ASTRONOMICAL INSTITUTE

Utrecht University, Beta Faculty
Department of Physcis and Astronomy

ANNUAL REPORT

2004

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Chapter 1

Astro plasma physics

Staff members: Prof.dr A. Achterberg, dr. J. Bergmans (postdoc), drs. J. Wiersma (PhD), B. van der Hoek (graduate)

1.1 Academic publications

Magnetic field generation in relativistic shocks. An early end of the exponential Weibel instability in electron-proton plasmas
Wiersma, J.; Achterberg, A.
(Sterrenkundig Instituut, Universiteit Utrecht,
Astronomy and Astrophysics, v.428, p.365-371 (2004)

We discuss magnetic field generation by the proton Weibel instability in relativistic shocks, a situation that applies to the external shocks in the fireball model for Gamma-ray Bursts, and possibly also to internal shocks. Our analytical estimates show that the linear phase of the instability ends well before it has converted a significant fraction of the energy in the proton beam into magnetic energy: the conversion efficiency is much smaller (of order me/mp) in electron-proton plasmas than in pair plasmas. We find this estimate by modelling the plasma in the shock transition zone with a waterbag momentum distribution for the protons and with a background of hot electrons. For ultra-relativistic shocks we find that the wavelength of the most efficient mode for magnetic field generation equals the electron skin depth, that the relevant nonlinear stabilization mechanism is magnetic trapping, and that the presence of the hot electrons limits the typical magnetic field strength generated by this mode so that it does not depend on the energy content of the protons. We conclude that other processes than the linear Weibel instability must convert the free energy of the protons into magnetic fields.

Non-thermal X-ray emission from young supernova remnants
van der Swaluw, E.; Achterberg, A.
Journal: Astronomy and Astrophysics, v.421, p.1021-1030 (2004) [1ex]

The Galactic (nucleonic) cosmic-ray spectrum up to the knee (E $\sim 10^{15}$ eV) is attributed to acceleration processes that take place near the external shocks around supernova remnants (SNRs). Theoretical predictions based on the theory of diffusive shock acceleration give a similar estimate for the maximum particle energy that can be reached at these shocks: E $\sim 10^{14} - 10^{15}$ eV. Electrons with energies E $\sim 10^{14}$ eV radiate X-ray photons in the $\sim 10 - 100$; μG magnetic fields present in many young SNRs. These electrons near the knee give rise to a non-thermal X-ray component in the spectrum of young supernova remnants. Recent observations of SN1006 and G347.3-0.5 confirm this prediction. We have combined hydrodynamical calculations of the evolution of a young remnant with an algorithm that simultaneously calculates the acceleration of electrons, their radiation losses and the synchrotron spectrum of a young supernova remnant. The electrons are treated using a test-particle approximation.
We give a semi-analytical estimate of the maximum electron energy and typical synchrotron frequencies for young remnants at the end of the free-expansion stage of their evolution. We present spectra of the energy distribution of the electrons in a young supernova remnant, and construct a synchrotron map in the X-ray domain, assuming Bohm diffusion within the remnant and a shock-compressed magnetic field.

Course 7: Cosmic Rays and Particle Acceleration at Astrophysical Shocks
Achterberg, Abraham
Journal: Accretion discs, jets and high energy phenomena in astrophysics. Editors: Vassily Beskin, Gilles Henri, Franois Menard, et al, Les Houches Summer School, vol. 78, p.313-401

The acceleration of particles in the vicinity of astrophysical shocks has become the main paradigm in astrophysics for the production of cosmic rays particles. In this review, I consider the basic theory of shock acceleration, the observational constraints, and the open questions.

1.2 Pulsar magnetosphere

A free-electron laser in the pulsar magnetosphere
Fung, P. K.; Kuijpers, J.
Astronomy and Astrophysics, v.422, p.817-830

We have studied systematically the free-electron laser in the context of high brightness pulsar radio emission. In this paper, we have numerically examined the case where a transverse electromagnetic wave is distorting the motion of a relativistic electron beam while travelling over one stellar radius ($\approx$10 km). For different sets of parameters, coherent emission is generated

by bunches of beam electrons in the radio domain, with bandwidths of 3 GHz. Pulse power often reached 10^{13} W, which corresponds with brightness temperature of 10^{30} K. The duration of these pulses is of the order of nanoseconds. In the context of pulsar radio emission, our results indicate that the laser can produce elementary bursts of radiation which build up the observed microstructures of a few tens of microseconds duration. The process is sensitive mostly to the beam particles energy, number density and the background magnetic field, but much less so to the transverse wave parameters. We demonstrate that the operation of a free-electron laser with a transverse electromagnetic wiggler in the pulsar magnetosphere occurs preferably at moderate Lorentz factors gamma ≥ 100, high beam density $n \gtrsim 0.1 n_{GJ}(r^*)$ where $n_{GJ}(r^*)$ is the Goldreich-Julian density at a stellar radius r^*, and finally, at large altitude where the background magnetic field is low $B_0 \leq 10^{-2}$ T.

Chapter 2

Magnetohydrodynamics of laboratory and astrophysical plasmas

Staff members: Prof.dr. J.P. Goedbloed, drs. Chunmei Wang

2.1 Academic publications

Local analysis of MHD spectra for cylindrical plasmas with flows
Wang, Chunmei; Blokland, J. W. S.; Keppens, R.; Goedbloed, J. P.
Journal of Plasma Physics, vol. 70, Issue 06, p.651-669

An analytical and numerical study of the ideal magnetohydrodynamic (MHD) spectrum of waves and instabilities of a cylindrical plasma column with flows is presented. Our analytical results are relevant for thermally stratified, rotating, magnetized cylindrical equilibria. The presence of azimuthal flow makes the general analysis of the MHD spectrum difficult, except in cases where the continuous parts of the spectrum are absent. In the presence of Doppler shifted Alfvén and slow continua, a local analysis at resonant surfaces or internal extrema can provide a simple and reliable way to access information on MHD spectroscopy. In this paper, local cluster conditions, which govern the occurrence of sequences of discrete global modes, have been generalized for rotating equilibria. The generalized Suydam criterion for instability is revisited. A numerical study confirms our analytical results and clearly demonstrates how the local criteria govern the existence of the accumulating eigenmodes.

Transsonic Instabilities in Laboratory and Astrophysical Plasmas
Goedbloed, J. P.
Physica Scripta, Volume T107, pp. 159.

Waves and instabilities of transsonically rotating axisymmetric plasmas present a highly complex problem that is of interest for two unrelated fields of research, viz. laboratory tokamak confinement for the eventual thermonuclear energy production and the dynamics of a vast number of astrophysical plasmas rotating about compact objects, broadly indicated as accretion disks. The complexity originates from the transsonic transitions of the poloidal flow which causes the character of the rotating equilibrium states to change dramatically, from elliptic to hyperbolic or vice versa, when the poloidal velocity surpasses certain critical speeds. Associated with these transitions the different types of magnetohydrodynamic (MHD) shocks may appear. Obviously, at such transitions the possible waves and instabilities of the system also change dramatically. We investigate these changes for the two mentioned classes of physical systems, starting from the point of view that the continuous spectrum of magnetohydrodynamics presents the best organizing principle for the structure of the complete spectrum of waves and instabilities since it is the most robust part of it, for that reason called the "essential spectrum" by mathematicians. The physical importance of the problem is that it provides the simplest approach to local waves and instabilities of the system and, possibly, to the onset of MHD turbulence in accretion disks.

