



Newsletter of the INTEGRAL Science Operations Centre



No. 16

September 2006

Foreword

Peter Kretschmar - Deputy Project Scientist

INTEGRAL is continuing to work smoothly and to produce interesting results. The spacecraft and the instruments function well and the ground segment operates routinely - see also the Science Operations Highlights. The publication rate keeps increasing with more than 196 papers published in refereed journals up to the end of June 2006, see also INTEGRAL Publication Status.

4th Announcement of Opportunity

The 4th Announcement of Opportunity (AO-4) for INTEGRAL observations was very successful with an over-subscription factor of 8 and a 31% increase in the number of proposals compared to AO-3, largely due to the inclusion of a prototype Key Programme on the Galactic Centre region. More details are reported below under AO-4 Results.

At the time of writing the first observations of AO-4 have been done, including already the first TOO (EXO 2030+375)!

Call for Key Programme proposals

In preparation for the 5th Announcement of Opportunity (AO-5) the scientific community is invited to propose specific Key Programmes for AO-5. Documentation will be released on 09 October 2006, the deadline for submissions is 17 November. See <http://integral.esac.esa.int> for more details. These special proposals will be peer reviewed and the selected proposals

incorporated into AO-5 as Key Programmes similar to the prototype available for AO-4.

6th INTEGRAL Workshop: "The Obscured Universe"

From July 2 to 8 more than 200 participants from European countries, the USA, Russia and Japan enjoyed a lively workshop and the hospitality of our Russian colleagues at the Space Research Institute (IKI) in Moscow. Some highlights from this Workshop are reported below.

Changes in ISOC

While the work at the SOC is going on routinely, there have been some changes and further changes will take place in the coming months, see Changes in ISOC to learn more.

INTEGRAL AO-4 Results

Celia Sanchez - Operations Scientist

The 4th Announcement of Opportunity (AO-4) for observing proposals with INTEGRAL was released on March 13th 2006. As a response to it, a total of 142 proposals, from 16 different countries were received at the ISOC, between 13th March and 21st April, 2006.

During AO-4 and as a pilot project, one INTEGRAL Key Programme (KP) observation of the Galactic Centre will be carried out. An INTEGRAL key programme is a scientific investigation which requires a very significant fraction of the observing time (available per AO cycle) in order to achieve its scientific objectives. KP observations are a new element

in the INTEGRAL observing programme, which take advantage of the unique "targets multiplicity" feature of INTEGRAL's coded aperture masks, and of its very large fields of view.

Scientists were invited to submit proposals for targets contained within the KP pointing area. Any target contained in the area exposed by the KP field could be the subject of a KP subscription, from ultra-long nucleosynthesis and diffuse emission studies, to (much) shorter observations of the many individual compact objects in the field. AO-4 KP subscriptions were submitted following the general guidelines for Open Time AO-4 proposals. The AO-4 KP observation was favourably accepted by the INTEGRAL community, and 43 KP subscriptions were received at the ISOC.

The INTEGRAL AO-4 Time Allocating Committee (TAC) met at ESTEC (The Netherlands) from 30th May to 02 June, 2006. The TAC approved 87 Open Time proposals (TOOs included) of which 35 were associated to the AO4 Key Programme observation.

The AO-4 observations started on August, 16th 2006, and will be carried out until August 16th 2007.

INTEGRAL AO-5 Key Programme

Celia Sanchez - Operations Scientist

A call for AO-5 Key Programme proposals will be opened to the scientific community on 23 October 2006, although the guideline documentation will be released earlier on 9 October 2006. The purpose of this call for proposals is to solicit proposed investigations to be considered as Key Programmes. Successful KP proposals from this call will be known before the release of the next call for AO-5 scheduled for release in Spring 2007, and they will be scheduled for execution during AO-5, which will commence in August, 2007. The list of

selected KP proposal(s) will be published in the AO-5 document package such that the scientific community can submit proposals for individual targets (point sources or extended areas) which are covered by the sky areas exposed to KP proposals.

The total amount of time which will be set aside (per year) for the sum of all approved KP's is still to be decided. But as a guideline, about 25% of the available open time per year, i.e. 6 MS for the AO-5 cycle can be considered.

