STOCKHOLM OBSERVATORY REPORT 1999

Juri Poutanen (Ed.)

Stockholm Observatory, S-133 36 Saltsjöbaden, Sweden

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PREFACE

Below follows the Annual Report of the Stockholm Observatory for the year 1999. It is gratifying to see that the scientific productivity of the Observatory continued to rise also during 1999. We had an exceptional year in terms of production of university points in the undergraduate teaching (50% more than our undertaking), mainly due to our introductory astronomy courses, and in particular a very successful course in general astronomy during the summer period. As usual, the activity with public shows in the evenings attracts many visitors, and the personal of the Observatory remains very active in different media.

A number of people have come and left the Observatory during the year. Anlaug Amanda Kaas defended her PhD thesis, and left for a post-doc position at ESTEC. Anna Grigorieva from Russia and Boris Gudiksen from Denmark started their PhD studies. Andrei Beloborodov from Russia stayed on at an NFR research associate position after finishing an NFR postdoctoral fellowship. Two new postdocs, Nicole van der Bliek from the Netherlands and Taku Takeuchi from Japan, and a guest scientist, Alexander Men'shchikov from Russia, arrived during the year. Göran Östlin came to the Observatory on an NFR repatriation grant. Finally, Matt Delaney was employed as a system manager.

In spite of the economical difficulties facing many university departments, Stockholm Observatory has been able to more or less balance its budget also during 1999, but continued, non-financed, salary rises are now threatening the budget for the running costs. The external funding remained at the same level, but external funding for graduate students is decreasing markedly. The building of the *Stockholm Centre for Astronomy and Physics* is proceeding according to plans, and the move of Stockholm Observatory to the new Centre is scheduled for the summer of 2001.

March 2000

Hans Olofsson, Director

STOCKHOLM OBSERVATORY REPORT 1999

Juri Poutanen (Editor)

Stockholm Observatory, SE-133 36 Saltsjöbaden, Sweden

1. INTRODUCTION

Stockholm Observatory [Stockholms Observatorium] is beautifully located in the archipelago 18 km southeast of Stockholm. The Research Station for Astrophysics of the Royal Swedish Academy of Sciences [Kungliga Svenska Vetenskapsakademien - KVA] is also located at Stockholm Observatory. The scientific staff, during 1999, included five professors, eight associate professors and senior researchers, one university lecturer, seven research associates and four postdoctoral fellows. About 1/3 of the staff is of foreign nationality.

At Stockholm Observatory observational, theoretical and experimental work is carried out. The fields of research include the interstellar medium and star formation, young stars and planetary systems, solar physics, AGB-stars and planetary nebulae, supernovae, galactic structure and dynamics, observational cosmology, high energy astrophysics, as well as infra-red equipment development. Stockholm Observatory has access to all European Southern Observatory (ESO) instruments, the Nordic Optical Telescope (NOT), the Swedish solar telescope on La Palma, the Swedish-ESO Submillimetre Telescope (SEST) and the Onsala telescopes, and European Space Agency (ESA) projects such as Hubble Space Telescope (HST), Infrared Space Observatory (ISO), the astrometry satellite HIPPARCOS, X-ray Multimirror Mission (XMM). Other instruments, such as the Keck telescope, the Very Large Array (VLA) the Australia Telescope (AT), the IRAM PdB mm-wave interferometer as well as the space based Compton Gamma-Ray Observatory (CGRO), the Advanced Satellite for Cosmology and Astrophysics (ASCA), and the Rossi X-ray Timing Explorer (RXTE) are also extensively used.

The scientists of the Stockholm Observatory are also actively involved in the development of future space missions such as Odin (Swedish submillimetre space telescope), ESA's INTEGRAL (International Gamma-Ray Astrophysics Laboratory), DARWIN (infra-red space interferometer), GLAST (Gamma-ray Large Area Space Telescope), EXTRA (Experiment for X-ray Timing and Relativistic Astrophysics, a $10\mathrm{m}^2$ X-ray telescope), and Ballerina (a Danish gamma-ray burst mission).

2. STAFF

2.1. Faculty

All positions are full-time {100%} except for a few cases where the relevant part-time percentage is written inside {}. The external financial sources have been indicated. Where no source is indicated, the financial source is Stockholm University.

Artymowicz, Pawel: Associate Professor (NFR) [NFR forskare]
Beloborodov, Andrei: Research Associate (from Oct 1999, NFR postdoc before Oct)
Björnsson, Claes-Ingvar: Associate Professor (NFR 50%)
Dorch, Bertil: Postdoctoral Fellow (KVA)
Fransson, Claes: Professor
Gahm, Gösta: Professor
Gullbring, Erik: Research Associate
Högbom, Jan: Associate Professor Emeritus
Justtanont, Kay: Research Associate (US)
Kiselman, Dan: Research Associate (KVA)
Kozma, Cecilia: Research Associate (NFR)
Larsson, Stefan: Research Scientist (RS) [RS forskare]
Lindblad, Per Olof: Professor Emeritus
Liseau, René: Associate Professor (RS)
Lodén, Kerstin: Associate Professor Emerita
Lundqvist, Peter: Associate Professor (NFR 75%)
Löfdahl, Mats: Research Associate (KVA)
Mellema, Garrelt: Research Associate
Men'shchikov, Alexander: Guest Scientist (RS, from May 1999)
Nordh, Lennart: Associate Professor (RS)
Olofsson, Göran: Associate Professor (RS)
Olofsson, Hans: Professor
Poutanen, Juri: Research Associate
Sandqvist, Aage: Associate Professor (NFR 25%, RS 25%, Almanacksförlaget 50%)
Scharmer, Göran: Professor (KVA)
Sundman, Anita: University Lecturer {50%}
Svensson, Roland: Professor
Takeuchi, Taku: Postdoctoral Fellow (NFR, from May 1999)
van der Bliek, Nicole: Postdoctoral Fellow (RS, from May 1999)
Östlin, Göran: Postdoctoral Fellow (NFR repatriation grant, from Dec 1999)

NFR - Swedish Natural Science Research Council [Naturvetenskapliga Forskningsrådet]
RS - Swedish National Space Board [Rymdstyrelsen]
KVA - The Royal Swedish Academy of Sciences [Kungliga Vetenskapsakademien]
US - position for underrepresented sex financed by Stockholm University, NFR, and Swedish Government

2.2. Technical Staff

Delaney, Matt: System Manager (from February 1999)
Florén, Hans-Gustav: Research Engineer
Wänn, Uno: Research Engineer
Wang Wei: System Engineer (KVA)

2.3. Administrative Staff

Olofsson, Lena: Senior Administrative Officer [byrådirektör]
Schober, Jan: Librarian {50%}
Tannenberg, Anne-Marie: Senior Administrative Officer

2.4. Graduate Students

The graduate students at Stockholm Observatory during the report period are listed below with the starting (or finishing) dates of their graduate studies following their names. In many cases, graduate students receive full-time economic support from Stockholm Observatory in terms of 80% Study grant [utbildningsbidrag] or Graduate studentship [doktorandtjänst], and 20% position as Teaching Assistant [assistent], the latter may also contain administrative duties in addition to teaching duties. Sometimes, students are partially supported as Research Assistants by research grants from the different research councils (NFR, RS), KVA or foundations (GG, KKS), or international organizations (NOTSA).

Andersson, Andreas
Brandeker, Alexis
Dahlén, Tomas
Gonzalez Delgado, David (NOTSA)
Grigorieva, Anna (from July 1999)
Gudiksen, Boris (KVA, from September 1999)
Kaas, Anlaug Amanda (RS, until April 1999)
Larsson, Bengt (RS)
Nymark, Tanja
Näslund, Magnus (KKS)
Rouppe van der Voort, Luc (KVA)
Ryde, Felix
Schöier Larsen, Fredrik (NFR)
Sollerman, Jesper (RS)
Wold, Margrethe (US)

GG - Göran Gustafsson Foundation
KKS - Stiftelsen för Kunskaps och Kompetensutvekling/ Foundation for Knowledge and Competence Development
NOTSA - Nordic Optical Telescope Scientific Association

2.5. 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, one representative (with 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).

