

STOCKHOLM OBSERVATORY

ANNUAL REPORT 2005

Editor Gösta Gahm

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Home page: www.astro.su.se

PREFACE

In retrospect, the year 2005 might have seemed rather quiet. However, a closer look shows the emergence of a few trends that may point to major changes in the future boundary conditions for our scientific activities. The Swedish government has clearly indicated in its research plan that it wants to focus more on the very best scientific groups/environments. The requirement for the universities to prioritize amongst its own research activities for the Linné-applications can be seen as part of this process. Likewise, the president of Stockholm university has made it clear that he finds it important to select high profile research areas within the university to be used in the increased competition for external fundings as well as students. The Faculty of natural sciences has, since a few years back, a strategic fund, which hitherto has not been extensively used to set directions for research activities. With the new strategic plan it is not unlikely that this will change.

The development and probable impact of these trends are hard to foresee. However, last year gave ample evidence that from our horizon, they should be seen as a possibility rather than a threat. The High Energy Astrophysics and Cosmology (HEAC) group was selected, as one of only ten groups within all of natural sciences in Sweden, for funding by the Swedish Research Council within its newly established program for “Excellent research environments”. The Faculty of sciences decided to fund a graduate school in astrobiology. These projects involve several other departments (SU and KTH) but are both led by our department. Together with the physics department at KTH we also received major funding from the Wallenberg foundations to participate in the PoGO-project, which is an international balloon project to observe polarization in the X- and γ -ray regime, and to buy a much wanted telescope to be placed here at AlbaNova.

During the year Pawel Artymowicz left the department to take up a chair in astronomy at the University of Toronto, Canada. Hans Olofsson started a five year leave of absence at the 80% level to act as director for the national facility in Onsala. We were much pleased to receive the news from Garrelt Mellema that he accepted our offer of a faculty position. Thanks to increased external funding we had a healthy influx of new graduate students. Laia Mencia Trinchant, Natalia Serafimowich, Teresa Riehm, Michael Blomqvist, Genoveva Micheva and Matthias Maercker joined our graduate program. It is with much joy and a bit of pride that we now see the number of graduate student approach the level motivated by the extent of our research activities. It is reassuring to note that quality has not been lost in the process; the prize for the best thesis in Sweden within the area of physics during the year 2005 was given to former graduate student Boris Gudiksen.

The year also marked the starting point for the Bologna process at the departmental level. Although, formally, this restructuring of university studies concerns only the undergraduate programs, it will have implications for the graduate programs. Since the majority of courses now taught on the graduate level is likely to be included in the new masterprogram, future graduate students will be expected to have a solid background in the subject already when entering the graduate program. Since the recruitment of a large fraction of our graduate students was based on their solid background in physics, this could adversely affect the fruitful mix of graduate students that we now have and which has contributed a great deal to the quality of our program. The implications of the Bologna process and what actions to take will be central issues during the present year.

Claes-Ingvar Björnsson, Director

1. INTRODUCTION

The Department of Astronomy at the Stockholm University (Stockholm Observatory) has responsibilities in teaching, research and public outreach. The institution also hosts the national Station for Astrophysics of the Royal Swedish Academy of Sciences [Kungliga Svenska Vetenskapsakademien - KVA]. About 60 persons were actively engaged at the department during 2005, including more than 20 graduate students.

The fields of research include the interstellar medium and star formation, young stars and planetary systems, solar physics, evolved stars and planetary nebulae, supernovae, galactic structure and dynamics, observational cosmology, and high energy astrophysics. Besides, instruments were developed in the Observatory workshop.

Stockholm Observatory made use of many instruments at the European Southern Observatory (ESO), including the Very Large Telescope (VLT). The Nordic Optical Telescope (NOT) and the Swedish solar telescope are both located on La Palma, Canary Islands. Other ground-based instruments were also used, like the 20m antenna at the Onsala Space Observatory (OSO).

Various research programs at the Observatory make use of space-based observatories including the Swedish Submillimetre Space Telescope (ODIN), the Hubble Space Telescope (HST), the Far Ultraviolet Space Explorer (FUSE), the International Gamma-Ray Astrophysics Laboratory (INTEGRAL), the Compton Gamma-Ray Observatory (CGRO), the X-ray Multimirror Mission (XMM), and the X-ray Observatory (CHANDRA).

Observatory members are also actively involved in the development of, and program planning for, new space missions such as the Far Infra-Red Space Telescope (HERSCHEL), the Infrared Space Interferometer (DARWIN), the Gamma-ray Large Area Space Telescope (GLAST) and the James Webb Space Telescope (JWST).

2. STAFF

Positions are financed by Stockholm University and/or by external financial sources indicated in parenthesis.

VR - Swedish Research Council [Vetenskapsrådet]

SNSB - Swedish National Space Board [Rymdstyrelsen]

ESMN - European Solar Magnetometry Network

EU - RTN - European Union Network

KVA - The Royal Swedish Academy of Sciences [Kungliga Vetenskapsakademien]

HS - House of Science [Vetenskapshuset]

NOTSA - Nordic Optical Telescope Scientific Association

2.1. Faculty

Artymowicz, Pawel: Associate Professor (VR, 50%) until Nov.

Björnsson, Claes-Ingvar: Associate Professor (VR, 25%)

Fransson, Claes: Professor

Gahm, Gösta: Professor

Justtanont Liseau, Kay: Research Scientist (SNSB). From July senior RS

Kiselman, Dan: Research Associate (KVA)

Kozma, Cecilia: Researcher (HS, 40%)

Thébault, Philippe: Guest Researcher

Larsson, Bengt: Research Scientist (SNSB)

Larsson, Stefan: Research Scientist (SNSB)

Lindblad, Per Olof: Professor Emeritus

Liseau, René: Professor (SNSB)

Lundqvist, Peter: Associate Professor (KVA)

Löfdahl, Mats: Research Associate (KVA 75%)

Mörtsell, Edvard: Research Associate

Näslund, Magnus: School-project leader (50% HS)

Olofsson, Göran: Professor (SNSB)

Olofsson, Hans: Professor. From Dec. 20%

Ryde, Felix: Research Associate (VR)

Sandqvist, Aage: Professor (SNSB 35%, Almanacksförlaget 50%)

Scharmer, Göran: Professor (KVA)

Schober, Jan: Researcher (50%, From Nov. 40%)

Schöier, Fredrik: Research Associate (VR)

Sollerman, Jesper: Research Associate (VR). From Sep. 20%

Sundman, Anita: University Lecturer (50%)

Östlin, Göran: Associate Professor (VR)

2.2. Postdoctoral Fellows

Delgado, Eduardo Donate: Postdoctoral Fellow (EU-RTN & VR) until Sep.

Edgar, Richard: Postdoctoral Fellow (EU-RTN & VR) until Aug.

Langhans, Kai: (KVA, ESMN)

van Noort, Michiel: KVA from Nov.

2.3. Technical Staff

Cumming, Robert (part-time VR/SNSB)
 Dettori, Pete: Research Engineer (KVA)
 Florén, Hans-Gustav: Research Engineer (SNSB 30%)
 Gelato, Sergio: System Manager
 Wänn, Uno: Research Engineer

2.4. Administrative Staff

Engberg, Ulla: Secretary, student office. From Aug. 80%
 Olofsson, Lena: Senior Administrative Officer
 Åberg, Sandra: Personnel adm (90%). From Oct. 100%

2.5. Graduate Students

In many cases, graduate students receive full-time economic support from Stockholm Observatory: 80% as a study grant [utbildningsbidrag, utbb] or a graduate position [doktorandtjänst, dokt.tjn] and 15% as a teaching assistant [assistent, ass] position. The latter may also include administrative duties in addition to teaching duties. In some cases students are supported by research grants from VR, SNSB, KVA, NOTSA and EU-RTN.

Axelsson, Magnus: dokt.tjn (80%), studievägledning (20%)
 Banhidi, Zita: dokt.tjn.
 Blomqvist, Michael: From Sep. utbb (VR)
 Borgonovo, Luis
 Elfhag, Torsten
 Grigorieva, Anna: dokt.tjn 50%
 Gröningsson, Per: dokt.tjn (50% SNSB, 50% SU)
 Gålfalk, Magnus: dokt.tjn (50% SNSB, 50% SU)
 Hayes, Matthew: dokt.tjn, (80% SNSB, 20% SU)
 Hillberg, Tomas dokt.tjn (20% KVA, 80% SU)
 Karlsson, Roland
 Melinder, Jens: doktn.tjn (80% VR, 20% SU)
 Maercker, Matthias: From Sep. utbb
 Micheva, Genoveva: From Sep. utbb
 Narayan, Gautam: utbb (40% KVA, 40% SU), 20% KVA ass
 Nymark, Tanja
 Näslund, Magnus
 Olofsson, Sven
 Peplinski, Adam: dokt.tjn. (50%)
 Ramstedt, Sofia: dokt.tjn. (80% VR, 20% SU)
 Riem, Teresa: From Sep. utbb (VR)
 Serafimovich, Natalia: From May utbb (EU-RTN)
 Trier Frederiksen, Jakob: dokt.tjn. (EU-RTN)
 Trinchant, Laia Mencia: From Feb. stipend (NOTSA)
 Tziamtzis, Anestis: utbb, From June dokt.tjn
 de Val Borro, Miguel: ass

2.6. Board of the Observatory

The board consists of regular members, and deputy members who may substitute when regular members are unable to participate. The present board consists of the Director, the Deputy director, three representatives (with three deputies) from the faculty, one representative (with deputy) from the technical/administrative (T/A) group, two representatives (with one deputy) from the graduate students, and one representative (with deputy) from the undergraduate students (the graduate and undergraduate student representatives are elected on a one year basis).

