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A 01

Towards a Consistent Theory of Star Formation

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Understanding the processes which lead to the formation of stars is one of the fundamental challenges in astronomy. Stars form at random locations and at random times by gravitational collapse of shock generated density fluctuations in turbulent molecular clouds. Stars furthermore form in groups or aggregates, hence the interaction of protostellar cores and their competition for mass accretion are important factors determining (proto)stellar properties.

We present the first study that *consistenly* includes *all* phases of the star formation process, the formation of protostellar cores via turbulent fragmentation in a dynamic molecular cloud environment (treated in a 3D simulation) and the subsequent collapse of gravitationally unstable fragments (followed in detail with a 1D radiation-hydrodynamic code) until they reach the central hydrogen burning phase.

A 02

Physical Properties of Protostars

Markus Nielbock, Rolf Chini (Astronomisches Institut der Ruhr-Universität Bochum, Universitätsstraße 150/NA 7, D-44801 Bochum)

Based on millimetre and submillimetre observations we present physical properties like luminosities, dust temperatures, gas and dust masses as well as H_2 column densities of millimetre sources (MMS) associated with Herbig-Haro-Objects (HHs). Typical values are e.g. $T = 20$ K and $n(H_2) = 10^{25\pm1}$ cm^{-2}. Judging from this, most of the MMS, which are now commonly thought to be the driving sources of these spectacular bipolar outflow phenomena, can be addressed as genuine protostars of Class 0. Following current models, their age range from some 10^6 down to less than 10^4 years.

It seems that molecular outflows are a common feature related to star formation and, furthermore, are already present at early stages of the evolution. The existence of multiple outflows associated with one MMS is commonly explained as a result of systems of close unresolved protostars, each of them being responsible for a HH. The fact that multiple outflows related to only one MMS have been detected fairly often, leads to the conclusion that multiple star formation might be generic.

A 03

Unbiased Surveys for Jets and Protostars in Orion A

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The presence of outflows, often in the form of well-collimated jets, is a phenomenon commonly associated with the birth of young stars. Emission from shock-excited molecular hydrogen at near-infrared wavelengths is one of the signposts of the presence of such an outflow, and generally can be observed even if the flow is obscured at optical wavelengths. We present the results of an unbiased, sensitive, wide-field search for flows from protostellar objects in the H_2 v=1–0 S(1) line at a wavelength of 2.12 μm, covering a 1 square degree area of the Orion A giant molecular cloud. Further data covering a wide wavelength range (most notably an unbiased 1.3 mm dust continuum survey) are used to search for the driving sources of the flows. The aim of this work is to obtain a sample of outflows and protostars which is free from biases as far as possible, to derive the typical properties of the outflows, to search for evolutionary trends and to find their cause in the evolution of the jet-driving protostellar systems, and to examine the impact of outflows on the ambient cloud. The data are in support of time-variable protostellar accretion rates, and it is found that jets might indeed have a significant impact on the cloud dynamics.

A 04

Revealing the Full (0.1 – 20 $M_\odot$) Initial Mass Function of the Upper Scorpius OB Association

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The low-mass IMF of OB associations is still very poorly known, because their low-mass pre-main sequence (PMS) members of spectral type K and M are very difficult to find due to the contamination by main sequence field stars and because the ROSAT All-Sky Survey was too shallow to detect them as young X-ray sources. We attempt a new approach to this problem and try to reveal the population of low-mass members of the Upper Scorpius OB association by means of large-scale multi-object optical spectroscopy. Upper Sco is a very young ($\sim$ 5 Myr old) and nearby (D = 145 pc) association that probably was created in a supernova-triggered mini starburst (Preibisch & Zinnecker 1999, AJ 117,2381). The population of high- and intermediate-mass members is completely known from detailed Hipparcos studies. The unique capabilities of the multi-object spectrograph 2dF at the Anglo Australian Telescope now allowed us to perform the first completely unbiased spectroscopic search for low-mass PMS in an OB association involving a statistically significant number of stars. We have obtained spectra for more than 500 stars in Upper Sco and could identify more than 80 new low-mass PMS star, most of them M-type stars. By placing these stars into the HR diagram, we can determine the full (0.1 – 20 $M_\odot$) IMF in an OB association for the first time. Initial results show that there is no deficit of low-mass stars.