Chapter 3

Mass loss from Stars

Staff members: Prof. Henny Lamers (lamers@astro.uu.nl,), Postdoc: dr. M. Kraus, PhD students: Nate Bastian (bastian@astro.uu.nl), Mark Gieles (gieles@astro.uu.nl)
Master students: Johan Martens, Jacqueline Mout, Remco Scheepmaker

3.1 Academic publications

Maximum mass-loss rates of line-driven winds of massive stars: The effect of rotation and an application to eta Carinae
Aerts, C.; Lamers, H. J. G. L. M.; Molenberghs, G.
Astronomy and Astrophysics, v.418, p.639-648

We investigate the effect of rotation on the maximum mass-loss rate due to an optically-thin radiatively-driven wind according to a formalism which takes into account the possible presence of any instability at the base of the wind that might increase the mass-loss rate. We include the Von Zeipel effect and the oblateness of the star in our calculations. We determine the maximum surface-integrated mass that can be lost from a star by line driving as a function of rotation for a number of relevant stellar models of massive OB stars with luminosities in the range of $5.0 < \log(L/L_\odot) < 6.0$. We also determine the corresponding maximum loss of angular momentum. We find that rotation increases the maximum mass-loss rate by a moderate factor for stars far from the Eddington limit as long as the ratio of equatorial to critical velocity remains below 0.7. For higher ratios, however, the temperature, flux and Eddington factor distributions change considerably over the stellar surface such that extreme mass loss is induced. Stars close to the Eddington-Gamma limit suffer extreme mass loss already for a low equatorial rotation velocity. We compare the maximum mass-loss rates as a function of rotation velocity with other predicted relations available in the literature which do not take into account possible instabilities at the stellar surface and we find that the inclusion thereof leads to extreme mass loss at much lower rotation

rates. We present a scaling law to predict maximum mass-loss rates. Finally, we provide a mass-loss model for the LBV eta Carinae that is able to explain the large observed current mass-loss rate of $\sim 10^{-3}$ $M_{\odot}$ yr^{-1} but that leads to too low wind velocities compared to those derived from observations.

A study of the expanding envelope of Nova V1974 Cyg 1992 based on IUE high resolution spectroscopy
Cassatella, A.; Lamers, H. J. G. L. M.; Rossi, C.; Altamore, A.; González-Riestra, R. Astronomy and Astrophysics, v.420, p.571-588

We have carried out a detailed analysis of the IUE archival high resolution spectra of the classical nova V1974 Cyg 1992. The main UV resonance lines show P Cygni profiles in the first days, which change into symmetric pure emission lines, and then slowly become fainter and narrower. Lines of higher ionization species reach their peak luminosity later than those of low ionization. This can be explained by a fast wind which is optically thick in the early days, when the pseudo-photosphere is located inside the wind. As the mass loss decreases, the radius of the pseudo-photosphere shrinks. This has three effects that explain the observed changes: (1) the deeper accelerating layers of the wind become visible where the emission lines are formed by collisional excitation and/or recombination; (2) as the mass loss rate decreases the emission comes from deeper regions of the wind where the velocities are smaller; (3) the effective temperature and the degree of ionization increase. In addition to the P Cygni and emission lines, we could identify two shortward shifted absorption systems which originate in two separate expanding shells, outside the wind layers where the emission lines are formed. The velocity of both shells increase with time. The outer main shell, containing most of the matter ejected at the outburst, produces the so-called "principal absorption line system", and the inner faster moving second shell produces the so-called "diffuse-enhanced absorption line system". The acceleration of the two shells is the result of increasing line-radiation pressure due to the UV-brightening of the star as the effective radius decreases. Around day 60 the second shell has overtaken the slower moving principal system shell, and merged with it. This explains: the sudden disappearance of the diffuse line system near that date, the upward jump of Δ v = 240 km s^{-1} in velocity of the principal system and the first detection of hard X-ray emission on day 63. This velocity jump indicates that the main shell is ap 4 times more massive than the second shell. The deceleration suffered by the diffuse-enhanced system after the shock provides a shock temperature T_{shock} ap 1.6 keV, in fairly good agreement with the temperature of the observed hard X-ray emission. The UV observations are interpreted through an empirical model in which the pre-nova slow wind phase is followed by the ejection of two shells, where the principal and the diffuse-enhanced absorption systems are formed, and by a phase of fast continuous lower density wind. Our empirical expansion velocity law for the principal system, together with Halpha interferometric observations of the angular radius on day 10 are used to de-

termine the distance to the nova, which is found to be 2.9 ± 0.2 kpc, in agreement with HST imaging and with the absolute magnitude versus rate of decline relationship.

On the Hipparcos parallaxes of O stars
Schröder, S. E.; Kaper, L.; Lamers, H. J. G. L. M.; Brown, A. G. A.
Astronomy and Astrophysics, v.428, p.149-157

We compare the absolute visual magnitude of the majority of bright O stars in the sky as predicted from their spectral type with the absolute magnitude calculated from their apparent magnitude and the Hipparcos parallax. We find that many stars appear to be much fainter than expected, up to five magnitudes. We find no evidence for a correlation between magnitude differences and the stellar rotational velocity as suggested for OB stars by Lamers et al. (1997, A&A, 325, L25), whose small sample of stars is partly included in ours. Instead, by means of a simulation we show how these differences arise naturally from the large distances at which O stars are located, and the level of precision of the parallax measurements achieved by Hipparcos. Straightforwardly deriving a distance from the Hipparcos parallax yields reliable results for one or two O stars only. We discuss several types of bias reported in the literature in connection with parallax samples (Lutz-Kelker, Malmquist) and investigate how they affect the O star sample. In addition, we test three absolute magnitude calibrations from the literature (Schmidt-Kaler et al. 1982, Landolt-Börnstein; Howarth & Prinja 1989, ApJS, 69, 527; Vacca et al. 1996, ApJ, 460, 914) and find that they are consistent with the Hipparcos measurements. Although O stars conform nicely to the simulation, we notice that some B stars in the sample of have a magnitude difference larger than expected.

The dynamical mass of the young cluster W3 in NGC 7252. Heavy-weight globular cluster or ultra compact dwarf galaxy?
Maraston, C.; Bastian, N.; Saglia, R. P.; Kissler-Patig, M.; Schweizer, F.; Goudfrooij, P.
Astronomy and Astrophysics, v.416, p.467-473

We have determined the dynamical mass of the most luminous stellar cluster known to date, i.e. object W3 in the merger remnant galaxy NGC 7252. The dynamical mass is estimated from the velocity dispersion measured with the high-resolution spectrograph UVES on VLT. Our result is the astonishingly high velocity dispersion of sigma=45 ± 5 km s^{-1}. Combined with the large cluster size Reff=17.5 1.8 pc, this translates into a dynamical virial mass for W3 of (8 ± 2) $\times 10^7 M_\odot$. This mass is in excellent agreement with the value ($\sim^7$ $.2 \times 10^7 M_\odot$) we previously estimated from the cluster luminosity (MV=-16.2) by means of stellar M/L ratios predicted by Simple Stellar Population models (with a Salpeter IMF) and confirms the heavy-weight nature of this object. This results points out that the NGC 7252-type of mergers are able

to form stellar systems with masses up to $\sim 10^8 M_\odot$. We find that W3, when evolved to ~ 10 Gyr, lies far from the typical Milky Way globular clusters, but appears to be also separated from omegaCen in the Milky Way and G1 in M 31, the most massive old stellar clusters of the Local Group, because it is too extended for a given mass, and from dwarf elliptical galaxies because it is much more compact for its mass. Instead the aged W3 is amazingly close to the compact objects named ultracompact dwarf galaxies (UCDGs) found in the Fornax cluster (Hilker et al.,; Drinkwater et al.), and to a miniature version of the compact elliptical M 32. These objects start populating a previously deserted region of the fundamental plane. Based on observations collected at the European Southern Observatory, ID: 67.D-0205(A).

