Chemical evolution and cluster physics with the deep CHEERS sample

Jelle de Plaa

Representing the CHEERS collaboration:

Francois Mernier (SRON), Ciro Pinto (IoA, Cambridge), Yu-Ying Zhang (Bonn), Lorenzo Lovisari (Bonn), Jelle Kaastra (SRON), Hiroki Akamatsu (SRON), Norbert Werner (Stanford), Aurora Simionescu (JAXA), Gerrit Schellenberger (Bonn), Thomas Reiprich (Bonn), Jeremy Sanders (MPE), Hans Boehringer (MPE), Florian Hoffman (MPE), Alexis Finoguenov (Helsinki), Onno Pols (Nijmegen Univ.), Andy Fabian (IoA, Cambridge), Jacco Vink (Univ. of Amsterdam)

SRON

Netherlands Institute for Space Research

Netherlands Organisation for Scientific Research (NWO)

CHEERS

CHEERS stands for: CHEmical Evolution RGS Sample

- Very large XMM-Newton program of 1.6 Ms
- Obtain deep RGS observations of 11 local clusters and groups ($z<0.2$)

Main science topics:

- ***Chemical evolution of the hot ICM***
- Cooling and feedback in cluster cores
- ***Velocity broadening in cluster cores***
- Mapping substructures with EPIC

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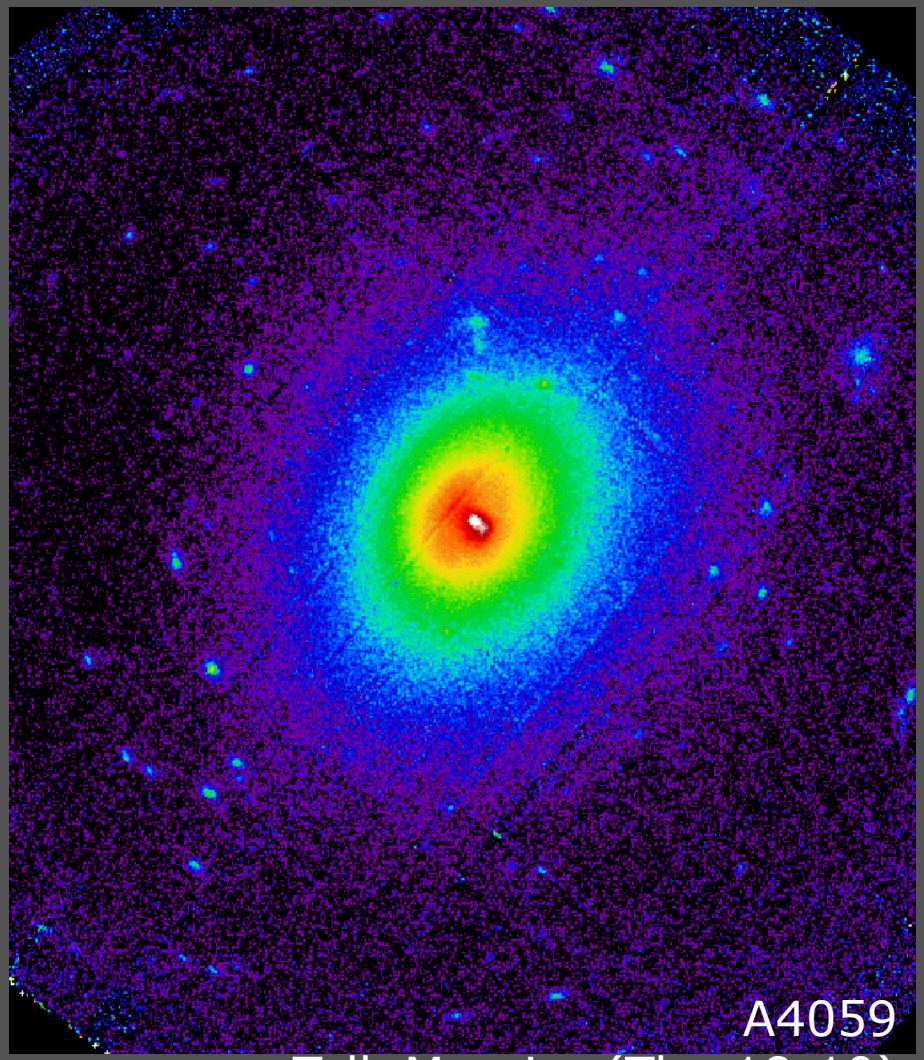
Origin of elements in clusters