A 05

Periodic Variability of Very Low Mass stars and Brown Dwarfs

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Rotation of late-type stars can be determined by measuring their rotation periods from periodic photometric variability. Rotation periods for solar-type stars down to about 0.3 $M_\odot$ have been published by many groups, but there are only three objects with measured rotation periods in the mass range below 0.3 $M_\odot$. Therefore, we have undertaken a systematic search for periodic photometric variability in VLM stars and Brown Dwarfs. From a RZIJ survey of the young open cluster IC4665 we obtained about 400 low mass candidates up to now; for about 300 of them we have spectra to confirm them as cluster members.

A time series was taken in a field with about 200 candidates. In this sample we searched for periodic variability on a timescale from 30 minutes up to about 35 hours. We found 20 candidates which show sign for such variability, seven of them are probably Brown Dwarfs.

The amplitudes of the found periods are comparable with the results of similar studies of solar-type stars, but in contrast to such studies we found no slow rotators with periods longer than one day. It is possible, that the origin of the found variability is different for stars and for Brown Dwarfs.

A 06

Surface Features and Variability of L Dwarfs and Brown Dwarfs

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The upper atmospheres of very cool (L and T) dwarfs show increasing chemical complexity as the temperature is decreased. In particular, below about 2000 K solid particles (dust) will form. Evidence for this via atmospheric modelling has already been seen in a number of optical and infrared spectra of L and late M dwarfs. However, the spatial distribution of this dust is not currently known. One possibility is that it agglomerates into opaque "clouds". Large scale cloud patterns could cause a modulation of the flux on the rotation period of the object. On the other hand, very small clouds would not give a detectable modulation, and time resolved flux measurement can place limits on the size and filling fraction of such clouds. Magnetically induced star spots could also produce a flux modulation as the star rotates, and distinguishing between these alternatives is a challenge. In either case, the pattern of the modulation can provide information about the distribution and possibly the evolution of surface features.

To address these questions, we have undertaken a program to photometrically monitor a number of M and L dwarfs, both in the field (from the 2MASS and SDSS surveys) and in the Pleiades and Sigma Orionis open clusters. Observations have so far been carried out in the I band for 21 targets, down to a sensitivity limit of 0.005 magnitudes on time scales of between 20 minutes and a few days. This is a continuation of the work of Bailer-Jones & Mundt (A&A 348, 800, 1999) which included the first detection of variability in an L dwarf.

A 07

Intermittent Distribution of Dust in Brown Dwarf Atmospheres

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The occurrence of turbulent motion influences the local thermodynamical situation in various astrophysical systems, for example in the atmospheres of Brown Dwarfs which are characterized by large Reynolds numbers. These objects also provide excellent conditions for dust formation which depends sensitively on the local temperature and density which result from a complex, non-linearly coupled interaction among chemistry, dust formation, hydrodynamics, thermodynamics, and radiative transfer.

The present study is based on a hypothesis regarding the role of turbulence in dust formation in generating strongly inhomogeneous dust distributions: Colliding turbulent gas elements produce shock waves with associated temperature, pressure and density increases. Detailed multi-dimensional simulations of compressible turbulence including elaborate dust formation kinetics show local increases of density in e.g. the colliding zones where conditions for dust growth are considerably improved. The resulting size of the core-mantle dust particles is rather small since nucleation is very efficient. Furthermore, fast adiabatic cooling as result of expansion waves provide temperatures low enough to form dust in regions of usually unfavorable conditions. Also spots of high temperature appear where dust formation is inhibited as result of colliding shock waves.

A 08

Cosmogony for Planet Searches

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Their expected luminosities make young giant planets favorable for the first direct detection of an extrasolar planet. The giant planet formation process is relatively slow with expected formation times ranging from comparable to the star formation timescale up to the nebula lifetime, depending on the formation theory. Therefore quantitative models of giant planet formation and star formation are needed to determine the properties of young giant planets orbiting young stars. I discuss sample faint companions in the TW Hydrae association.

A 09

Direct Imaging Search for Sub-stellar Companions Next to Young Nearby Stars

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We report first results from our ground-based infrared imaging search for sub-stellar companions (brown dwarfs and giant planets) of young (up to 100 Myrs) nearby (up to 75 pc) stars, where companions should be well separated from the central stars and still relatively bright due to ongoing accretion and/or contraction. Among our targets are all members of the TW Hya, MBM 12, and Tucanae associations, as well as other binary and single young stars either discovered recently among ROSAT sources (some of which as yet unpublished) or known before. Our observations are performed mainly with SOFI and SHARP at the ESO 3.5m NTT on La Silla and with ISAAC at the ESO 8.2m Antu (VLT-UT1) on Cerro Paranal, as well as with the ALFA adaptive optics facility on the Calar Alto 3.5m, all in the H- and K-bands. We present direct imaging data and H-band spectra of a several faint objects detected next to young nearby stars, which (if at the same age and distance as the central star), are substellar, with masses from a few to 40 Jupiters. For the brown dwarf companion of TWA-5 we also show optical data taken with FORS2 at the VLT-UT2 with tentative indication for orbital motion.