Chapter 4

Stellar evolution and Nucleosynthesis

Permanent staff: Norbert Langer, Onno Pols
Group members: Jasinta Dewi, Allard-Jan van Marle, Selma de Mink, Robert Nolet, Aarnout van Oosten, Jerome Petri, Jelena Petrovic, Arend-Jan Poelarends, Dagmar de Rooij, Marc van der Sluys, Sung-Chul Yoon
Former members: Hartmut Braun, Luc Dessart, Andreas Deutschmann, Jens Fliegner, Alexander Heger, Falk Herwig, Silvia Scheithauer, Stephan Wellstein

4.1 Academic publications

Helium accreting CO white dwarfs with rotation: Helium novae instead of double detonation
Yoon, S.-C.; Langer, N. Astronomy and Astrophysics, v.419, p.645-652 (2004)

We present evolutionary models of helium-accreting carbon-oxygen white dwarfs in which we include the effects of the spin-up of the accreting star induced by angular momentum accretion, rotationally induced chemical mixing and rotational energy dissipation. Initial masses of 0.6 $M_\odot$ and 0.8 $M_\odot$ and constant accretion rates of a few times 10-8 $M_\odot$/yr of helium-rich matter have been considered, which is typical for the sub-Chandrasekhar mass progenitor scenario for Type Ia supernovae. It is found that the helium envelope in an accreting white dwarf is heated efficiently by friction in the differentially rotating spun-up layers. As a result, helium ignites much earlier and under much less degenerate conditions compared to the corresponding non-rotating case. Consequently, a helium detonation may be avoided, which questions the sub-Chandrasekhar mass progenitor scenario for Type Ia supernovae. We discuss implications of our results for the evolution of helium star plus white dwarf binary systems as possible progenitors of recurrent helium novae.

Presupernova evolution of accreting white dwarfs with rotation
Yoon, S.-C.; Langer, N.
Astronomy and Astrophysics, v.419, p.623-644 (2004)

We discuss the effects of rotation on the evolution of accreting carbon-oxygen white dwarfs, with the emphasis on possible consequences in Type Ia supernova (SN Ia) progenitors. Starting with a slowly rotating white dwarf, we consider the accretion of matter and angular momentum from a quasi-Keplerian accretion disk. Numerical simulations with initial white dwarf masses of 0.8, 0.9 and 1.0 $M_\odot$ and accretion of carbon-oxygen rich matter at rates of $3 \ldots 10 \times 10^{-7} M_\odot$yr are performed. The models are evolved either up to a ratio of rotational to potential energy of T/W=0.18 - as angular momentum loss through gravitational wave radiation will become important for T/W < 0.18 - or to central carbon ignition. The role of the various rotationally induced hydrodynamic instabilities for the transport of angular momentum inside the white dwarf is investigated. We find that the dynamical shear instability is the most important one in the highly degenerate core, while Eddington-Sweet circulations, Goldreich-Schubert-Fricke instability and secular shear instability are most relevant in the non-degenerate envelope. Our results imply that accreting white dwarfs rotate differentially throughout, with a shear rate close to the threshold value for the onset of the dynamical shear instability. As the latter depends on the temperature of the white dwarf, the thermal evolution of the white dwarf core is found to be relevant for the angular momentum redistribution. As found previously, significant rotation is shown to lead to carbon ignition masses well above 1.4 $M_\odot$. Our models suggest a wide range of white dwarf explosion masses, which could be responsible for some aspects of the diversity observed in SNe Ia. We analyze the potential role of the bar-mode and the r-mode instability in rapidly rotating white dwarfs, which may impose angular momentum loss by gravitational wave radiation. We discuss the consequences of the resulting spin-down for the fate of the white dwarf, and the possibility to detect the emitted gravitational waves at frequencies of $0.1 \ldots 1.0$ Hz in nearby galaxies with LISA. Possible implications of fast and differentially rotating white dwarf cores for the flame propagation in exploding white dwarfs are also briefly discussed.

The Effects of Binary Evolution on the Dynamics of Core Collapse and Neutron Star Kicks
Podsiadlowski, Ph.; Langer, N.; Poelarends, A. J. T.; Rappaport, S.; Heger, A.; Pfahl, E.
The Astrophysical Journal, Volume 612, Issue 2, pp. 1044-1051.

We systematically examine how the presence in a binary affects the final core structure of a massive star and its consequences for the subsequent supernova explosion. Interactions with a companion star may change the

final rate of rotation, the size of the helium core, the strength of carbon burning, and the final iron core mass. Stars with initial masses larger than $\sim$ 11 M_{solar} that experience core collapse will generally have smaller iron cores at the point of explosion if they lost their envelopes through a binary interaction during or soon after core hydrogen burning. Stars below $\sim$ 11 M_{solar}, on the other hand, can end up with larger helium and metal cores if they have a close companion, since the second dredge-up phase that reduces the helium core mass dramatically in single stars does not occur once the hydrogen envelope is lost. We find that the initially more massive stars in binary systems with masses in the range 8-11 M_{solar} are likely to undergo an electron-capture supernova, while single stars in the same mass range would end as ONeMg white dwarfs. We suggest that the core collapse in an electron-capture supernova (and possibly in the case of relatively small iron cores) leads to a prompt or fast explosion rather than a very slow, delayed neutrino-driven explosion and that this naturally produces neutron stars with low-velocity kicks. This leads to a dichotomous distribution of neutron star kicks, as inferred previously, where neutron stars in relatively close binaries attain low kick velocities. We illustrate the consequences of such a dichotomous kick scenario using binary population synthesis simulations and discuss its implications. This scenario has also important consequences for the minimum initial mass of a massive star that becomes a neutron star. For single stars the critical mass may be as high as 10-12 M_{solar}, while for close binaries it may be as low as 6-8 $\sim$ 11 M_{solar}. These critical masses depend on the treatment of convection, the amount of convective overshooting, and the metallicity of the star, and will generally be lower for larger amounts of convective overshooting and lower metallicity.

Nucleosynthesis of s-elements in rotating AGB stars
Siess, L.; Goriely, S.; Langer, N.
Astronomy and Astrophysics, v.415, p.1089-1097 (2004)

We analyze the s-process nucleosynthesis in models of rotating AGB stars, using a complete nuclear network covering nuclei up to Polonium. During the stage of thermal pulses, the extreme shear field that develops at the base of the convective envelope leads to the injection of protons into the adjacent ^{12}C-rich core. Subsequent proton captures lead to overlapping ^{14}N-rich and ^{13}C-rich layers. While the ^{13}C nuclei release neutrons due to alpha- captures during the interpulse phase, the persistence of mixing due to differential rotation produces a contamination of the whole ^{13}C-rich layer with ^{14}N. The result is a quenching of the s-process efficiency. Our study emphasizes the sensitivity of the s-process nucleosynthesis to the strength and duration of the shear mixing phase. Uncertainties in the rate of ^{13}C(alpha,n) turn out to have small effects on the resultant distribution of s-elements. Finally, we show that in this framework, a deeper third dredge-up tends to further inhibit the production of s-elements.

