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X-raying the interstellar medium: the study of SNR shells at the OAPa

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Abstract. The shock wave of shell supernova remnant (SNR) offers the unique opportunity to detect directly the structures of the interstellar medium, both at large and small scale. Unfortunately, the several physical effects at work in the interaction between the shock and the medium, along with the superposition effects along a given light of sight, require detailed modeling and high resolution observations of the systems in order to understand its physical behavior At the Osservatorio Astronomico di Palermo, we have started a long-term project which will lead, for the first time, to a self-consistent methodological approach for comparison of new accurate numerical models and high resolution multi-wavelength observations. In this poster, we introduce the observation we have already analyzed,while in the talk of S. Orlando the new numerical models we have developed are presented

Key words. ISM: clouds - ISM: general - ISM: individual objects: Vela Supernova Remnant - ISM: structure - ISM: supernova remnants - X-rays: ISM

1. Introduction: evolved SNR shells as tracers of the ISM structures and energetic

Evolved supernova remnant shells traces small ans large scale structure of the interstellar medium. The interpretation of multi-wavelength data may seem straightforward at a first glance. However, high resolution observations of post-shock regions reveal a great complexity which is difficult to understand in terms of simple models. It seems that superposition effects as long as real physical effects (hydrodynamics of shock-cloud interactions, radiative losses, thermal conduction, amplitude and orientation of magnetic fields) must be taken into account to model the observed emission. Energy exchange between the shock and the ISM also critically depends on the characteristic of the clouds. Several efforts have been made in trying to detect simple regions where the shock is interacting with relatively small and isolated clouds since these regions are the best candidates to study all the physical processes involved in shock-ISM interactions.

For instance, the Cygnus Loop is the prototypical shell SNR. Patnaude et al. (2002) has argued that the filament in the southwest may be interpreted as the very early stage of a blast-wave interaction with an isolated interstellar cloud. The Vela SNR is the shell located nearest to us at only 250 pc. Its morphology suggests large-scale density enhancements toward the galactic plane, but small scale structures are

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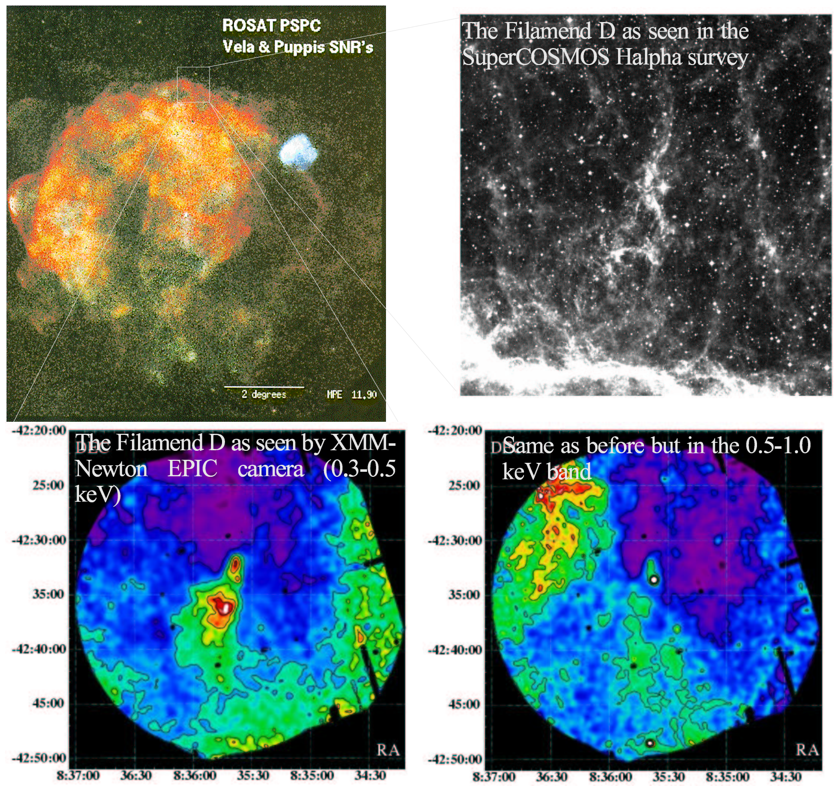

Fig. 1. Multiwavelength images of the Vela SNR and the Filament D region.

seen in the X-ray and optical bands down to few arcminutes. Bocchino et al. (1999) have identified a bright X-ray spot (Filament D) with an associated arc-like optical filaments, subsequently studied by Miceli et al. (2005). G272.2-3.2 is small shell discovered in the ROSAT All-Sky Survey. It has both a bright interior and a bright X-ray limb. Egger et al. (1996) has identified a region of interaction with a small isolated cloud in the eastern part of the shell.

