

XMM-Newton: The Next Decade 2007 Science Workshop

4th-6th June 2007 Madrid, España



A high-resolution survey of the physical and chemical inhomogeneities in the Vela SNR

Marco Miceli, INAF - Osservatorio Astronomico di Palermo Consorzio COMETA, Italy

<u>Collaborators</u>

F. Bocchino, INAF - Osservatorio Astronomico di Palermo, Italy

- F. Reale, INAF OAPa, Università di Palermo, Italy
- S. Orlando, INAF Osservatorio Astronomico di Palermo, Italy

The Vela SNR



0.1-2.4 keV (ROSAT All-Sky-Survey)

Combined analysis of 3 XMM-Newton EPIC observations of the northern rim of the shell

Our aims:

- High-resolution study of a large area (~11 pc²) of the shell
- Distribution of the physical and chemical properties of the shocked plasma

Miceli, M.: Inhomogeneities in the Vela SNR - XMM Workshop, Madrid

The data



-	CAMERA	t_{exp} (ksec) ^I	Mode	Filter
FilD {	pn	26.8/11.5	Ext. Full Frame	medium
	MOS1	31.1/25.2	Large Window	medium
	MOS2	31.1/25.2	Large Window	medium

I. Unscreened/Screened exposure time.

Miceli et al. 2005, A&A, 442,513

	CAMERA	t_{exp} (ks)*	Mode	Filter
egNE {	MOS1	52.1/26.3	Large Window	medium
	MOS2	52.1/27.3	Large Window	medium
	pn	48.6/18.2	Ext. Full Frame	medium
FilE {	MOS1	39.8/32.7	Large Window	medium
	MOS2	40.0/28.5	Large Window	medium
	pn	35.8/23.7	Ext. Full Frame	medium

* Unscreened/Screened exposure time.

Morphology of the X-ray emission



Green: X-ray contour levels at 75% of the maximum in the 0.3-0.5 keV band Red: X-ray contour levels at 50% of the maximum in the 0.5-1 keV band



Spatially resolved spectral analysis

Spectra extracted from homogeneous regions where the median photon energy has low fluctuations ($\Delta MPE/MPE \leq 3\%$).



All spectra are described well by two thermal components (only one component in RegNE).

The temperatures of the two components are almost uniform in the whole region.



Chemical abundances in middle-aged SNR

In middle-aged SNR the bulk of the X-ray emission is commonly associated with shocked ISM, **but**:

 Vela SNR: 6 X-ray emitting shrapnels, probably associated with ejecta (e. g. shrapnel D, with overabundant O, Ne, and Mg, Katsuda & Tsunemi 2005)



Cygnus Loop: claims of chemical inhomogeneities at large (Miyata & Tsunemi, 1999, but see Levenson et al. 2002) and small scale (Leahy 2002), but with values always lower than (or consistent with) solar.

Miceli, M.: Inhomogeneities in the Vela SNR - XMM Workshop, Madrid

Equivalent width maps

To investigate the spatial distribution of the chemical abundances we produce equivalent width images of the Ne IX and Mg XI emission lines:



N.B. The continuum slope and the N_H are quite uniform in the whole region Warning 1: Blending between the Ne IX K-lines and the Fe XVII L-lines Warning 2: Poor statistics for the Mg XI line

Miceli, M.: Inhomogeneities in the Vela SNR - XMM Workshop, Madrid

Equivalent width maps





Spatially resolved spectral analysis - abundances



Ejecta (shrapnels?) mixed with the ISM/CSM?

New X-ray emitting ejecta within the Vela shell?

The position of the shrapnels depends on their initial velocity (which is a function of their initial position in the ejecta profile)

The chemical abundances of the shrapnels depends on their initial position (burning layer) during the SN explosion Dynamics of the SN explosion

Nucleosynthesis processes



A complete XMM-Newton survey (2 Ms) of the Vela SNR (because of its proximity) may provide new clues for the study of the nucleosynthesis processes and the explosion mechanisms in SNe

Conclusions

Three XMM-Newton observations of the northern rim of the Vela SNR, covering a large area of the shell (~11 pc^2)

Thermal structure: two thermal components with large variations of the emission measures. The high values of N_I at South (where we observe low values of the median photon energy) may indicate the presence of dense, unresolved cloudlets. The hardening at North may be a consequence of the lack of these inhomogeneities.

Chemical structure: inhomogeneities in the O, Ne, Mg, and Fe abundances. Significant overabundance of Ne and Mg.
Chemically inhomogeneous ISM?
Chemically inhomogeneous CSM?

Ejecta (shrapnels?) mixed with the ISM/CSM?

A complete survey of the Vela SNR may provide new clues for the study of the physical and chemical properties of the ejecta and of the CSM