Claes-Ingvar Björnsson, (director)
Göran Olofsson (deputy director)
Claes Fransson (faculty repr.)
Kay Justtanont Liseau (faculty repr.)
Hans Olofsson (faculty repr.)
Stefan Larsson (1st deputy faculty repr.)
Peter Lundqvist (2nd deputy faculty repr.)
Göran Östlin (3rd deputy faculty repr.)
Ulla Engberg (T/A repr.)
Hans-Gustav Florén (deputy T/A repr.)
Jens Melinder (grad. stud. repr.)
Jacob Trier Frederiksen (grad. stud. repr.)
Tomas Hillberg (deputy grad. stud. repr.)
Jeanette Bast (undergr. stud.)
Kristina Wigren (deputy undergr. stud.)

3. RESEARCH

3.1. Young Stars and Star Formation Regions

(Z. Banhidi, A. Brandeker, H.-G. Florén, G. Gahm, M. Gålfalk, K. Justtanont, B. Larsson, R. Liseau, G. Olofsson, S. Olofsson, Aa. Sandqvist, F. Schöier)

The research at the Stockholm Observatory in the field of star formation is oriented along four major lines:

(i) The study of the interstellar medium, in particular the physics and evolution of filamentary molecular clouds, star forming clouds, and the molecular emission and polarization from circumstellar environments.

(ii) The study of ensembles of very young stellar objects, aiming to determine empirically the mass spectrum of stars at their birth. The functional form of this spectrum appears universal, i.e., it is the same in our Galaxy and in external galaxies. Our primary objective is to understand to what degree the memory of the initial cloud condition is “frozen” in this spectrum.

(iii) The study of the dynamics of forming stars, especially during the earliest, protostellar phases. The physics of the mass building infall and the coexisting mass outflows are not well understood. These processes are of major interest since they determine the final stellar mass and the formation of planets.

(iv) The study of young stars, in particular close T Tauri binaries, and the evolution of accretion disks.

The group is involved in a number of observational programs at different telescopes such as the Infrared Space Observatory (ISO), HST, XMM, CHANDRA, ODIN, APEX, NOT, ESO (VLT, NTT) as well as in preparations for HERSCHEL, JWST and DARWIN.

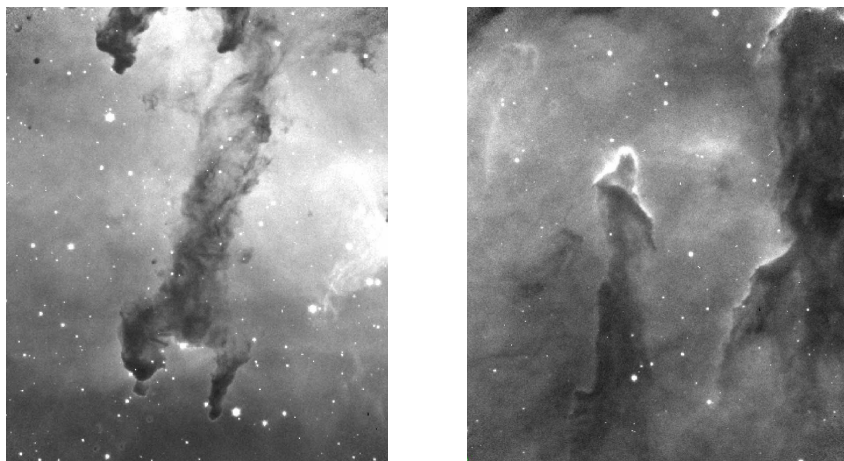


Figure 1. Two examples of “elephant trunks”, cold pillars of gas and dust silhouetted against a background of bright nebulosity in regions of star formation. The trunks are sculptured by the expanding warm plasma. Our recent radio observations of the molecular gas shows that the trunks are accelerated. The more massive “heads” are lagging behind, so the trunks are stretching with time. Furthermore, they also rotate about their major axes, and immense amount of rotational energy is transported from the central star forming regions.

3.2. Astrophysics of Planetary Systems

(P.Thebault, A. Grigorieva, A. Peplinski, M. de Val Borro, Richard Edgar, P. Artymowicz)

The focus has been on theoretical investigations of the origins of planetary systems around stars within the following three main areas:

(i) Primordial solar nebulae with embedded protoplanets. More than 100 exoplanets (planets around stars other than the sun) have been discovered to date, mostly by Doppler spectroscopy, which reveals their minimum mass, orbital distance and eccentricity. All of these three basic parameters are distributed in wide ranges, surprisingly dissimilar to our own system. Theoretical understanding of the sometimes eccentric, or very tight (short-period) orbits, or super-Jupiter masses requires a thorough knowledge of how the protoplanets interact with the accretion disks in which they are growing, and whether that interaction alone can produce the observed orbits. If not, one could argue for the basic importance of gravitational interactions between several planets forming concurrently.

The group studies the interaction both analytically and using sophisticated multidimensional hydrodynamical simulations. A variety of high-resolution codes are used, and some are similar to those needed to study supersonic flows around aircrafts (for movies see <http://www.astro.su.se/~pawel/planets/movies.html>)

In 2005, our group has been the driving force behind a major collective effort of code comparison. The goal of this project was to assess the reliability of various so called SPH- and grid-based codes presently treating the problem of disk-planet interaction. A paper presenting the results of this thorough comparison study has been submitted to MNRAS (de Val Borro et al., 2005)

(ii) Planetary systems around nearby stars, revealed through the presence of circumstellar, replenished dust disks. A first approach is to study the so called “collisional avalanches”, a mechanism by which isolated catastrophic collisions of big cometary objects can lead to dramatic collisional chain reactions within a debris disc. Our aim is to see if such avalanches could produce observable features and thus be a possible explanation for some of the observed asymmetries within debris discs.

Another project is to study the coupled evolution of dust and gas in the specific β Pictoris system. We have used dust dynamics submitted to gas drag as a way to constrain the total amount of gas in this system. Our thorough numerical investigation puts an upper limit of $\simeq 0.5$ earth masses for gas around β Pictoris. This study has been published by Thebault & Augereau (2005, A&A, 437, 141)

(iii) Planetesimal accretion in binary systems. This study is part of a collaboration with the Nice and Padova Observatories aimed at studying how planetesimal accretion in the terrestrial regions is affected by the perturbing presence of a close secondary star companion. We use a deterministic dynamical model to study the evolution of a swarm of kilometre-sized planetesimals under the influence of an external gravitational perturber and gaseous friction. Our main result is that for binaries of separation $< 40\text{AU}$, the coupled effect of the secondary’s perturbations and gaseous friction almost always increases planetesimal encounter velocities to values preventing mutual accretion, and hence “killing” any growth process.

3.3. AGB stars and post-AGB objects

(K. Justtanont, H. Olofsson, S. Ramstedt, F. Schöier)

The research at the Stockholm Observatory in this area centers on the properties of stellar mass loss on the AGB (Asymptotic Giant Branch), and the subsequent evolution of these objects beyond the AGB. Extensive multi-transition, single-dish CO line surveys, as well as surveys in other molecular line emissions, of large samples of M-type stars and carbon stars form the observational basis of our work. However, it is also necessary to use a multi-wavelength (radio to UV) and a multi-method (radio interferometers to space-borne telescopes) approach. The different methods of exploration are complementary and disclose different regions at different spatial resolution and reflect different physical and chemical properties of the envelopes. We have in particular used ISO observations to put constraints on the conditions in the inner parts of the circumstellar envelopes (CSEs), radio interferometry observations to obtain information on intermediate regions, and imaging in scattered stellar light to supplement the radio observations of the coldest outer regions. Detailed radiative transfer models, combined with a physical/chemical model of the CSE, are used to derive quantitative results from molecular line and dust continuum data, such as reliable mass loss rates, molecular abundances, and isotope ratios.

AGB-stars also play an important role in studies of galaxy stellar populations and galactic structure and their mass loss significantly contributes to the enrichment of the ISM, and their luminosities to the integrated galaxy light. Therefore, the efficient detection and characterization of such objects in extragalactic systems are essential. We are therefore pursuing a census of AGB-stars in Local Group galaxies.