The deadline for AO-5 Key Programme proposal submission will be 17th November, 2006.

INTEGRAL Publication Status

Jean Matagne - ISOC Webmaster

A list of INTEGRAL related publications is maintained on <http://integral.esac.esa.int/Publications/>. Although we cannot claim the list is complete, it still contains (as of August 2006) 587 records: 205 in refereed journals and 382 in non-refereed literature. The rate of publications in the period since the last ISOC Newsletter has been very good, with an all-time high in April 2006 of 13 papers in refereed journals.

The current search tool allows the use to select journals alphabetically by author, chronologically, or by subject (e.g. Extragalactic objects, Nucleosynthesis, Compact Galactic Objects etc.).

Later this year this publication database will also be accessible from the ISDA Science Data Archive (ISDA). It will then be possible to search for papers containing data on a particular source.

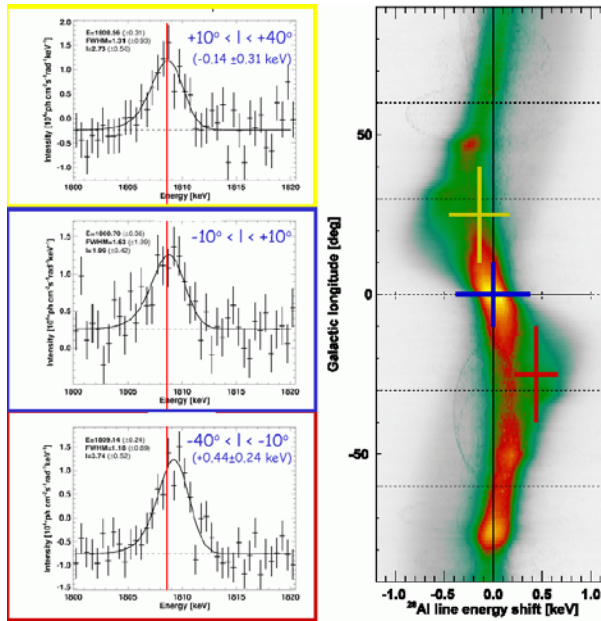


Fig. 1: Shift in position of the ^{26}Al line along the galactic plane (Diehl et al. 2006, *Nature* 439, 45)

Science Highlights

Peter Kretschmar - Deputy Project Scientist

With an increasing publication rate for INTEGRAL results (see INTEGRAL Publication Status above), this section evidently can only give a small selection of scientific highlights.

Early in 2006, Diehl et al. (2006, *Nature* 439, 45; 2006, *A&A* 449, 1025) found a wide echo both in specialized publications and in general media with their precise determination of the line shift in ^{26}Al along the galactic plane (see Fig. 1). The line shift, well explained by Galactic rotation, proves the Galaxy-wide origin of this emission and thus allows an independent estimate of the supernova rate (1.9 ± 1.1 SN/century) and the star forming rate (~ 7 stars/y) in the Galaxy.

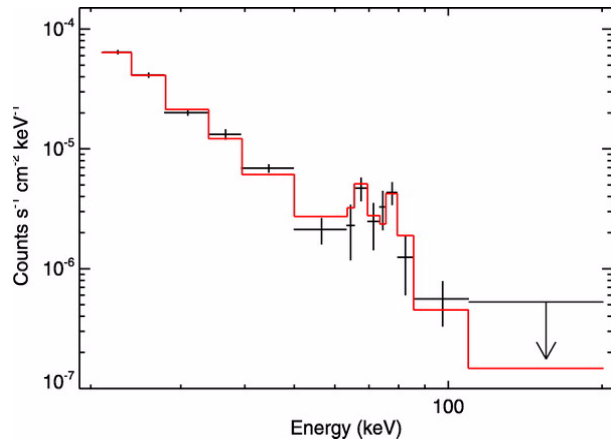


Fig. 2: Spectrum of Cas A showing both the 67.9 and 78.4 keV ^{44}Sc gamma-ray lines from the decay chain $^{44}\text{Ti} \rightarrow ^{44}\text{Sc} \rightarrow ^{44}\text{Ca}$ (Renaud et al. 2006, *ApJ*, 647, L41)

The surprising concentration of 511 keV emission in the inner Galaxy reported in the last newsletter has led to various explanations including Light Dark Matter as one option. However a paper by N. Prantzos (2006, *A&A* 449, 869) shows that this can also be explained by conventional sources if a large fraction of the disk positrons can in fact be channeled to the bulge via the large scale magnetic field of the Galaxy and annihilate there.

