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DIVISION XI: SPACE AND HIGH ENERGY ASTROPHYSICS
(ASTROPHYSIQUE SPATIALE ET DES HAUTES ENERGIES)

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Commission 44: Space and High Energy Astrophysics

1. GENERAL ACTIVITIES

The reporting period has shown that Space has become a firmly established domain in observational Astrophysics, also in the low energy astrophysics area. The launching of new spacecraft is always an important addition to the capabilities of the Astronomers, but the availability of space observatories is strongly affected by the fact that they disappear as their subsystems become damaged or, for other reasons, become inoperable. The relatively short life of astronomical space facilities has generated new dynamic in the life cycle of observational tools for the astronomer, rather different from that for ground facilities. Launch failures or the final in-orbit functionality verification can also very strongly affect the availability of observational capabilities in space astrophysics. The only spacecraft designed without this built-in life time restriction, is the Hubble Space Telescope, which can be serviced by the Space Shuttle.

The activities of the Space Agencies in support of Astronomy are clearly illustrated by the 7 spacecraft kept in operations during this time; the launch of 3 new astronomy missions and the termination of the operations of 4 spacecraft. Currently 20 countries are, at different levels, involved in the astronomical space facilities. This is a clear illustration that space astrophysics is quite dynamic at this stage. Some concerns are on the horizon with the funding plateaus of the different agencies, which could in the future turn more complex and might make the support for astrophysics from space become too concentrated. This could possibly require a more active role for the IAU in order to maintain a balanced approach to the space capabilities necessary for astronomy(see Figure 1).

The Division President has been involved, in cooperation with the United Nations Outer Space Division, in the stimulation of enhanced participation of scientists in the developing world (UN/ESA Workshops). It also participated in the evaluation of the implications and possible needs of astronomy in relation to concepts associated with a World Space Observatory (UN, 1999).

Another matter which might become of concern for the Division is the possible future impact of the International Space Station (ISS) on the capabilities available for Space Astrophysics.

The one issue where the community has responded quite well, after a few false starts, is related to the fact that the data gathering efficiency of many space astronomy missions produce data at a higher rate than the community can digest and interpret. This could possibly create a phase lag between increase in knowledge and the possibility to acquire new data, which could be detrimental for a logical and sustained development in our science. The archival activities currently done for space data as pioneered in the *INES* system for the IUE Project and the *TARTARUS* initiative for ASCA, clearly show the way in which the optimum benefit of the space astronomy missions can be obtained for the community.

Over the reporting period, Division XI –current membership of 728 scientists– has tried to establish its functionality within the revised structural context of the IAU. This has been somewhat more complex than foreseen, since there was no longer an underlying Commission structure to assure continuity in its functionality. This was a consequence of the decision, at the XXIIIrd IAU GA, to merge Commissions 44 and 48 and at the XXIVth GA to maintain only the Divisional structure under Division XI (Space). Consequently a rather large divisional board has been made which, although not fully in accordance with the Working Rules of the IAU, has functioned very well.

Under the area of activities of the Division some failed launches were unfortunately demonstrating that, to maintain an observational capability in space, requires not only a political position, but also the good fortune that project preparation and launch all work together to make a successful project. In this report we will mainly concentrate on Science highlights and indicate the current operational status of the projects mainly related to Space Astrophysics in the, from the ground, inaccessible windows. Specialized missions such as *ULYSSES*, *SOHO* and *TRACE* which study the details of the Sun and the Heliosphere, as well as the in situ studies of the Planets and their Satellites, by the missions *GALILEO*, *CASSINI-HUYGENS*, the international *MARS Initiative*, *STARDUST* and *NEAR* will be covered in the reports of the respective Commissions and Divisions (II for Sun and Heliosphere; III for Planetary System Science). For more details of the operational status of the different astrophysics missions we refer to the reports from Division XI in the IAU Bulletins and the Divisional WWW-page at *http://www.vilspa.esa.es/external/IAU – XI/* .