- ICM is metal enriched
- Most metals originate from star burst at z~2-3
- Metal producers:
  - Type Ia supernovae
  - Core-collapse supernovae
  - Intermediate-mass AGB stars

Talk Mernier (Thu 18:10)

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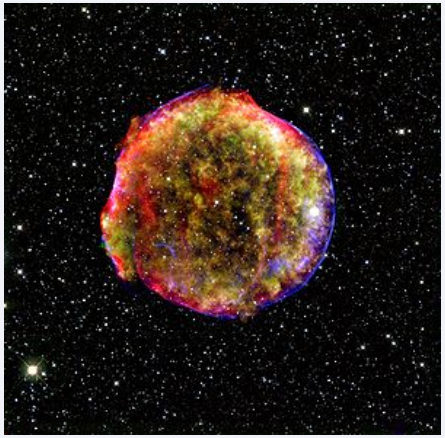
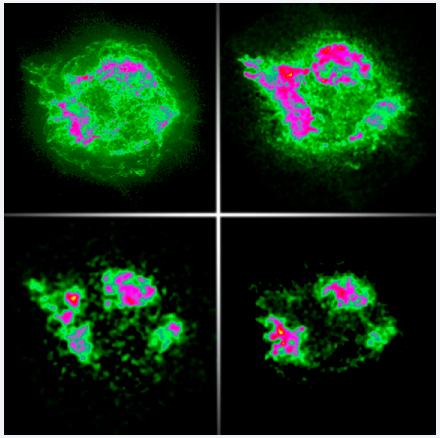
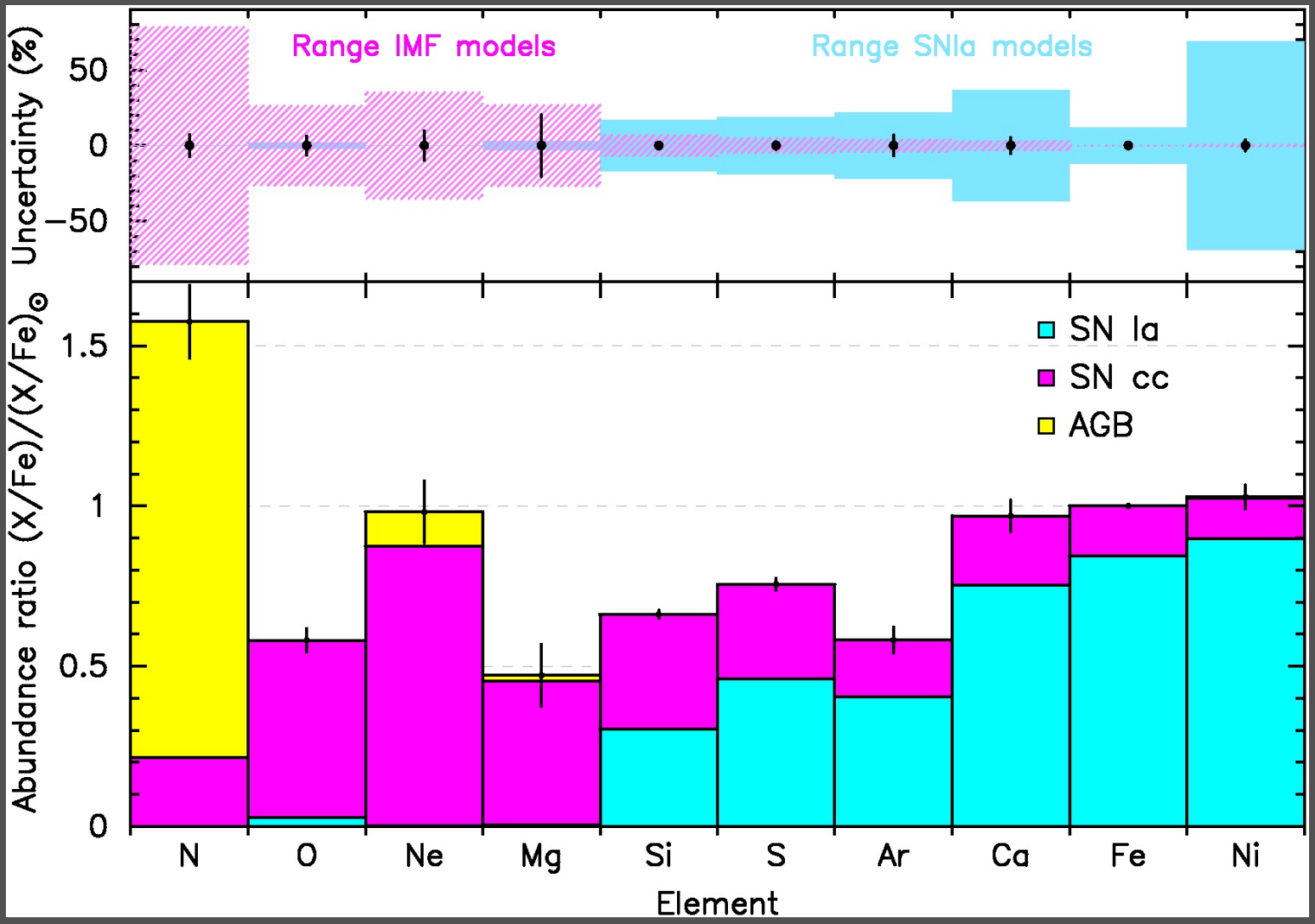
Sources of metals