Renaud et al. (2006, *ApJ* 647, L41) have observed both the 67.9 and 78.4 keV ^{44}Sc gamma-ray lines from the decay chain $^{44}\text{Ti} \rightarrow ^{44}\text{Sc} \rightarrow ^{44}\text{Ca}$ in Cassiopeia A with the INTEGRAL IBIS/ISGRI instrument (see Fig. 2). Compared to previous observations, the lines are now clearly separated and the underlying continuum emission is determined up to ~ 100 keV. ^{44}Ti is a key isotope for the investigation of the inner regions of core-collapse supernovae and their young remnants. The high yield (about 1.6×10^{-4} solar masses) of this isotope in Cas A indicates that the remnant is peculiar in comparison to other SNRs.

Using the Earth as an occulter - a difficult feat that is described in more detail under Science Operations Highlights - a large group of scientists led by E. Churazov has made a new determination of the Cosmic X-ray Background (CXB) in the energy range 5-100 keV. The recently published first results (2006, A&A submitted, astro-ph/0608250) show a spectral shape similar to that previously determined from HEAO-1 data, but a $\sim 10\%$ higher normalization.

One of the complications in the above analysis is the contribution of the Galactic Ridge emission. This has now been mapped in the 17-60 keV range with INTEGRAL data by Krivonos et al. (2006, A&A submitted; astro-ph/0605420). The results agree with the main part of the emission coming from accreting magnetic white dwarfs in the solar neighbourhood. The shape of the spectrum constraining the average mass of such white dwarfs as ~ 0.5 solar masses.

A widespread view is that a large fraction of the CXB is produced by Compton-thick AGN "hidden" from classical X-ray surveys through their high absorption. But INTEGRAL studies by Bassani et al. (2006, ApJ 636, L65) and Beckmann et al. (2006, ApJ accepted; astro-ph/0606687) draw a different picture: At least in the local universe, the fraction of Compton-thick AGN is less than 10% and not sufficient to explain the CXB emission. This could indicate that shrouded sources are more frequent at higher redshifts or that a yet to be detected sample of even deeper shrouded sources is responsible.

A first census of the sky as seen by IBIS above 100 keV has recently been published by Bazzano et al. (2006, ApJ accepted; astro-ph/0608164). These results also indicate that while Galactic emission in the 100-300 keV range is strongly dominated by point sources, active galaxies detected above 1 mCrab