During this period, space astrophysics has remained a very active business with the following scientific spacecraft activities:

CGRO	Continued operations
ROSAT	Operations stopped on 12 February 1999 (after 8.5 years)
ASCA	Continued operations (Re-entry foreseen middle of 2000)
Rossi XTE	Continued operations
BeppoSAX	Continued operations
IUE	Operations stopped on 30 September 1996 (after 18.5 years)
EUVE	Continued operations
FUSE	In operations (verification phase) launched on 24 June 1999
HST	Continued operations
ISO	Operations stopped on April 1998 (after 2.4 years)
GRANAT	Operations stopped in 1999 (after 9 years)
HALCA	Continued operations
SWAS	In operations; launched on 5 December 1998
MINISAT	In operations launched in April 1997

2. PROJECTS CONCLUDED

IUE (USA, Europe, UK) *Y. Kondo* and *W. Wamsteker*

The International Ultraviolet Explorer (IUE) stopped orbital operations in September 1996. After 18.5 years in orbit, its results have affected all corners of Astrophysics and Solar System studies. A complete summary of the IUE related science, as well as the outlook for the future of Ultraviolet observing capabilities, and some aspects of a **World Space Observatory** concept, have been reported in the Proceedings of the last IUE Conference (Wamsteker and Gonzalez-Riestra, 1998). Its archive has been retained for the future through the combined efforts in the production of the IUE Final Archive and the reduction revision in the complete Archival system INES (IUE Newly Extracted Spectra) for National Host distribution in all countries (*http://ines.vilspa.esa.es/*). The description of this end product of IUE can be found in a series of papers *The INES System* (Rodriguez et al., *Photon Astrophysics from Space*

Mission	Range	1990	1995	2000	2005	2010 2015
GRANAT	2 - 40 MeV	·······γ	■			
CGRO	.2 MeV - 3 GeV	γ······	············	··		
GLAST	10 MeV – 100 GeV		■		γ??????????	??????????
INTEGRAL	15 keV - 10 MeV		■	γ······		
GINGA	1 -400 keV	X	■			
ROSAT	.1 - 2.4 keV	X·····	·········X ■			
ASCA	1 - 12 keV	X··	············	·		
RXTE	2 - 200 keV		X·········	·		
SAX	.1 - 200 keV		X···	··		
~~ABRIXAS~~(Battery fail)	.5 – 15 keV		----	-		
CHANDRA	.1 - 10 keV		X·	·········		
HETE II	2 - 400 keV			X·····		
XMM	.2 - 10 keV		X	·······		
ASTRO-E	.2 – 700 keV		■	X······		
SPECTRUM –X-γ	4 eV – 150 keV		■	X/γ??????????	????	
CONSTELLATION-X	.25 – 40 keV		■		X??????????	????????????
IUE	110 - 320 nm	·············	··U ■			
EUVE	1 - 75 nm	U··	············	··		
FUSE	91 - 120 nm		U·	··		
GALLEX	135 – 300 nm		■	U·		
HIPPARCOS	375 - 750 nm	···O	■			
HST	110 - 1000 nm	···········	···········	···········	···········	
COROT	500 – 800 nm		■	O····		
SIM	400 – 1000 nm				O===========	
GAIA	500 – 1000 nm		■		O/I?	????????
COBE	1 - 300 μm	·I	■			
IRTS	1.2 - 800 μm	I·	I ■			
ISO	3 - 200 μm		I··I ■			
~~WIRE~~ *(Launch failure)*	10 – 25 μm		---			
SWAS	500 GHz		I·	·		
ODIN 280-800nm	1270 nm; 119-560 Ghz		U/R/I	===		
MAP	30 – 150 GHz		■	I·		
SIRTF	3 – 180 μm		■	I·········		
IRIS	1.2 - 800 μm		■	I····		
FIRST	80 - 670 μm		■		I······	
PLANCK	30 – 857 GHz		■		I······	
NGST	0.5 – 20 μm		■		I····	······
HALCA	1.6, 5, 22 GHz		R··········	··		
RADIOASTRON	.3,1.6,4.8,22.2 GHz		■	R????	?????	
ARISE	5,22,43,86 GHz		■		R???	????????
Missions in orbit		11	15	20	10	5

Figure 1. A 25 year overview of photon astrophysics from space. In this table, the current epoch is indicated by the square filled blocks, and the missions are coded according to energy, wavelength or frequency domain (as customary in the field). The symbols to identify the wavelength domains are γ (for the MeV to GeV range); **X** (for the .1 keV to 500 keV range) ; **U** (for the UV range from 1 to 300 nm) ; **O** (for the optical NIR range 200 to 1000 nm) ; **I** (for the IR-mm range from μm to 1000 μm), and **R** (for the radio domain in GHz). If the coding symbol (γ, **X, U, O, I, R**) is given to the left and right of the horizontal duration bar in the table, it indicates a mission which has been completed.

 https://doi.org/10.1017/S0251107X0000331X

1999, Gonzalez-Riestra et al., 2000; Cassatella et al, 2000). During the last year of IUE Observing, special programmes were implemented which emphasized the unique capabilities of the mission. As an example one could mention the first time that power spectrum of the ultraviolet variability of an Active Galaxy has been fully sampled, as reported by Wanders et al. (1997).

