THE HITOMI X-RAY SPECTRUM OF THE CORE OF THE PERSEUS CLUSTER: AN APERITIF FOR ATHENA

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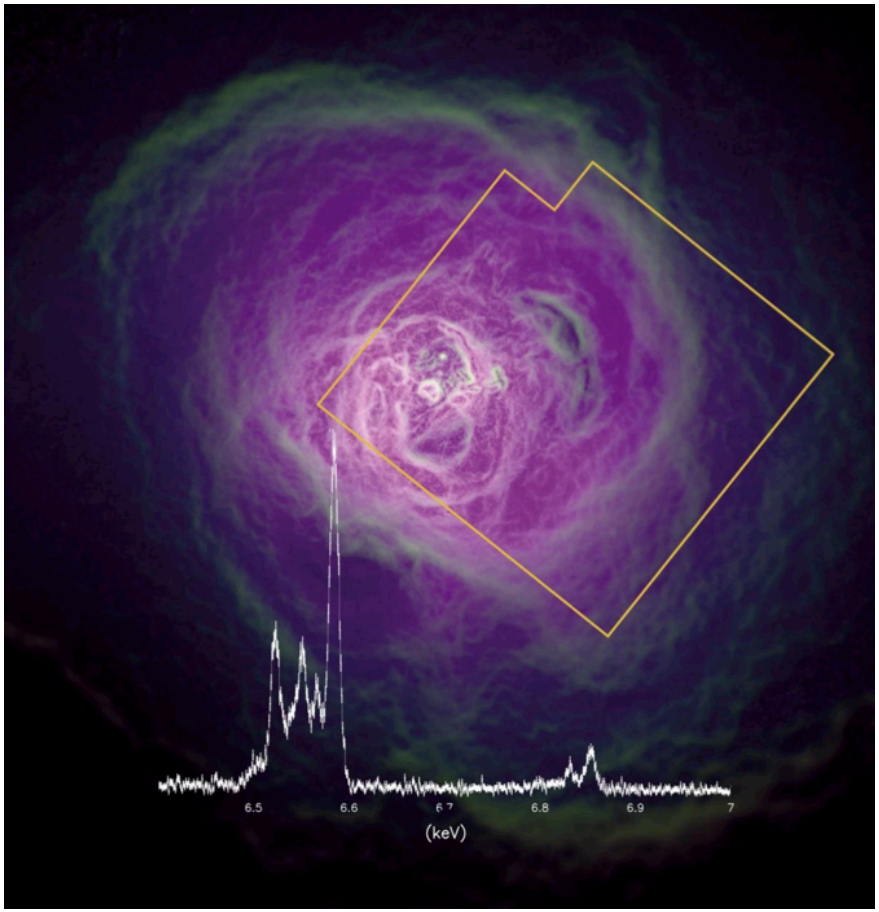
The ill-fated Hitomi satellite took its first and only, deep, high resolution, X-ray spectrum early this year. Its X-ray calorimeter, operating at 50 mK, observed the central part of the Perseus cluster of galaxies for a total exposure of about 3 days. The target is X-ray bright due to its hot, 50 million K, intracluster medium composed of metal-enriched gas lying between the galaxies and peaking around its central massive galaxy NGC1275. The main goal of the observation was to determine the level of turbulent velocities in the gas revealed by Doppler broadening of strong X-ray emission lines due to highly ionized iron in the hot gas. This was spectacularly successful and yielded a result of 164±10 km/s for the velocity of turbulent motions in the outermost gas. The instrument worked as well as when it was in the lab. It was remarkably stable and demonstrated the enormous scientific potential for spaceborne X-ray calorimeters such as the X-IFU planned for flight on Athena. Unfortunately, Hitomi was lost a few weeks later before making any further significant observations.



The Hitomi SXS spectrum of highly-ionized iron ions is superimposed on an enhanced Chandra X-ray image of the Perseus cluster core. The nucleus of NGC1275 is at the centre. The yellow clipped square shows the field of view of the 35 pixel SXS.
Credit: A.C. Fabian and Hitomi Collaboration.

The measurement achieved by Hitomi is important in revealing that the level of turbulence in a cluster core is relatively low, representing an energy density and pressure of only 4 per cent of thermal values there. This is encouraging for cluster cosmology studies, that assume that clusters evolve throughout cosmic time as closed systems, since it suggests that they will not be seriously disturbed by the effects of turbulence. It also provides a strong constraint on the manner in which mechanical energy supplied to the intracluster gas by the powerfully jetted active nucleus of NGC1275 is propagated throughout the cluster core. The energy radiated from the gas in X-rays is too large for turbulence alone to be responsible. One possibility is that sound waves transport the energy.

Such beautiful data gave us only a taste of the exciting perspective enabled by high X-ray spectral resolution. This new observing window has been briefly opened but is now again firmly shut. But with the spectral resolution of the Athena X-IFU, twice that of Hitomi, its two orders of magnitude larger number of imaging pixels, the vastly greater collecting area of the telescope and the spatial resolution an order of magnitude better, the astronomical community will be served a full course of the hot and energetic Universe. There will be so much to see and do when it is launched!