A 10

Infrared Spectroscopy of Extra-solar Planets

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Giant extra-solar planets with short orbital periods may be detected directly via the infrared line spectra emitted by their heated atmospheres. Ground-based measurements of the planetary lines at $\sim 10^{-4}$ of the stellar flux are possible if one exploits the large-amplitude Doppler modulation caused by the orbital velocity, whereby the period and phase are known for stars with established reflex motions. A measured radial velocity amplitude of the planet yields directly the star/planet mass ratio and the inclination angle of the orbital plane. A search for methane in the IR 3.3 μm spectrum of τ Boo has been carried out at the NASA IRTF. The Southern Saturn-type planet of HD 75289 has been observed over a six week period by the VLT (2.3 μm CO) and future CO and CH4 observations are scheduled.

A 11

Discovery of Very Young Free-floating Giant Planets in the σ Orionis Cluster

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Via optical and near-infrared imaging we have discovered an extremely red, low-luminosity population of free-floating objects in the young, nearby stellar cluster around the multiple, massive star σ Orionis. The proximity (352 pc), youth (1–5 Myr), and low internal extinction make this cluster an ideal site to explore the substellar domain from the hydrogen burning limit ($\sim$ 75 M_{Jup}) down to a few M_{Jup}. Optical and near-infrared low-resolution spectroscopy of three of our objects confirm the very cool spectral energy distribution (atmospheric effective temperatures of 2200–1700 K) expected for cluster members with masses in the range of 5–15 M_{Jup}. Like the planets of the Solar System, these objects are unable to sustain stable nuclear burning in their interiors, but in contrast they are not bound to stars. This new kind of isolated giant planet, which apparently forms in a timescale of less than a few million years, offers a challenge to our understanding of the formation processes of planetary mass objects.

A 12

From Dust to Planetesimals – Fast and Easy?

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The formation of planetesimals from preplanetary dust involves a variety of physical processes, such as dust transport, dust collisions, adhesion, or aerodynamics of non-spherical dust grains. Recent progress in theoretical and experimental work has brought us closer to a detailed understanding of the various stages that lead from micrometer-sized dust to kilometer-sized planetesimals. Based on the latest results from the laboratory and from modeling, an overview of the "hard facts" of preplanetary dust aggregation will be given.

A 13

Formation of Non-symmetric Fractals During the First Stage of Pre-planetesimal Dust Growth

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It is a generally accepted view that the genesis of a planetary system coincides with the formation of sun-like young stellar objects surrounded by gaseous discs. The building blocks of the planetesimals are micron-sized solid particles (the so-called dust) embedded in the gas of the disc. The relevant process for forming larger aggregates is the growth due to collisional sticking. For particles to collide and stick, a relative velocity component between the grains must be present. In the onset of dust growth, Brownian motion dominates other relative-velocity sources. However, numerically determined time scales of the pure Brownian dust growth are much too large for explaining the formation of planets within the lifetime of a proto-planetary disc. In order to verify the validity of the theoretical models, the Cosmic Dust Aggregation Experiment CODAG was developed. It allows to observe the growth of micron-sized dust analogs under astrophysical realistic conditions. Surprisingly, the experiments showed that at least in the onset of the dust growth needle-like fractal aggregates rather than symmetric fractals are formed. Here we discuss the implication of this experimental finding for the pre-planetesimal growth models.

A 14

Galactic Dust Measurements Near Earth

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Galactic interstellar dust (ISD) is the major ingredient in planetary formation. However, information on this important material has been extremely limited. Recently the Ulysses dust detector has identified and measured interstellar dust outside 1.8 AU from the Sun at ecliptic latitudes above 50 deg. Recent Cassini measurements show that a significant ISD flux exists even inside the Earth's orbit. The Stardust mission is under way to analyze by an in-situ detector and to collect ISD between 2 and 3 AU from the Sun. Modelling the Ulysses data suggests that up to 30 AU is of interstellar origin. It is proposed that interstellar dust flux can be identified and quantified in high-Earth orbit (outside the debris belts). A new in-situ dust telescope is used to distinguish interplanetary from interstellar dust and to provide important physical, chemical and isotopic information on ISD. The dust telescope consists of three types of instruments sharing a common impact plane of 1 square meter in size and has an aperture of approximately 50 deg. opening angle. The instruments are a high resolution impact mass spectrometer, a dust analyzer for the determination of physical and chemical dust properties, and a large-area impact detector with trajectory analysis.