Effects of rotation on the helium burning shell source in accreting white dwarfs
Yoon, S.-C.; Langer, N.; Scheithauer, S.
Astronomy and Astrophysics, v.425, p.217-228

We investigate the effects of rotation on the behavior of the helium-burning shell source in accreting carbon-oxygen white dwarfs, in the context of the single degenerate Chandrasekhar mass progenitor scenario for type Ia supernovae (SNe Ia). We model the evolution of helium-accreting white dwarfs of initially 1 $M_{\odot}$, assuming four different constant accretion rates (2, 3, 5 and 10×10^{-7} M$\odot$/yr). In a one-dimensional approximation, we compute the mass accretion and subsequent nuclear fusion of helium into carbon and oxygen, as well as angular momentum accretion, angular momentum transport inside the white dwarf, and rotationally induced chemical mixing. Our models show two major effects of rotation: a) The helium-burning nuclear shell source in the rotating models is much more stable than in corresponding non-rotating models - which increases the likelihood that accreting white dwarfs reach the stage of central carbon ignition. This effect is mainly due to rotationally induced mixing at the CO/He interface which widens the shell source, and due to the centrifugal force lowering the density and degeneracy at the shell source location. b) The C/O-ratio in the layers which experience helium shell burning - which may affect the energy of an SN Ia explosion - is strongly decreased by the rotationally induced mixing of alpha-particles into the carbon-rich layers. We discuss implications of our results for the evolution of SNe Ia progenitors.

On the stability of thermonuclear shell sources in stars
Yoon, S.-C.; Langer, N.; van der Sluys, M.
Astronomy and Astrophysics, v.425, p.207-216

We present a quantitative criterion for the thermal stability of thermonuclear shell sources. We find that the thermal stability of shell sources depends on exactly three factors: they are more stable when they are geometrically thicker, less degenerate and hotter. This confirms and unifies previously obtained results in terms of the geometry, temperature and density of the shell source, by a simplified but quantitative approach to the physics of shell nuclear burning. We present instability diagrams in the temperature-density plane for hydrogen and helium shell burning, which allow a simple evaluation of the stability conditions of such shell sources in stellar models. The performance of our stability criterion is demonstrated in various numerical models: in a 3 $M_{\odot}$ AGB star, in helium accreting CO white dwarfs, in a helium white dwarf which is covered by a thin hydrogen envelope, and in a 1.0 $M_{\odot}$ giant.

Deep dredge-up in intermediate-mass thermally pulsing asymptotic giant branch stars
Stancliffe, Richard J.; Tout, Christopher A.; Pols, Onno R.
Monthly Notices of the Royal Astronomical Society, Volume 352, Issue 3, pp. 984-992.

We present results of the evolution of asymptotic giant branch (AGB) stars of 3 and 5 M_{solar} with solar metallicity calculated with the Eggleton stellar evolution code (STARS), which has a fully implicit and simultaneous method for solving for the stellar structure, convective mixing and nuclear burning. We introduce the concept of a viscous mesh in order to improve the numerical stability of the calculations. For the 5 M_{solar} star, we evolve through 25 thermal pulses and their associated third dredge-up events. We obtain a maximum helium luminosity of 1.7 10^9 L_{solar} and significantly deep dredge-up after the second pulse. Strong hot-bottom burning is observed after the fifth pulse. The 3-M_{solar} model is evolved through 20 thermal pulse events, and we find third dredge-up after the seventh pulse. During the 14th pulse, sufficient carbon has been brought to the surface to produce a carbon star. We find that dredge-up and the transformation into a carbon star occur at significantly smaller core masses (0.584 and 0.608 M_{solar}, respectively) than in previous calculations for 3 M_{solar}.

A new synthetic model for asymptotic giant branch stars
Izzard, Robert G.; Tout, Christopher A.; Karakas, Amanda I.; Pols, Onno R.
Monthly Notices of the Royal Astronomical Society, Volume 350, Issue 2, pp. 407-426.

We present a synthetic model for thermally pulsing asymptotic giant branch (TPAGB) evolution constructed by fitting expressions to full evolutionary models in the metallicity range 0.0001 <= Z <= 0.02. Our model includes parametrizations of third dredge-up and hot-bottom burning with mass and metallicity. The Large Magellanic Cloud and Small Magellanic Cloud carbon star luminosity functions are used to calibrate third dredge-up. We calculate yields appropriate for galactic chemical evolution models for ^{1}H, ^{4}He, ^{12}C, ^{13}C, ^{14}N, ^{15}N, ^{16}O and ^{17}O. The initial-final mass relation is examined for our stars and found to fit to within 0.1 M_{solar} of the observations. We also reproduce well the white dwarf mass function for masses above about 0.58 M_{solar}. The new model is to be implemented in a rapid binary star evolution code.

Metallicity effects on open cluster dynamics
Hurley, Jarrod R.; Tout, Christopher A.; Aarseth, Sverre J.; Pols, Onno R.
Monthly Notices of the Royal Astronomical Society, Volume 355, Issue 4, pp. 1207-1216.

We take advantage of an N-body code that treats a range of metallicities to investigate the effect of metallicity on the internal dynamics of star clusters. Simulations of a set of large open clusters without primordial binaries are performed. We find that core collapse is postponed in low-metallicity star clusters, compared with Population I clusters, owing to the increased rate of mass loss through stellar evolution suffered at early times. However, earlier core collapse in high-metallicity clusters leads to an increase in the escape of stars from the cluster. We find that by remarkable cancellation of these two effects cluster dissolution times are little affected by changes in metallicity: high-metallicity clusters dissolve first but the difference is less than 10 per cent of the lifetime. We illustrate the behaviour of key structural properties of star clusters for models of different metallicity. We also look at the effect this has on the stellar populations of the clusters and the incidence of binary formation and exchange interactions. While the effect of metallicity on certain gross characteristics of a star cluster is found to be weak, we also find that in many respects metallicity is an important parameter in the evolution of a star cluster and should not be ignored.

Chapter 5

Solar Physics

Staff members: Rutten, R. J.; Bettonvil, F. C. M.; Hammerschlag, R. H.; Jägers, A. P. L.; Leenaarts, J.; Snik, F.; Sütterlin, P.; Tziotziou, K.; de Wijn, A. G.

5.1 Academic publications

The Dutch Open Telescope on La Palma
Rutten, R. J.; Bettonvil, F. C. M.; Hammerschlag, R. H.; Jägers, A. P. L.; Leenaarts, J.; Snik, F.; Sütterlin, P.; Tziotziou, K.; de Wijn, A. G.
Multi-Wavelength Investigations of Solar Activity, IAU Symposium, No. 223. Edited by Alexander V. Stepanov and Elena E. Benevolenskaya and Alexander G. Kosovichev Cambridge, UK: Cambridge University Press, 2004., p.597-604

The Dutch Open Telescope (DOT) on La Palma is an innovative solar telescope combining open telescope structure and an open support tower with a multi-wavelength imaging assembly and with synchronous speckle cameras to generate high-resolution movies which sample different layers of the solar atmosphere simultaneously and co-spatially at high resolution over long durations. The DOT test and development phase is nearly concluded. The installation of an advanced speckle processor enables full science utilization including "Open-DOT" time allocation to the international community. Co-pointing with spectropolarimeters at other Canary Island telescopes and with TRACE furnishes valuable Solar-B precursor capabilities.

DOT tomography of the solar atmosphere. II. Reversed granulation in Ca II H
Rutten, R. J.; de Wijn, A. G.; Sütterlin, P.
Astronomy and Astrophysics, v.416, p.333-340

High-quality simultaneous image sequences from the Dutch Open Telescope (DOT) in the G band and the Ca II H line are used to quantify the occurrence of reversed granulation as a constituent of the subsonic brightness pattern observed as a background to acoustic oscillations in the quiet-Sun internetwork atmosphere. In the middle photosphere reversed granulation constitutes a much larger part of this background than at the larger heights sampled by ultraviolet radiation. The anticorrelation with the underlying granulation reaches about 50% at a temporal delay of 2-3 min, and increases with spatial image smoothing to mesogranular resolution. We discuss the nature of reversed granulation in terms of convection reversal, gravity waves, acoustic waves, and intergranular magnetism, suggest that the internetwork background pattern is primarily a mixture of the first two ingredients, and speculate that it is also an inverse canopy mapper.