GRANAT (Russia) *E. Churazov* and *R. Sunyaev*

The successful GRANAT high energy observatory was launched in late 1989 and re-entered the Earth atmosphere in the middle 1999. The observatory outlasted by a factor of more than 10 the guaranteed life time of the mission. Lack of the propellant for satellite pointing restricted, towards the end the mission, most observations on the central 10 degrees of the Milky Way (for a total exposure time of almost 10^7 seconds). This region contains (apart from several transient objects) at least seven quasi-persistent bright sources. The high quality images in the X-rays ($>$ 40 keV), at a spatial resolution of some 15 arcmin., impose strong limit of 3 mCrab (3 sigma) on the luminosity of a super-massive black hole at the dynamic centre of our Galaxy (see also Figure 2). The combination of the data from GRANAT with those of the MIR-KVANT Observatory at lower energies, provides an averaged picture of the larger area around Galactic Center from few keV up to few hundred keV.

Over 200 Gamma-ray bursts, in a very broad energy range from 8 keV to 100 MeV, were detected and catalogued. 47 of these were localized with an accuracy better than 1 degree. It was found that energy spectra of the short ($<$ 2 sec.) events are harder that spectra of the long gamma-ray bursts. Another important result related to Gamma Ray Bursts is the existence of an early soft gamma-ray afterglow, immediately after the burst. This early afterglow, which decays on a time scale of about 300 seconds, has important implications for the fireball model of gamma-ray bursts.

GRANAT detected and catalogued 110 solar flares for which the energy of detected photons was greater than 100 keV. During these high-energy solar flares the synthesis of Deuterium was observed. Analysis of the of 2.2 MeV line light curves shows that the amount of Deuterium, created on the Solar surface, in these strong flares amounts to several tons. Such events on the Sun indicate that flaring stars could be an additional source of Deuterium in the Universe. For two flares high energy (1GeV) free neutrons created on the Sun were discovered. Observations beyond the limb of flares gave evidence that prompt gamma-ray line emission takes place in the lower corona with densities below $10^{11} - 5 * 10^{11} cm^{-3}$.

ROSAT (Germany, USA, UK) *J. Truemper*

The X-ray astronomy satellite ROSAT performed its last observation on 18 December 1998 after eight and a half year of extremely successful operation. Apart from many new scientific discoveries in the soft X-Ray band, the major accomplishment of the ROSAT project was the performance of an All Sky Survey. The resulting ROSAT Bright Source catalogue with 20,000 sources and the Diffuse X-ray Sky Maps with 12 arcmin resolution have been completed and are used by many astrophysicists (Voges et al., 1998). The same applies to the archived ROSAT pointed data obtained with the PSPC and the HRI on some 9,000 fields in the sky.

Special mention can be made of the non-generic results such as:

The Deep Surveys have resolved about 80 percent of the total extragalactic X-ray cosmic background flux in discrete sources. Most of these sources were found to be quasars. The ROSAT cluster surveys showed evidence for evolution out to $z = 0.8$. This result suggests a low density universe ($\Omega = 0.3$).

X-Ray emission from Comets has been discovered and firmly established as a normal phenomenon for Comets through the observation of it in 10 objects.