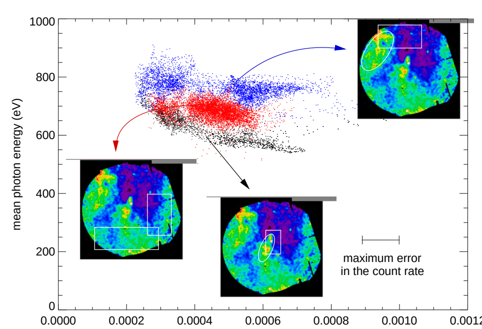

Fig. 2. Scatter plot of median energy and count rate in the Filament D region of Vela SNR.

2. Shock-cloud interaction in the Vela SNR shell

We have already analyzed the Filament D ("FilD") region in the Vela SNR shell. The Mean Photon Energy map (MPE) of "FilD and surroundings allow us to identify thermally homogeneous regions for subsequent analysis, while the relation between MPE and count-rate straightforwardly inform us about pressure equilibrium and different

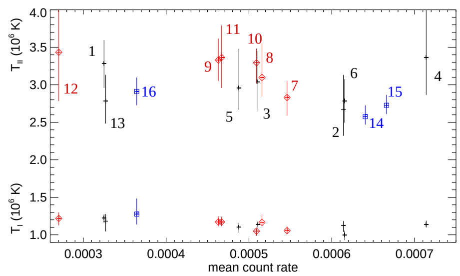

Fig. 3. Best-fit value of cool and hot thermal component in the Filament D region.

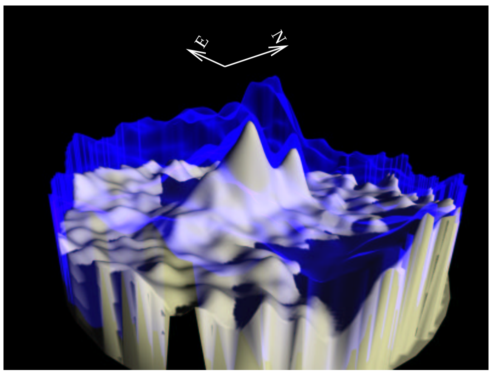

Fig. 4. 3D representation of shocked ISM plasma in the Filament D Vela SNR region.

volumes of the emitting plasma. Spectral fits of selected regions yields very mild variation of best-fit temperatures of the two thermal component, and large variation in the emission measures. This in turns implies that the observed X-ray structures are mostly due to different extension along the line of sight of the two emitting components. There seems to be no signs of overpressured zones (i.e. reflected shocks). A three-dimensional representation of the shocked ISM is derived extrapolating the fittings results to the whole field of view observed in Fig. 2, bottom panels. The hot and diluted X-ray component (transparent blue) is assumed to sit on top of the cold and dense X-ray component (opaque white). A simple model for the "FilD. For the derived densities and temperatures, thermal conduction was found to be dominant over radiative losses in shaping the observed morphology. Both the corona and the core of the inhomogeneities should be evaporating (yellow arrows) with significant energy and mass exchange with the surroundings.

3. Open questions

In spite of the recent results, there are still many open questions in the field of SNR shock-ISM interactions. In particular, the size and mass of the clouds are difficult to estimate. Moreover, do we see plasma instabilities in real observations? Or are they suppressed by thermal conduction? Why temperature variations are so mild? Why we do not see reflected shocks? Why the plasma is in equilibrium of ionization and the post-shock Neon abundance is above solar? Are optical filaments due to pristine dense cloud cores or are they the result of radiative instabilities developed in the evolution of a relatively rarefied ISM cloud? Finally, the heating efficiency (HE) of ISM by SN shocks is a key parameter which plays a crucial role in a number of astrophysical situations. ISM clouds may, in principle, largely reduce the HE. What are the models and the observational constraints to estimate the HE of evolved galactic SNR shells in realistic conditions?

References

Bocchino, F., Maggio, A., & Sciortino, S. 1999, A&A, 342, 839

Egger, R., Greiner, J., & Aschenbach, B. 1996, in Roentgenstrahlung from the Universe, 247–248

Miceli, M., Bocchino, F., Maggio, A., & Reale, F. 2005, Advances in Space Research, 35, 1012

Patnaude, D. J., Fesen, R. A., Raymond, J. C., et al. 2002, AJ, 124, 2118