform a recovery mission, there is spare hardware for key components of SXS.

Both agencies have a full plate of space science missions already on their dockets, so adding a new mission to replace Hitomi would be difficult to achieve. The next planned x-ray astronomy satellite is the European Space Agency's (ESA's) ATHENA, scheduled for launch in 2028.

# Key work 5 - 10 yrs

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# Key work > 10 yrs

## Athena

### WFI

- Cluster outskirts imaging
- Unveil the physics of proto-ICM from SZ/optical-IR clusters/protoclusters

### XIFU

- Gas Dynamics on few arcsec scale
- Thermodynamic Structure
- Metal content also of rare elements