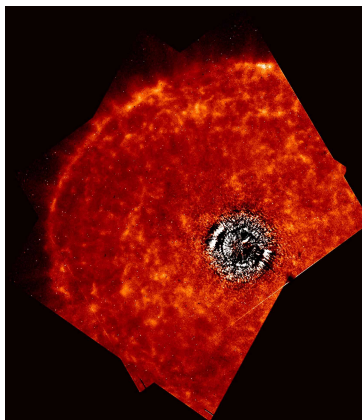


Figure 2. An image of part of a thin shell surrounding the carbon star R Scl obtained with the ACS instrument on the HST. The image is obtained in coronagraphic mode at a wavelength of about 600 nm. An image of a reference star has been subtracted leaving only the circumstellar scattered (by dust particles) stellar light. The artefacts of the coronagraphic imaging and the reference star subtraction are substantial only in a small region around the star. The shell geometry is visible as an edge brightening. The diameter of the shell is about 2.5×10^{17} cm, or about 0.3 light years.

3.4. Supernovae

(C.-I. Björnsson, C. Fransson, P. Gröningsson, C. Kozma, P. Lundqvist, S. Mattila, J. Melinder, E. Mörtzell, T. Nymark, J. Sollerman, A. Tziamtzis)

The supernova group at the Stockholm observatory works with both observations and modeling. On the observational side, much of the effort has been put into optical observations with the VLT telescopes, but also space based observations with HST have been of great importance. Added to that, the group is also involved in studies using Chandra in X-rays and FUSE in the far-UV. These observations cover a broad range of instrumentation and wavelength regions. Much of the supernova modeling at the observatory is also closely related to these observations. We still have a large interest in the famous SN 1987A in the Large Magellanic Cloud, but recent research interests in the group cover also a wider area of topics like supernova remnants, pulsars, supernova statistics, radiation processes, the gamma-ray burst connection and circumstellar interaction in supernovae. We are also involved in using thermonuclear supernovae for cosmology, and in constraining the nature of the progenitor systems for such supernovae.

Part of the work is to study systematic effects in current and future supernova observations aiming at mapping the expansion history of the universe and thus gaining knowledge on the nature of the dark energy component. It also includes the study of methods to investigate, e.g., the dark matter distribution and current expansion velocity of the universe by looking at gravitationally lensed SNe with multiple images. The group is also actively participating in the SNAP project, a 2-metre telescope dedicated to observe light curves and spectra of more than 2000 SNIa per year as well as observing dark matter via weak gravitational lensing and providing ample high quality data for auxiliary science.



Figure 3. ESO VLT image of the Crab Nebula, which is the remnant of the historical supernova that flared up in 1054 AD. The green and red light is from atomic transitions whereas the blue light is predominantly emitted by very high-energy (“relativistic”) electrons that spiral in a large-scale magnetic field (so-called synchrotron emission). It is believed that these electrons are continuously accelerated and ejected by the rapidly spinning neutron star at the center of the nebula and which is the remnant core of the exploded star. The supernova group at Stockholm observatory studies this and many other supernovae and supernova remnants.

3.5. Galaxies and the Milky Way

(M. Hayes, R. Karlsson, P.O. Lindblad, A. Lundgren, M. Näslund, G. Östlin, H. Olofsson, Aa. Sandqvist)

The Galaxy group at Stockholm Observatory focuses on the physics of spiral galaxies including the Milky Way, especially the structure and dynamics of barred systems, nuclear activity including the Galactic Centre, blue compact galaxies and dark matter. Blue compact galaxies (BCGs) are metal-poor low mass systems, characterised by blue colours and strong emission lines in their spectra, indicating that the light is dominated by young stars. This makes them ideal laboratories for studying galaxy formation and evolution. Work on BCGs in Stockholm focuses on their kinematics and star formation histories, primarily utilising data from ESO and the Hubble Space Telescope (HST).

Detailed studies of special galaxies are performed using the ESO telescopes, NOT and HST in the optical and infrared, and the VLA, Australia Telescope and SEST in the radio regime. One specific such galaxy is M83, which has been mapped in detail with the SEST in the $J = 1 - 0$ and $J = 2 - 1$ CO lines, and in the K and J bands with the ESO-NTT. The nuclear velocity field of the barred galaxy NGC 1358 is being mapped from long slit spectra obtained with EFOSC2 at ESO and ALFOSC at NOT.

The Galactic Nucleus, at a distance of about 8 kpc and hidden behind 30 magnitudes of visual extinction by cool interstellar dust along the line of sight, cannot be studied at visible, ultraviolet or soft X-ray wavelengths. The radio and millimeter wave region research at Stockholm Observatory concentrates on the distribution and kinematics of Galactic Centre molecular cloud structures and their physical and chemical properties, as well as their interactions with the radio continuum components, from the inner parsec out to about a hundred parsecs from the Galactic Nucleus.

The group plays a leading role in two ODIN satellite projects concerning the Galactic Plane and the Galactic Centre and is also involved in the Extragalactic project.

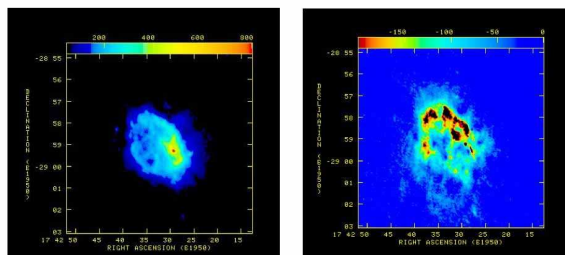


Figure 4. Left : Radio image from the Galactic Centre (GC) observed by the VLA at $\lambda = 18$ cm. The dynamical centre, Sgr A*, is the red spot and the mini-spiral Sgr A West, SgrA East, and parts of the halo can be seen. Right : The integrated OH absorption in the GC between radial velocities $+32$ and $+59$ km s^{-1} . The OH streamer pointing towards the CG and parts of the $+20$ and $+50$ km s^{-1} molecular clouds are clearly visible. Both images are from concatenation of observations with short and long baselines.

3.6. Observational Cosmology

(R. Cumming, T. Elfhag, C. Fransson, M. Hayes, P. Lundqvist, J. Melinder, L. Mencia-Trinchant, E. Mörtzell, J. Sollerman, G. Östlin)

The group on observational cosmology focuses their studies on: clusters of galaxies; star formation, Ly α emission and supernovae (SNe) activity in starburst galaxies, galaxy evolution, Lyman Break Galaxies, modelling of high redshift compact galaxies and early SN activity, as well the use of SNe as cosmological probes.

We have developed models for predicting the number of high redshift supernovae of different types as a function of the cosmic star formation rate. A large programme with the objective of detecting more than 50 high redshift SNe has been performed using the VIMOS instrument at the ESO VLT, and the data acquisition is near completion. The frequency of core collapse supernovae will be used as a probe of the cosmic star formation rate at high redshift.

The study of galaxy clusters as probes of the hierarchical galaxy formation scenario is continuing. The photometric redshift technique has been employed to significantly enhance the contrast in the subtraction of background galaxies. With this method the galaxy populations and luminosity functions of four high redshift ($z = 0.3$ to 0.6) clusters have been probed down to dwarf galaxy luminosities. Our current focus is on K-band photometry and searches for emission line galaxies.

Local starburst galaxies are studied in Ly α by means of HST/ACS data with the objective of improving our understanding of this cosmologically important emission line. Through detailed modelling of the continuum, the first photometrically valid Ly α images of a local starburst (ESO 338–04, see figure) was recently published.

The group is part of the HEAC (High Energy Astrophysics and Cosmology) collaboration, funded by the Swedish Research Council (VR) through their "*strong research environments*" program.

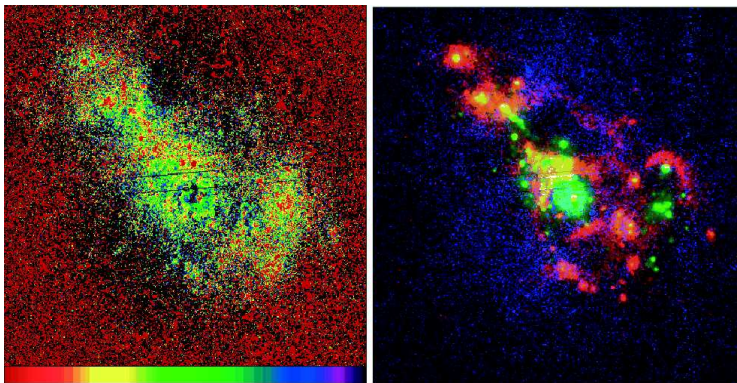


Figure 5. The first valid Ly α images from the local universe – the blue compact starburst ESO 338–04. Left: Ly α equivalent width map (cuts levels are -50 to $+50$ Å, regions of high equivalent width show up in dark colours). Particularly visible are the diffuse emission regions outside the starburst region. Right: a false colour image: red shows an [O III] HST/STIS image; green shows the 1500 Å UV continuum; blue shows continuum subtracted Ly α .

