We present an analysis of Suzaku spatially resolved spectroscopy data for nearby galaxy clusters. Galaxy clusters are the largest gravitationally bounded objects in the universe and contain galaxies, X-ray emitted hot gas (intracluster medium: ICM), and a large amount of dark matter. Studies of galaxy clusters are important for understanding cosmological structure formation and evolution.

The X-ray Imaging Spectrometer (XIS) system onboard Suzaku is best suited for measurements of the outermost regions of clusters due to its large effective area and low and stable non-X-ray background (NXB). In order to make the best use of the low and stable NXB, we construct an NXB database with an exposure of approximately 785 ks for each XIS. We also establish a method to model the NXB spectrum using the cut-off-rigidity or the count rate of the PIN upper discriminator (PIN-UD) in hard X-ray detector onboard Suzaku. The reproducibility of the NXB model using PIN-UD is better than that of the model using the cut-off-rigidity. The reproducibility of the NXB model using PIN-UD is 4.55–5.63% for each XIS NXB in the 1–7 keV band and 2.79–4.36% for each XIS NXB in the 5–12 keV band. data.

The estimation of the cosmic X-ray background (CXB) is also important for the analysis of faint diffuse sources such as galaxy clusters. Therefore, we analyze six blank sky observations with Suzaku and evaluate the CXB spectrum and its spatial fluctuation. The CXB spectrum can be well reproduced by an absorbed single power-law model whose average photon index is 1.451 ± 0.034 (1σ confidence level, CL). On the other hand, the average 2–10 keV flux of the CXB is $(4.37 \pm 0.14) \times 10^{-15}$ erg cm^{-2} s^{-1} (1σ CL), and its spatial fluctuation in the XIS field of view by one third, ~ 78.66 arcmin^2, is $12.0 \pm 2.4\%$ (1σ CL).

Using the NXB model for background subtraction and considering the CXB fluctuation for the error estimation, we determine the temperature and surface brightness profiles of eight regular clusters, which include A1060, A1413, A1795, A2052, A2218, A2801, A2804, and A2811. While there are large scatters at the center, these both profiles exhibit self-similarity from a radius of $0.15r_{180}$ to r_{180}, where r_{180} denotes the virial radius. The temperatures significantly decline with the radius in the outer region ($r \gtrsim 0.15r_{180}$), and their general trend is fitted with a model with a polytropic index of 1.190 ± 0.034 (90% CL). Our temperature profiles are in good agreement with previous measurements from ASCA, BeppoSAX, Chandra, and XMM-Newton at $0.2r_{180}$ to $0.6r_{180}$, but show the boundary to be extended up to r_{180}. Moreover, our temperature profiles show good agreement with recent numerical simulations of the cold dark matter model from $0.15r_{180}$ to r_{180}.

We measure the metallicities of our sample of the eight regular clusters, A1674, and the link region between A399 and A401. While there is a large scatter in the metallicity profiles at the center, the metallicities in the outer region ($0.4r_{180} \lesssim r \lesssim 0.7$–$0.8r_{180}$) approximately constant at $0.2Z_\odot$. We extend the measurement of metallicity by a factor of approximately two. The constant and high metallicities in the outer region suggest that metals were transported into the ICM by galactic outflows before the clusters formed ($z \sim 2$) and that the proto-cluster region was heavily polluted with the metals.

Finally, we search for the O VII line emitted from the warm-hot intergalactic medium (WHIM) surrounding A1413 and in the Sculptor supercluster to which A2801, A2804, and A2811 belong. These galaxy clusters have relatively high redshifts, which is important to distinguish the redshifted O VII line of the WHIM from the unredshifted one of the soft X-ray background. We detect no significant line and set a tight constraint on the intensity with upper limits for the surface brightness of O VII line of 1.6×10^{-7} photons cm^{-2} s^{-1} arcmin^{-2} for A1413 and 5.2×10^{-8} photons cm^{-2} s^{-1} arcmin^{-2} for the Sculptor supercluster.