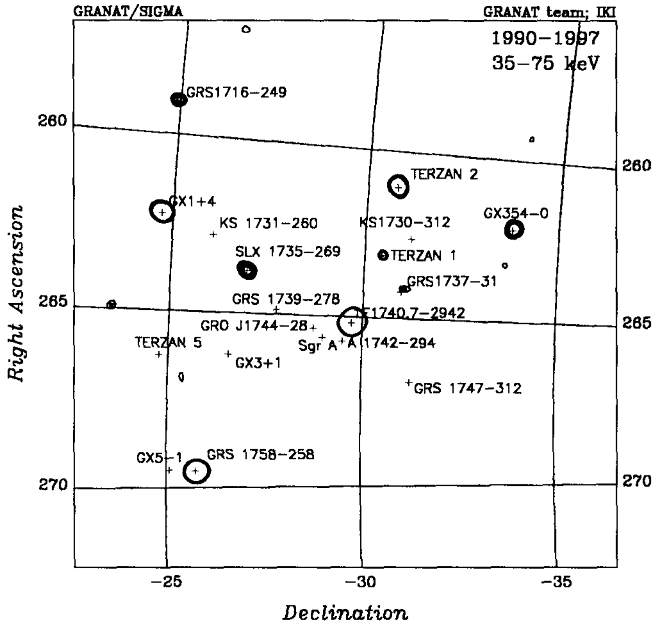

Figure 2. This figure shows the Galactic Center region in the hard (35-75 keV) X–ray band as obtained by the long duration observations towards the end of the life of GRANAT. The image has a spatial resolution of the order of 15 arcminutes. and a sensitivity of 3 mCrab (3 sigma). The contours show the significance of the source detection at 5 mCrab (4.5σ level) at the center of the image). Sgr A marks the position of the dynamic center of the Galaxy. This imposes a strong limit on the hard X-ray luminosity of the supermassive black hole at the dynamic center of our Galaxy. This 10 by 10 degree field shows at least seven quasi-persistent bright sources, of which five "softer" sources are firmly identified as LMXRB with neutron stars because of pulsations or X-ray bursts. The two "harder" sources (1E1740.7-2942 and GRS1758-258) are thought to be accreting black holes with low mass companion. The quasi- persistent nature of these two objects has very important implications for the whole population of the galactic LMXBs with black holes, most of which are transients with a very small duty cycle.

Through their X-Ray emission T Tauri stars far from known sites of active star formation have been found. Also young brown dwarfs have been found to emit in the X-Ray domain. The distinction between thermal (photospheric) emission and non-thermal (magnetospheric) emission of radio pulsars through X-ray observations has been an important contribution to the understanding of these compact objects. ROSAT archival access and other important results can be found at *http : //wave.xray.mpe.mpg.de/rosat/*.

ISO (Europe, Japan, USA) *M.F. Kessler*

The Infrared Space Observatory terminated orbital science operations in 1998 through the depletion of the Helium coolant on board. As the first pointed Infrared Space Observatory ISO had significant impact in almost all fields of modern astrophysics, from comets to cosmology. The results are summarized in the proceedings of the ISO Conference (Cox and Kessler, 1999). Some highlights:

The abundant presence of water in all its different morphologies in mostastronomical objects from Comets to ultra–luminous IR galaxies such as Arp 220. The identification of forsterite –magnesium silicate crystals– in the surroundings of young stars as well as in comet Hale-Bopp, establishes the first direct linkage between interplanetary dust and its and interstellar counterpart.

The discovery of the existence of the Hydrofluoric Acid (HF) in interstellar space.

Also the S(0) pure rotational transition of the hydrogen molecule has been observed in the ISM. For the HD molecule the transition R(0) has also been detected.

Detailed investigations of star forming regions in our own and external galaxies have allowed the detection of pre-stellar cores of contracting masses. Determinations of initial mass functions in star forming regions suggest the presence of substantial numbers of objects in the mass range associated with brown dwarfs.

The discovery, in the highly evolved star IRC+10420 and the galaxy Arp 220,of the OH absorptions at 35 micron, predicted to be the exciting absorption driving the inversion, which is responsible for OH mega-masers in dusty environments, supplied strong confirmation to this excitation model. The detailed observations of ultra-luminous infrared galaxies allow the evaluation of the star formation activity in these objects, and supplies important discrimination for the nuclear energy sources in these objects (thermal versus non-thermal).