Hans Olofsson (director)
Claes Fransson (deputy director)
Göran Olofsson (faculty repr.)
Claes-Ingvar Björnsson (faculty repr.)
Roland Svensson (faculty repr.)
Aage Sandqvist (1st deputy faculty repr.)
Stefan Larsson (2nd deputy faculty repr.)
Gösta Gahm (3rd deputy faculty repr.)
Uno Wänn (T/A repr.)
Hans-Gustav Florén (deputy T/A repr.)
Fredrik Larsen Schöier (grad. stud. repr., until May 1999)
Andreas Andersson (deputy grad. stud. repr. until April, regular from May 1999)
Georgios Dimitriadis (undergr. stud. repr., until May 1999)
Alexandra Balogh (undergr. stud. repr., from May 1999)

3. RESEARCH

3.1. Young Stars and Star Formation Regions

(N. van der Bliek, H.-G. Florén, G. Gahm, E. Gullbring, A.A. Kaas, Bengt Larsson, R. Liseau, A. Men'shchikov, L. Nordh, G. Olofsson, Aa. Sandqvist, G. White)

One of the great challenges of modern astrophysics is the proper understanding of the interstellar processes that lead to new generations of stars, or, if you wish, of how older stars like our Sun once formed. The problems involved are of relevance to both our own galaxy, the Milky Way, and to external galaxies.

According to current understanding the formation of stars involves a complex feed-back, and presumably self-regulating, energy-transforming scheme of non-linear, non-equilibrium physics and chemistry. The building blocks are ensembles of elementary particles, atoms, molecules and solid state particles being subject to gravitational, electromagnetic and radiative interactions. These forces bring eventually order into chaos, 'creating' out of close to nothingness a stellar body that is dense and hot enough to ignite and maintain thermonuclear fusion reactions as in our Sun. Together with this new sun, there will also have formed planets, one of which might eventually become inhabited by beings who are able to contemplate their life giving star's formation and evolution.

Our research in the field of stellar formation is oriented along four major lines: (i) The study of the media forming stars, with particular emphasis on the understanding of the initial physical and chemical conditions as functions of space and time. (ii) The study of ensembles of very young stellar objects, in order to empirically determine the mass distribution spectrum at stellar birth. The functional form of this spectrum appears universal, i.e., it is the same in our Galaxy and in external galaxies, and our primary objective is to understand to what degree the memory of the initial cloud condition is 'frozen in' into this function. (iii) The study of the dynamics of forming stars, especially during the earliest, protostellar, phases. The physics of the apparently co-existent mass building infall and angular momentum shedding mass outflows are not well understood, but this understanding is clearly important as these processes limit the final stellar mass and incorporate the formation of planets. (iv) The study of young stars and in particular the evolution of their accretion disks.

The analyses of the ISOCAM survey of nearby star formation regions continued. A.A. Kaas defended her PhD thesis mainly based on this work. A theoretical interpretation of the ISOCAM colours for field stars was initiated. The reduction and analyses of LWS data continued. The work has been concentrated on two regions, L1551 (a well known outflow region) and the Serpens star formation region.

Brown dwarf candidates discovered in the ISOCAM survey were observed spectroscopically at ESO. For some of them the analysis confirms their brown dwarf status. Based on high resolution spectroscopy (NOT/SOFIN), the T Tauri star RW Aur A was found to have a close low-mass companion, possibly a brown dwarf. An extended survey of dark globules, mainly carried out using the SEST, has been completed. This catalogue will be useful as a reference in different contexts an in particular serve as a database for the Odin mission. Research on interstellar filaments in regions with no star formation continued in 1999. An extensive study of the patterns of linear polarization of stars in such regions were completed during the year. New observations were collected at Onsala and NOT.

Laboratory tests and some software and hardware modifications of the infrared camera 'SIRCA' were carried out in preparation for the first telescope tests on the NOT (scheduled for Feb. 2000). Regarding ODIN satellite, the international coordination of scientific preparations has continued and the scheduling program was further developed. The participation in the ESA satellite FIRST (to be launched around 2007) concerns the heterodyne receiver and the bolometer camera/spectrometer and continued during 1999. The ESA study called 'Darwin' concerns a space infrared interferometer capable of identifying earth-like planets. We participated in this study and organized an international conference 'Darwin and Astronomy' in Stockholm.

3.2. Theory of Binary Star and Planetary System Formation
(P. Artymowicz, T. Takeuchi)

A small new group appeared at the Observatory in 1999 to scrutinize the mechanisms of formation of the newly discovered extrasolar planetary systems. Other interests of the group (described in the 1997-1998 Report) include the dynamics of binary star formation, and a range of dust-related topics in Beta Pictoris-type circumstellar dust disks.

Exoplanet discovery (32 non-controversial candidates are known) and exoplanet theory are a booming area of astrophysics. The first multi-planet system around a normal star (ups And), and dust disks in 3 of the 6 studied systems with known exoplanets have been discovered. Theory developed at the Observatory concerns the principles of protoplanet interaction with primordial disks, as one of the leading proposed causes for the very unusual orbital properties of the giant exoplanets. In particular, numerical simulations were done of the important processes of radial planet migration in disks, and eccentricity generation. We developed a new theory of dust migration in optically thin disks, which will find application to the disks such as HR4796 and HD141569 imaged recently by HST, showing a little understood ring-and-gap morphology. We performed one of the first numerical stability analyses of ups And on a 2 Gyr time scale on a mini-supercomputer Hydra, built and operated by the group in 1999 (http://astro.su.se/~pawel/hydra).

3.3. AGB Stars and Planetary Nebulae
(D. Gonzalez Delgado, K. Justtanont, G. Mellema, H. Olofsson, F.L. Schöier)

The research at Stockholm Observatory centres on the properties of the AGB mass loss and the formation and evolution of planetary nebulae (PNe). On the observational side a number of projects have been concluded, and some new have been started. Detailed observations of the CO radio line emission from two stars, U Cam and TT Cyg, both seem to have gone through a brief period of very intense mass loss, have been performed using the IRAM interferometer on Plateau de Bure, France. This study of episodic mass loss of AGB-stars is now extended to include imaging of the shells in resonance line scattered stellar light. Observations at the ESO 3.6m telescope and the NOT have been done, and the first results on the carbon stars R Scl and U Ant are prepared for publication. In another interferometric study, using the Cal.tech. interferometer at Owens Valley, evidence for a Keplerian disk around an apparently normal AGB-star, RV Boo, was found. In order to interpret our CO_2 emission results obtained with ISO, we have observed OH masers in order to verify the suggestion that CO_2 is formed by the reaction of OH and CO in the inner part of the circumstellar envelope. A preliminary result shows that OH masers exist in the region where CO_2 is emitting, thus giving weight to the proposed formation path. A major project aimed at a census of AGB-stars in Local Group galaxies have been started on the NOT. Images in four filters are used to identify the AGB-stars and to classify them chemically. A probable post-AGB object, HD101584, was found to have a remarkable molecular envelope, where high-velocity features outline a spatially resolved bipolar outflow, while the central region appears complicated, with the possible existence of disks at two spatial scales.