A 15

The Structure of Self-Gravitating Accretion Disks

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In recent years the HST detected numerous massive disks around young stars and in the centers of galaxies. Furthermore it is likely that disks around black holes in AGN are at least marginally self-gravitating. To compare the observed features of those disks with theoretical models it is necessary to take self-gravity into account – in the vertical direction for all disks with masses above a few percent of the central mass and in radial direction for all disks with comparable mass.

In our theoretical models we assume differentially but not necessarely Keplerian rotating, thin but massive disks, that are in vertical hydrostatic equlibrium. To avoid the disadvantages of standard α-disks in the limit of self-gravitating accretion disks we use for the viscosity the β-ansatz (Duschl et.al., 2000). Our disk models include radiation transport and different kinds of opacity sources, and our disks are allowed to become optical thin.

Applications for these models are protoplanetary disks in early evolution phases before planetesimals build and the azimuthal symmetry breaks down, and massive gaseous and molecular disks around black holes in the centers of galaxies, particularly in the centers of merging galaxies, where the gas is known to collaps inwards very rapidly. Here we present model calculations for these applications.

References

Duschl, W.J., Strittmatter, P.A., Biermann, P.L.; 2000, A&A 357, 1123

A 16

Gas/dust Separation in Protoplanetary Disks around A Stars

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The λ Bootis stars define a group of metal-poor A stars with stellar parameters that place them slightly above the main-sequence. Further characteristics are high rotational velocities, a high incidence for circumstellar absorption lines and for the brightest stars, that were detectable by IRAS and ISO, a clear IR excess. The peculiar abundance pattern in the atmopheres of the λ Bootis stars may be due to ongoing accretion of matter depleted in condensable elements from the circumstellar surrounding.

We present here the first steps towards a two-fluid hydrodynamical model to quantitatively address the question of gas/dust separation in the disks around young A stars, in particular around λ Bootis stars.

A 17

Adaptive Optics in Star Formation Research – The Example of ALFA

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Since about 1995, when adaptive optics (AO) was broadly introduced into astronomical imaging techniques, the field of star formation has seen revolutionary progress.

In this paper, we will presented selected results obtained by a single AO system, ALFA (*A*daptive Optics with a *L*aser *f*or *A*stronomy, which is run by the two Max Planck Institutes for Astronomy and extraterrestrial physics in Heidelberg and Garching, Germany. We concentrate on fields of star formation research which are examined at the two institutes.

These fields include research on the initial mass functions (IMFs) of young clusters, Ultracompact HII regions (UCHIIs), and the triplet System T Tau. IMFs contain a wealth of hints towards the influence of the environment on the formation mechanisms of stars. Particularly interesting is the interaction between massive stars and their winds and ionising radiation, and low-mass stars forming in the same molecular cloud. An earlier and more compact environment to study these phenomena are ultracompact HII regions (UCHIIs).

The AO system ALFA can be operated in combination with the integral field sepctrometer 3D. This combination was used in September 1999 to observe the young binary system T Tau. ALFA delivered a resolution of $0\farcs14$, so clearly separated spectra of the two main components of the T Tau system could be extracted.

Splinter Meeting B

Dusty and Obscured Objects Observed by ISO

Contributed Talks: B 01 . . . B 14

Chairmen:

Dietrich Lemke, Heidelberg
Dieter Lutz, Garching

B 01

Old and Young Vega-like Stars

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Recent studies of Vega-like stars with ISO have shown that the dust disks associated with some main-sequence stars (the so-called Vega-like stars) have a typical lifetime of 400 Myr (Habing et al. 1999, Nature 401, 456). After that time, most disks become undetectable, probably because the planetesimals which are the source of these grains have been cleared out. The Kuiper Belt of our own solar system probably forms one of these "disappeared" disks, even though it still produces small amounts of dust grains by collisions between Kuiper Belt objects. However, some old G and K stars still possess much more massive disks.

We discuss the observations from which the 400 Myr timescale has been derived. Furthermore the collisional history of planetesimals belts will be considered. We will discuss the mechanisms which replenish the dust particles and possible mechanisms to explain the long life of some stellar debris disks.