ISO data access *http : //www.iso.vilspa.esa.es/users/idc/IDC.html*

3. PROJECTS IN CONTINUED OPERATION

HST (USA, Europe) *M. Livio*

The current complement of science instruments in operation on the Hubble Space Telescope (HST) includes the wide field imager (WFPC2), the Space Telescope Imaging Spectrograph (STIS), and the Fine Guidance System (FGS), used for astrometry. The Near Infrared Camera and Multi-Object Spectrometer (NICMOS) were installed in February 1997. However a thermal short made the solid nitrogen coolant evaporate faster than foreseen, and NICMOS reached cryogen exhaustion in January 1999. Two new servicing missions are foreseen for late 1999 and middle 2000, with most of the instrumental upgrades (the installation of the Advanced Camera for Surveys (ACS) and the inclusion of the NICMOS Cooling System (NCS), which would revive NICMOS) for the later mission. The capabilities of WFPC2 on HST have been superbly demonstrated by the Medium Deep Survey, and also with the Hubble Deep Fields (HDF-North and HDF-South) (Williams et al. 1996, 2000; Savaglio et al. 1999). These last were dedicated observing campaigns on specially selected fields, allowing to reach the faintest objects for multi-filter photometry. The primary results of these studies have been associated with the fact that galaxies appear to be smaller at high redshifts. This indicates that galaxies were physically smaller in the early Universe, consistent with hierarchical structure formation. It has also been shown that photometric measurements of galaxies at high redshift allow accurate redshift determinations and this presents an important new tool for cosmological studies.

For the observations of SN Ia at high redshift the observations of HST represent an important tool for galactic contribution subtraction, this is essential for confirmation of a non-zero cosmological constant, and an accelerated expansion of the Universe, suggested by high redshift supernova Type Ia observations. The confirmation of the currently obtained values for Omega(matter) and Omega(lambda) represents an important challenge for the future, because of its profound implications on fundamental physics.

The exceptional quality of the HST optics after correction is fulfilling all expectations. This is especially having its impact on studies of stellar evolution through observations of galactic and extragalactic globular clusters. These results have confirmed that the age spread in the globular clusters throughout the galaxy is small, and implies a short time scale for the formation of this spheroidal component of our Galaxy, and possibly by extrapolation for all galaxies.

In the nearby globular clusters it has been possible to observe in details the sequence of cooling white dwarfs. The full resolution of globular cluster cores has shown the existence of unexpected populations, such as a great number of blue stragglers, strongly suggesting that these objects are formed by stellar mergers. Also cataclysmic variables and stripped stellar cores seem to be present.

The possibility to resolve nearby dwarf galaxies to faint enough levels to determine stellar age distributions have shown that in these objects star formation has occurred in a sporadic manner over the past 10 Gyr.

The detailed study of the mass distribution and velocity fields in normal galaxies suggests that, even in these, supermassive black holes are a common occurrence.

The HST Key Project to determine accurate Cepheid distances to "distant" (Virgo and Fornax cluster) galaxies has been completed and the results have been published (e.g. Madore, et al, 1999). This has led to the calibration of more distant objects, such as Sne of Type Ia, which allowed to measure the Hubble flow directly. The resulting measurements of various determinations have resulted in an age of the Universe of 14 Gyrs. This is no longer in conflict with the ages of the globular clusters.

For the Gamma-ray burst GRB970228, HST observations showed that the burst is not in the centre of its host galaxy, and as a consequence, even though the bursts are clearly extra-galactic phenomena, they are not necessarily associated with the nuclear activity in AGN.

HST images of gravitational lensing have contributed in a spectacular and crucial way to derive unambiguous mass models for clusters of galaxies, independent of X-ray and velocity-dispersion- dependent models. These have led to quantitative results that can be used to measure masses and distances to the lensing clusters. Using gravitational lens modelling it has been possible to estimate H_0 with an uncertainty less than 20 percent at around $50 +/- 10\ km\ s^{-1} Mpc^{-1}$. The HST data archive can be accessed through the MAST Archive *http://archive.stsci.edu/mast.html*.

CGRO (USA) *C. Schrader*

The Compton Gamma Ray Observatory, was launched in 1991. Four scientific instrument packages cover the high energy regime from 15 keV upward. Additionally, Compton provides also a capability to study the high-energy properties of solar flares. The Compton GRO Instruments are the Burst and Transient Source Experiment (BATSE) to measure brightness variations in gamma-ray bursts and solar flares on time scales down to microseconds over the energy range 30 keV to 1.9 MeV. BATSE also continuously monitors all transient sources and bright persistent sources in the gamma–ray sky. The Oriented Scintillation Spectroscopy Experiment (OSSE) makes spectral observations of astrophysical sources in the 0.05 to 10 MeV range, with capability above 10 MeV for solar gamma–ray and neutron observations. The Imaging Compton Telescope (COMPTEL) detects gamma rays and source mapping is provided over a field of view of about 1 steradian. The Energetic Gamma Ray Experiment Telescope (EGRET) is a high energy instrument covering a range from 20 MeV to 30 GeV. Scientific highlights include:

The discovery that gamma-ray bursts are isotropic but spatially inhomogenous, effectively sampled to the edge of their distribution, as they are now known to be a cosmological population. The establishment of a very efficient distributed coordination network has allowed real-time optical follow-up observations, not only from the ground but also through cooperation with other space observatories (Paciesas, et al., 1999) The prolonged gamma-ray emission long after the burst suggests continued particle acceleration, lasting considerably longer than the GRB itself.

