WHAT'S HOT IN... PHYSICS , November/December 2008

Extraordinary X-Ray Observatory Excites Astronomers

by Simon Mitton

PDF

Space astronomy zooms aloft in physics Hot Papers this period, as technical descriptions of a unique X-ray observatory grab places #2 and #3. The Wilkinson Microwave Anisotropy Probe again takes pole position: #1 charts the cosmological implications and is highly cited because it is the standard source document for values of the fundamental parameters that describe our universe. Papers #2 and #3 describe the Suzaku observatory and its imaging spectrometer. Suzaku mission research scientists have already produced 100 research papers in 2007-8, all of which cite #2 and #3. Next on the grid is high flier #4 on the third Japanese solar observatory, Hinode (sunrise), carrying three major telescopes, all of which have made successful first light observations.

Suzaku is a joint Japanese-U.S. satellite for X-ray astronomy, and it is the fifth such rocket-science mission from the Japanese space agency in the past 25 years. As #2 and #3 explain, Suzaku has four X-ray telescopes, each equipped with a focal plane low-energy X-ray spectrometer and CCD. With this quartet, Suzaku has the best spectral resolution of any cosmic X-ray instrument. Additionally, the satellite carries a hard X-ray detector sensitive to the 10-600 keV band. This detector extends the bandpass of the Suzaku observatory to gamma-ray energies, thus allowing broadband studies of celestial objects.

The detector's high sensitivity has opened up X-ray variability studies, an important

Physics Top Ten Papers

Rank	Papers	Cites May-Jun 08	Rank Mar-Apr 08
1	D.N. Spergel, *et al.*, "Three-year *Wilkinson Microwave Anisotropy Probe* (*WMAP*) observations: Implications for cosmology," *Astrophys. J. Suppl. Ser.*, 170(2): 377-408, June 2007. [13 U.S. and Canadian institutions] *178TD	148	1
2	K. Mitsuda, *et al.*, "The X-ray observatory Suzaku," *Pub. Astron. Soc. Japan*, 59(SP1): S1-7, 25 January 2007. [42 institutions worldwide] *139ON	35	5
3	K. Koyama, *et al.*, "X-ray imaging spectrometer (XIS) on board Suzaku," *Pub. Astron. Soc. Japan*, 59(SP1): S23-33, 25 January 2007. [12 Japanese and U.S. institutions] *139ON	35	9
4	T. Kosugi, *et al.*, "The *Hinode* (Solar-B) Mission: An overview," *Solar Physics*, 243(1): 3-17, June 2007. [8 Japanese, U.S., and U.K. institutions] *215JB	34	†
5	G. Hinshaw, *et al.*, "Three-year *Wilkinson Microwave Anisotropy Probe* (*WMAP*) observations: Temperature analysis," *Astrophys. J. Suppl. Ser.*, 170(2): 288-334, June 2007. [14 U.S. and Canadian institutions] *178TD	28	†

step towards understanding the behavior of jets in sources such as Cyg X-1, a binary star consisting of a blue supergiant, a black hole, and an accretion disk. The detector can be used as a wide field monitor of bright X-ray transients, gamma-ray bursts, and solar flares. The unique capability of the satellite is its ability to cover an enormous energy range simultaneously. That's important because Suzaku is capable of studying in detail both thermal and non-thermal phenomena, a first in X-ray astronomy.

In September 2008 the Johns Hopkins University hosted a one-day workshop to review the scientific advances made in the first three years of operation. At the workshop, the U.S. Suzaku Project Scientist Dr. Rob Petre (NASA Goddard Space Flight Center, Greenbelt, Maryland) showcased three big questions for which Suzaku is providing answers. What is the nature of spacetime near black holes? What is dark energy? And how do cosmic accelerators work?

The strong gravitational field near a black hole can be probed by this satellite through broadband spectroscopy of many X-ray sources in our Galaxy. Galactic black holes and neutron stars are, in effect, laboratories for research into general relativity. Suzaku provides a handle on the size of the accreting object, and thus flags up binaries containing a stellar mass black hole. That's because the time scale for flickering in the intensity of X-rays is a direct measure of the light travel time across the object.

6	J.B. Pendry [see also], D. Schurig, D.R. Smith, "Controlling electromagnetic fields," *Science*, 312(5781): 1780-2, 23 June 2006. (Imperial College London, U.K.; Duke U., Durham, NC] *055LS	27	7
7	M. Tegmark, *et al.*, "Cosmological constraints from the SDSS luminous red galaxies," *Phys. Rev. D*, 74(12): no. 123507, December 2006. [36 institutions worldwide] *121QJ	20	8
8	A.L. Westerling, *et al.*, "Warming and earlier spring increase western U.S. forest wildfire activity," *Science*, 313 (5789): 940-3, 18 August 2006. [Scripps Inst. Oceanography, La Jolla, CA; U. Calif., Merced; USGS, La Jolla, CA; U. Arizona, Tucson] *074MR	18	†
9	J.Y. Kim, *et al.*, "Efficient tandem polymer solar cells fabricated by all-solution processing," *Science*, 317 (5835): 222-5, 13 July 2007. [U. Calif., Santa Barbara; Gwangju Inst. Sci. Tech., Korea] *189DC	18	†
10	U. Leonhardt, "Optical conformal mapping," *Science*, 312(5781): 1777-80, 23 June 2006. [U. St. Andrews, U.K.] *55LS	17	†

SOURCE: Thomson Reuter's Hot Papers Database. Read the Legend.

Suzaku probes the interstellar medium and supernova remnants in its quest to get a better grasp of the abundances of elements that are created in supernova explosions. As an example of what can be achieved by Suzaku, consider Type 1a supernova explosions, which are of central importance to supernova cosmology. It is absolutely imperative to improve our knowledge of the physics of these explosions because they provide "standard candles" at great distances where the acceleration of the universe is detectable. Suzaku measurements of the abundances of rare elements in a supernova remnant in our Galaxy show that the initial trigger was a carbon explosion at the center of a star, followed by a slow burn, or delayed detonation of material outside the central core. The point being that a Type 1a supernova is a controlled explosion, which is good for a standard candle, rather than a shattering firework display with chaotic physics. Further contributions to supernova physics come from Suzaku's imaging of ejecta distribution in supernova remnants in the Galaxy.

The satellite holds much promise for further discoveries in the next few years of operation. Spectroscopy will be carried out of all active galactic nuclei (AGNs) discovered by the Swift gamma-ray observatory. Since AGNs trace the large scale structure of the universe, the study will contribute towards solving the mystery of dark matter. And the good news continues: a snapshot survey of 500 clusters of galaxies will shed fresh light on dark energy.

Dr. Simon Mitton is an associate of the department for History and Philosophy of Science at the University of Cambridge, U.K.

Keywords: Suzaku, X-ray astronomy, Hinode, solar flares, black holes, supernovae, dark matter, Rob Petre, X-ray spectrometry.

PDF