DOT tomography of the solar atmosphere. I. Telescope summary and program definition
Rutten, R. J.; Hammerschlag, R. H.; Bettonvil, F. C. M.; Sütterlin, P.; de Wijn, A. G.
Astronomy and Astrophysics, v.413, p.1183-1189

The Dutch Open Telescope (DOT) on La Palma is an innovative optical solar telescope capable of reaching 0.2 arcsec angular resolution over extended durations. The DOT presently progresses from technology testbed to a stable science configuration providing multi-wavelength imaging and multi-camera speckle data acquisition for tomographic mapping of the solar atmosphere. Large-volume speckle processing will soon enable frequent usage and community-wide time allocation, in particular for tandem operation with other solar telescopes pursuing spectropolarimetry and EUV imaging. We summarize the DOT hardware and software in the context of this increasing availability and outline the corresponding "open-DOT" program.

FIFIE - Fireball Filming Equipment: All sky imaging with video
Bettonvil, F.
Proceedings of the International Meteor Conference, Bollmannsruh, Germany, September 19-21, 2003, Eds.: Triglav-Cekada, M.,
Trayner, C., International Meteor Organization, p.8-12

This contribution revolves around the construction of a video camera equipped with a fisheye lens for the observation of fireballs. The described camera Fifie (Fireball Filming Equipment) will be installed in Utrecht, centrally located in the Netherlands, being able to witness any fireball sighting above the lowlands. It is a valuable support for visual fireball reports as it can provide accurate timing. Such a camera must be seen as an addition to photographic all-sky cameras because its lower spatial resolution cannot replace them. On the other hand, the effort to make such a camera operational is reduced to a

minimum. It has the potential to be used by a much larger group of meteor observers, improving the quality of a fireball network too.

bf GISOT: a giant solar telescope
Hammerschlag, Robert H.; von der Lühe, Oskar F.; Bettonvil, Felix C.; Jägers, Aswin P.; Snik, Frans
Proceedings of the SPIE, Volume 5489, pp. 491-506

A concept is presented for an extremely large high-resolution solar telescope with an aperture of 11 m and diffraction limited for visual wavelengths. The structure of GISOT will be transparent to wind and placed on a transparent stiff tower. For efficient wind flushing, all optics, including the primary mirror, will be located above the elevation axis. The aperture will be of the order of 11 m, not rotatively symmetrical, but of an elongated shape with dimensions 11 x 4 m. It consists of a central on-axis 4 m mirror with on both sides 3 pieces of 2 m mirrors. The optical layout will be kept simple to guarantee quality and minimize stray light. A Coud room for instruments is planned below the telescope. The telescope will not be housed in a dome-like construction, which interferes with the open principle. Instead the telescope will be protected by a foldable tent construction with a diameter of the order of 30 m, which doesn"t form any obstruction during observations, but can withstand the severe weather circumstances on mountain sites. Because of the nature of the solar scene, extremely high resolution in only one dimension is sufficient to solve many exciting problems in solar physics and in this respect the concept of GISOT is very promising.

DOT++: the Dutch Open Telescope with 1.4-m aperture
Bettonvil, Felix C.; Hammerschlag, Robert H.; Sütterlin, Peter; Rutten, Robert J.; Jägers, Aswin P.; Snik, Frans
Proceedings of the SPIE, Volume 5489, pp. 362-373

The Dutch Open Telescope (DOT; http://dot.astro.uu.nl) on La Palma is a revolutionary open solar telescope, on an excellent site, on top of a transparent steel tower, and uses natural air flow to minimize local seeing. The aim is long-duration high-resolution imaging with a multi-wavelength camera system. In order to achieve this, the DOT is equipped with a diffraction limited imaging system and uses the speckle reconstruction technique for removing the remaining atmospheric turbulence. The DOT optical system is simple and consists currently of a 0.45m/F4.44 parabolic mirror and a 10x enlargement lens system. We present our plans to increase the aperture of the DOT from 0.45m to 1.4m. The mirror support and telescope top shall be redesigned, but telescope, tower, multi-wavelength camera system and speckle system remain intact. The new optical design permits user selectable choice between angular resolution and field size, as well as transversal pupil shift introducing the possibility to use obstruction free apertures

up to 65cm. The design will include a low order AO system, which improves the speckle S/N substantially during moderate seeing conditions.

Asymmetrical appearance of dark-cored filaments in sunspot penumbrae

Sütterlin, P.; Bellot Rubio, L. R.; Schlichenmaier, R.

Astronomy and Astrophysics, v.424, p.1049-1053

Recent sunspot observations at unprecedented resolution have led to the discovery of dark cores in the bright filaments that form the penumbra. The discovery paper considered spots at disk center only, so the properties of the dark-cored filaments remain largely unknown. Here we analyze a speckle-reconstructed time series of G-band and blue continuum images of a sunspot acquired with the Dutch Open Telescope. The target was located at an heliocentric angle of 27 deg. We confirm the existence of dark-cored penumbral filaments also in spots outside the disk center, and report on distinct differences between the center and limb-side penumbra. In the inner center-side penumbra, filaments are detected as two narrow bright streaks separated by a central obscuration. These structures move together as a single entity. On the limb side, dark cores are hardly seen. The time series is used to determine the sizes ($\sim$200-250 km), proper motions ($\sim$280 m s^{-1}), and lifetimes (lap 45 min) of typical dark-cored filaments.

Chapter 6

High-energy Astrophysics

Staff members: Prof.dr F. Verbunt, drs. M. Fenovcik, drs. N. Werner, drs. A.G.J. van Leeuwen, drs. C.G. Bassa, E. Bauwens

6.1 Academic publications

Long-term variability in the X-ray emission of RX J0720.4-3125
de Vries, C. P.; Vink, J.; Méndez, M.; Verbunt, F.
Astronomy and Astrophysics, v.415, p.L31-L34 (2004)

We detect a gradual, long-term change in the shape of the X-ray spectrum of the isolated neutron star RX J0720.4-3125, such that the spectrum of the source can no longer be described as a blackbody spectrum. The change is accompanied by an energy-dependent change in the pulse profile. If the X-ray emission is influenced by the magnetic field of the pulsar, these changes in spectral shape may point to precession of the neutron star.

Magnetic Field Decay, or Just Period-Dependent Beaming?
van Leeuwen, J.; Verbunt, F.
Young Neutron Stars and Their Environments, IAU Symposium no. 218, held as part of the IAU General Assembly, 14-17 July, 2003 in Sydney, Australia. Edited by Fernando Camilo and Bryan M. Gaensler, San Francisco, CA: Astronomical Society of the Pacific, 2004., p.41

Several recent papers conclude that radio-pulsar magnetic fields decay on a time-scale of 10 Myr, apparently contradicting earlier results. We have implemented the methods of these papers in our code and show that this preference for rapid field decay is caused by the assumption that the beaming fraction does not depend on the period. When we do include this dependence, we find that the observed pulsar properties are reproduced best when the modeled field does not decay. When we assume that magnetic fields of new-born neutron stars are from a distribution sufficiently wide to explain

magnetars, the magnetic field and period distributions we predict for radio are pulsars wider than observed. Finally we find that the observed velocities overestimate the intrinsic velocity distribution.

The Continued Spectral Evolution of the Neutron Star RX J0720.4-3125

Vink, Jacco; de Vries, Cor P.; Méndez, Mariano; Verbunt, Frank
The Astrophysical Journal, Volume 609, Issue 2, pp. L75-L78.