B 02

ISOPHOT Observations of the Circumstellar Environment of Young Stars

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The young pre-main sequence T Tau and Herbig Ae/Be stars are associated with circumstellar dust, whose thermal emission can be observed at infrared wavelengths. We report on 3.6–200 micron photometric observations performed with ISOPHOT, the photometer on-board the Infrared Space Observatory.

Seven Herbig Ae/Be stars were observed at mid- and far-infrared wavelengths. At $\lambda \leq 25\mu$m the emission mainly arises from a compact circumstellar region, and the observed spectral energy distributions follow the power-law relationship $F_\nu \propto \nu^{-n}$ with n typically around 1. The peak of the SEDs (in F_ν) is at 60–100μm, corresponding to temperatures of around 50 K. At longer wavelengths the observed emission is spatially extended, and at $\lambda > 100\mu$m the emission observed by ISOPHOT is never dominated by the Herbig Ae/Be stars. The most likely sources of the far-infrared radiation are arcminute size dust cores located in the vicinity of the stars, and probably related to the star forming process.

We also analysed ISOPHOT observations of 16 binary T Tau stars. For the 7 brightest objects the broad-band photometry was supplemented by 2.5–11.7μm spectrophotometry obtained by the PHT-S subinstrument. In most cases strong silicate emission at 10μm was detected with some indications for the presence of crystalline silicate. The comparison of the derived SEDs with those of single T Tau stars will help to understand how the presence of companions could affect the evolution of the circumstellar disks.

B 03

The Protostellar System HH108MMS

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We probe the region around the protostar HH108MMS by deep mid infrared photometric and polarimetric imaging. The protostar is detected at 14μm in absorption against the diffuse background. Next to HH108MMS, we find a second absorbing core, named Q1, and the young stellar object IRAS18331–0035 which is more advanced in its evolution and already seen in emission at 12μm and 14μm. HH108MMS, Q1 and IRAS18331–0035 form a triplet along an extended disk-like absorption feature. From the variation of the surface brightness across the source, we derive for HH108MMS and Q1 the optical depth and density profile. Along the axes which are parallel to the disk feature, the density distributions follow a $\rho \propto r^{-1.8}$ power law. We estimate that the intensity of the background radiation at 14μm is about two times stronger than the intensity of the interstellar radiation field in the solar neighborhood. The present photometric data of IRAS18331–0035 between 12μm and 1.3mm can be explained by a central source with a luminosity of 2.5 $L_\odot$ that is surrounded by a spherical cloud of 1.1 $M_\odot$ with a $1/r$ density distribution. As HH108MMS is also seen in the millimeter dust emission, we can derive the ratio of the dust extinction coefficients at 14μm and 1.3mm and obtain $\kappa_{14\mu m}/\kappa_{1300\mu m} \sim 470$. Because models for the dust in the diffuse interstellar medium predict a ratio of around 2000, our value points to fluffy composite grains which are expected to prevail in dense and cold environments. We also present mid infrared polarisation images of the region around HH108MMS. The polarisation is strong ($\geq$ 15%) and tightly correlated with the source triplet. The high degree of polarisation can be explained by extinction of rotationally aligned dust particles of moderate elongation.

B 04

Analysis of ISOPHOT-maps of Protostellar Condensations

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We present results of a mapping project with ISOPHOT investigating dense dust condensations that contain protostellar candidates. The sources have been selected from a 1300 μm survey of southern dark clouds with the 15 m Swedish-ESO Submillimetre Telescope (Reipurth, Nyman & Chini, 1996). To establish the protostellar nature of the embedded cold clumps, observations shortward of 1.300 μm are required in order to accurately determine their spectral energy distribution, their physical properties and thus their evolutionary stage. For most of the sources only upper limits exist from IRAS data. We mapped the objects of our sample at 60, 90, 105, 120 and 180 μm using the C100 and C200 cameras of ISOPHOT, the photometer on board the ISO-satellite. The maps were obtained in the chopping raster mode P32, which allows for the highest possible resolution. Here we describe details of the analysis process and present the derived spectral energy distributions. Further results will given for the temperature and the amount of dust, the IR-luminosity, the morphology and the possible evolutionary status of the objects.

B 05

Cold Dust around Protostars in the HH 108/109 Region

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We present results of a long term study, searching for protostars in the vicinity of Herbig-Haro-Objects. During multiple submillimetre and millimetre observations many compact sources were found turning out to be the driving sources of the bipolar outflows, which in most cases appeared to be the long sought protostars. The famous example HH 24 MMS was also found during that programme.