Intermediate mass stars (AGB) $M < 8\ M_{sun}$	Type Ia Supernovae	Core-collapse Supernovae
•Nitrogen & Carbon •Strong winds	•High-mass elements (Si, S, Fe, Ni) •Explosive ejection into ISM	•Low-mass elements (O, Ne, Si) •Explosive ejection into ISM
		

Expected ICM abundances from SN/AGB models



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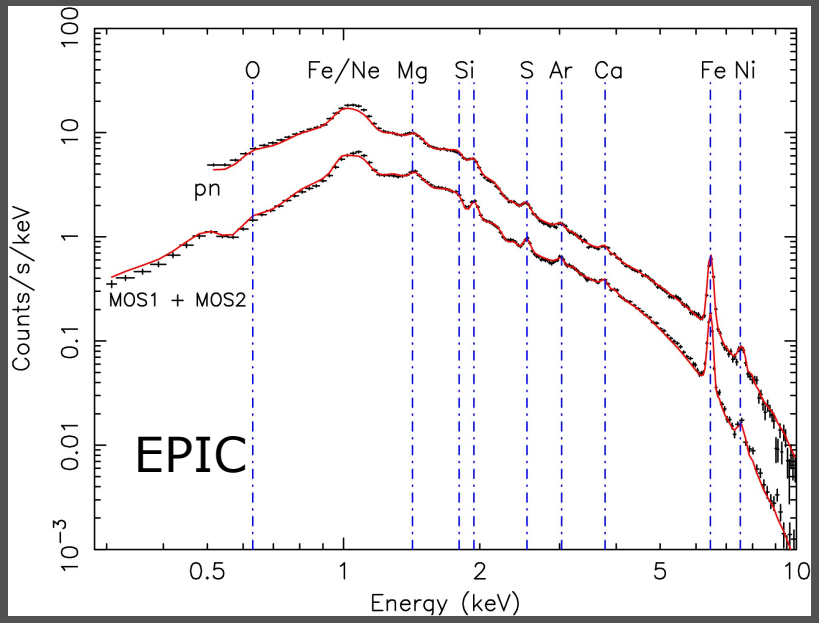
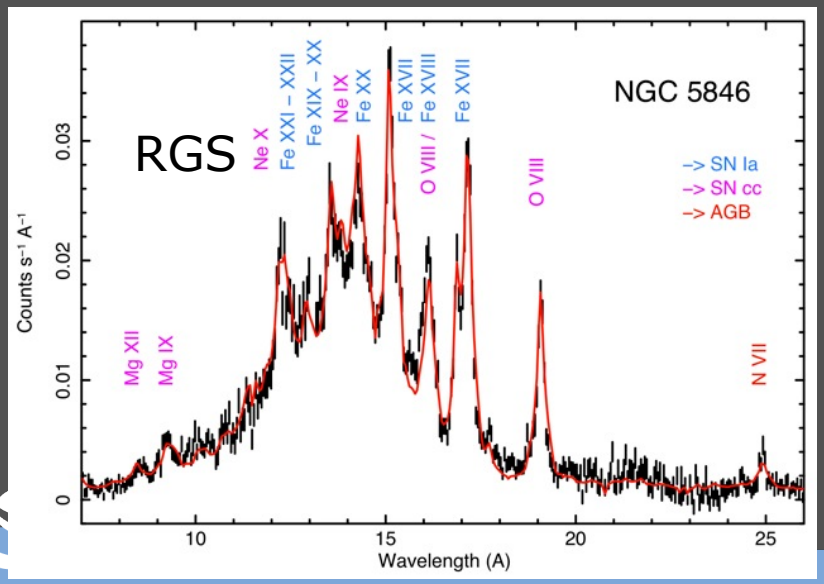
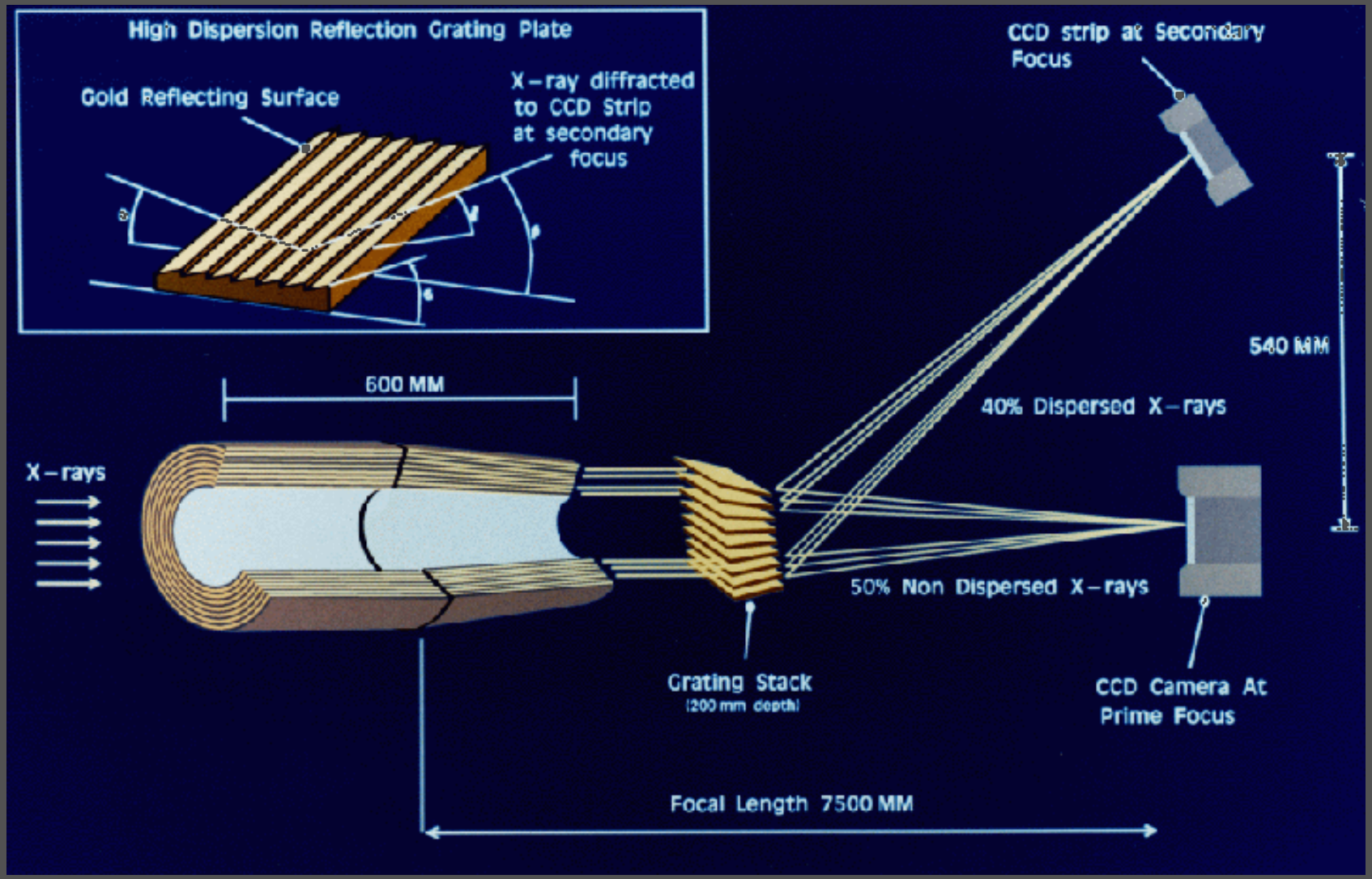
Measuring abundances with XMM