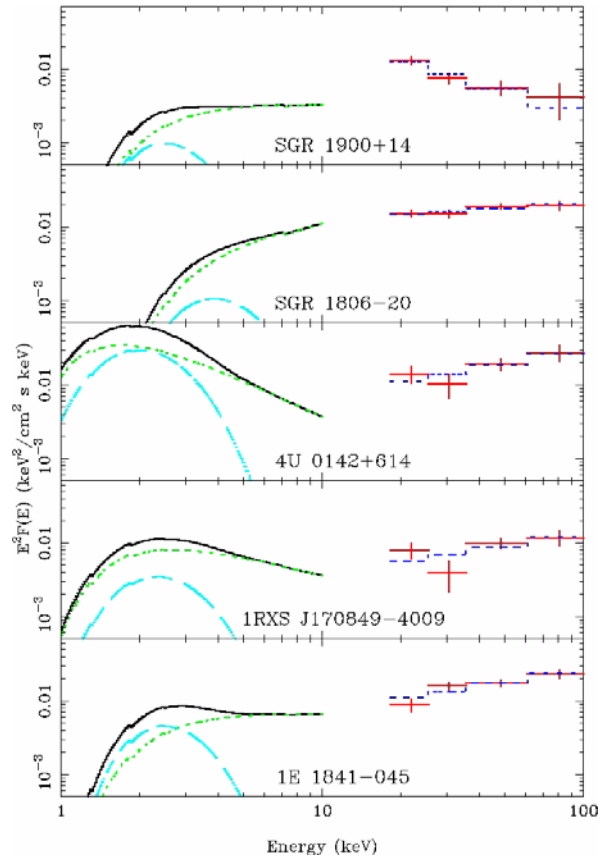


Fig. 3: Spectra of several anomalous X-ray Pulsars (Kuiper et al. 2006, ApJ 645, 556) and of Soft Gamma-ray Repeaters (Götz et al. 2006, A&A, 449, L31)

account for only $\sim 3\%$ of the cosmic hard X-ray background in the 100-150 keV range.

Among the unexpected results of INTEGRAL are the very hard continuum spectra found for several Anomalous X-ray Pulsars (Kuiper et al. 2006, ApJ 645, 556). Deep observations of Soft Gamma-ray Repeaters (SGRs) by Götz et al. (2006, A&A, 449, L31) now also show persistent hard emission for these sources at energies above 20 keV. Both source classes are thought to be magnetars but their broadband spectra show very different overall shapes (see Fig. 3).

Several papers have been published based on the public TOO observations in late 2004/early

2005 of the transient X-ray pulsar and cyclotron line source V0332+53. Both Tsygankov et al. (MNRAS 371, 19) and Mowlavi et al. (A&A 451, 187) find a clear increase of the fundamental cyclotron line energy as the luminosity decreases which could be interpreted as the region of line formation moving closer to the neutron star surface. The former group also noted strong variations of the pulse profile, especially around the line energies with luminosity. Finally, Reig et al. (A&A 449, 703), combining INTEGRAL and RXTE data found that the source shows color-color variations and timing properties similar to Z source LMXBs.

Since the last newsletter appeared, 28 Astronomer's Telegrams have been published on a variety of sources, ranging from new sources over activity of transient galactic objects to AGNs.

In the same time range only 5 gamma-ray bursts have been observed within the IBIS FOV, the last one in February indicating a serious case of Poisson statistics, a.k.a. bad luck for the IBAS team! On the other hand, Marcinkowski et al. (A&A 452, 113) have demonstrated that using Compton mode data, in some cases the position of a GRB can even be determined if the bursts happens outside the FOV!

Science Operations - Highlights

Erik Kuulkers - Operations Scientist

A couple of operational changes have been implemented since the last Newsletter of November.

Following a recommendation from the INTEGRAL science working team, the step size of the standard 5x5 raster pattern was changed from 2.0 to 2.17 degrees. This change, which became effective as of revolution 421 (25 March 2006) further improves the imaging

performance of the IBIS instrument. Note that as a side effect, the effective exposure for JEM-X during 5x5 pattern observations is slightly decreased.

The background counting rates seen in the INTEGRAL instruments are increasing. In the first few months of 2006 this has resulted in valuable science data being lost, as the allocated telemetry of 129 packets to IBIS, 103 to SPI, 8 to JEM-X1, 1 to JEM-X2 and 5 to OMC per 8 sec started to be fully used by SPI and increasingly by IBIS on many occasions. In order to alleviate the situation, ESA, in consultation with the instrument teams, decided to change the telemetry production of some of the instruments, as well as the allocation of telemetry between the different INTEGRAL instruments. At short notice, from revolution 421 (25 March 2006), one telemetry packet was allocated to SPI, and taken from IBIS.

Further setting changes were investigated and defined. With respect to IBIS it was decided to reduce the number of indirect mode packets produced with a minimal impact on science yield. This was accomplished by incrementing the integration time of the Spectral Timing packets of PICsIT by a factor of four from 3.90625 msec to 15.625 msec, while doubling the number of energy channels from 4 to 8. Increasing the PICsIT integration time means a loss in sensitivity for fast pulsars, but doubling the number of energy channels helps in GRB studies. The boundaries of the 8 Spectral Timing channels are now set to:

Channel 1: 208-260 keV, Channel 2: 260-312 keV, Channel 3: 312-364 keV, Channel 4: 364-468 keV, Channel 5: 468-572 keV, Channel 6: 572-780 keV, Channel 7: 780-1196 keV, Channel 8: 1196-2600 keV.

