

**Balloon borne hard X-ray imaging observations of  
active galactic nuclei and cluster of galaxies**

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**【Outline of survey】**

X-ray astronomy with X-ray telescopes has been quite successful to obtain new views of the Universe, especially hot Universe, which has never been observed with optical telescopes. Some observations, however, showed hard X-ray components extending above 10 keV, which could not be attributed to thermal phenomena, typical for the hot Universe. We are trying to examine such non-thermal components by hard X-ray imaging telescopes. The key technology is the multilayer coating to reflect hard X-rays in broad bands by introducing graded density multilayer, so called "Super mirror". Deposited multilayers on glass mandrels are replicated on thin Al foil substrates. We have established such process and could produce more than 1000 mirror shells necessary for a full telescope onboard balloon experiments. Hard X-ray imaging observations have been performed in three balloon campaigns, InFOCuS(J-US) and SUMIT(J-Brazil). Based on the technology we have developed, we plan to perform a few more balloon flights to open the new field of hard X-ray astronomy to be explained below.

**【Expected results】**

One of two major objectives of our project is hard X-ray emission from cluster of galaxies. The power law components above 10 keV result from the interaction of high energy particles with intergalactic magnetic field. Imaging observations of such hard X-rays allow us to examine the acceleration site and its mechanisms in cluster of galaxies. Another objective is the active galactic nuclei, which harbor massive blackholes. In soft X-rays, some of them are hidden by absorbing material, while hard X-ray imaging observations may pick them up because of their high sensitivity. It may be expected to find ten times more massive blackholes than we have detected in soft X-rays below 10 keV. The whole history of blackhole evolution will be studied without bias of absorption column.

**【References by the principal investigator】**

- H. Kunieda. "Balloon-borne hard x-ray imaging observations of non-thermal phenomena" Proceeding of SPIE. Vol. 6266E...8K(2006)
- P. J. Serlemitsos, H. Kunieda, et al. "The X-Ray Telescope onboard Suzaku" Publication of Astronomical Society of Japan. Vol. 59, 9(2007)

**【Term of project】** FY2007 – 2011

**【Budget allocation】** 12,200,000 yen

(2007 direct cost)

**【Homepage address】**

<http://www.u.phys.nagoya-u.ac.jp/uxgj.html>