3.7. High Energy Astrophysics

(M. Axelsson, M. Battelino, C.-I. Björnsson, L. Borgonovo, J. Trier Frederiksen, L. Hjalmarsson, S. Larsson, F. Ryde)

The group specializes in observational/theoretical high energy astrophysics with emphasis on radiation processes in high energy plasmas in compact objects. Models are developed for the interpretation of broad band observations of active galactic nuclei (AGN), X-ray binaries (XRB), X-ray pulsars, and γ -ray bursts (GRB). Most observations are space-based (CGRO, RXTE, INTEGRAL, and future GLAST), and some are ground-based (e.g. NOT, ESO). Archival data are extensively used.

On the theoretical and numerical side, the group is involved in modeling of GRB physics – specifically the prompt and afterglow phases. More generally, the group studies collisionless, radiative, highly relativistic outflows and shocks using fully kinetic modeling of plasmas in high-performance parallel computing environments. The group's expertise falls within particle-in-cell modeling.

In February 2005 we arranged and hosted a workshop with purpose to initiate and produce an advanced numerical model of detailed plasma/photon kinetics in high compactness shocked regions. Specifically, our aim is to study the parameter regimes relevant for the prompt and early afterglow phases in GRBs.

During 2005 the group has continued its development and upgrade of science software for the X-ray monitor, JEM-X on INTEGRAL, which was launched in 2002. Members of the group have been involved in the analysis of INTEGRAL observations of GRBs, black hole candidates and accreting X-ray pulsars in addition to surveys and instrument calibration.

The group is part of the Swedish GLAST (launch in August 2007) consortium, which now has delivered the crystals for the instruments calorimeter (supported by a 20 MSEK grant from the Wallenberg foundation). The group also participates in two of the Analysis Groups (GRB and AGN/Blazars) for GLAST-LAT by taking part in the evaluation of data analysis software for the mission. A visit to INFN in Pisa to develop these tools was made. Planning for the 2006 GLAST-LAT collaboration meeting to be hosted by the group is underway.

An observational tool which has been essentially unexplored so far in astronomy is X-ray polarimetry. Most of the sources studied by the group are expected to show polarization that would be detectable with a dedicated polarimetry experiment. Together with KTH particle physics and groups in USA and Japan, the group is involved in preparations for a hard X-ray polarimetry mission, PoGO. During 2005 funding for the swedish hardware contribution was provided by the Wallenberg foundation (8 MSEK).

Archival RXTE data was used to make a systematic study of changes in the variability pattern of the black hole candidate Cygnus X-1. In addition, the temporal and spectral properties of the GRB prompt emission, e.g., of individual pulses, are studied in a long term program to uncover the physics of GRB. The group has been part of the Stockholm node of the EU-network: "GRB: An Enigma and a Tool".

3.8. The Sun

(P. Dettori, T. Hillberg, D. Kiselman, K. Langhans, M. Löfdahl, G. Narayan, M. van Noort, G. Scharmer)

The Institute for Solar Physics of the Royal Swedish Academy of Sciences [Kungl. Vetenskapsakademiens institut för solfysik] operates a solar observatory on the island of La Palma in the Spanish Canary islands. The research in solar physics takes advantage of the superb observing site to study small-scale solar phenomena such as granulation, sunspot structure, and small magnetic elements. The Swedish 1-m Solar Telescope (SST) is a world leading high-resolution solar telescope and this season we accommodated about 20 visiting observers from 6 countries. The telescope routinely produces near-diffraction limited images, i.e. close to $0''.1$ resolution in the blue part of the spectrum. Among the results based on SST data presented this year we note the new model for penumbral filaments, explaining the dark cores discovered with the SST in 2002.

Important for our sub-arcsecond resolution ability is the in-house development of techniques for imaging, spectroscopy, polarimetry, wavefront sensing, adaptive optics, and image restoration, as well as instrumentation provided by our international partners. New instrumentation for this season was centered on the development of polarimetry for imaging as well as for spectroscopy.

The subjects of studies performed in the group include photospheric line-formation processes aimed at improving abundance analysis work, modeling of diagnostics for solar flux-tubes, sunspot structure and dynamics including the Evershed effect in the penumbra.

4. UNIVERSITY COURSES

Stockholm Observatory is the Department of Astronomy at the Stockholm University. As such, it offers a number of undergraduate and graduate courses in astronomy and has programs leading to the bachelor, licentiate and PhD degrees. The director for undergraduate studies [studierektorer för grundutbildningen] was Peter Lundqvist, the counselor for undergraduate studies [studievägledare för grundutbildning] was Magnus Axelsson

The director for the Graduate School [studierektor för forskarutbildningen] was Hans Olofsson.

The courses taught in 2005 are listed below with lecturers indicated in parenthesis. 1p corresponds to one week of full-time studies.

4.1. Undergraduate Courses

Prerequisites: General Admission [Grundläggande Behörighet]

Introductory Courses in Astronomy [Orienteringskurser i astronomi]

General Astronomy, introductory course (5p) Översiktskurs i astronomi (spring, G. Gahm; summer, M. Näslund)

Planets and Life in the Universe (5p) Om planeter och liv i universum (spring, Aa. Sandqvist)

Astronomy and Cosmology through the Ages (5p) Astronomiska världsbildens utveckling (spring, J. Schober)

The Sun and other Stars (5p) Solen och andra stjärnor (summer: C. Kozma; fall, G. Gahm)

Astronomy contra Astrology (5p) Astronomi kontra astrologi (fall, M. Näslund)

Prerequisites: High School Mathematics and Physics [Gymnasium matematik och fysik från Naturvetenskapliga eller Tekniska Programmet]

Modern Astronomy (10p) Modern Astronomi (spring, A. Sundman; fall, F. Ryde & F. Schöier)

Basic Courses in Astronomy [Grundkurser i Astronomi]

Prerequisites: University Mathematics (40p) and Physics (60p)

Structure and Evolution of the Stars (5p) Stjärnornas struktur och utveckling (spring, H. Olofsson)

Astrophysical spectra (5p) Astrofysikaliska spektra (spring, F. Schöier)

Observational Techniques in Astronomy I (5p) Astronomisk observationsteknik (spring, S. Larsson)

Observational Techniques in Astronomy II (5p) Astronomisk observationsteknik (spring, R. Liseau)

Radiation Processes in Astrophysics (5p) Astrofysikaliska Strålningsprocesser (fall, F. Ryde)

Galaxies (5) Galaxer (fall, G. Östlin)

High Energy Astrophysics (5p) Högenergiastrofysik (fall, C. Fransson)

Cosmology (5p) Kosmologi (fall, E. Mörtzell)

Astrophysics (4p) Astrofysik (course given at KTH by G. Gahm)

4.2. Graduate Courses

The Graduate School at Stockholm Observatory has a program consisting of 60p courses (35p Basic Courses and 25p Additional Courses) and 100p PhD thesis work. The Basic Courses are given on a rolling two-year schedule and consist of seven compulsory courses and one exercise chosen from a menu of numerical and observational exercises. Some courses are taught in collaboration with or by the Physics Department of Stockholm University. Some courses may also be of the self-study type. During 2005, the following courses were taught:

Cosmology and Particle Astrophysics (5p) Kosmologi och partikelastrofysik (spring, M. Fairbairn, Physics Dept.)

Gas dynamics (5p) (spring, E. Delgado Donate)

Polarized radiative transfer and inversion techniques (5p) Polariserad strålningstransport och inversionstekniker (fall, B. Lites, M. Löfdahl, N. Piskunov)

Stellar atmospheres (5p) (spring, G. Scharmer, D. Kieselmann)

The physics of the interstellar medium (5p) (fall, P. Lundqvist; self study)

Numerical exercise in The interstellar medium (5p) Tillämpningsuppgift i Det interstellära mediet (P. Lundqvist)

4.3. Externally given courses

Jesper Sollerman, The Development of the Astronomical View of the World, 5 p, Högskolan Gotland.

4.4. Master theses

Selbing, J.: September 2005, *SST polarization model and polarimeter calibration*, supervisor G. Scharmer.

5. SEMINARS

Normally seminars were held on Fridays at 10:15 in 2005. The seminar organizers were Gösta Gahm and Kay Justtanont.