In order to fix physical parameters like dust temperature, mass and density of the ambient medium, also far-infrared (FIR) data is mandatory to carry out proper grey-body fits. This is mostly assured by IRAS FIR data. Alas, the poor resolution makes comparison with submillimetre data difficult and, in various cases, IRAS data does not even exist.

An example for the latter is the millimetre source HH 108 MMS, which is close to IRAS 18331–0035, the object driving the HH 108/109 outflow. Only the ISOPHOT data gathered in P32 mode enabled us to derive properties to label it as a true Class 0 protostar. With a dust temperature of only 13 K it is the coldest object in our sample by far. Further examination shows, that it also carries at least one warmer dust component of 24 K.

B 06

An Intermediate-mass Class 0 Object – ISO Observations of CB3

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The massive core of the molecular cloud CB 3 is associated with a molecular outflow and water maser emission as signs of active star formation. We present observations of this star-forming region obtained with the Infrared Space Telescope (ISO). We used the photospectrometer ISOPHOT and the infrared camera ISOCAM to investigate the cloud core of CB 3. A bright IR object is found very near to the centre of the core, but we argue that it is not the object responsible for the high luminosity. The ISOCAM observations revealed a cloud of PAH emission next to the dense core. Two Herbig-Haro objects are detected along the "blue" outflow axis by their H_2 emission. They appear also in the ISOCAM observations.

Far infrared (FIR) and ground-based sub-millimetre observations yielded the complete spectral energy distribution (SED) of the CB 3 cloud core. The lack of an NIR source associated with the cloud core and the strongly rising SED with a maximum at about 120 μm implies that CB 3 hosts a Class 0 protostar still accreting and producing the outflow. Fitting a modified blackbody curve to the SED returned a temperature of 34 K, a luminosity of 725 $L_\odot$ and a dust emissivity proportional to $\nu^{1.6}$. Assuming that the luminosity is due to accretion and deuterium burning, we conclude that the protostar has a mass between 5 and 10 $M_\odot$ and accretes at a rate between 5 and $2 \cdot 10^{-5} M_\odot \mathrm{yr}^{-1}$.

B 07

FIR Observations of Molecular Outflows

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ISO provided a powerful tool for far-infrared observations of molecular outflows within molecular clouds. We present SWS/LWS data for seven locations in two outflows, Cepheus A and L 1448. A large variety of H_2 ro-vibrational, CO pure-vibrational and forebidden atomic fine structure lines are observed.

We interpret simultaneously the data for H_2 and CO lines by shocks. A collection of bow shocks or supersonic turbulence is needed to explain the data. Bows ($z \propto R^S$) with flanks extended much more than paraboloids are required.

For Cep A we found C-type physics to provide the best interpretation of the H_2 (low excitation), CO (high-J) and [OI] 63 μm lines. Both lobes contain high density ($1\text{–}3 \cdot 10^6\,\mathrm{cm}^{-3}$) gas and the bows are of shape $s = 1.4$. In contrast, we found in L 1448 densities are a factor of 10 lower. There is higher excitation and the bows are of shape $s = 1.6$. The properties vary over the object, so the centre and the southern lobe posses a higher excitation.

B 08

Cold, Dense Cores in Molecular Clouds Oberved with the ISOPHOT Serendipity Survey

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The ISOPHOT Serendipity Survey (ISOSS) is a far-infrared survey at 170 μm, using ISO's slewing time. Altogether about 15 % of the sky is covered with an angular resolution (FWHM) of $2'$. With ISOSS, it is possible for the first time to trace the cold dust ($T \leq$ 15 K) in molecular cloud cores over a large fraction of the sky. We have developed a method to determine dust temperatures and column densities for sources with angular diameters between $\approx 2'$ and $10'$, the typical sizes of molecular cloud cores in the nearest star forming regions. In order to compare the physical parameters of the dust and the gas inside dense cores, we have used our method to look for cold dust in objects, for which the kinetic temperature of the gas is known. Jijina et al. (1999) compiled a catalog of dense cores mapped in ammonia, and we have used their list for a gas – dust comparison.

51 out of 125 ammonia cores with NH_3 diameters $> 1'$ were crossed by ISOSS slews. The detection rate is 82 %. A surprisingly strong correlation has been found between the temperatures of the dust and the gas, which range from 12 K – 21 K and 9 K – 20 K respecively. A similar correlation holds between dust temperature and NH_3 line-width, while no correlation could be found between the peak FIR intensity and the central gas number density. The latter can be understood as ammonia tracing the densest part of the core only, while dust emission arises from the whole core. The tight correlation of temperatures on the other hand, points to an efficient thermal coupling between the dust and the gas over the whole volume of the core.