Another change is to switch off the DPE (Data Processing Electronics) of the dormant JEM-X2 unit and to re-allocate one telemetry packet currently used to transmit housekeeping data

of this unit to the SPI science telemetry. In summary, the new default telemetry allocation, which became effective from revolution 441 (24 May 2006), is 128 packets for IBIS, 105 for SPI, 8 for JEM-X1, 0 for JEM-X2 and 5 for OMC. Nevertheless, the telemetry bandwidth allocated to SPI (105pkts/cycle) was again fully saturated after the 8th annealing. In order to recover some telemetry bandwidth, with reduced impact to the science it was decided to enable the SPI Multiple Event Reduction Function. The function was enabled after radiation belt entry of revolution 453 (1 July 2006). From revolution 454 onwards, the average telemetry band occupation of SPI was 93.6 packets/cycle over the science window.

In order to maintain the SPI high spectral resolution, a SPI annealing period (for the 8th time, but using a revised procedure) was performed from revolutions 446 to 451 (8-25 June 2006). Note that during this period INTEGRAL performed mainly observations where SPI was not the main instrument for the science (e.g., LEDA170194, Mrk 421). SPI is now operating at a lower temperature; its energy resolution at 882.5 keV just after the annealing was about 2.4 keV.

Since the last Newsletter, INTEGRAL performed long observations of the Vela Region (pointed towards GRO J0852-4642) and the Cas A/Tycho region during (northern) winter 2005/2006. In late January and early February (revolutions 401, 404-406; 24-25 January and 2-3, 5-6, 8-9 February 2006) INTEGRAL observed an unusual target - the Earth - in order to learn more about the cosmic background between 20 and 200 keV. By comparing observations with and without the Earth blocking the sky the CXB can be reconstructed. Since the Earth cannot be directly targeted, ISOC and MOC, in consultation with the instruments teams, developed a special operational procedure, in order to on one hand allow the Earth to be within the field of views

of the instruments and on the other hand to ensure a safe mode of operations. INTEGRAL was settled on a point in the sky and then the Earth drifted through the instruments field of view.

As soon as the Galactic Center region was visible again in February 2006 INTEGRAL mainly focused on this region using proposals from both the Guest Observer and Core Programme, except for revolution 422 (28-31 March 2006) where INTEGRAL was pointed close to the anti-center, i.e., performing instrument, and attitude and orbit control calibration observations on and close to the Crab. A large part of the Crab observations was dedicated to investigate the IBIS off-axis efficiency.

After the Galactic Center visibility period INTEGRAL directed towards the Scutum arm, continued by observations concentrating on extra-galactic objects (e.g., 1ES 1426+428) and fields. INTEGRAL finished AO-3 with an observation of IGR J16318-4848, which was simultaneously done with Suzaku.

Since the (gamma-ray) sky is highly variable, it is no surprise that TOO observations interrupted the normal observing schedule. The extra-galactic objects 3C 279 and Mrk 421 became X/gamma-ray bright, and INTEGRAL performed long observations to characterize their behaviour (500 and 830 ksec, in revolutions 397-400, 13-22 January, and 448-451, 14-25 June, respectively). In the Galactic Center region a new black-hole candidate X-ray binary discovered by RXTE became active, XTE J1817-330, and triggered a TOO from the Core Programme. Observations were performed in revolutions 408 (15-17 February 2006) and 414 (4-7 March 2006). The soft gamma-ray repeater SGR 1900+14 became active again at the end of March 2006, which triggered a Guest Observer observation in revolution 423 (1-3 April 2006). Unexpectedly, the anomalous X-ray pulsar 4U 0142+61

entered an extended active state end of June 2006, with bursting activity observed in RXTE monitoring observations. It was decided to perform a TOO observation, outside the nominal TAC approved Guest Observer programme, in revolution 455 (2-4 July 2006, just at the start of the 6th INTEGRAL Workshop).