- January 21, René Liseau (Stockholm Observatory). Protostars and their mass flows
- January 28, Jan Erik Wahlund (IRF, Uppsala University). The Cassini/Huygens project and some first science results
- February 4, Jana Tikhomirova (Astro Space Center of Lebedev Physical Institute, Moscow). Extremely long and extremely soft GRBs in the BATSE data
- February 11, Johan Hansson (Luleå Univ. of Tech.). Preon Stars - An Entirely New Class of Compact Objects
- February 18, Philippe Thebault (Stockholm Observatory & Observatoire de Paris). Understanding the formation of extrasolar planets: The ORESTE project
- February 25, Rudiger Haas (Onsala Space Observatory). Global geodynamics with geodetic VLBI
- March 4, Cathy Horellou (Onsala Space Observatory). Cosmology using the Sunyaev-Zeldovich effect
- April 1, Stephan Hundertmark (Physics Dep., Stockholm University). Neutrino Astronomy with IceCube/AMANDA
- April 15, Jiyune Yi (Onsala Space Observatory). Masers in AGB stars
- April 22, Melvyn Davies (Lund Observatory). The Stars of the Galactic Centre
- May 13, Claes Ingvar Lagerkvist (Uppsala University). Minor Planets Beyond the Main Asteroid Belt
- May 20, Greg Madejski (Stanford University). X-ray and gamma-ray emission as a probe of structure of active galaxies
- May 27, Edvard Mörtzell (Stockholm Observatory). Corrections for gravitational lensing of supernovae: better than average?
- June 3, Tanya Nymark (Stockholm Observatory). X-ray emission from radiative shocks in Type II supernovae
- June 9, Tom Ray (Dublin Institute of Advanced Study). Outflows from Young Stars and Brown Dwarfs
- September 9, Frederick M. Walter (Stony Brook University). The Extended Atmosphere of V471 Tau: Clues to the magnetic morphology of T Tauri stars and the young Sun?
- September 16, Eva Grebel (University of Basel). The Violent Local Group - A History of Accretion and Survival
- October 7, Mette Owner-Petersen (Lund Observatory). Adaptive Optics: prospects and challenges
- October 28, Hans Olofsson (Stockholm Observatory). A multi-wavelength study of highly episodic stellar mass loss on the AGB
- November 11, Mark Dieckman (Linköping University). Particle-in-cell simulations of ultrarelativistic streaming instabilities
- November 18, Alexis Brandeker (University of Toronto). The origin of gas in debris disks

November 25, Donal Murtagh (Chalmers University). Highlights of the Odin Aeronomy mission

December 2, Göran Scharmer (KVA). Fine Structure and Heating of Sunspot Penumbrae

December 9, Tomas Dahlen (Stockholm University). Galaxy evolution as seen by the Hubble Space Telescope

6. GUESTS

Guests visiting the Stockholm Observatory in 2005.

Michael Schirmer (INT, La Palma), January

Dr. Mark Dieckmann (University of Linköping), May

Dr. Greg Madejski (Stanford University, California, USA), May

van Noort, Michiel (Institute for Theoretical Astrophysics, University of Oslo, Norway), August

Spruit, Henk (Max-Planck Institute for Astrophysics, Garching, Germany), September

Lites, Bruce (High Altitude Observatory, Boulder, USA), October–December

Rubina Kotak (ESO, Garching), October

Professor Guido Barbeillini (INFN Trieste, Italy), November

7. ACTIVITIES FOR THE GENERAL PUBLIC AND SCHOOLS

The Department provides open telephone lines for questions from the general public (Gösta Gahm and Göran Olofsson), and staff members are available for consultation by secondary and high school students. The news column on our web site (www.astro.su.se) was maintained by Jesper Sollerman.

2005 was labelled "The Year of Physics" in honour of some of Albert Einstein's major discoveries 100 years ago. Several activities were organised in collaboration with the physicists, and also with the Swedish Astronomical Society (which is hosted at the Astronomy Department). One big event of this kind was a broad presentation in Kungsträdgården, Stockholm in September. Felix Ryde co-ordinated the astronomical activities located in one of the many tents raised in the park. On September 25 an Open House was held at AlbaNova, and the astronomical activities were co-ordinated by Göran Olofsson.

Stockholm Observatory has an intimate relationship with COSMONOVA, the Planetarium/Omnitheatre located at the Swedish National Museum of Natural History in Stockholm. Aage Sandqvist has been the astronomical consultant to Cosmonova since 1972, vice-chairman of the Swedish Omnitheatre (Cosmonova) Foundation since 1991. As a token of appreciation of his continuing efforts, Cosmonova is placed at the disposal of Stockholm Observatory twice a year, and free of charge, for presentations of astronomical programs to astronomy students at Stockholm University and Saltsjöbadens Samskola.

The Sweden Solar System is the world largest model (by area) of our solar system. The Globe theatre in Stockholm represents the Sun, and the scale is set to 1:20 millions. The system spans from Karlshamn in the very south to Kiruna in the very north (see www.astro.su.se/swesolsyst). This project is coordinated by Gösta Gahm and Nils Brenning (at the Alfvén Laboratory). On December 8 another "planet", the trans-neptunian object named Sedna, was inaugurated at "Teknikens Hus" in Luleå.

Staff members have participated in a number of presentations for the general public, schools, TV, radio and the press. For example Jesper Sollerman has given general lectures for Gymnasieskolan and for the Stockholm amateur astronomers (STAR). He also participated on TV in Kunskapskanalen, Mera Vetenskap, and on Reality Radio. He is one of the 'bloggers' at www.fof.se. Göran Östlin participated on several occasions in the Swedish Public Service television programme "Hjärnkontoret" (popular science for youngsters).

8. PEDAGOGICAL PROJECTS

Jesper Sollerman and Magnus Näslund implemented a project called SISU at the Department of Astronomy at Stockholm University in 2003/2004. SISU is a version of Supplemental Instruction, which is used at many institutes worldwide. The project focuses on discussion groups for introductory students to provide a deeper learning, and increase critical thinking.

In 2004, SISU was offered in two courses, *Översiktskurs i astronomi* and *Universums byggnad*. Preliminary results of this first test were presented at *Studierektorskonferensen* at the Stockholm University in April 2005. SISU was financially supported by The Faculty of Natural Sciences of the university. For more information see <http://www.astro.su.se/sisu>.

9. HONOURS and AWARDS

Mats Löfdahl: Strömer-Ferrnerska priset

Edvard Mörtzell, Jesper Sollerman & Göran Östlin: Stiftelsen Anna-Greta och Holger Crafoords fond

Jesper Sollerman & Göran Östlin: Edlundska priset

10. LIST OF PUBLICATIONS

10.1. Books

1. Ahlin, P., Stenholm, B., **Sundman, A.**, 2005, *Astronomisk Uppslagsbok*, Prisma, Stockholm.

10.2. Reviews

1. Bergvall N., Marquart T., **Östlin G.**, Zackrisson E., 2005, *The starburst phenomenon from the optical/near-IR perspective*, Invited review in "Starbursts: from 30 Doradus to Lyman Break Galaxies" eds. R. de Grijs & R. M. Gonzalez Delgado (Kluwer), p. 103
2. **Liseau R.**, 2005, *Outflows in regions of star formation*, eds. U. Käuft, R. Siebenmorgen & A.F.M. Moorwood, *ESO Astrophysics Symposia*, Springer: Berlin, p. 105
3. **Olofsson H.**, 2005, *Molecular abundances in AGB circumstellar envelopes*, in "The Dusty and Molecular Universe", ed. A. Wilson, *ESA Conference Proc. No. SP-577*, p. 223
4. **Olofsson H.**, 2005, *High-resolution IR Spectroscopy of the Circumstellar Medium of AGB Stars*, in "High Resolution Infrared Spectroscopy in Astronomy", eds. U. Käuft, R. Siebenmorgen & A.F.M. Moorwood, *ESO Astrophysics Symposia*, Springer: Berlin, p. 377

10.3. Scientific Publications in Refereed Journals

1. Biver N., Lecacheux A., Encrenaz T., Lellouch E., Baron P., Crovisier J., Frisk U., Hjalmarson Å., Olberg M., **Sandqvist Aa.**, Kwok S., 2005, *Observations of H₂O, H₂¹⁸O and CO in Mars with Odin*, *A&A*, 435, 765
2. Asplund, M., Grevesse, N., Sauval, A. J., Allende Prieto, C., **Kiselman, D.**, 2005, *Erratum: Line formation in solar granulation: IV. [O I], O I and OH lines and the photospheric O abundance*, *A&A*, 435, 339