B 09

ISO Spectroscopy of the Galactic Center

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We present ISO observations in the wavelength range of 2.4 to 45 microns toward two different positions of the Molecular Torus surrounding the Galactic Center. These data provide a unique picture of the emsission processes in the Galactic Torus at a spectral resolution of 900 to 2500. The most prominent emissions are low excitation fine structure lines, molecular hydrogen transition lines, and in contrast with ISO spectra centered on SgrA*, strong Polycyclic Aromatic Hydrocarbon (PAH) emission features. The temperature structure of the gas in the molecular ring, as determined by H_2 line emission, can be described by a simple two temperature model. In addidion, these observations are used to probe the extinction of the intervening interstellar medium, providing new constraints on the physical conditions in the vicinity of the Galactic Center. We find that the Draine & Lee (1989) extinction model does not properly correct the derived H_2 column densities. However, the data are well fit by the empirical extinction law derived by Lutz (1998) from ISO observations towards SgrA*.

B 10

FIR Surface Photometry of the Crab Nebula

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We present diffraction limited maps of the Crab Nebula at 60, 100 and 160μm, observed by ISOPHOT using the dedicated mapping mode (P32). The data were processed by a new software package to correct for detector hysteresis effects. This allows a quantitative evaluation of the radial profile of the smooth synchrotron emission, as well as of discrete emission peaks associated with the filaments. The latter are are interpreted in terms of contributions from dust, line and synchrotron emission from the nebula.

B 11

Dust Emission of the SN 1987A – 11 Years after Outburst

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ISOCAM measurements of SN1987A reveal an mid-IR source with position and extent indicative of an association with the circumstellar medium. We analyse the mid-IR spectral energy distribution in terms of collisionally heated grains downstream of the blast wave. Dust-to-gas ratios derived from a comparison with X-ray measurements are only of order 0.01 percent in the interection zone, which supposedly contains material from the red supergiant evolutionary phase of the progenitor. This result is discussed in relation to knowledge of dust abundances in LMC red supergiant stars, and potential dust removal mechanisms, such as evaporation in the UV flash from the supernova outburst, and sputtering.

B 12

Star Formation Histories of Starbursts from ISO

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In recent years, it has become clear that vigorous episodes of star formation activity, or "starbursts," play an important role in galaxy formation and evolution at all epochs in the Universe. However, despite extensive studies in the past two decades, a quantitative understanding of the starburst phenomenon is still lacking. Observations at infrared wavelengths, where starburst activity is conspicuous and extinction effects much less important than in the optical/UV regimes, offer a unique opportunity to gain further insight into the properties of starbursts which are often obscured by large amounts of interstellar dust.

I will present the results of a study of 27 starburst galaxies based on *ISO* Short Wavelength Spectrometer observations. I will discuss the implications of this sample study, together with those of detailed investigations of nearby systems (*e.g.* M 82 and IC 342), on the massive star formation in starburst environments and on the evolution of starburst activity. These are key issues notably for the understanding of the interplay between triggering and quenching mechanisms of starburst activity as well as for the interpretation of the properties of star-forming galaxies at high redshifts.

B 13

FIR Emission from Intracluster Dust in Abell Clusters

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The presence of dust distributed in the intergalactic medium of galaxy clusters is of considerable interest for studies of the large scale structure and cosmology such as the number counts of galaxies and quasars as well as the study of the evolution of galaxies and clusters of galaxies.

ISOPHOT FIR observations have been used to search for spatially extended intracluster dust in six Abell clusters in the redshift range $0.015 < z < 0.075$. Scanning measurements crossing the clusters were used to derive the $120\,\mu$m/$180\,\mu$m FIR color ratio which is expected to show a systematic change such as a dip or a bump centered on the cluster if intracluster dust with properties different from the foreground galactic cirrus is present.

Since the expected signal from intracluster dust is weak a careful data analysis including the subtraction of the zodiacal light component was carried out. In no case has the characteristic intracluster dust signature of a color ratio changing across the cluster been found. These data do not confirm the evidence for intracluster dust in two promising candidates where hints for extended FIR emission had been found from the shorter wavelength IRAS data.

B 14

Dust Emission From 3C Radio Galaxies and Quasars seen by ISO: New Evidence Favouring the Unified Scheme

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In order to test the unified scheme between luminous radio galaxies (RGs) and radio loud quasars (RQs) via their presumably isotropic dust emission, infrared to millimeter spectral energy distributions (SEDs) have been obtained by ISO and IRAM for 20 sources of the 3CR catalogue.