Cyg X-3 is a story on itself. It is an enigmatic X-ray binary showing all kinds of behaviour, many of them not encountered in other high-energy objects. An AO-3 TOO proposal was designed to cover certain stages of its behaviour. However, not only were the trigger criteria complicated; it turned out that also from an operational view the observations were difficult to plan. Cygnus X-3 went into an extended quenched state (i.e., very low radio fluxes) near the end of January 2006. TOO observations were to be done as soon as possible after the source leaves this state; however, around that time INTEGRAL was programmed to observe the Earth and no TOO observations were foreseen. Subsequently (but after an unusually long time), Cygnus X-3 showed a major radio flare in the beginning of May, triggering the second part of the proposal; this time a TOO observation was performed in revolution (437; 12-13 May 2006), contemporaneously with RXTE and Swift. Hard X-ray were detected during the major radio flare, which triggered another INTEGRAL observation in the next revolution, 438 (16-18 May 2006). Nature decided to be nice, and Cygnus X-3 went into a quenched state again at the end of July. Subsequent TOO observations were performed in revolution 462 (26-27 July 2006).

In the meantime, we have started AO-4 on Aug 16 with a Galactic bulge observation. Further focus on the Galactic Center region is foreseen using Guest Observer and Key Programme proposals. EXO 2030+375 was already bright for some weeks, and since it met the trigger criteria in AO-4 a TOO observation

was performed in the 2nd AO-4 revolution (470; 19-21 Aug 2006). Further details on the planning can be found at the ISOC INTEGRAL Target and Scheduling Information web pages. Note the new feature on these pages to see where INTEGRAL is or will be pointing to on the sky. ISOC has also released the AO-4 Long-Term Observation Plan which gives an overview of all observations currently foreseen during the AO-4:

http://integral.esac.esa.int/isoc/html/schedules/AO4_Long_Term_Plan.html.

Note that while this is the best long-term currently available, the schedule will change from time to time, e.g., due to TOO observations.

The ISOC Science Data Archive

Rees Williams - Archive and Operations Scientist

Version 2.5 of the ISOC Science Data Archive (ISDA), was released in May 2006. In this version it is possible to perform queries to external archival facilities. A new pop-up panel appears after clicking on the button "Query other Archives", which is located besides each record of an observation or SCW list. This panel allows users to define the radius of a cone search around the nominal INTEGRAL pointing direction, and the external archive facility (or facilities) to be searched. More than 20 external archives can be queried from the ISDA user interface:

- high-energy mission archives (all the main X-ray and gamma-ray observatories from Einstein to XMM-Newton)
- observatories in other wavelengths (IRAS, ISO, IUE, MAST, Spitzer, etc.)
- source catalogues, both the X-ray domain (RASS) and in other wavelengths (2MASS, MSX) as well as general catalogue services (Simbad, NED, VizieR)

The result of the queries depends on the nature of the external archive being searched. Generally, a list of the observations whose field-of-

view overlaps the INTEGRAL observation's one, or of the sources falling in the INTEGRAL field-of-view are returned. Whenever allowed by the external facility, a direct link to data download is provided.

Also in ISDA version 2.5 it is possible to retrieve data from the Second IBIS/ISGRI Soft Gamma-ray Survey Catalogue. The full catalogue, including associated light-curves and spectra can be accessed via the ISDA browser interface. Alternatively a FITS file containing source positions and broad-band fluxes can be downloaded.

Should you have any questions or suggestions about these or any other ISDA facilities, please do not hesitate to contact the [INTEGRAL HelpDesk](mailto:INTEGRAL.HelpDesk@esa.int). The archive can be found at <http://integral.esac.esa.int/isda>

The 6th INTEGRAL Workshop

Erik Kuulkers - Operations Scientist

The 6th INTEGRAL Workshop was this time hosted by the Space Research Institute (IKI) in Moscow, Russia. Note that contrary to the previous Newsletter information, the workshop was not held in St. Petersburg, Russia. The workshop took place during INTEGRAL revolutions 454 and 455 (i.e., from 2 to 8 July 2006). The theme this time was "The Obscured Universe". The well organized workshop was attended by more than 200 participants from European countries, the USA, Russia and Japan. The workshop was jointly co-sponsored by IKI (Space Research Institute), ESA (European Space Agency), RAS (Russian Academy of Sciences) and RFBR (Russian Foundation for Basic Research).