On the interpretational side also a number of projects have been concluded, and some new have been started. Using near- and mid-infrared ISO observations, we detect several molecular absorption and emission bands, e.g., H_2O, CO, OH and CO_2. The models give estimates of the temperature of the absorbing/emitting gas and the column density of the gas. Heating mechanisms in post-AGB pbjects and PNe have been investigated using ISO LWS observations. In AFGL 2688 where there is evidence for a fast wind interacting with the remnant AGB envelope, shocks are used to desbribe the gas heating while in NGC 7027, the strong far-UV radiation is thought to be heating the gas. In the intermediate object, AFGL 618, both mechanisms may be operating. A molecular excitation and radiative transfer code based on the Monte Carlo method, which include the energy balance equation and line overlaps, has been developed and applied in two studies. In one of them, radio and ISO ^{12}CO and ^{13}CO line data on the carbon star IRAS15194-5155 could be modelled assuming a constant mass loss rate and ^{12}CO/^{13}CO during at least a few thousand years. This star may be massive enough that it has experienced hot bottom burning, but not massive enough to convert carbon to nitrogen, and hence it remains a carbon star, but with a low ^{12}C/^{13}C-ratio. In the other, interferometric and single-dish circumstellar HCN and CN emission from carbon stars have been modelled. It was found that the predictions of a photodissociation model are qualitatively, and in most cases also quantitatively, correct. For both molecules the inclusion of line overlap in the radiative transfer analysis is important.

Some AGB stars manage to lose their entire hydrogen envelope and become the so-called Wolf-Rayet (WR) type central stars of Planetary Nebulae (PN). These stars are normally characterised by heavy mass loss (up to 10^{-5} $M_\odot$ yr^{-1}) at high velocities (1000 km s^{-1}). Because of the absence of hydrogen, the thermal behaviour of the winds can differ from the usual. We investigated the effects the WR abundances can have on the formation of the PN shells. It is expected that the nebular expansion velocities will be higher, the shell more turbulent, and the so-called momentum-conserving will last longer. We also continued the study of the properties of the cometary knots in the Helix nebula (NGC 7392). We used HST observations to estimate the intensity of the ionizing flux from the star, as well as the intensity of the diffuse ionizing flux of scattered photons inside the nebula. It was found that the values provided by the knots are consistent with previously determined values, and that the diffuse ionizing flux is substantially less than the popular 'On The Spot' estimate and it is indicative of a non-closed nebular shell.

3.4. Supernovae

(C. Fransson, C. Kozma, P. Lundqvist, T. Nymark, J. Sollerman)

The supernova group at Stockholm Observatory is heavily involved in various observational projects using space observatories like HST, Chandra, FUSE and XMM. Data from IUE and ISO are also analyzed, and a substantial amount of ground-based data have been gathered using telescopes mainly at ESO, La Silla and ESO/VLT, Paranal. Much of the group's efforts have been to model these and other observations. The research has during 1999 focused mainly on SN 1987A, supernovae showing circumstellar emission, and on pulsars.

Radiation-hydrodynamical multi-group NLTE simulations of SN 1987A have been performed to model the shock breakout of the supernova, and the evolution of the emission from the ejecta during the subsequent $3 - 4$ months. The best models have energies in the range $E = (1.10 \pm 0.25) \times 10^{51}$ ergs. The maximum velocity of the ejecta ($\sim c/10$) in the models is similar to that indicated by early IUE spectra. Detailed NLTE radiation transfer has been added to make a detailed spectral analysis.

To prepare for HST/STIS and FUSE observations, the expected emission in narrow lines from the H II region inside the inner ring around the supernova 1987A was calculated. The strongest lines are N V $\lambda1240$ and O VI $\lambda1034$. A spin-off from the analysis of the ring itself is that one can derive an upper limit of ~ 55 kpc for the distance to the Large Magellanic Cloud.

HST images of a new unresolved source of emission near the inner circumstellar ring of SN 1987A have been obtained by the SINS team. The data show a brightening spot on the ring, which marks the onset of the collision between the SN 1987A ejecta and the dense gas in the ring.

Data obtained in 1998 with the ISO/SWS and ISO/LWS for SN 1987A have been reduced and analyzed. In particular, the upper limit on the flux of [Fe II] 25.99μm on day 3999 is ~ 1.4 Jy, which together with the group's theoretical models gives an upper limit of the mass of ejected ^{44}Ti which is 1.5×10^{-4} solar masses.

The temperature, ionization and line emission of the ejecta of SN 1987A has been modeled in its nebular phase, using a time-dependent model. It is found that freeze-out of the recombination is important in the hydrogen and helium zones. An IR-catastrophe is seen in the metal lines as a transition from thermal to non-thermal excitation, most clearly in the [O I] $\lambda\lambda6300$, 6364 lines, and from the evolution of the [Fe II] lines. The distribution of hydrogen, helium, and oxygen is determined from the line profiles. Photometric UBVRI observations from day ~ 3600 have also been added to refine the model and to estimate the amount of ejected ^{44}Ti.

Supernovae 1979C and 1980K have been studied with HST and from the ground, and these Type II linear supernovae (SNe II-L) spectra show general agreement with the lines expected in a circumstellar interaction model by Chevalier & Fransson. For SN 1979C WFPC2 imaging has been used to place constraints on the mass of the SN progenitor, based on photometry of the stellar populations in its environment. For the Type Ic SN 1994I synthetic spectra are compared to observed photospheric-phase spectra.

The members of the group have also studied the Crab pulsar. The pulsar's far-UV spectrum ($1140 - 1720$ Å) was studied with HST/STIS in time-tag mode which provides 125 μs time resolution. These data have been added to previously obtained near-UV data (see the Report from 1997-1998), and data obtained at NOT. The dereddened spectrum is flat with spectral index $\alpha_\nu = 0.10$. Absorption from the Crab nebula is seen in C IV $\lambda1550$, and modeling this absorption was initiated.

PSR 1706-44 was studied using the science verification observations with the test camera on VLT/UT1. (This made the Supernova group the first group in Sweden to analyze and publish VLT data.) The excellent seeing at Paranal made it possible to put a 3σ limit on the optical flux from the pulsar at $V = 25.5$ if the pulsar is not close to a projected bright star.

In preparation for NGST and wide-field VLT instruments, explosion models coupled with radiation transfer of core-collapse supernovae have been made to estimate the possibility of detecting SNe II at different redshifts. Another study of this sort, using template supernova light curves, and including dust absorption is presented under Observational Cosmology.

3.5. Galaxies and the Milky Way

(A. Andersson, P.O. Lindblad, M. Näslund, 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, and dark matter. Detailed studies are performed using the ESO telescopes, NOT and HST in the optical and infrared, and the VLA, AT and SEST in the radio regime.

The local burst of star formation in our Galaxy, giving rise to the phenomenon called Gould's Belt, is studied by means of observations by the Hipparcos satellite. Using recently published data, analyses of the kinematics of the Gould Belt stars are being made in terms of two models. (i) An inclined rotating selfgravitating and expanding system. (ii) A stellar density wave. From the observational data the parameters entering these two models are derived.

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. In August, the group had another observing session on SEST during which the mapping of the immediate environment of Sgr A in the $J = 2-1$ $C^{18}O$ line was completed. The recalibration and map production of the four 18-cm OH line observations, made with the VLA, were also completed.

Another project is aimed at mapping the molecular gas in the barred, grand-design, face-on, spiral galaxy M 83 with the SEST. This galaxy is relatively nearby (3.7 Mpc), which makes it possible to do a detailed study of the kinematics of the gas, and correlate the distribution of the molecular gas with other tracers of stellar activity.

A major study of the effects of metallicity and far-ultraviolet radiation on the physical/chemical properties of the molecular gas in the Magellanic Clouds were completed this year. Among the results should be mentioned the abundance deficits, relative to the Galaxy, of all molecules by, on the average, a factor of ten in the LMC, and an additional factor of five in the SMC.

3.6. Observational Cosmology

(T. Dahlén, C. Fransson, M. Näslund, M. Wold)

The emphasis of the group on observational cosmology has up to now mainly been on the study of clusters of galaxies at high and low redshifts, as well as their relation to active galactic nuclei (AGN). New directions also include modeling of early supernova activity, as well the use of supernovae as cosmological probes. In the latter field the group is collaborating with especially the cosmology group at the Dept. of Physics at Stockholm University.