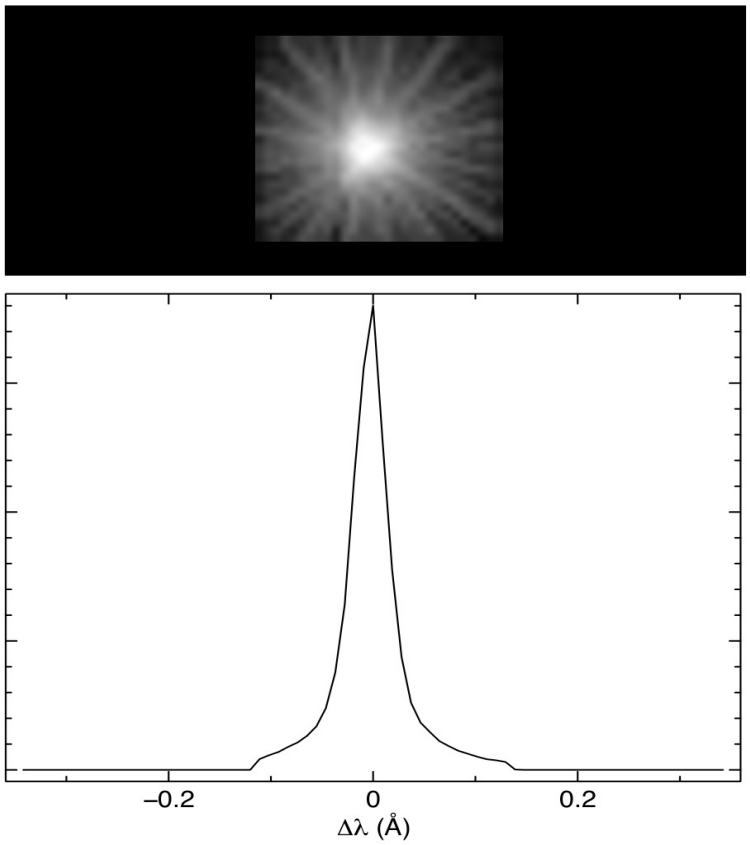
- EPIC: O, Mg, Si, S, Ar, Ca, Fe, Ni
- RGS: N, O, Ne, Mg, Fe
- Both EPIC and RGS needed to cover many elements!