3. **Axelsson, M., Borgonovo, L., Larsson, S.**, 2005, *Evolution of the 0.01-25 Hz power spectral components in Cygnus X-1*, A&A, 438, 999
4. Bellot Rubio, L. R., **Langhans, K.**, Schlichenmaier, R., 2005, *Line formation in solar granulation. IV. [O I], O I and OH lines and the photospheric O abundance*, A&A, 443, L7
5. **Delgado-Donate, E.**, Clarke, C., 2005, *Numerical results on low mass star and brown dwarf multiplicity*, MSAI, 76, 223
6. **Edgar, R. G.**, 2005, *Self-Gravity Troubles with Adaptive Mesh Refinement*, A&A, 434, 41
7. **Fransson, C.**, Challis, P. M., Chevalier, R. A., Filippenko, A. V., Kirshner, R. P., **Kozma, C.**, Leonard, D. C., Matheson, T., Baron, E., Garnavich, P., Jha, S., Leibundgut, B., **Lundqvist, P.**, Pun, C. S. J., Wang, L., Wheeler, J. C., 2005, *Hubble Space Telescope and ground-based observations of SN 1993J and SN 1998S: CNO processing in the progenitors*, ApJ, 622, 991
8. Fridlund, C.V.M., **Liseau, R.**, Djupvik, A.A., Huldtgren, M., White, G.J., Favata, F., Giardino, G., 2005, *HST and spectroscopic observations of the L1551 IRS5 jets (HH154)*, A&A, 436, 983
9. Giannini, T., Massi, F., Podio, L., Lorenzetti, D., Nisini, B., Caratti o Garatti, A., **Liseau, R.**, Lo Curto, G., Vitali, F., 2005, *Star formation in the Vela Molecular Clouds: A new protostar powering a bipolar jet*, A&A, 433, 41
10. Graves, G. J. M., Challis, P. M., Chevalier, R. A., Crotts, A., Filippenko, A. V., **Fransson, C.**, Garnavich, P., Kirshner, R. P., Li, W., Lundqvist, P., McCray, R., Panagia, N., Phillips, M. M., Pun, C. J. S., Schmidt, B. P., Sonneborn, G., Suntzeff, N. B.; Wang, L., Wheeler, J. C., 2005, *Limits from the Hubble Space Telescope on a Point Source in SN 1987A*, ApJ, 629, 944
11. Gehrels, N., Sarazin, C. L., O'Brien, P. T., ... , **Sollerman, J.**, et al., 2005, *A short gamma-ray burst apparently associated with an elliptical galaxy at redshift $z = 0.225$* , Nature, 437, 851
12. Gorosabel, J., Prez-Ramrez, D., **Sollerman, J.**, et al., 2005, *The GRB 030329 host: a blue low metallicity subluminoous galaxy with intense star formation*, A&A, 444, 711
13. **Hayes, M., Östlin, G.**, Mas-Hesse, J. M., Kunth, D., Leitherer, C., Petrosian, A., 2005, *HST/ACS Lyman α imaging of the nearby starburst ESO 338-IG04*, A&A, 438, 71
14. Herczeg, G.J., Walter, F.M., Linsky, J.L., **Gahm, G.F.**, Ardila, D.R., Brown, A., Johns.Krull, C.M., Simon, M., Valenti, J.A., 2005, *The loopy ultraviolet line profiles of RU Lupi, accretion, outflows, and fluorescence*, AJ, 129, 2777
15. Hjalmarsen, Å., Bergman, P., Biver, N., **Florén, H.G.**, Frisk, U., Hasegawa, T., **Justtanont, K., Larsson, B.**, Lundin, S., Olberg, M., Olofsson, A.O.H., Persson, G., Rydbeck, G., **Sandqvist, Aa.**, the Odin Team, 2005, *Recent astronomy highlights from the Odin satellite*, Advances in Space Research 36, 1031

16. Hjorth, J., **Sollerman, J.**, Gorosabel, J., ... , **Melinder, J.**, et al., 2005, *Constraints on short gamma-ray burst models with optical limits of GRB 050509b*, ApJ, 630, L117
17. Hjorth, J., Watson, D., Fynbo, J., ... , **Sollerman, J.**, et al., 2005, Nature 437, 859
18. Jakobsson, P., Björnsson, G., Fynbo, J.P.U., Johannesson, G., Hjorth, J., Thomsen, B., Möller, P., Jensen, B.L., **Östlin, G.**, Gorosabel, J., Gudmundsson E.H., 2005, *Metal-poor low-mass gamma-ray burst host galaxies: unbiased star formation tracers?*, MNRAS, 362, 245
19. **Justtanont, K.**, Bergman, P. **Larsson, B.**, **Olofsson, H.**, **Schöier, F.L.**, Frisk, U., Hasegawa, Hjalmarsen, Å., Kwok, S., Olberg, M., **Sandqvist, Aa.**, Volk, K., Elitzur, M., 2005, *W Hya through the eye of Odin. Satellite observations of circumstellar submillimetre H₂O line emission*, A&A, 439, 627
20. Jørgensen J.K., Bourke T.L., Myers P.C., **Schöier F.L.**, van Dishoeck E.F., Wilner D.J. 2005, *Probing the inner 200 AU of low-mass protostars with the Submillimeter Array: Dust and organic molecules in NGC 1333-IRAS2A*, ApJ 632, 973
21. Jørgensen J.K., Lahuis F., **Schöier F.L.**, van Dishoeck E.F., Blake G.A., Boogert A.C.A., Dullemond C.P., Evans N.J., Kessler-Silacci J., Pontoppidan K.M. 2005, *Protostellar holes: Spitzer space telescope observations of the protostellar binary IRAS 16293-2422*, ApJ 631, L77
22. Jørgensen J.K., **Schöier F.L.**, van Dishoeck E.F. 2005, *H₂CO and CH₃OH abundances in the envelopes around low-mass protostars*, A&A 437, 501
23. Jørgensen J.K., **Schöier F.L.**, van Dishoeck E.F. 2005, *Molecular freeze-out as a tracer of the thermal and dynamical evolution of pre- and protostellar cores*, A&A 435, 177
24. **Kozma, C.**, **Fransson, C.**, Hillebrandt, W., Travaglio, C., **Sollerman, J.**, Reinecke, M., Roepke, F. K., & Spyromilio, J., 2005, *Three-dimensional modeling of Type Ia supernovae - The power of late time spectra*, A&A, 437, 983
25. Krisciunas, K., Garnavich, P. M., Challis, P., ... , **Sollerman, J.**, et al., 2005, *Hubble Space Telescope Observations of nine high-redshift ESSENCE supernovae*, AJ, 130, 2453
26. **Langhans, K.**, **Scharmer, G.**, **Kiselman, D.**, **Löfdahl, M. G.**, Berger, T. E., 2005, *Inclination of magnetic fields and flows in sunspot penumbrae*, A&A, 436, 1087
27. **Liseau, R.**, Fridlund, C.V.M. **Larsson, B.**, 2005, *Physics of outflows: the binary protostar L1551 IRS 5 and its Jets*, ApJ, 619, 959
28. Lodato, G., **Delgado-Donate, E.**, Clarke, C. J., 2005, *Constraints on the formation mechanism of the planetary mass companion of 2MASS 1207334-393254*, MNRAS, 364, L91
29. Matheson, T., Blondin, S., Foley, R. J., ... , **Sollerman, J.**, et al., 2005, *Spectroscopy of High-z Supernovae*, AJ, 129, 2352

30. **Mattila, S., Lundqvist, P., Sollerman, J., Kozma, C.,** Baron, E., **Fransson, C.,** Leibundgut, B., Nomoto, K. 2005, *Early and late time VLT spectroscopy of SN 2001el - progenitor constraints for a type Ia supernova*, A&A, 443, 649
31. Mazzali, P. A., Benetti, S., Altavilla, G., ... **Lundqvist, P., Mattila, S., Sollerman, J.,** et al., 2005, *High-Velocity Features: a ubiquitous property of Type Ia SNe*, ApJ, 623, L37
32. **Mörtsell, E., Sollerman, J.** 2005. *On the future of gamma-ray burst cosmology*, JCAP, 6, 9.
33. **Mörtsell, E.,** Dahle, H., Hannestad, S. 2005. *Probing Galaxy Density Profiles with Future Supernova Surveys*. ApJ, 619, 733-740
34. van Noort, M., Rouppe van der Voort, L., **Löfdahl, M. G.,** 2005, *Solar image restoration by use of multi-frame blind deconvolution with multiple objects and phase diversity*, Solar Physics, 228, 191
35. Pastorello, A., Baron, E., Branch, D., ... **Sollerman, J.,** et al. , 2005, *SN 1998A: Explosion of a Blue Supergiant*, MNRAS, 360, 950
36. Pedersen, K., Elasdttir, ., Hjorth, J., Starling, R., Cern, J. M. Castro, Fynbo, J. P. U., Gorosabel, J., Jakobsson, P., **Sollerman, J.,** Watson, D., 2005, *The Host Galaxy Cluster of the Short Gamma-Ray Burst GRB 050509B*, ApJ, 634, L17
37. Ricaud, P., Lefevre, F., Berthet, G., ...**Sandqvist, Aa.,...**, 2005, *Polar vortex evolution during the 2002 Antarctic major warming as observed by the Odin satellite*, Journal of Geophysical Research, 110, 1
38. **Ryde, F.,** 2005, *Is Thermal Emission in Gamma-Ray Bursts Ubiquitous?*, ApJ, 625, L95
39. **Ryde, F.,** 2005, *Interpretations of Gamma-Ray Burst Spectroscopy I. Analytical and numerical study of spectral lags*, A&A, 429, 869
40. **Ryde, F.,** Kocevski, D., Bagoly, Z., Ryde, N., Mészáros, A., 2005, *Interpretations of Gamma-Ray Burst Spectroscopy II. Bright BATSE bursts*, A&A, 432, 105
41. **Schöier F.L.,** Lindqvist M., **Olofsson H.,** 2005, *Properties of detached shells around carbon stars: Evidence of interacting winds*, A&A, 436, 633
42. **Schöier F.L.,** van der Tak F.F.S., van Dishoeck E.F., Black J.H. 2005, *An atomic and molecular database for analysis of submillimetre line observations*, A&A 432, 369
43. **Serafimovich, N. I.,** Shibanov, Yu. A. **Lundqvist, P., Sollerman, J.,** 2005, *The young supernova remnant SNR 0540-69.3 and its pulsar*, Advances in Space Research, 35, 1106
44. Shibanov, Yu. A., **Sollerman J., Lundqvist, P.,** Gull, T., Lindler, D., 2005, *The near-UV pulse profile and spectrum of the pulsar PSR B0656+14*, A&A, 440, 693

