X-ray gaseous emission in star forming galaxies

Piero Ranalli

National Observatory of Athens
&
INAF - OA Bologna
Different views of the same phenomenon
Spatially resolved spectroscopy with EPIC
Understanding chemical evolution and enrichment

The spectral parameters of the outflow plasma in M82 are spatially dependent (Ranalli et al. 2008).

They are probably connected to the supernova yields and/or to mass loading.

Ranalli et al. 2008 MNRAS 386, 1464
also Tsuru et al. 2007
NGC3256

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(outflow is superimposed on the centre)

Chandra:
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Observed 130ks with XMM:
NGC3256

$L_x \sim 10^{41}$ erg/s, observed face-on $\Rightarrow$ cannot slice the outflow
Highly (3-5 x) super-solar abundances
OVII triplet shows CE on top of thermal
NGC253
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170 ks with XMM:
NGC 253
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Fe K  +XXVI
NGC253
170 ks with XMM:

Fe K + XXVI
Mg
NGC253
170 ks with XMM:

Mg
Ne
NGC253
170 ks with XMM:

Mg
Ne
Fe XVII (L shell)
NGC253
170 ks with XMM:

Mg
Ne
Fe XVII (L shell)
O VII+VIII
NGC253
170 ks with XMM:
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$\alpha$/Fe $\sim$ 1.2
$kT$ $\sim$ 0.2 keV

$-2000 < \Delta v < 7000$ km/s

10x faster than H$\alpha$, but X-ray gas is expected to be faster than H$\alpha$ (Strickland et al.; Lehnert et al.)
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The XMM/RGS has produced a beatiful **average** spectrum which is extremely difficult to analyse.
The future / 1 : Astro-H

The calorimeter in development for Astro-H (FOV ~3', ΔE ~7 eV) performs almost like the XMM RGS does for point sources. Same performance for point and extended sources.

There is sufficient resolution in the O\text{VII} triplet to identify the origin (thermal or CE)
The future / 2 : XEUS→Athena→(Pollon?)

A calorimeter as proposed for Athena (~5' FOV, ΔE~1.5--2.5 eV) performs more or less like the XMM RGS does for point sources and allows the separation of different patches of the sky (and, hopefully, exclude point sources)

E/ΔE @ 1 keV: EPIC/PN~7 RGS~300 (point sources)
ASTRO-H~150 Athena~400--700
Conclusions:

**M82**
- chemical abundances depend on distance from the galaxy centre
- shows chemical enhancement in the far outflow
- bimodal temperature distribution => nonthermal electrons?
- detection of CE
- O cooling by CE?

**NGC3256**
- spectrum shows CE on top of thermal
- super-solar abundances => can compare with stellar (NIR data available)

**NGC253**
- $\alpha$/Fe $\sim$ 1.2
- blueshifts in the outflow