A new class of high-energy gamma-ray sources, the gamma-ray quasars, which are now known to be associated with flat-spectrum, core-dominated radio loud AGN or "blazars" has been discovered.

The fact that Seyfert 1 AGN high-energy spectra typically cut-off at 100 keV is indicative of Comptonized thermal plasma emission and has important consequences for the problem of the origin of the diffuse-X-ray background.

The line of radioactive 44-Ti has been detected from Cas A, and a previously unknown supernova remnant in the Vela region. Maps have been produced showing the distribution of radioactive 26-Al in the Galaxy, allowing to constrain the production mechanism through explosive nucleosynthesis or evolution of massive stars.

From the six high energy pulsars detected it has been possible to show that the conversion of rotational energy into gamma radiation becomes more efficient with age. Cosmic rays have been found to be of Galactic origin, through the comparison of galactic and Magellanic Cloud diffuse gamma ray comparison. Access to CGRO data can be obtained through the High Energy Archive site *http://heasarc.gsfc.nasa.gov/*

EUVE (USA) *S. Bowyer*

The Extreme Ultraviolet Explorer continues to operate nominally. Trimonthly calibrations show that all instruments have retained their full sensitivity since launch. Guest observers are allotted all available observing time. The main goal of the mission was to make an all sky survey in the EUV range (7 – 76 nm). (Lampton et al., 1997; Craig et al., 1997) A few highlights of the many results obtained in the past year include the confirmation of the unexplained excess EUV emission found in some clusters of galaxies; the discovery of gradients in the ionization state of the interstellar medium; the delineation of the Local Interstellar Cloud surrounding the Sun; and new insights into the nature of white dwarf and late type star atmospheres. Archival data can be accessed at *http://www.cea.berkeley.edu/ science/html/Archive.html*

HALCA (Japan) *P.G. Edwards* and *H. Hirabayashi*

The Highly Advanced Laboratory for Communications and Astronomy is the first astronomical satellite dedicated to radio-astronomical observations using the Very Long Baseline Interferometry (VLBI) technique. HALCA and ground radio telescopes simultaneously observe radio sources at 1.6 GHz (18cm) and 5.0 GHz (6cm) in the VLBI Space Observatory Programme (VSOP) with baselines extending to 20,000 km. Apart from the normal General Observing programme, a special survey of approximately 300 active galactic nuclei (AGN) is being carried out at 5 GHz. Important results include the discovery that the jet in 3C273 is transversely resolved and is found to be edge-brightened, indicating interaction between relativistic plasma and the ambient medium.

The first VSOP observations of the very active quasar 3C279 were conducted in January 1998, revealing that the core and a secondary component 3 milli-arcseconds from the core dominate the compact radio emission at 5 GHz, but that synchrotron self-absorption in the core makes the jet component being the brighter feature at 1.6 GHz. A map of the spectral index variation between 1.6 and 5.0 GHz across the source allows the sites of shock acceleration in the jet and its components to be clearly discerned.

The most striking result of VSOP Polarization observations at 5 and 1.6 GHz, has been the discovery of a twisted jet in the AGN 1803+784, where the magnetic field remains

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perpendicular to the jet direction all along the bent structure. This may represent a whole series of energetic relativistic shock waves that have compressed the magnetic field, so that it is transverse to the direction of compression. Another intriguing explanation could be the wrapping of a toroidal magnetic field around the jet. This type of magnetic field structure is predicted by many theories of relativistic jet flows, but has never been directly observed before on such compact scales.

VSOP observations of NRAO 530 have revealed a brightness temperature of $3x10^{12}K$, well in excess of both the Inverse Compton and equipartition brightness temperature limits. This result can be explained by an inhomogeneous jet model with a Doppler factor higher of 15. (Bower and Backer, 1998). Results on PKS1921-293 in combination with the reported jet component speed, suggest that the jet is traveling at an angle of less than 5 degrees to the line of sight, and at 0.99 c. More details of the HALCA and VSOP observations and results can be obtained from the VSOP website : *http : //www.vsop.isas.ac.jp*