We observed the isolated neutron star RX J0720.4-3125 with Chandra's Low Energy Transmission Grating Spectrometer, following the XMM-Newton discovery of the long-term spectral evolution of this source. The new observation shows that the spectrum of RX J0720.4-3125 has continued to change in the course of 5 months. It has remained hard, similar to the last XMM-Newton observation, but the strong depression observed with XMM-Newton at long wavelengths has disappeared. Contrary to the XMM-Newton observations, the new Chandra observation shows that the flux increase at short wavelength and the decrease at long wavelength do not necessarily occur simultaneously.

X-Ray Sources and Their Optical Counterparts in the Globular Cluster M4

Bassa, Cees; Pooley, David; Homer, Lee; Verbunt, Frank; Gaensler, Bryan M.; Lewin, Walter H. G.; Anderson, Scott F.; Margon, Bruce; Kaspi, Victoria M.; van der Klis, Michiel
The Astrophysical Journal, Volume 609, Issue 2, pp. 755-765.

We report on the Chandra X-Ray Observatory ACIS-S3 imaging observation of the Galactic globular cluster M4 (NGC 6121). We detect 12 X-ray sources inside the core and 19 more within the cluster half-mass radius. The limiting luminosity of this observation is LX$\sim 10^{29}$ ergs s$-$1 for sources associated with the cluster, the deepest X-ray observation of a globular cluster to date. We identify six X-ray sources with known objects and use ROSAT observations to show that the brightest X-ray source is variable. Archival data from the Hubble Space Telescope allow us to identify optical counterparts to 16 X-ray sources. Based on the X-ray and optical properties of the identifications and the information from the literature, we classify two (possibly three) sources as cataclysmic variables, one X-ray source as a millisecond pulsar, and 12 sources as chromospherically active binaries. Comparison of M4 with 47 Tuc and NGC 6397 suggests a scaling of the number of active binaries in these clusters with the cluster (core) mass.

Celestial position of the companion of PSR J1740-5340

Bassa, C. G.; Stappers, B. W.
Astronomy and Astrophysics, v.425, p.1143-1145

We present optical astrometry of archival ground and space based imaging of the companion to PSR J1740-5340. The optical position of the companion is significantly offset from the timing position of the pulsar. We briefly investigate the effects of this inconsistency on other timing parameters and compare our position with an improved position of PSR J1740-5340 from recent, preliminary, timing results.

Green Bank Telescope Discovery of Two Binary Millisecond Pulsars in the Globular Cluster M30
Ransom, Scott M.; Stairs, Ingrid H.; Backer, Donald C.; Greenhill, Lincoln J.; Bassa, Cees G.; Hessels, Jason W. T.; Kaspi, Victoria M.
The Astrophysical Journal, Volume 604, Issue 1, pp. 328-338.

We report the discovery of two binary millisecond pulsars in the core-collapsed globular cluster M30 using the Green Bank Telescope (GBT) at 20 cm. PSR J2140-2310A (M30A) is an eclipsing 11 ms pulsar in a 4 hr circular orbit, and PSR J2140-23B (M30B) is a 13 ms pulsar in an as yet undetermined but most likely highly eccentric (e>0.5) and relativistic orbit. Timing observations of M30A with a 20 month baseline have provided precise determinations of the pulsar's position (within 4" of the optical centroid of the cluster) and spin and orbital parameters, which constrain the mass of the companion star to be $m^2 \gtrsim 1\ M_{solar}$. The position of M30A is coincident with a possible thermal X-ray point source found in archival Chandra data, which is most likely caused by emission from hot polar caps on the neutron star. In addition, there is a faint (V555$\sim$23.8) star visible in archival Hubble Space Telescope (HST) F555W data that may be the companion to the pulsar. Eclipses of the pulsed radio emission from M30A by the ionized wind from the compact companion star show a frequency-dependent duration ($\sim \nu - \alpha$ with $\alpha \sim 0.4$-0.5) and delay the pulse arrival times near eclipse ingress and egress by up to 2-3 ms. Future observations of M30 may allow both the measurement of post-Keplerian orbital parameters from M30B and the detection of new pulsars through the effects of strong diffractive scintillation.

X-ray/UV campaign on the Mrk 279 outflow: Density diagnostics in Active Galactic Nuclei using O V K-shell absorption lines
Kaastra, J. S.; Raassen, A. J. J.; Mewe, R.; Arav, N.; Behar, E.; Costantini, E.; Gabel, J. R.; Kriss, G. A.; Proga, D.; Sako, M.; Steenbrugge, K. C.
Astronomy and Astrophysics, v.428, p.57-66 (2004)

One of the main problems in modeling the ionised outflows in Active Galactic Nuclei is the unknown distance of the outflowing wind to the central source. Only if the density is known this distance can be determined through the ionisation parameter. Here we study density diagnostics based upon O V transitions. O V is known to have metastable levels that are density dependent. We study the population of those levels under photoionisation

equilibrium conditions and determine for which parameter range they can have a significant population. We find that resonance line trapping plays an important role in reducing the critical densities above which the metastable population becomes important. We investigate the K-shell absorption lines from these metastable levels. Provided that there is a sufficient population of the metastable levels, the corresponding K-shell absorption lines are detectable and are well separated from the main absorption line originating from the ground state. We then present the Chandra LETGS spectrum of the Seyfert 1 galaxy Mrk 279 that may show for the first time the presence of these metastable level absorption lines. A firm identification is not yet possible due to both uncertainties in the observed wavelength of the strongest line as well as uncertainties in the predicted wavelength. If the line is indeed due to absorption from O V, then we deduce a distance to the central source of one light week to a few light months, depending upon the importance of additional heating processes.

The Anomalous X-ray Pulsar 4U 0142+61: Variability in the infrared and a spectral break in the optical
Hulleman, F.; van Kerkwijk, M. H.; Kulkarni, S. R.
Astronomy and Astrophysics, v.416, p.1037-1045

We present new optical and infrared observations of the counterpart to the Anomalous X-ray Pulsar (AXP) 4U 0142+61 taken with the Keck I telescope. The counterpart is found to be variable in the infrared. This contrasts with our optical observations, which do not show any evidence for variability. Apart from the variability the AXP shows a remarkable spectral energy distribution. In particular, we find a sudden drop in flux going from V to B, presumably due to a spectral feature. We compare our results to those obtained for the two other securely identified AXP counterparts, to 1E 2259+586 and 1E 1048.1-5937. 4U 0142+61 is very similar to the former source in its X-ray timing and spectral properties, and we find that this similarity extends to the quiescent infrared to X-ray flux ratio. For 1E 1048.1-5937, which has different X-ray properties, the situation is less clear: in one observation, the infrared to X-ray flux ratio was much larger, but another observation gave an upper limit which is consistent with that observed for 4U 0142+61. Assuming the quiescent ratios are all similar, we estimate the optical and infrared brightnesses for the three AXPs that remain to be identified as well as for the four Soft Gamma-ray Repeaters. We also discuss briefly how the observed optical and infrared emission might arise, in particular in the context of the magnetar model. Table 3 is only available in electronic form at the CDS via anonymous ftp to cdsarc.u-strasbg.fr (130.79.128.5) or via http://cdsweb.u-strasbg.fr/cgi-bin/qcat?J/A+A/416/1037

Chapter 7

Academic Reputation

Achterberg

- CHEAF Board

Bettonvil

- Member Site Properties Sub committee (SUCOSIP) of the Oberservatorio del Roque de los Muchachos on La Palma and the Observatorio del Teide on Tenerife

