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「すざく」衛星で探る宇宙高温プラズマ

Cosmic Hot Plasmas as probed with the X-ray Satellite Suzaku

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Baryons in the Universe are found mostly in the form of plasmas. Among them, relatively hot ones (with temperatures >1e6 K) emit X-rays, in the form of blackbody radiation, thermal Bremsstrahlung, or some non-thermal emission components. Therefore, X-ray observations have been providing valuable probes into physics of these hot plasmas. The observations have been carried out in Japan by a series of satellites launched by JAXA; Hakucho (launched in 1979), Tenma (1983), Ginga (1987), ASCA (1993), and Suzaku (2005). The next mission, called ASTRO -H, is scheduled for launch in 2014. Here, we review several topics from the latest Suzaku observations.
1. Unusually hot plasmas in clusters of galaxies. The most dominant known baryonic component in the Universe is tenuous hot (1e7-1e8 K) plasmas associated with clusters of galaxies. They are thought to be heated and confined gravitationally. With Suzaku, unusually hot emission components were detected in the 1-30 keV range from two clusters of galaxies (Nakazawa+, Publ. Astr. Soc. J. 61, 339, 2009; Ota +, Astron. Ap. 491, 363, 2008). These hot plasmas are possibly created by cluster mergers.
2. Supernova remnants (SNRs). SNRs are a site where propagating and reverse shocks produce hot plasmas. Their electron temperature is about 1e7 K. however, their kinetic ion temperature could be much higher (e.g., 2e10 K; Furuzawa +, Astrophys. J. Lett. 693, L61, 2009), as evidenced by a possible broadening in Fe-K emission lines. This is because ions are first heated by the shocks.
3. Over-ionized plasmas in SNRs. Usually, the plasmas in SNRs are in an ionizing condition, wherein the ionization temperature of heavy elements is lower than their excitation temperature (which in turn is close to the electron temperature). However, over-ionized plasmas, in a recombining condition, was discovered from a few SNRs (Yamaguchi +, Astrophys. J. Lett. 705, L 6, 2009; Ozawa +, Astrophys. J. Lett. 706, L71, 2009).
4. Measuring the mass of white dwarfs. A magnetized white dwarf in a mass-accreting binary emits optically-thin thermal emission form its magnetic poles, where free-falling matter is converted by a standing shock into hot (1e8-1e9 K) plasmas. Accurate measurements of 1-50 keV X-ray spectra of such objects tell us their shock temperatures, which in turn yield their mass-to-radius ratios.
5. Mass accretion onto black holes. Matter accreting onto a black hole forms a rotating accretion disk. The disk is sometimes surrounded by an inflated corona, where the ion kinetic temperature much exceeds that of electrons. Using the 1-300 keV Suzaku data, we have carried out detailed diagnostics of disk-corona connection in the prototypical black-hole binary, Cygnus X-1 (Makishima +, Publ. Astr. Soc. J. 60, 585, 2008).

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