The RGS instrument

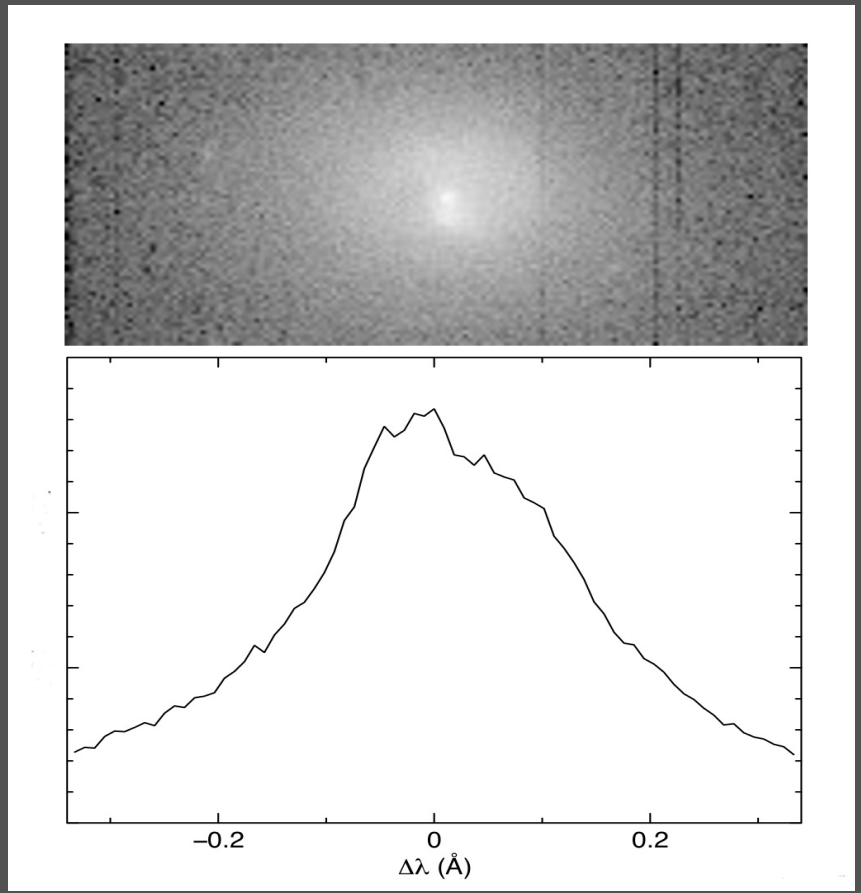


Line broadening in RGS

Point sources

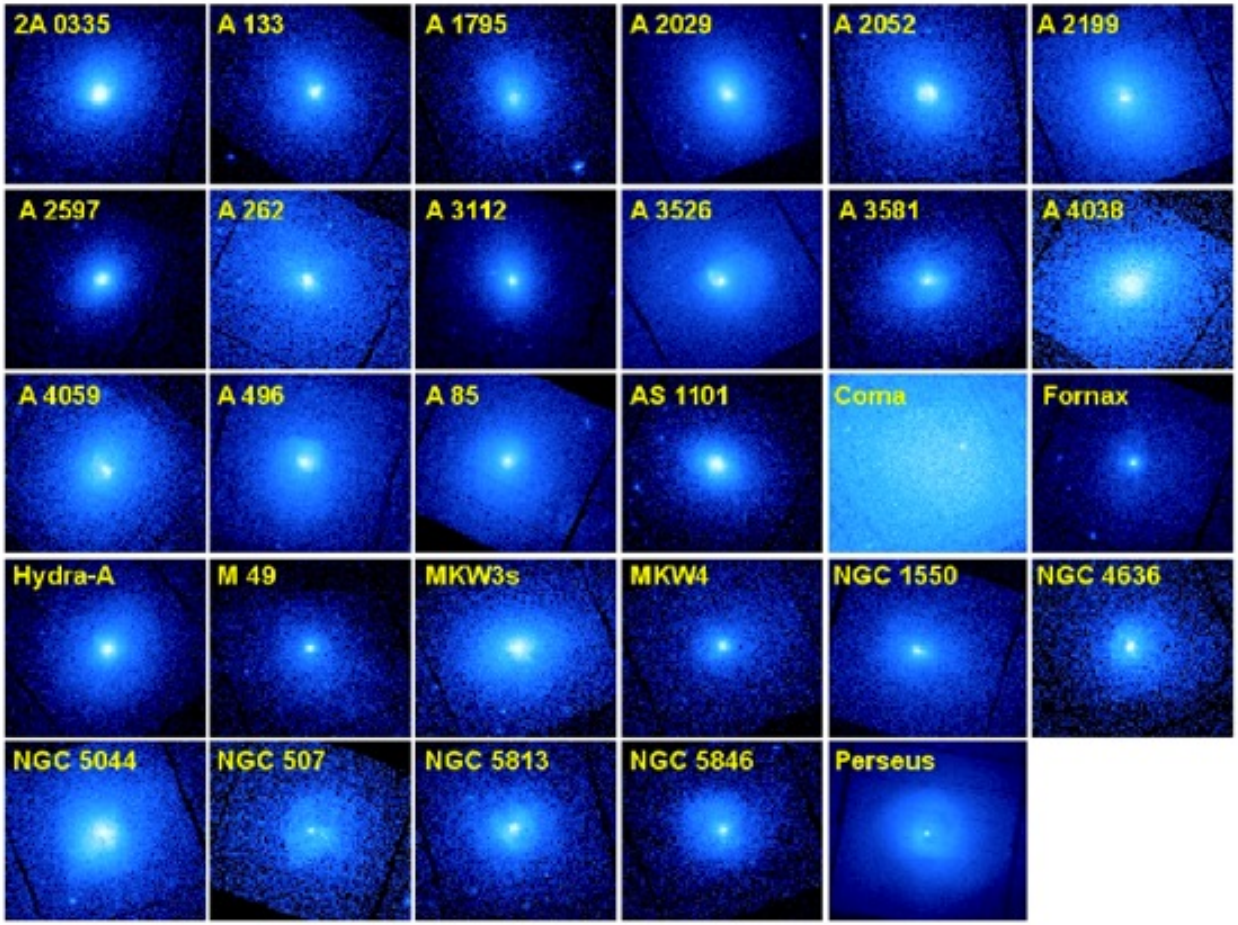


Extended sources



$\Delta\lambda = 0.138\ \Delta\Theta$ (arcmin)

Selection of clusters



- Need bright clusters (-> HIFLUGCS sample Reiprich & Bohringer 2002)
- Need compact (cool) cores

Goal:

- 'Complete' sample of RGS clusters within reasonable exposure.
- Significance of O line main criterion exp. time

Credits: Ciro Pinto (IoA Cambridge)