Bleeker

- NLR-NIVR member Sub committee Space Technique, Scientific Committee NLR-NIVR
- member Netherlands Committee on Astronomy NCA
- co-chairman Science Steering Committee, Italian-Dutch X-ray Satellite (SAX)
- member IAU Commission 44 on Space and High Energy Astrophysics
- COSPAR Associate, Scientific Commission E on Research in Astrophysics from Space
- Member Programme Executive Committee, Italian-Dutch X-ray satellite (SAX)
- Member European Low Gravity Research Association (ELGRA)
- Member Koninklijke Nederlandse Akademie van Wetenschappen
- Member Academia Europea
- Member Hollandsche Maatschappij der Wetenschappen
- Co-chairman XMM-Science Working Team (ESA-mission scientist)

- Member Selection committee International Space University (ISU)
- Member Editorial Board Space Science Reviews
- Advisor Netherlands Industrial Space Organisation (NISO)
- Member European Astronomical Society (EAS)
- Board member Foundation for Experimental and Technical Physics
- Advisory member board Netherlands Research school for Astronomy (NOVA)
- Dutch delegate Science Programme Committee (SPC) of the European Space Agency (ESA)
- Member Board of Trustees, Basic Sciences, International Academy of Astronautics (IAA)
- Advisory member Interdepartmental Commission for Space (ICR)
- Member advisory board Foundation SPACE
- Member scientific advisory commission Anton Pannekoek of the University of Amsterdam
- Member advisory board of the NIVR
- Member board of Physics and Astronomy of the KNAW
- Member XEUS Science Advisory Group
- Member Scientific Organizing Committee "High Energy Astrophysics Symposium" for the 32nd COSPAR assembly
- Chair European Space Physical Sciences Panel ESSC/ESF
- Member ad hoc panel "New initiatives for large-scale collaborative space missions", ESSC/ESF

Goedbloed

- Board of NCF (National Computing Facilities Foundation)
- Program Committee Computational Science NWO

Hammerschlag

- Member Operations Sub-Committee (OSC) of the Observatorio del Roque de los Muchachos on La Palma

Lamers

- Netherlands Foundation for Radio Astronomy (NFRA/ASTRON), board member

- Leidsch-Kerkhoven Bosscha Fonds, member Board of Directors
- Leidse Sterrenwacht Foundation, member Board of Directors
- Jan Hendrik Oort Foundation , member Board of Directors
- Kapteyn Foundation, board member
- Pastoor Schmeitz Foundation, board member
- Olga Koning Foundation, director
- Minnaert Committee for Popularization of Astronomy, member
- Mentor for PhD students of the Faculty of Physics and Astronomy

Langer

- Advisory committee of Astronomy of the Gebiedsbestuur Exacte Wetenschappen of NWO
- Lorentz Center Advisory Board
- Advisor Deutsche Forschungsgemeinschaft
- Advisor Australian Research Council
- NOVA board
- ASTRON "contact raad"
- Editor Astronomy & Astrophysics
- Advisor Swedisch Research Council

Pols

- Time allocation Committee of the Netherlands Foundation for Research in Astronomy (NFRA)

Rutten

- Professor II, Institute of Theoretical Astrophysics, Oslo University
- Member NOVA Instrument Steering Committee
- Member National Astronomy Education Committee

Verbunt
none

Chapter 8

Guests

Dieter Nickeler, PhD student of Prof. J.P. Goedbloed
dr. Raphael Hirschi
Prof. Walter van Rensbergen
dr. Goetz Graefener
dr. Linda Smith
dr. Antonella Nota
Simon Campbell
dr. Christoph Keller

Chapter 9

Colloquia

January 14	Mass loss from red giants in globular clusters	Jacco van Loon, Keele, UK
February 4	Jet/Disc coupling through a common energy reservoir in the black XTEJ1118+480	Julien Malzac, Cambridge, UK
March 3	High-mass eclipsing binaries in Local Group galaxies	Ron Hilditch, St. Andrews, Scotland
March 24	Magnetic field configurations above solar active regions	Stephane Regnier, ESTEC
April 21	The production of the Na, Mg, and Al isotopes inside AGB stars	Amanda Karakas, Halifax, Canada
April 23	The Spitzer Space Telescope at 8 months on orbit	Patrick Morris, Caltech, USA
May 6	Modelling the small-scale structure of the solar atmosphere	Sven Wedemayer, Freiburg, Germany
May 12	Rotating massive single stars: from the ZAMS to the SN explosion	Raphael Hirschi, Geneve, Switzerland
June 1	Can the viscosity in accretion disks be of hydrodynamic origin?	Giora Shaviv, Haifa, Israel
June 9	Probing the solar wind with cometary X-ray emission	Dennis Bodewits, Groningen, The Netherlands
June 11	Ultraluminous X-ray sources in nearby galaxies	Daniel Wang, Massachusetts, Amherst, USA
June 16	Extrasolar Planets	Norm Murray, Toronto, Canada
June 23	Explanation of recent Swedish Solar Telescope discoveries with numerical MHD simulations	Christoph Keller, Tucson, USA
June 30	Super star culsters and star burst galaxies	Linda Smith, London, UK
July 28	New candidates for dust-forming hot stars	Anatoly Miroshnichenko, Bonn, Germany

October 20	Did the VOYAGER spacecraft cross the solar wind termination shock?	Hans Fahr, Bonn, Germany
November 3	Galactic Disks	Ken Freeman, Stromlo Obs
November 10	Self-consistent models for Wolf-Rayet winds	Goetz Graefener, Potsdam, Germany
November 17	Probing the intergalactic medium with the Lyman-alpha forest	Saleem Zaroubi, Groningen, The Netherlands
November 24	On the zoo of the flux variability in the emission of anomalous X-ray pulsars and soft-gamma ray repeaters: is there a single common physical process?	Nanda Rea, Rome, Italy
December 1	The circumstellar geometries of young stars as a function of mass	Jorick Vink, London, United Kingdom
December 8	Triangulating Radiation: A new approach to radiative transfer	Jelle Ritzerveld, Leiden, The Netherlands
December 15	Molecular views of planet-forming disks	Michiel Hogerheijde, Leiden, The Netherlands

Colloquia are held every Wednesday at 15:30h at either the Sterrekundig Instituut Utrecht, Minnaertzaal, Buijs Ballotlaboratorium, Princetonplein 5, 3584 CC Utrecht or the SRON: Stichting RuimteOnderzoek Nederland, Conferentiezaal Sorbonnelaan 2, 3584 CA Utrecht
E-mail: Mariano Mendez, M.Mendez@sron.nl (SRON)
Onno Pols, O.R.Pols@astro.uu.nl (SIU)
http://www.astro.uu.nl/colloq

Chapter 10

People of the Institute

10.1 Department members

Professors

Full professors:	A. Achterberg, H.J.G.L.M. Lamers, N. Langer, F. Verbunt	
Associate professors:	R.J. Rutten (full professor in Oslo)	
Assistant professors:	R.H. Hammerschlag, O.R. Pols	
Part-time professor	prof.dr.ir. J.A.M. Bleeker (0.2)	1 Sept 96 - 1 Sept 06
Adjunct professor:	prof.dr.ir. J.P. Goedbloed (0.1)	1 Sept 94 - 1 Sept 05

Postdocs

dr. J. Bergmans	(UU)	Verbunt	18 Feb 01 18 Aug 04
Ms.dr. E. Costantini	(SRON, UU)	Verbunt	1 Mar 04 1 Mar 06
dr. D. Khechinashvili	UU	(Achterberg)	1 Oct 03 1 Oct 04
Mrs.dr. M. Kraus	(German Soc., NOVA)	Lamers	1 Oct 01 1 Oct 05
dr. J. Petri	(FOM)	Langer	15 Oct 02 15 Oct 04
dr. P. Sütterlin	(ASTRON)	Rutten	1 May 04 - 1 May 07
dr. K. Tziotziou	(EC RTN)	Rutten	1 Mar 03 1 Sep 05