In preparation for New Generation Space Telescope (NGST), we have used different assumptions for the combination of dust extinction and star formation up to redshifts $z \gtrsim 5$, as well as detailed modelling of supernova properties, to estimate the number of supernovae that should be observable with this telescope. Realistic light curves and spectral shapes that evolve with time for the different types supernovae are used. It is found that NGST should be able to detect several tens of core-collapse events in a single detection if the observational limit in the range $1 - 5$ μm is 1 nJy and the field is 16 square arcmin. The observable number of Type Ia supernovae is also estimated.

3.7. High Energy Astrophysics

(A.M. Beloborodov, C.-I. Björnsson, L. Borgonovo, S. Larsson, J. Poutanen, F. Ryde, B.E. Stern, R. Svensson, Y. Tikhomirova)

The group specializes in observational and theoretical high energy astrophysics with emphasis on radiation processes in highly energetic plasmas and the interpretation of the broad band observations of active galactic nuclei (AGN), X-ray binaries, and γ-ray bursts. Observations are both space-based (ASCA, CGRO, RXTE) and ground-based (NOT, ESO, etc.). Archival data are also used.

Accreting black holes

X-ray spectra of accreting black holes (both supermassive and stellar mass ones) can be deconvolved into a power-law produced by thermal Comptonization and a components due to the reflection of hard X-rays from cold material (presumably the accretion disc). In some sources, the amount of reflection is much below the value corresponding to an X-ray source above a flat infinite reflector. It was suggested that the lack of reflection is due to mildly relativistic bulk motion of the coronal plasma away from the reflector. Bulk motion causes aberration reducing the X-ray emission towards the disc, which leads to smaller reflection. This model predicts a correlation between the spectral slope and the amount of reflection that successfully reproduces the recently observed correlation.

Galactic black holes (GBH) radiate in one of several spectral states. In the soft state the spectra extend up to at least 1 MeV without a spectral break. Such a behaviour contradicts the standard thermal Comptonization picture. A hybrid, thermal/non-thermal model was developed where such spectra are produced by Comptonization of soft photons from the cool accretion disc by non-thermal electrons in the corona.

GBHs also show time lags between the variability in different energy bands. These lags sometimes become as large as 0.3 sec. A model was proposed where the time lags are related to the time scales of the spectral evolution of magnetic flares which may be comparable to the Keplerian time scales at 3–100 gravitational radii from the central black hole. The proposed model describes well the time-averaged spectra as well as the temporal characteristics such as the power-density spectrum, the time/phase lags, and the coherence function of Cygnus X-1.

Some quasars demonstrate mysterious steep rises in polarization blueward of the Lyman limit. It was shown that strong rises in polarization can be produced in the plasma outflowing from the accretion disc with mildly relativistic velocities and by an ionized "skin" covering the disc.

Gamma-ray bursts

Research on the statistical properties of the temporal variability of GRBs was continued. It was shown that complex (containing many pulses) bursts have a different brightness distribution when compared with simple bursts. It is consistent with the fact that complex bursts are intrinsically brighter. This fact can have important implications for the models of GRBs. GRBs being extremely different in their temporal appearance turn out to be very similar in Fourier space. The power density spectra of long GRBs are consistent with a power-law with the index $-5/3$ close to the Kolmogorov law.

The energy spectra of GRBs and their time evolution are also analyzed. The behaviour of the instantaneous (i.e., temporally resolved) spectra are of interest as they directly reflect the physics of the underlying emission processes. Especially, the spectral evolution within individual pulses is studied. The connection between the spectral and the intensity evolution has been formulated in a compact form. It was also demonstrated in what way the instantaneous spectra are related to the generally studied time-integrated pulse spectrum. It was shown how this can be used when studying observed GRB spectra.

Many detectable GRBs escaped detection (triggering) by BATSE because of too low intensity, or, so called, dead-time intervals. Such GRBs can be found in the daily count rate records which are accumulated during the full CGRO operation. Analysing the ~ 40 Gb of archival data using an advanced triggering procedure about 1700 non-triggered GRBs were found which doubles the available sample of GRBs. Most importantly, the efficiency of the search was measured with a novel "test burst" technique. A database of non-triggered GRBs is publically available at http://www.astro.su.se/groups/head/grb_archive.html.

Instruments

The high energy astrophysics group is part of the team that will deliver the X-ray monitor, JEM-X, for the INTEGRAL-satellite. INTEGRAL is an ESA satellite dedicated to spectroscopy and imaging of hard X-ray and gamma-ray sources. The launch of the satellite is scheduled for 2001. The group in Stockholm participates in the development of the science software for JEM-X. JEM-X is a coded mask instrument, so the task of the software is to deconvolve detector images and extract light curves and spectra for individual sources.

The group also participates in the experimental and/or theoretical teams for the Spectrum Röntgen-Gamma (SRG) satellite, Ballerina (a mainly Danish gamma-ray burst mission), the Experiment for X-ray Timing and Relativistic Astrophysics (EXTRA), and the Gamma-ray Large Area Space Telescope (GLAST).

3.8. The Sun

(B. Dorch, B. Gudiksen, D. Kiselman, M. Löfdahl, L. Rouppe van der Voort, G. Scharmer, Wang Wei)

The Research Station for Astrophysics of the Royal Swedish Academy of Sciences runs a 47.5-cm solar telescope on the Canary Island of La Palma. 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. This is done with techniques for imaging, spectroscopy, and polarimetry that are being developed in Stockholm and on La Palma to allow sub-arcsecond resolution.

The telescope is used by many guest observers for solar (and planetary) studies. Many of their observing programs are collaborations with the scientific staff based in Stockholm. Essentially all the observational programs are designed to take advantage of the high spatial resolution obtainable. During 1999 there were several observational runs that were coordinated with observations by the SOHO and TRACE spacecraft and other terrestrial telescopes. Notable in this context is the Dutch Open Telescope which is situated close to the SVST and controlled from that building. This telescope, which has an innovative open design, started regular observations this year.

A common subject of the observational projects is small-scale solar magnetic fields as traced by the small photospheric bright points that are especially bright when imaged in the wavelength of the G band. These bright points are barely resolved at the diffraction-limit of the telescope, and the phase-diversity technique for image restorations has been frequently employed in their study. The later technique is currently being refined and developed. (Also with other applications in mind such as the phasing of segmented space telescopes.)

The formation of the G band in magnetic flux tubes (believed to give rise to the bright points mentioned) as well as other spectral diagnostics of these structures is being investigated theoretically as a collaboration project within the European Solar Magnometry Network, wherein our group is one of the nodes.

Other scientific projects include observational and theoretical studies of photospheric line-formation processes aimed at improving abundance analysis work, observations of H-β wings for testing photospheric convection models, observational studies of the structure and dynamics of sunspot penumbræ, and numerical magnetohydrodynamic modelling of magnetic flux structures in the solar convection zone and at the solar surface.

An adaptive optical system featuring a bimorph mirror with 18 actuators and a Shack-Hartmann wavefront sensor was installed and used for observations during the year. This is an important preparation for the New Swedish Solar Telescope (NSST) for which funding has been acquired and construction was started during the year. This telescope will have a clear aperture of 95 cm and will be placed in the existing building. It will keep some of the principles from the SVST being a vacuum telescope with a turret construction on top of the tower. The optical system is however different since the objective is a single lens whose chromatic aberration will be corrected by a Schupmann system. The telescope will be equipped with adaptive optics. Current planning calls for observations starting in 2001.