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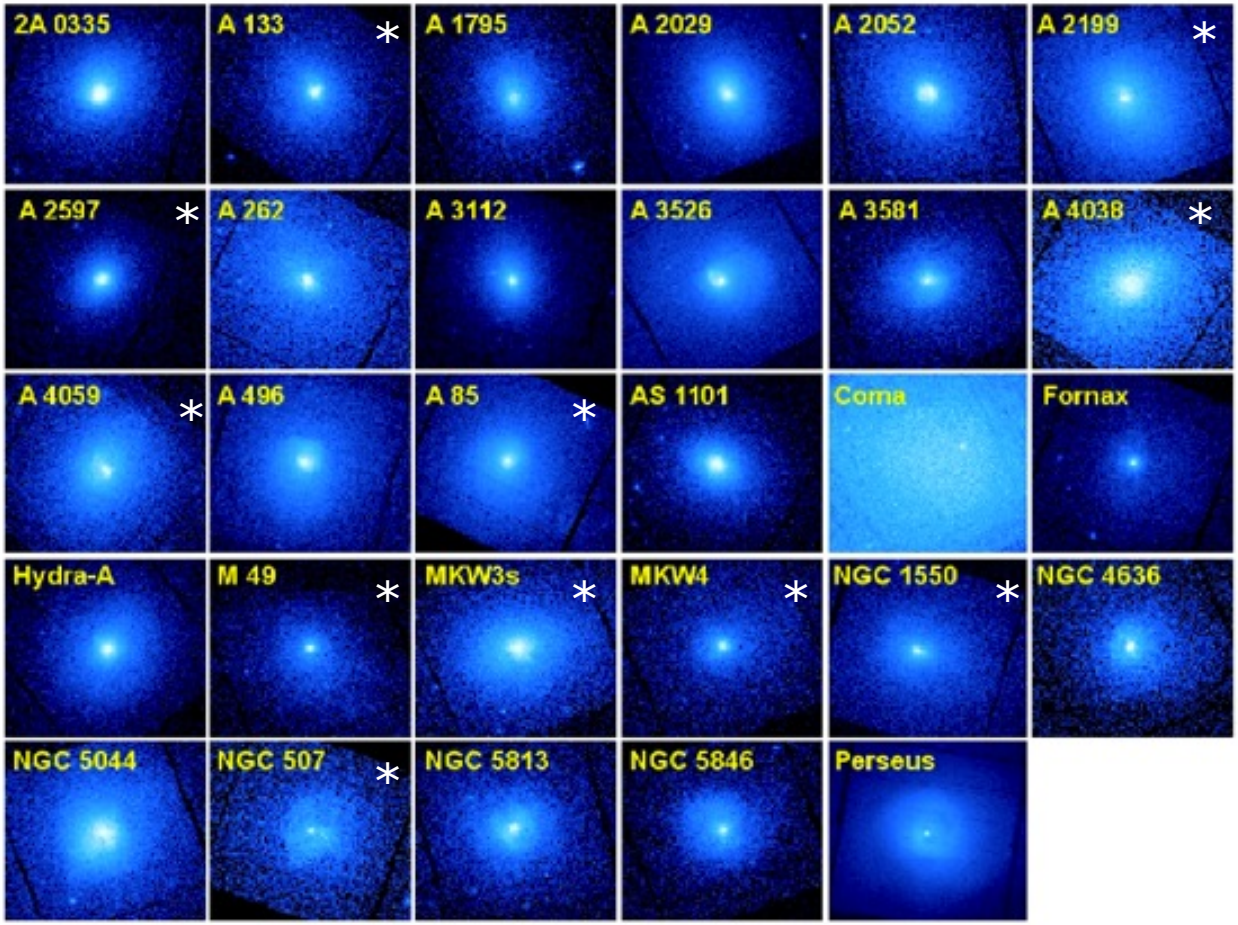
Selection of clusters



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Science topics that we address

Presented at this conference:

- Chemical evolution (see talk Francois Mernier, Thu 18:10)
- Velocity broadening (see **next talk** by Ciro Pinto)

Also in development:

- Heating and cooling in clusters
- Cluster substructures
- Radio relics

Summary

Exciting long exposures of 11 bright clusters

- Data suitable for abundance studies
- RGS data puts constraints on velocity broadening
- See talks by Ciro Pinto and Francois Mernier!

The CHEERS collaboration:

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