45. Sidoli, L., Mereghetti, S., **Larsson, S.**, Chernyakova, M., Kreykenbohm, I., Kretschmar, P., Paizis, A., Santangelo, A., Ferrigno, C., Falanga, M., 2005, *A large spin-up rate measured with INTEGRAL in the high mass X-ray binary pulsar SAX J2103.5+4545*, A&A, 440, 1033 – 1039
46. **Sollerman, J.**, Cox, N., **Mattila, S.**, Ehrenfreund, P., Kaper, L., Leibundgut, B., **Lundqvist, P.**, 2005, *Diffuse interstellar bands in NGC 1448*, A&A, 429, 559
47. **Sollerman, J.**, **Östlin, G.**, Fynbo, J. P. U., Hjorth, J., Fruchter, A., Pedersen, K., 2005, *On the nature of nearby GRB/SN host galaxies*, New Astronomy, 11, 103
48. **Thebault, P.**, Augereau, J.-C., 2005, *Upper limit on the gas density in the β Pictoris system*, A&A, 437, 141
49. Turrini, D., Barbieri, M., Marzari, F., **Thebault, P.**, Tricarico, P., 2005, *Planetary formation and orbital stability in binary star systems*, MSAI, 6, 172
50. Woods P.M., Nyman L.-Å., **Schöier F.L.**, Zijlstra A.A., Millar T.J., **Olofsson H.**, 2005, *Molecules in Bipolar Proto-planetary Nebulae*, A&A, 429, 977
51. Wilson C.D., Olofsson A.O.H., Pagani L., Booth R.S., Frisk U., Hjalmarsen Å., Olberg M., **Sandqvist Aa.**, 2005, *Searching for O₂ in the SMC: Constraints on oxygen chemistry at low metallicities*, A&A, 433, L5
52. Zackrisson, E., Bergvall, N., **Östlin, G.**, 2005, *The stellar populations of the bluest low surface brightness galaxies*, A&A, 435, 29
53. Zakharov, V., Gandorfer, A., Solanki, S. K., **Löfdahl, M. G.**, 2005, *A comparative study of the contrast of solar magnetic elements in CN and CH*, A&A, 437, L43
54. **Östlin, G.**, Mouhcine, M., 2005, *A new infrared view of evolved stars in IZw 18*, A&A, 433, 797
55. Östman, L., **Mörtsell, E.**, 2005. *Limiting the dimming of distant type Ia supernovae*, JCAP, 2, 5

A&A - Astronomy and Astrophysics

AJ - Astronomical Journal

ApJ - Astrophysical Journal

JCAP - Journal of Cosmology and Astroparticle Physics

MNRAS - Monthly Notices of the Royal Astronomical Society

MSAIS - Memorie della Societa Astronomica Italiana,

10.4. Other Scientific Publications (or related)

1. Bagoly, Z., Horváth, I., Balasz, L., **Brogonovo, L.**, **Larsson, S.**, Mészáros, A., **Ryde, F.**, 2005, In Proc. Workshop on Gamma-Ray Bursts in the Afterglow Era, *Principal-Component Analysis of Gamma-Ray Bursts' Spectra*, Nuovo Cimento, 28 C, 295

2. Berger, T. E., Rouppe van der Voort, L., **Löfdahl, M. G.**, 2005, *High resolution magnetogram measurements of solar faculae*, AGU Spring Meeting, Abstracts
3. Biver, N., Bockelee-Morvan, D., Boissier, J., ...**Sandqvist, Aa.**, ..., 2005, *Radio observations of Comet 9P/Tempel 1 before and after Deep Impact*, AAS, DPS 37, 42.09
4. Biver, N., Lecacheux, A., Crovisier, J., Lellouch, E., Encrenaz, T., Frisk, U., Hjalmarson, Å., **Sandqvist, Aa.**, 2005, *Observations of H₂O, H₂¹⁸O and CO in Mars with Odin*, 35th COSPAR Scientific Assembly, p. 2791
5. **Borgonovo, L.**, Frontera, F., Guidorzi, C., Montanari, E., Soffitta, P. 2005. In Proc. Workshop on Gamma-Ray Bursts in the Afterglow Era, *On the temporal and spectral evolution of the autocorrelation function in GRBs*, Il Nuovo Cimento, Vol. 28 C, 275
6. Chugai, N. N., **Cumming, R. J.**, Blinnikov, S. I., **Lundqvist, P.**, Filippenko, A. V., Barth, A. J., Bragalia, A., Leonard, D. C., Matheson, T., **Sollerman, J.**, 2005, *SN 1994W: evidence of explosive mass ejection a few years before explosion*, IAU Colloq. 192: Cosmic Explosions, On the 10th Anniversary of SN1993J, eds. J. M. Marcaide, & K. W. Weiler, p. 111
7. Denker, C., Tritschler, A., and **Löfdahl, M. G.**, 2005, *Image restoration*, in Encyclopedia of Optical Engineering, ed. Driggers, R. G. (Marcel Dekker, Inc.)
8. van Dishoeck E.F., Jørgensen J.K., Maret S., Ceccarelli C., Caux E., **Schöier F.L.**, Castets A., Tielens A.G.G.M. 2005, *A submillimeter line survey of low-mass protostars: prelude to ALMA and Herschel*, The Dusty Universe: a prelude to Herschel and ALMA, Proceedings of the conference held in Paris, France, October, 2004, ESA-SP557
9. Fynbo, J. P. U., Jensen, B. L., Hjorth, J., **Sollerman, J.**, Watson, D., Castro Ceron, J. M., Gorosabel, J., **Gälfalk, M.**, Kaas, A., 2005, *GRB 050802.422: fading of the afterglow and detection of the host.*, GCN, 3756
10. Fynbo, J. P. U., Jensen, B. L., Hjorth, J., Woller, K. G., Watson, D., **Sollerman, J.**, Fouque, P., Andersen, M. I., 2005, *GRB 050801: unchanged decay slope.*, GCN, 3743
11. Fynbo, J. P. U., Jensen, B. L., Jakobsson, P., Hjorth, J., **Sollerman, J.**, Castro Ceron, J. M., Holhjem, K., Salinas, R., 2005, *GRB 050922C: break in the lightcurve*, GCN, 4040, 1
12. Fynbo, J. P. U., Jensen, B. L., **Sollerman, J.**, et al., 2005, *GRB 050824: spectroscopic redshift from the VLT*, GCN, 3874
13. Fynbo, J. P. U., **Sollerman, J.**, Jensen, B. L., et al., 2005, *GRB050802: tentative absorption redshift*, GCN, 3749
14. **Gahm, G.F.**, Petrov, P.P., Stempels, H.C., 2005, *Close binarity in CTTS*, Proc. 13th Cambridge Workshop on Cool Stars, Stellar Systems and the Sun, eds. F. Favata et al., p. 563

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AAS - American Astronomical Society Meeting