4. PhD and MASTER THESES

Kaas A.A.: September 1999, *Luminosity Functions of Embedded Young Stellar Clusters*, PhD Thesis

Blomberg H.L.A.: March 1999, *Adaptive optics for the Swedish vacuum solar telescope*, Master's thesis, Royal Institute of Technology (KTH), Stockholm

Lundqvist A.: March 1999, *Undersökning av det interstellära molekylmolnet MBM25*, ALP-1999-101, Master's thesis, Alfvénlaboratoriet, Royal Institute of Technology (KTH), Stockholm

Gålfalk M.: November 1999, *An Investigation of the Young Stellar Population in the Cep A Region*, Master's thesis, Stockholm Observatory

5. 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 licentiate and PhD degrees. The directors for undergraduate studies [studierektorer för grundutbildningen] are Claes-Ingvar Björnsson and Anita Sundman. The counsellor for undergraduate studies [studievägledare för grundutbildning] is Tomas Dahlén. The director for the Graduate School [studierektor för forskarutbildningen] is Roland Svensson (and Claes-Ingvar Björnsson substituted him during the first half of 1999). Lecturers of the courses are given in parenthesis. (1p corresponds to one week of full-time studies.) During 1999, the following courses were taught:

5.1. Undergraduate Courses

Introductory Courses in Astronomy [Översiktskurser i Astronomi]
Prerequisites: General Admission [Grundläggande Behörighet]
Introductory Course to Astronomy (5p) Orienteringskurs i Astronomi (summer, M. Näslund; spring, A. Sundman)
Structure of the Universe (5p) Universums Byggnad (fall, 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 (spring, C. Kozma)
Prerequisites: High School Mathematics and Physics [Gymnasium matematik och fysik från Naturvetenskapliga eller Tekniska Programmet]
Modern Astronomy (10p) Modern Astronomi (spring, A. Sundman; fall, G. Gahm)

Basic Courses in Astronomy [Grundkurser i Astronomi]
Prerequisites: University Mathematics (40p) and Physics (60p)
Atomic and Molecular Physics (5p) Atom- och Molekylfysik (spring, C.-I. Björnsson)
Observational Techniques in Astronomy (5p) Astronomisk Observationsteknik (spring, R. Liseau)
Stellar Atmospheres (5p) Stjärnatmosfärer (spring, K. Justtanont)
Structure and Evolution of the Stars (5p) Stjärnornas Struktur och Utveckling (spring, G. Mellema)
Cosmology (5p) Kosmologi (fall, C. Fransson)

Radiation Processes in Astrophysics (5p) Astrofysikaliska Strålningsprocesser (fall, R. Svensson)
Physics of the Interstellar Medium (5p) Interstellära Mediets Fysik (fall, P. Lundqvist)
Galaxies and Galactic Dynamics (5p) Galaxer och Galaktisk Dynamik (fall, P. Artymowicz)
Astrophysics (3p) Astrofysik (course given at KTH by G. Gahm)
Waves and Information (5p) Vågor som Informationsbärare (a cross disciplinary course, astronomical part, 1p, given by S. Larsson)

Advanced Courses in Astronomy [Påbyggnadskurser i Astronomi]
High Energy Astrophysics (5p) Högenergiastrofysik (fall, J. Poutanen)
Degree Project in Astronomy (10/20p) Examensarbete i Astronomi

5.2. Graduate Courses

The Graduate School at Stockholm Observatory has a programme consisting of 60p courses (40p Basic Courses and 20p Additional Courses) and 100p PhD thesis work. The Basic Courses are given on a rolling two-year schedule and consist of six 5p compulsory courses and two exercises chosen from a menu of numerical and observational exercises. The observational exercises are under development. Some courses are taught in collaboration with, or by, the Physics Dept, Stockholm University. Some courses may also be of the self-study type. During 1999, the following courses were taught:

Basic Courses [Baskurser]
Galaxies: Formation, Structure and Dynamics (5p) Galaxer: Bildning, Struktur och Dynamik (spring, P. Artymowicz)
Cosmology/Astroparticle Physics (5p) Kosmologi/Astropartikelfysik (spring and fall, L. Bergström, Physics Dept.)
Stellar Structure and Evolution (5p) Stjärnornas Struktur och Utveckling (spring, supervised by C. Fransson)

Numerical Exercise in Galactic Dynamics (4p) Tillämpningsuppgift i Galaxdynamik (P. Artymowicz)
Numerical Exercise in Interstellar Matter (5p) Tillämpningsuppgift i Interstellär Materia (P. Lundqvist)
Numerical Exercise in Hydrodynamics (5p) Tillämpningsuppgift i Hydrodynamik (G. Mellema)
Numerical Exercise in Stellar Atmospheres (5p) Tillämpningsuppgift i Stjärnatmosfärer (D. Kiselman)

Additional Courses [Tillvalskurser]
Atomic and Molecular Physics (5p) Atom och Molekylfysik (spring, C.-I. Björnsson)
Radiation Processes in Astrophysics (5p) Astrofysikaliska Strålningsprocesser (fall, R. Svensson)
High Energy Astrophysics (5p) Högenergiastrofysik (fall, J. Poutanen)

6. SYMPOSIA and WORKSHOPS

In 1999, two symposia were organized by the scientists of the Stockholm Observatory

International Workshop on "Gamma-Ray Bursts: The First Three Minutes", February 6-11, 1999, Gräftåvallen, Sweden (Organizing Committee: Juri Poutanen, Roland Svensson, Boris E. Stern)

International Conference "Darwin and Astronomy: The Infrared Space Interferometer", November 17-19, 1999, Stockholm (Organizing Committee: René Liseau, Lennart Nordh, Bengt Larsson, Nicole van der Bliek)

7. GUESTS

A number of guest scientists have visited Stockholm Observatory (d – days, w – weeks, m – months).

Briggs M.F. (Univ. of Alabama, Huntsville, USA), Feb 2d
Bulik T. (N. Copernicus Astron. Center, Warsaw, Poland), Feb 2d
Chugai N. (INASAN, Moscow, Russia), Sept 2w
Fich M. (Observatoire de Paris and Univ. of Waterloo, Canada), April 3d
Gilmozzi R. (ESO, Garching, Germany), June 2d
Illarionov A.F. (Lebedev Phys. Inst., Moscow, Russia), May-July 2m
Ivanov P. (TAC, Copenhagen, Denmark), March 1w
Kerschbaum F. (Vienna Observatory, Austria), June 1w
Kiseleva L. (Inst. of Astronomy, Cambridge University, UK), June 3d
Kouznetsova I. (Lebedev Phys. Inst., Moscow, Russia), November 1w
Lacy M. (Lawrence Livermore National Lab., USA), December 1w
Leibundgut B. (ESO, Garching, Germany), August 2w
Lindqvist M. (Onsala Space Observatory, Sweden), October 2d
Malzac J. (Centre d'Etude Spatiale des Rayon., Toulouse, France), Nov-Dec 1m
Nagirner D.I. (Sobolev Astron. Inst., St. Petersburg, Russia), July 2w
Pantin E. (Instituut voor Sterrenkunde, Belgium), November 4d
Peplinski A. (N. Copernicus Univ., Torun, Poland), April 1w
Preece R. (Univ. of Alabama, Huntsville, USA), Feb 2d
Rutten R. (Sterrekundig Inst., Univ. of Utrecht, the Netherlands), August 4d
Schwarz H. (NOT, Spain), November 2w
Sjouwerman L.O. (Joint Inst. for VLBI, the Netherlands), Jan 1w, April 1w
Soltau D. (Kiepenheuer-Institut für Sonnenphysik, Freiburg, Germany), April 4d
Stern B.E. (Inst. for Nucl. Res., Moscow, Russia), Feb-March, July, Nov-Dec, 4m
Szczerba R. (N. Copernicus Astron. Center, Warsaw, Poland), Jan 1w
Tielens A.G.G.M. (Kapteyn Inst. and SRON, the Netherlands), April 1w
Tikhomirova Y. (Lebedev Phys. Inst., Moscow, Russia), Feb, July, Nov-Dec, 4m
White G. (Queen Mary College, London, UK), 5m
Zdziarski A.A. (N. Copernicus Astron. Center, Warsaw, Poland), Nov 3d

8. SEMINARS

The usual seminar day and time is Friday at 10:30. The location is the main lecture room at Stockholm Observatory. The seminar organizers in 1999 were Gösta Gahm and Peter Lundqvist.