PhD students

Name	Funding	Supervisor	Period
drs. C. Bassa	NWO	Verbunt	1 Jan 03 1 Jan 07
drs. N. Bastian	NOVA	Lamers	1 Mar 01 1 Mar 05
drs. A. Bonacic Marinovic	Fac.	Pols/Langer	1 Oct 03 1 Oct 07
drs. M. Fenovcik	SRON	Verbunt	2 Jun 04 1 Jun 08
drs. C. Ferrigno	SRON	Bleeker	15 Jan 00 15 Jan 04
Ms.drs. P.K. Fung	SIU	Kuijpers	1 Jun 00 1 Jun 04
drs. M. Gieles	NOVA/UU	Lamers	1 Nov 02 1 Nov 06
drs. E. Glebbeek	NWO	Pols/Langer	1 Jun 04 1 Jun 08
drs. J. Leenaarts	Fac.	Rutten	15 Sep 03 15 Sep 07
drs. A.G.J. van Leeuwen	NWO	Verbunt	1 Jan 99 1 May 2004
drs. A.J. van Marle	NWO	Langer	1 May 02 1 May 06
Mrs. drs. J. Petrovic	Fac.	Langer	1 Nov 00 1 Nov 04
drs. A.J.T. Poelarends	NWO	Langer	1 Jan 03 1 Jan 07
drs. M. van der Sluys	NOVA	Verbunt	1 Oct 01 1 Oct 05
drs. S.Ch.Yoon	UU	Langer	15 Dec 00 15 Dec 04
drs. N. Werner	SRON NWO	Verbunt	2 Jun 04 1 Jun 08
drs. J. Wiersma	NOVA	Achterberg	1 Feb 01 1 Feb 06
drs. A.G. de Wijn	SIU	Rutten	1 Nov 02 1 Nov 06

Technical staff

ir. F.C.M. Bettonvil	ASTRON	Rutten	1 Sep 92 1 Oct 07

10.2 Undergraduate students

Name and supervisor
Maarten van Beek, Verbunt
Thom Janssen, Verbunt
Mabula Haverkamp, Rutten
Bart van der Hoek, Achterberg
Rudy Knaap, Langer
Frans van der Lek, Lamers
Teffie Schneider, Achterberg
Lukas van der Wiel, Lamers

ongoing in 2004
Name and supervisor
Alexander Doxiadis, Achterberg
Martijn Duvoort, Achterberg
Marcel Haas, Lamers
Adam Hosford, Rutten
Selma de Mink, Pols

Dagmar de Rooij, Langer
Lucien Staarink, Achterberg
Rob Detmers, Langer
Maarten Suijs, Langer
Ilaan Stein, Lamers

Chapter 11

Guests

Dieter Nickeler, PhD student of Prof. J.P. Goedbloed
dr. Raphael Hirschi
Prof. Walter van Rensbergen
dr. Goetz Graefener
dr. Linda Smith
dr. Antonella Nota
Simon Campbell
dr. Christoph Keller

Chapter 12

Dissertations

02-02-2004 Kurt J.van der Heyden
promotor: prof.dr J.A.M. Bleeker co-promotor: dr. J.S. Kaastra
High-resolution X-ray spectral diagnostics of shell type Supernova Remnants

22-04-2004 Sung-Chul Yoon
promotor: prof.dr N. Langer
On the evolution of accreting white dwarfs in binary systems

10-05-2004 A.G.J. van Leeuwen
promotor: Prof.dr. F. Verbunt
Radio pulsars

27-10-2004 J. Petrovic
promotor: Prof. N. Langer
On the evolution of massive close binary systems

01-03-2004 W.M. Bergmann Tiest
promotor: prof.dr J.A.M. Bleeker
co-promotor: dr. H.F.C. Hoevers
Energy Resolving Power of Transition-Edge X-ray Microcalorimeters

Chapter 13

Full list of publications

13.1 Refereed

Aerts, C., H.J.G.L.M. Lamers, G. Molenberghs, Maximum mass-loss rates of line-driven winds of massive stars: The effect of rotation and an application to eta Carinae, Astron. Astrophys., 418, 639.

Bassa, C.G., D. Pooley, L. Homer, F. Verbunt, B.M. Gaensler, W.H.G. Lewin, S.F. Anderson, B. Margon, V.M. Kaspi, M. van der Klis, X-Ray Sources and Their Optical Counterparts in the Globular Cluster M4, Astrophysical Journal 609, p.755-765.

Bassa, C.G., B.W. Stappers, Celestial position of the companion of PSR J1740-5340, Astron. Astrophys. 425, p.1143-1145.

Bettonvil, F.C., R.H. Hammerschlag, P. Sütterlin, R.J. Rutten, A.P. Jägers, F. Snik, DOT++: the Dutch Open Telescope with 1.4-m aperture, SPIE 5489, 362.

Cassatella A., H.J.G.L.M. Lamers, C. Rossi, A. Altamore, R. Gonzlez-Riestra, A study of the expanding envelope of Nova V1974 Cyg 1992 based on IUE high resolution spectroscopy, Astron. Astrophys. 420, 571.

De Vries, C.P., J. Vink, M. Méndez, F. Verbunt, Long-term variability in the X-ray emission of RXJ0720.4-3125, Astronomy & Astrophysics 418, L31-34.

Fung, P.K., J. Kuijpers, A free-electron laser in the pulsar magnetosphere, Astron. Astrophys. 422, 817.

Goedbloed, J.P., A.J.C. Beliën, B. van der Holst, and R. Keppens, Unstable continuous spectra of transonic axisymmetric plasmas, Phys. Plasmas 11, 28–54.

Goedbloed, J.P., S. Poedts, Principles of Magnetohydrodynamics, with Applications to Laboratory and Astrophysical Plasmas, Cambridge University Press, Cambridge.
; ISBN 0521 62347 (PB), 2 0521 62607 2 (HB).

Goedbloed, J.P., A.J.C. Beliën, B. van der Holst, and R. Keppens, No additional flow continua in magnetohydrodynamics, Phys. Plasmas 11, 4332–4340.

Goedbloed, J.P., Variational principles for stationary one- and two-fluid equilibria of axisymmetric laboratory and astrophysical plasmas, Phys. Plasmas, 11, L81–L84.

Goedbloed, J.P., Transonic instabilities in laboratory and astrophysical plasmas, in Complex Plasmas in the New Millennium, International Topical Conference on Plasma Physics, Santorini, 8–12 September 2003, ed. Lennart Stenflo; Physica Scripta T107, 159–162.

Goedbloed, J.P., A.J.C. Beliën, B. van der Holst, and R. Keppens, Transonic instabilities in laboratory and astrophysical plasmas, in Plasmas in the Laboratory and in the Universe, ed. G. Bertin, D. Farina, R. Pozzoli, Symposium Como, 16–19 September 2003, AIP Conference Proceedings, Vol. 703 (Melville, New York.

Hammerschlag, R.H., O. von der Lühe, F.C.M. Bettonvil, A.P.L. Jägers, F. Snik.
GISOT: A giant solar telescope, SPIE 5489, 491.

Hurley, J.R., C.A. Tout, S.J. Aarseth, O.R. Pols, Metallicity effects on open cluster dynamics, MNRAS 355, 1207.

Izzard, R.G., C.A. Tout, A.I. Karakas, O.R. Pols, A new synthetic model for asymptotic giant branch stars, MNRAS 350, 407.

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