Not solely many interesting talks and posters with results from INTEGRAL were presented, but also exciting (new) results from other high-energy instruments, such as XMM-Newton, Chandra, RHESSI, Swift and Suzaku. The

workshop can be regarded as a success, not only because of the great (new) results, but also due to the great hospitality of our Russian colleagues.

The scientific programme started to touch upon the electron-positron annihilation emission from the Galaxy and gamma-ray lines, followed by the Galactic continuum emission, as well as the cosmic X-ray background radiation. Thanks to the added exposure of recent months, further progress was reported in the nucleosynthesis area, including improved 1.8 MeV sky maps showing a good correlation between gamma-ray longitude profiles and DMR data. The concentration of the diffuse 511 keV emission seems to be even more concentrated to the Galactic Center (FWHM ~ 6 deg) and the detection significance of the two ⁶⁰Fe lines from the Galaxy has now been increased to 5 sigma. With respect to the cosmic X-ray background, the first exciting results from the INTEGRAL Earth observations were shown. For more details see the section on Science Highlights.

Attention was then shifted towards extragalactic targets. The number of AGN seen by INTEGRAL (and Swift) is increasing, making (sample) studies of them scientifically important.

Going back to our own Galaxy, the focus was then changed to its point source population and their characteristics in behaviour and identification of those detected by INTEGRAL and hitherto unknown. Two new kinds of high-mass X-ray binaries have been identified thanks to INTEGRAL: those with high (intrinsic) absorption which are (weakly) active for most of the time and those which appear only for a short amount of time (typically hours to day; note that they do not necessarily have high absorption). The latter are nowadays referred to as supergiant fast X-ray transients. INTEGRAL is rapidly increasing the number

of high-mass X-ray binaries, either because at hard energies intrinsic or interstellar absorption is non-existent, and/or because of the large field of view INTEGRAL is picking up the fast transients.

Finally, results on various X-ray point sources were discussed, i.e., binaries such as black-hole candidate binaries, X-ray bursters, millisecond X-ray pulsars, as well as single (compact) stars such as isolated pulsars and anomalous X-ray pulsars. Last, but not least, the most energetic phenomena in the universe were discussed, i.e., the soft gamma-ray repeaters and gamma-ray bursts. Excitingly new is the detection of (unexpected) hard X-ray/gamma-ray emission from the anomalous X-ray pulsars and soft gamma-ray repeaters (see Science Highlights).

The atmosphere of the workshop was lively, which was particularly well reflected during the conference dinner. Although a thousand words can say a lot (e.g., many of us will remember the eloquent Prof. Ed van den Heuvel at the after-dinner speech), but a picture can capture almost of all of it. No wonder that a photo taken during the conference dinner made it as the INTEGRAL picture of the month of August (<http://integral.esac.esa.int/POMAug2006.html>). That picture shows some of the (young) workshop attendants celebrating at the conference dinner together with Prof. Rashid Sunyaev, chair of the Science Advisory and Local Organizing Committees.

Changes at ISOC

Lars Hansson - ISOC Manager

At the end of 2005 Mathijs Homminga, one of the ISOC Software Engineers moved back to the Netherlands to join another company. He was replaced by Marnix Bindels, another Dutch software engineer.

Pieter-Jan Baeck from Belgium joined ISOC in June this year as Young Graduate Trainee. He is working on a visualization tool for the Integral Science Data Archive.

More changes are coming up in the near future: Lars Hansson will retire from ESA 1 January 2007. Peter Kretschmar will take over the role of Science Operations Manager at ISOC and will be replaced by a new Operations Scientist before the end of the year.

Contact INTEGRAL science operations

The INTEGRAL science operations team is located at ESAC, while the Mission Manager and Project Scientist are located in ESTEC. Details are provided below.

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