January 15, Lorant Sjouwerman (Joint Institute for VLBI in Europe, Dwingeloo) OH/IR stars in the Galactic center: signs for an ancient starburst

January 26, Ryszard Szczerba (N. Copernicus Astronomical Center) Dust around post-AGB sources with 21 micron feature

January 27, Tord Nordstrand (Stockholm Observatory) Multicolour photometric analysis of the interactive binary white dwarf system CR Boo (Master Thesis)

January 29, Andrei Beloborodov (Stockholm Observatory) Gamma-ray bursts: the fireball emission and its temporal structure

February 5, Bengt Gustafsson (Uppsala Observatory) On the origin of carbon

February 12, Ana Hidalgo-Gamez (Uppsala Observatory) Hubble V and Hubble X without HUBBLE

February 19, Bertil Dorch (Stockholm Observatory, KVA) Illustrating a piece of the solar dynamo

February 26, Alexander Men'shchikov (Max Planck Institute for Radioastronomy, Bonn) High-resolution speckle imaging and 2D radiative transfer modeling of IRC+10216

March 12, Nikolai Piskunov (Uppsala Observatory) The Vienna atomic line database

March 18, Bo Milvang-Jensen (Ph.D. stipend talk, Copenhagen) E and S0 galaxies: The fundamental plane, ages and metallicities

March 19, Kay Justtanont (Stockholm Observatory) Atomic and molecular spectra of supergiants

March 19, Anna Grigorieva (Ph.D. stipend talk, PhysTech, Moscow) The possibilities of energy spectra measurements of protons and electrons in the TeV energy range in the "RIM-PAMELA" experiment

March 24, Kirsten Kraiberg Knudsen (Ph.D. stipend talk, Copenhagen) Determining the dust-to-gas ratio at high redshift and selection biases in flux limited samples

March 25, Luis Borgonovo (Ph.D. stipend talk, Stockholm Observatory) Time histories and spectral evolution of GRBs in the context of the external shock models

April 12, A.G.G.M. Tielens (Kapteyn Institute and SRON, Groningen) Interstellar Ices

April 13, Michel Fich (Observatoire de Paris and University of Waterloo, Canada) The driving mechanism of bipolar molecular outflows

April 23, Torben Andersen (Lund Observatory) New Astronomical Telescope Projects

April 29, Adam Peplinski (N. Copernicus University, Torun) Maxwell's electrodynamics and magnetic monopoles

May 7, Hans Olofsson (Stockholm Observatory) Radio interferometry observations of AGB-stars with highly episodic mass loss

May 28, Claes-Ingvar Lagerkvist (Uppsala Observatory) UDTS: A Trojan Survey of the Jupiter L4 Cloud

June 4, Roberto Gilmozzi (ESO, Garching) Science and technology of a 100m ground based optical telescope: the OWL concept

June 11, Göran Marklund (Alfvénlaboratoriet, KTH) New perspective on the aurora: Results from Freja & Astrid-2

June 21, Ludmila Kiseleva (Institute of Astronomy, Cambridge) Three-body dynamics and a possible way of producing close stellar and planetary orbits

July 2, Andrei Illarionov (Lebedev Physical Institute, Moscow) Hard X-ray emitting black hole fed by accretion of low angular momentum matter

July 6, James Muzerolle (Center for Astrophysics, Harvard) Models and observations of magnetospheric emission lines from pre-main-sequence stars

August 20, Bruno Leibundgut (ESO, Garching) Is Λ real?

September 10, Taku Takeuchi (Stockholm Observatory) Orbital evolution of protoplanets during their formation

September 17, Nikolai Chugai (INASAN, Moscow) The nature of the unusual supernova 1997D

September 24, Amanda Kaas (Stockholm Observatory and ESA) Ph.D. thesis defense: Luminosity functions of embedded young stellar clusters

October 8, Hans-Georg Scherneck (Onsala Space Observatory) Deformations of the solid Earth - tides, glaciation, and tectonics

October 18, Ralf Klessen (Leiden Observatory) Local collapse in turbulent clouds: implications for star formation

October 26, Susanne Höfner (Uppsala Observatory) Y2K-safe model atmospheres for AGB stars

November 3, John Black (Onsala Space Observatory) Infrared absorption spectroscopy of interstellar molecules

November 12, Inga Kuznetsova (Ph.D. stipend talk, PhysTech, Moscow) The internal structure of nonrelativistic jets

November 22, Alexander Sakharov (Space Research Institute, Moscow) The Russian Phobos sample return mission

December 3, Christoph Bargholtz (Nuclear Physics Division, Stockholm University) Neutrino mass - a bewildering mass of experiments.

December 17, Mark Lacy (Lawrence Livermore National Labs, Univ. of California) The role of AGN in cosmology

9. ACTIVITIES for the GENERAL PUBLIC

Stockholm Observatory has a regular program of activities for the general public. Twice a month from October till March, the observatory makes available its 10-m-long 0.5m- and 0.6m-diameter double refractor for observations of the Moon, planets, and nebulae. Attendance is by reservation for individuals, groups or school classes. Lectures are also given by the observatory staff at these occasions. Because they are very popular they are fully booked early, and in order not to disappoint too many people, the Stockholm Observatory also has an approximately annual "Open House" on a Saturday or Sunday, at which no reservations are needed. These Open Houses may be timed to coincide with a celestial event such as a solar eclipse or the appearance of a bright comet. During 1999, such an occasion was a partial solar eclipse on August 11. The Stockholm Observatory has a stand at the popular Saltsjöbaden Festival that takes place near Grand Hotel, Saltsjöbaden in early June every year.

Twice a week, an astronomer is on telephone-duty for questions from the general public. Other staff members are available for consultation by secondary and high school students. Stockholm Observatory also accepts apprentice students from secondary schools for one-week internships at the Observatory. A program of collaboration is ongoing with a nearby upper secondary and high school (Saltsjöbadens Samskola) which has a special astronomical curriculum. Finally, some of the faculty members and graduate students are very active in media such as radio, TV and the press. A number of astronomical articles in the newspapers, about ten TV- and radio-programs have appeared that are based on interviews with the researchers from Stockholm Observatory. About 20 popular lectures have been given in different cities all over Sweden.

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.

Gösta Gahm has continued the work with Sweden Solar System (SSS), the world's largest model of the solar system. In 1999 three inaugurations took place: The comet Swifft-Tuttle at the Science Center Kreativum, Karlshamn, Blekinge, the planet Mars at Mörby Centrum, Danderyd, and the planet Earth at Cosmonova at the Swedish Museum of Natural History. Special activities were given at several stations, like the "Rymddagarna" at the Stockholms stadsmuseum and astronomy exhibitions in for instance Karlshamn. Several national/local radio/TV-programs and dayly/weakly journals/magazines have been high-lighting SSS during the year. In addition to numerous talks and interviews in connection to SSS, Gahm has given public lectures at Bokmässan, Gothenburgh, and Strindbergsmuseet and Geologiska föreningen, both in Stockholm. Finally, Gahm has participated in several TV-programs on astronomy (Utbildningsradion, Hjärnkontoret and TV1).

Magnus Näslund has been participating in a number of public activities, in most cases in the context of Project SkolAstro, such as interviews related to astronomical events in national TV channels as well as local and national radio channels, Sweden Solar System activities, seminar at "Skolforum 99" and as an expert in astronomy in educational TV programs ("Hjärnkontoret" and "Utbildningsradion").

Hans Olofsson was invited by the Svenska Astronomiska Sällskapet to give the first Nordenmarkföredrag. The title was "Stormen före lugnet: solliknade stjärnors dödskamp". Mats Löfdahl gave interviews related to 1999 solar eclipse for TV3 "TV3 Direct" and SVT2 "Rapport morgon". Roland Svensson gave an interview on Gamma-Ray Bursts for Dagens Nyheter. Bertil Dorch gave lectures at the Danish Astronomical Society Solar-section Workshop on Sunspots (Arden, Denmark) and at a course for Danish gymnasium-lecturers The Active Sun (Haslev, Denmark).