ASCA (Japan, USA) *H. Inoue*

ASCA, the 4th X-ray Astronomy satellite from Japan, has been in orbit for more than 6.5 years without any troubles (Makino and Mitsuda, 1997). The CCD cameras on board ASCA have very good spectral resolution and have brought X-ray spectroscopy clearly in the tool-chest for Astrophysics. For example, the K-alpha lines from helium-like and hydrogen-like ions of Si, S through Fe are clearly distinguished from several SNRs. This spectral capability has also allowed to separate non-thermal emissions from thermal emissions in SNRs, for the first time. In particular, synchrotron emission even in the X-ray band was clearly discovered in SN1006 and strongly suggests that SNRs are an important source for cosmic-ray accelerations. The imaging capability in the hard X-ray band allows to map the distribution of hot gas and its temperature in galaxies and clusters of galaxies. These results have important consequences for the distribution of dark matter in these objects. From these, it appears that the matter in the Universe is composed of dark matter (80 percent), hot gas (15 percent) and stars and interstellar gas (5 percent).

The combination of very high sensitivity with imaging in the hard X-rays has almost resolved the origin of the cosmic X-ray background (CXB). The first non-biased sky survey in 2-10 keV was made with the imaging instrument and the hard X-ray sky was resolved into many faint sources. The integrated emission of these accounts for 30 percent of the CXB, and the average spectrum of these is harder than that of nearby bright sources, similar to that of the CXB. Faint sources were identified with help of optical and soft X-ray (ROSAT) observations and were found to be mainly distant AGNs. Further information on ASCA and archival access can be found at *http : //www.darts.isas.ac.jp/*

Rossi XTE (USA)

The Rossi X-Ray Timing Explorer remains in nominal operations (e.g. Markwardt, Strohmayer and Swank, 1999). Further information:
http : //heasarc.gsfc.nasa.gov/docs/xte/xte_1st.html

Beppo SAX (Italy, the Netherlands, Europe)

The Beppo Sax Satellite is devoted to systematic, integrated and comprehensive studies of galactic and extragalactic X-ray sources in the energy band 0.1 - 300 keV. It has made a major contribution through the early detection and position determination of Gamma Ray bursts (Covino, et al., 1999), which led to the identification of these phenomena to be extragalactic. *http : //www.sdc.asi.it/sax_main.html*

4. PROJECTS LAUNCHED

MINISAT (Spain, USA, UK) *C. Morales*

EURD, the Extreme Ultraviolet spectrograph for Diffuse Radiation, on-board of the Spanish satellite MINISAT-01 has obtained important results about the Sciama neutrinos and early type stars, after two years operation. The data seem to rule out the Sciama hypothesis on decaying neutrinos (Bowyer, et al., 1999), postulated to explain the ionization of the interstellar medium in galaxies. The stellar spectra obtained by EURD have a very high spectral resolution, and confirmed the absolute fluxes found by Voyager, as compared with other discrepant results. For more information: *http : //www.inta.es/entrada/entrada.html*

SWAS (USA)

The Submillimeter Wave Astronomy Satellite is in continued operations to study the chemical composition of interstellar gas clouds.

Information at *http : //www.harvard.edu/cfa/oir/Research/swas.html*.

FUSE (USA, Canada, France) *H.W. Moos*

The Far Ultraviolet Spectroscopic Explorer (FUSE) mission has been designed to access the spectral region 905-1197 Ångstroms with a spectral resolution equivalent to a velocity resolution better than 15 km/s. The sensitivity is sufficient to examine lines of sight throughout the Milky Way and to use quasars and active galactic nuclei as continuum sources for absorption line studies of distant gas clouds.

In orbit checkout and scientific calibration of the instrument are under way. The first science observations have been made at the time of this writing. Regular science operations will begin in late 1999. FUSE is a "Principal Investigator-class" mission with a nominal science mission lifetime of three years. Roughly half of the observing time over the three year period will be available for use by Guest Investigators. FUSE has been developed and is operated by the Johns Hopkins University in collaboration with the University of Colorado and the University of California, Berkeley. Additional information about the FUSE mission can be found at *http : //fusewww.gsfc.nasa.gov/fuse*.

5. WORKING GROUP

Chairman: Y. Terzian
The only working group of the Division (Working Group on Astronomy From the Moon) continued its work to evaluate and examine the possibilities of Lunar bases for astronomical projects. Several members of the WG (e.g. Chen, et al., 1999) presented papers advocating the positive aspects for Lunar observatories.

Willem Wamsteker
President of the Division

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