AGU - American Geophysical Union

GCN - Gamma Ray Burst circular network

IAU - International Astronomical Union

10.5. Popular Science Publications

1. **Gahm, G.F.**, 2005, *Hur är det egentligen med Sweden Solar System?*, Populär Astronomi, (2), 24
2. **Gahm, G.F.**, 2005, *Saltis i Saltsjöbaden*, www.cafecreme.se, våren 2005
3. **Gahm, G.F.**, 2005, *Jorden – stjärnornas barn*, Geologiskt Forum, 47, 6
4. Hjorth, J., Andersen, A., Fynbo, J., **Sollerman, J.** & Watson, D., 2005, *Gammaglimt - explosioner fra Universets ungdom*, Naturens Verden, (11/12), 55
5. **Kiselman, D.** and Lundqvist, S., 2005, *Utsikt från jorden 12: Vacker som en dag*, Populär Astronomi, (1), 45
6. **Kiselman, D.** and Lundqvist, S., 2005, *Utsikt från jorden 13: Latitud*, Populär Astronomi, (2), 15
7. **Näslund, M., Cumming R.**, Paulson L., 2005, *Från Arvika till Vintergatan*, Populär Astronomi, (1), 42
8. **Näslund, M.**, 2005, *Lärare sökes till Darwin Space Sweden*, Populär Astronomi, (2), 42
9. **Näslund, M.**, 2005, *Kan man bygga satelliter på nätet?*, Populär Astronomi, (4), 42
10. **Näslund, M.**, 2005, *Gymnasieelever besöker forskarvärlden*, Populär Astronomi, (4), 43
11. Pedersen, K., Andersen, A., Fynbo, J., Hjorth, J., & **Sollerman, J.**, *Det Mörke Univers*, Naturens Verden, (5) , 34
12. **Sandqvist, Aa.**, 2005, *Att föra ut astronomin*, Vanliga Almanackan 2006, eds. Aa. Sandqvist, K. Wiberg, (Almanacksförlaget), p. 57
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14. **Sollerman, J.**, Andersen, A., Fynbo, J., Hjorth, J., & Pedersen, K., 2005, *Supernovaer kaster lys över mörk energi*, Naturens Verden, (7/8), 2
15. **Sollerman, J.**, 2005, *Finns Framtiden?*, Framtider, (3), 25
16. **Sollerman, J.**, 2005, *Varför är Augustimånen så stor?*, Forskning och Framsteg, (6), 59
17. **Sollerman, J.**, 2005, *Gammablixtar*, Den Svenska Almanackan 2006, eds. Aa Sandqvist, Almanacksförlaget, Stockholm, p. 132

10.6. Pedagogical Publications

1. Näslund, M., Sollerman, J., 2005, *SISU - slutrapport*, on www.astro.su.se/sisu/sisu.html

10.7. Other publications

The Swedish Almanac [*Den Svenska Almanackan*] is the official astronomical almanac in Sweden, with roots going back to the sixteenth century. From 1749 to 1972, it was published with exclusive almanac rights by the Royal Swedish Academy of Sciences (KVA). Subsequently, it has been published by Esselte Almanacksförlag (now known as Almanacksförlaget) in collaboration with Stockholm Observatory. Its editor since 1977 is Aage Sandqvist. A simpler, but much more widely distributed, version of this almanac (*Vanliga Almanackan*) contains in addition a considerable amount of non-astronomical matter, but the astronomical part of the latter almanac is also produced in collaboration with the Stockholm Observatory. The editor for the astronomical part of this almanac since 1977 is also Aage Sandqvist. Computer programs have been developed in collaboration with David Kennedal. Both *Den Svenska Almanackan* and *Vanliga Almanackan* are published each year.

1. *Den Svenska Almanackan 2006*, 2005, ed. **Aa. Sandqvist**, Almanacksförlaget, Stockholm, 160 pages
2. *Vanliga Almanackan 2006*, 2005, eds. **Aa. Sandqvist**, K. Wiberg, Almanacksförlaget, Stockholm, 80 pages

11. SYMPOSIA, WORKSHOPS AND MEETINGS

The following meetings were organized by scientists at the Stockholm Observatory in 2005.

Thinkshop on "Modeling and Simulation of Photon-Plasma Interaction", Stockholm, February (SOC/LOC Jacob Trier Frederiksen)

The 42nd Meeting of the Board of Directors of the Scientific Journal Astronomy & Astrophysics, 5-7 May, La Laguna, Tenerife, Canary Islands (Aage Sandqvist in the organizing committee)

Workshop on "Cyclic phenomena in the pre-main-sequence objects" within an INTAS project was held at the Stockholm Observatory in June (organized by Gösta Gahm, Miguel de Val Borro and Pawel Artymowicz)

Crafoord Symposia on "The structure of the universe and the future of cosmology" at KVA, Sep. 20-21 (chairman of the SOC: Claes Fransson, co-organized by Göran Östlin)

Micro-workshop on "Blue compact galaxies and their role in the cosmic scenery" in Uppsala and Stockholm, October 26-28 (co-organized by Göran Östlin)

The Cosmology Workshop "A Reality Check" was held in Copenhagen in December (co-organized by Jesper Sollerman)

12. COMMITTEE MEMBERSHIPS

Faculty members participate in national or international committees. The list below is not complete, but indicates the role played by the faculty in such committees.

- Claes-Ingvar Björnsson:** *National* – Member of the Science Research Council ESO-NOT Committee; Member of the Swedish National Committee for Astronomy (until June); *International* – Member of Nordita Astrophysics Committee; Member of NOT Council.
- Claes Fransson:** *National* – Member of the Royal Swedish Academy of Sciences. Chairman of the Crafoord prize committee for astronomy. Member of the Crafoord Committee of KVA. Member of the Swedish National Committee for Astronomy. Vice chairman of the Swedish Research Council Particle Physics and Astrophysics Committee. Member of the Committee for Research Infrastructures of the Swedish research Council (KFI). Vice chairman of the Subcommittee for subatomic physics and astronomy of KFI. Chairman of the Swedish Research Council ESO-NOT Committee; *International* – Member of ESO Council. Member of ESO Strategy Working Group. Member of "Fachbeirat der Max-Planck-Institut für Astrophysik" in Garching. Member of the prize committee for Padova Citta delle Stelle,
- Gösta Gahm:** *National* – Chairman of the Swedish Astronomical Society and of the related Planetarium Foundation and Editorial Board of Populär Astronomi. *International* – Member of the ESO-outreach committee (until June). Advisory member of the ESO Observing Programme Committee.
- Kay Justtanont:** *International* – member of the IAU commission 34 (interstellar medium). National project manager for Sweden and Ireland for the JWST/MIRI project.
- Dan Kiselman:** *National* – Secretary of the Swedish Astronomical Society; *International* – Member of the organising committee of IAU commission 36 (theory of stellar atmospheres).
- Per Olof Lindblad:** *National* – Member of the Royal Swedish Academy of Sciences; *International* – Member of the General Prize Committee of the Balzan Foundation. Foreign member of the Norwegian Academy of Science and Letters.
- René Liseau:** *National* – Chairman of the Scientific Reference Group (SRG) to the National Space Board (SNSB). Secretary of the Swedish National Committee for Astronomy; *International* – Swedish Lead Co-I of the Herschel/HIFI consortium. Member of the TE-SAT (Darwin scientific advisory team to ESA). Member of the TPF-SWG (Terrestrial Planet Finder of NASA, Scientific Working Group). Consultant to SPIRE Specialist Astronomy Group. Member of the Astronomy Working Group (ESA). Lead. CoI of the Odin Astronomical Team. Member of the American Astronomical Society.
- Peter Lundqvist:** *National* – Member of the "Matematisk-fysiska sektionensberedningen" at Stockholm University. Deputy member of the institutional board of the Stockholm Observatory; *International* – Swedish representative in IAU Commission 46. Member of a Review Panel for proposal evaluation for Hubble Space Telescope Cycle 14
- Göran Olofsson:** *National* – Member of the VR ESO-NOT Committee; *International* – Co-I and member of the steering committee for Herschel/SPIRE. Co-PI of the European JWST/MIRI consortium.

- Hans Olofsson:** *National* – Member of the Royal Society of Sciences (Uppsala). Chairman of evaluation committee M (Sub-atomic physics and astrophysics), Swedish Research Council. Chairman of the OSO/APEX time allocation committee. Member of the Swedish National Committee for Astronomy, KVA. Director of the Swedish National Facility for Radio Astronomy, Onsala Space Observatory, Chalmers
- Aage Sandqvist:** *National* – Vice-Chairman of the Swedish Omnitheatre (Cosmonova) Foundation; *International* – Chairman of the Board of Directors for the Scientific Journal *Astronomy & Astrophysics*. Swedish representative on the European Astrophysics Doctoral Network (EADN).
- Göran Scharmer:** *National* – Member of the Royal Swedish Academy of Sciences; Member of the Swedish National Committee for Astronomy; *International* – Member of the International Scientific Committee for the observatories of the Instituto Astrofísico de Canarias. Member of the Norwegian Academy for Science and Letters.
- Jesper Sollerman:** *National* – Member of the Editorial Board of *Populär Astronomi*; *International* – Member of the International Astronomical Union (IAU), commission 47. Member of the Nordic Optical Telescope Observing Programme Committee. Member of the ESA XMM-Newton Observing Time Allocation Committee AO-5. Member of the ESO Outreach Network. Member of DARK board, NBI, KU
- Göran Östlin:** *National* – Member of the Swedish Research Council ESO-NOT Committee. Member of the Manne Siegbahn Memorial Lecture Committee. Member of the Swedish National Committee for Astronomy; *International* – Member of the ESO Observing Programmes Committee. Member of the Swedish MIRI consortium.