Peter Lundqvist, who is the Observatory's official contact person to media, gave several radio and TV interviews during 1999, mainly in connection with the solar eclipse in August, and the Leonid storm in November. He also participated in preparations for the program "Hjärnkontoret".

10. LIST of PUBLICATIONS

10.1. Books

1. *Nordic Symposium in Theoretical High Energy Astrophysics: Use of the Spectrum X-Gamma and INTEGRAL Missions*, Proceedings of Symposium held in Copenhagen, Sept 14-16, 1997, Eds. N.J. Westergard, O. Vilhu and **R. Svensson**, 1998, Physica Scripta, T77, 150 pages

2. *High Energy Processes in Accreting Black Holes*, 1999, Proceedings of the International Workshop on "High Energy Processes in Accreting Black Holes: Observational and Theoretical Advances due to Ongoing Space Missions" held at Gräftåvallen, Sweden, June 29-July 4, 1998, eds. **J. Poutanen, R. Svensson**, ASP Conference Series, Vol. 161, 450 pages

3. *Gamma Ray Bursts: The First Three Minutes*, 1999, Proceedings of the International Workshop on "Gamma Ray Bursts: The First Three Minutes" held at Gräftåvallen, Sweden, Feb 6-11, 1999, eds. **J. Poutanen, R. Svensson**, ASP Conference Series, Vol. 190, 310 pages

4. *Kosmiska Ursprung*, 1999, **Gahm G.F.**, Compendium for the course "Astrofysik", KTH

5. *Solsystemet i Tid och Rum - och en Resa genom Sweden Solar System*, 1999, **Gahm G.F.**, Graphium Norstedts media

6. *Den Svenska Almanackan 2000*, 1999, ed. **Aa. Sandqvist**, Almanacksförlaget, Stockholm, 160 pages

7. *Astronomisk almanacka 2000*, 1999, eds. **Aa. Sandqvist**, D. Kennedal, Almanacksförlaget, Stockholm, 96 pages

8. *Den Vanliga Almanackan 2000*, 1999, eds. **Aa. Sandqvist**, I. Wåhlstedt, Almanacksförlaget, Stockholm, 80 pages

10.2. Reviews

1. **Artymowicz P.**, 1999, *Supermassive Binary Black Holes in Galaxies*, in Theory of Black Hole Accretion Discs, eds. M.A. Abramowicz, G. Björnsson, J. Pringle, Cambridge University Press, 202
2. **Beloborodov A.M.**, 1999, *Accretion Disk Models*, in High Energy Processes in Accreting Black Holes, eds. J. Poutanen, R. Svensson, ASP Conf. Series Vol. 161, 295
3. **Beloborodov A.M.**, 1999, *Power Density Spectra of Gamma-Ray Bursts*, in Gamma-Ray Bursts: The First Three Minutes, eds. J. Poutanen, R. Svensson, ASP Conf. Series Vol. 190, 47
4. **Lindblad P.O.**, 1999, *NGC 1365*, Astron. Astrophys. Rev., 9, 221
5. **Olofsson H.**, 1999, *The AGB-star Phenomenon: Setting The Stage*, in Asymptotic Giant Branch stars, eds. T. Le Bertre, A. Lebre, C. Waelkens, IAU Symp. No. 191, 3
6. **Poutanen J.**, 1999, *Accretion Disc-Corona Models and X/gamma-ray Spectra of Accreting Black Holes*, in Theory of Black Hole Accretion Discs, eds. M.A. Abramowicz, G. Björnsson, J. Pringle, Cambridge University Press, 100
7. **Ryde F.**, 1999, *Spectral Aspects of the Evolution of Gamma-Ray Bursts*, in Gamma-Ray Bursts: The First Three Minutes, eds. J. Poutanen, R. Svensson, ASP Conf. Series Vol. 190, 103
8. **Stern B.E.**, 1999, *Relativistic Outflows in Gamma Ray Bursts*, in High Energy Processes in Accreting Black Holes, eds. J. Poutanen, R. Svensson, ASP Conf. Series Vol. 161, 277
9. **Stern B.E.**, 1999, *Time Variability of Gamma-Ray Bursts: A Search for a Unifying Law*, in Gamma-Ray Bursts: The First Three Minutes, eds. J. Poutanen, R. Svensson, ASP Conf. Series Vol. 190, 31
10. **Svensson R.**, 1999, *Thermalization Mechanisms in Compact Sources*, in High Energy Processes in Accreting Black Holes, eds. J. Poutanen, R. Svensson, ASP Conf. Series, Vol. 161, 361
11. **Svensson R.**, 1999, *Old and New Advances in Black Hole Accretion Disk Theory*, in Theory of Black Hole Accretion Discs, eds. M.A. Abramowicz, G. Björnsson, J. Pringle, Cambridge University Press, 284

10.3. Scientific Publications in Refereed Journals

1. **Beloborodov A.M.**, 1999, *Plasma Ejection from Magnetic Flares and the X-ray Spectrum of Cygnus X-1*, ApJ, 510, L123

2. **Beloborodov A.M.**, 1999, *Electron-positron Outflows from Gamma-Ray Emitting Accretion Discs*, MNRAS, 305, 181

3. **Beloborodov A.M., Poutanen J.**, 1999, *On the Origin of Polarization near the Lyman Edge in Quasars*, ApJ, 517, L77

4. Bryce M., **Mellema G.**, 1999, *The kinematics of the planetary nebula BD+30^{o}3639*, MNRAS, 309, 731

5. Caux E., Ceccarelli C., Castets A., Vastel C., **Liseau R.**, Molinari S., Nisini B., Saraceno P., White G.J., 1999, *Large atomic oxygen abundance towards the molecular cloud L1689N*, A&A, 347, L1

6. Ceccarelli C., Caux E., Loinard L., Castets A., Tielens A.G.G.M., Molinari S., **Liseau R.**, Saraceno P., Smith H., White G., 1999, *Water line emission in low-mass protostars*, A&A, 342, L21

7. **Dahlén T., Fransson C.**, 1999, *Rates and redshift distributions of high-z supernovae*, A&A, 350, 349

8. **Dorch S.B.F.**, Archontis V., Nordlund Å., 1999, *3D Simulations of Twisted Magnetic Flux Ropes*, A&A, 352, L79

9. Fesen R.A., Gerardy C.L., Filippenko A.V., Matheson T., Chevalier R.A., Kirshner R.P., Schmidt B.P., Challis P., **Fransson C.**, Leibundgut B., Van Dyk S.D., 1999, *Late-Time Optical and Ultraviolet Spectra of SN 1979C and SN 1980K*, AJ, 117, 725

10. **Gahm G.F.**, Petrov P., Duemmler R., Gameiro J.F., Lago M.T.V.T., 1999, *RW Aur A, a close binary?*, A&A, 352, 95

11. Giannini T., Lorenzetti D., Tommasi E., Nisini B., Benedettini M., Pezzuto S., Strafella F., Barlow M., Clegg P. E., Cohen M., di Giorgio A.M., **Liseau R.**, Molinari S., Palla F., Saraceno P., Smith H.A., Spinoglio L., White G.J., 1999, *ISO-LWS observations of Herbig Ae/Be stars. II. Molecular lines*, A&A, 346, 617

12. Gierlinski M., Zdziarski A.A., **Poutanen J.**, Coppi P.S., Ebisawa K., Johnson W.N., 1999, *Radiation Mechanisms and Geometry of Cygnus X-1 in the Soft State*, MNRAS, 309, 496

13. **Harjunpää P., Kaas A.A.**, Carlqvist P., **Gahm G.F.**, 1999, *Linear polarization and molecular filamentary clouds*, A&A, 349, 912

14. Heikkilä A., Johansson L.E.B., **Olofsson H.**, 1999, *Molecular Abundance Variations in the Magellanic Clouds*, A&A, 344, 817

