We present X-ray studies of the brightest evolved supernova remnants (SNRs) in the X-ray sky, i.e., the Vela SNR, the Puppis A SNR, and the Cygnus Loop. We focus on elemental distributions and compositions in the three SNRs which are revealed by our spatially resolved spectral analyses.

Using XMM-Newton data, we perform X-ray spectroscopy for Vela shrapnels A, D, and E which were identified as explosion fragments protruding beyond the primary blast wave of the Vela SNR (Aschenbach et al. 1995). We find/confirm highly non-solar metal-abundance ratios in the three shrapnels: Si/O is 10 times the solar value in the shrapnel A; O/Fe, Ne/Fe, and Mg/Fe are 5, 10, and 10 times the solar values, respectively in the shrapnel D; Ne/Fe is 6 times the solar value in the shrapnel E. These facts strongly supports the idea that they originate from explosion ejecta. From our spatially resolved spectral analyses for the shrapnels A and D, we find that the temperature increases toward the leading edge in both of the two shrapnels, which is in stark contrast with the temperature structures generally seen behind the shock front of SNRs. We also find that the ejecta material are well mixed with the swept-up interstellar medium (ISM) in the shrapnel A, whereas such mixing has not yet occurred in the shrapnel D.

We analyze five XMM-Newton observations nearly covering the entire Galactic Oxygen-rich SNR, Puppis A. We generate "equivalent width" (EW) images for the elements of O, Ne, Mg, Si, S, and Fe. The EW images of all elements but Fe reveal regionally enhanced line features which are most likely caused by overabundance of these species. EWs for Si and S are enhanced only in a relatively compact region in the northeast (NE) of the remnant, which suggests asymmetric ejection of these elements during the SN explosion itself. In addition, we also find a knotty ejecta feature with blue-shifted emission lines in the NE portion of Puppis A. On the other hand, proper motion of the stellar remnant behind the SN explosion was recently measured to be directed toward the southwest with a high velocity (Hui & Becker 2006b; Winkler & Petre 2007). We suggest that the metal-rich ejecta in the NE portion of Puppis A disclosed here are parts of the recoiled materials to the high velocity stellar remnant according to momentum conservation. We have observed the Cygnus Loop in eleven pointings by Suzaku and seven pointings by XMM-Newton. Extended low-energy coverage of Suzaku, for the first time, allow us to detect emission lines from highly-ionized Carbon and Nitrogen from the Cygnus Loop. Our spatially resolved spectral analyses reveal that hot (0.5 keV) metal-rich ejecta, surrounded by cool (0.2 keV) swept-up matter, distribute inside a large area of the Cygnus Loop. Si, S, and Fe ejecta turn out to be distributed more in the south than in the north of the Cygnus Loop by a factor of 2. The degree of the ejecta asymmetry is consistent with that expected by recent supernova explosion models (e.g., Burrows et al. 2007).

In addition to the ejecta distributions, we find abundance inhomogeneities in the NE rim of the Cygnus Loop where the swept-up matter dominates the X-ray emission: the values of metal abundances in the northern outermost region in the NE rim are consistent with the solar values within a factor of 2, whereas they are depleted by a factor of 5 in the rest of the region.

The abundance inhomogeneity is also confirmed from our follow-up spectral analysis with Chandra data. Judging from the measured abundances, we suggest that the plasma in the abundance-enhanced region originates from the ISM. On the other hand, the origin of the abundance depletion in the rest of the region still remains as an open question.