15. **Justtanont K.**, Tielens A.G.G.M., de Jong T., Cami J., Waters L.B.F.M., Yamamura I., 1999, *Atomic fine-structure lines in the ISO-SWS spectra of the supergiants alpha Orionis and alpha Scorpii*, A&A 345, 605

16. **Kaas A.A.**, 1999, *K-Band Variability as a Method to Select Young Stellar Object Candidates*, AJ, 118, 558

17. **Kaas A.A.**, Aksnes K., Franklin F., Lieske J., 1999, *Astrometry from Mutual Phenomena of the Galilean Satellites in 1990-1992*, AJ, 117, 1933

18. Kerschbaum F., **Olofsson H.**, 1999, *Oxygen-rich semiregular and irregular variables: A catalogue of circumstellar CO observations*, A&AS, 138, 299

19. Lacy M., Ridgway S.E., **Wold M.**, Lilje P.B., Rawlings S., 1999, *Radio-optical alignments in a low radio luminosity sample*, MNRAS, 307, 420

20. Lindqvist M., **Olofsson H.**, Lucas R., **Schöier F.L.**, Neri R., Bujarrabal V., Kahane C., 1999, *The Young Detached CO Shell around U Camelopardalis*, A&A, 351, L1

21. **Liseau R.**, 1999, *Molecular line observations of southern main-sequence stars with dust disks: α Ps A, β Pic, ε Eri and HR 796 A: Does the low gas content of the β Pic and ε Eri disks hint at the presence of planets?*, A&A, 348, 133

22. **Liseau R., Olofsson G.**, 1999, *The H_2O abundance and star formation history in ρ Oph Cloud*, A&A, 343, L83

23. **Liseau R.**, White, G.J., **Larsson B.**, Sidher, S., **Olofsson G., Kaas A.A., Nordh L.**, Caux E., Lorenzetti D., Molinari S., Nisini B., Sibille F., 1999, *Looking at the bright side of the ρ Ophiuchi dark cloud*, A&A, 344, 342

24. Lorenzetti D., Tommasi, E., Giannini T., Nisini B., Benedettini M., Pezzuto S., Strafella F., Barlow M., Clegg P.E., Cohen M., di Giorgio A.M., **Liseau R.**, Molinari, S., Palla F., Saraceno P., Smith H.A., Spinoglio L., White G.J., 1999, *ISO-LWS observations of Herbig Ae/Be stars. I. Fine structure lines*, A&A, 346, 604

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A&A- Astronomy and Astrophysics
A&AS- Astronomy and Astrophysics Supplement Series
ApJ- The Astrophysical Journal
ApJS- Astrophysical Journal Supplement
AJ- The Astronomical Journal
MNRAS- Monthly Notices of the Royal Astronomical Society
PASP- Publications of the Astronomical Society of the Pacific

10.4. Other Scientific Publications

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37. **Scharmer G.B., Blomberg H.**, 1999, *Optimized Shack-Hartmann wavefront sensing for adaptive optics and post processing*, in High Resolution Solar Physics: Theory, Observations and Techniques, eds. T. Rimmele, R.R. Radick, K.S. Balasubramaniam, ASP Conf. Series Vol. 183, 239

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39. Shand M., **Scharmer G.B.**, **Wang Wei**, 1999, *Correlation tracking and adaptive optics control using off-the-shelf workstation technology*, in High Resolution Solar Physics: Theory, Observations and Techniques, eds. T. Rimmele, R.R. Radick, K.S. Balasubramaniam, ASP Conf. Series Vol. 183, 231

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41. Vilhu O., Alha L., Malmivaara K., Huovelin J., **Poutanen J.**, Nevalainen J., 1999, *Broad Band Disc-Corona Modelling of GRS 1915+105*, in The 3rd INTEGRAL Workshop: The Extreme Universe, eds. A. Bazzano, C. Winkler, G. Palumbo, Astrophysical Letters and Communications, 38, 241

42. Waters L.B.F.M., Beintema D.A., Cami J., de Graauw Th., Hony S., de Jong T., **Justtanont K.**, Kemper F., de Koter A., van Loon J. Th., Molster F., Tielens A.G.G.M., Waelkens C., van Winkel H., Yamamura I., 1999, *ISO observations of AGB and post-AGB stars*, in The Universe as Seen by ISO, eds. P. Cox, M.F. Kessler, ESA SP-427, ESA, Noordwijk, 219

43. Wijers R.A.M.J., **Poutanen J.**, Svensson R., 1999, *Gamma-ray Bursts: The First Three Minutes*, Publ. Astron. Soc. Pac., 111, 1589

IAUC - International Astronomical Union Circulars
BAAS - Bulletin of the American Astronomical Society

10.5. Popular Science Publications

1. **Gahm G.F.**, 1999, *Det svenska solsystemet inför år 2000*, in Astronomisk Årsbok 2000, eds. A. Larsson, J. Schildt (INOVA), 54

2. **Kiselman D.**, 1999, *Finns solkromosfären?*, in Astronomisk Årsbok 2000, eds. A. Larsson, J. Schildt (INOVA), 51

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4. **Näslund M.**, 1999, *Galaxer och äpplen, SkolAstro – att göra fysik spännande med astronomi*, in Astronomisk Årsbok 2000, eds. A. Larsson, J. Schildt (INOVA), 65

5. **Sandqvist Aa.**, 1999, *Adjö, universum, vi ses kanske igen*, in Den Vanliga Almanackan 2000, eds. Aa. Sandqvist, I. Wåhlstedt (Almanacksförlaget, Stockholm), 56

10.6. The Swedish Almanac [Den Svenska Almanackan]

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 (*Den 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 Stockholm Observatory. The editor for the astronomical part of this almanac since 1977 is also Aage Sandqvist. Both *Den Svenska Almanackan* and *Den Vanliga Almanackan* are published each year. During 1999, a new almanac was developed in collaboration between David Kennedal and Aage Sandqvist, namely *Astronomisk Almanacka* - starting with the year 2000 it will also be published annually under the auspices of Stockholm Observatory.

11. COMMITTEE MEMBERSHIPS

Faculty members are often involved in the work of national or international committees. The membership list presented here is not complete, but gives an indication of the role played by the faculty in national and international committees.

Claes-Ingvar Björnsson: *National* - Member of NFR's ESO-NOT Committee; *International* - Sweden's national representative in IAU Commission 46; Member of Nordita Astrophysics Committee

Gösta Gahm: *National* - Member of the board for the Onsala National Facility; Member of the board for Stiftelsen Observatoriekullen

Claes Fransson: *National* - Member of the Royal Academy of Sciences; Member of NFR's ESO-NOT Committee; *International* - Chairman of Nordita astrophysics committee; Member of Nordita board

Dan Kiselman: *National* - Secretary of the Swedish Astronomical Society

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: *International* - Swedish representative in the Scientific Advisory Group to ESA for the Cornerstone 5 candidate Infrared Space Interferometer Darwin; Swedish representative in the Astronomy Working Group (ESA)

Peter Lundqvist: *National* - Member of Manne Siegbahn Memorial Lecture Committee; *International* - Member of the NOT Observing Programme Committee; Deputy member of the ESO Observing Programme Committee

Lennart Nordh: *National* - Member of the Swedish National Committee for Astronomy; *International* - member of ESA's Science Programme Committee

Göran Olofsson: *National* - Member of NFR's ESO-NOT Committee; *International* - Member of NOT Scientific and Technical Committee

Hans Olofsson: *National* - Chairman of the Observing Proposal Programme Committee of the Swedish National Facility for Radio Astronomy, Onsala Space Observatory

Aage Sandqvist: *National* - Vice-Chairman of the Swedish Omnitheatre (Cosmonova) Foundation; *International* - Chairman of the Board of Directors for the European Journal *Astronomy and Astrophysics*; Swedish representative on the European Astrophysics Doctoral Network (EADN)

Roland Svensson: *National* - Member of the Swedish National Committee for Astronomy

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 Astrofisico de Canarias