The sample contains 10 RG–RQ pairs with similar redshifts and comparable 178 MHz radio fluxes which are independent of aspect angle.

The SEDs reveal thermal dust emission showing up as clear bumps above the synchrotron radiation. Also a comparison of the RG–RQ pairs indicates similar thermal dust components for RGs and RQs.

The detection statistics RG/RQ = 6/7 is well balanced for the whole sample.

In agreement with the predictions of the unified scheme, the galaxies and quasars cannot be distinguished by their observed mid-and-far-infrared properties. Thus the observations provide evidence in favour of the RG–RQ unification.

Splinter Meeting C

Evolution of Star Clusters and Galaxies

Contributed Talks: C 01 ... C 17

Chairmen:

Christian Theis, Kiel
Rainer Spurzem, Heidelberg

Related posters: P 41 ... P 53

C 01

Yet Another *N*-body Code

Walter Dehnen (Max-Planck-Institut für Astronomie, Königstuhl, 69117 Heidelberg)

A new N-body code for simulations of collisioness stellar dynamics is presented. The main features of the code are:

- Gravity is computed using the very fast tree-code of Dehnen (2000, ApJ, 536, L39), which needs only $\mathcal{O}(N)$ operations for computation of the forces for *all* bodies, and is ~ 5 times faster than the ordinary tree code. The key of this code are mutual cell-cell interactions: the force field due to some source cell and for all bodies inside some sink cell is computed in one step.
- The softening is done employing the $n = 1$ Ferrers sphere as softening kernel. Because of its finite density support, the force deviates from Newtonian only for inter body seperations $r < \epsilon$, avoiding unphysical artifacts introduced by the long-range Plummer softening. A further advantage of this method is that all mutual interactions of bodies inside one cell can be computed in one step provided they are all softened with the same ϵ.
- The time integration is performed using the blockstep schems (Makino, 1991, PASJ, 43, 859) of hierarchical nested time-step levels. The algorithm for controlling the time-steps is *time symmetric* by construction, avoiding artificial secular evolution.

C 02

A Stochastic Monte Carlo Approach for Star Cluster Models

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Recent advances using the Monte Carlo technique of Hénon (1971), Stodółkiewicz (1982, 1986), and Giersz (1998, 2000). are presented. This is up to now the only technique capable of modelling a large number of binaries and millions of particles self-consistently for collisional star clusters, including also other effects such as stellar evolution. A hybrid stochastic Monte Carlo scheme is used to treat single stars by using a simplified gaseous model and binaries by a detailed Monte Carlo technique (Spurzem & Giersz 1996, Giersz & Spurzem 2000). The self-consistent evolution of 30.000 hard binaries in a star cluster consisting of 330.000 stars in total is followed during several hundreds of half mass relaxation times, undergoing binary burning and gravothermal oscillations. New results and projects related to modelling a mass spectrum with stellar evolution will be briefly discussed.

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C 03

Gaseous Models of Globular Clusters: The Effects of Stellar Evolution

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Comparing different approaches for modeling the evolution of star clusters, gaseous models have the advantage of easy access to very high "particle numbers" (i.e. those of real astrophysical systems such as globular star clusters or even galactic nuclei) but – until now – they are less realistic. Competing Fokker-Planck models acquired the lead here for many years. Hence we have embarked on a project to improve gaseous models towards a more realistic description of globular clusters, including the effects of stellar evolution and many (primordial) binaries, and a consistent treatment of the tidal field of the Galaxy.

Here we report on the effects of a mass spectrum and stellar evolution on the dynamical evolution of the cluster's post-collapse phase (gravothermal oscillations) and show how only small changes in the mass loss rate can change the internal dynamics of the cluster dramatically. This is even the case for a rather simple description of the stellar evolution and the resulting mass loss.

To get further insight into these effects we included a more detailed description of the mass loss in our code which should be comparable with the description of stellar evolution in other numerical models of star clusters. It is planned to present first results of this new and more realistic model.

C 04

Gas Expulsion from Star Forming Regions and the Formation of Globular Clusters

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Shortly after the formation of a globular cluster (GC) the remaining gas will be expelled by ionizing radiation, stellar winds or supernova explosions during a few dynamical timescales. As a result of this gas expulsion phase some or all stars in the cluster will get unbound. The fraction of finally bound stars is mainly determined by the efficiency of star formation and the timescale of the gas expulsion. Our results allow us to quantify the star formation efficiency (SFE) necessary for forming bound GCs.

Two sets of numerical N–body simulations are presented: As a first simplified approach we treat the residual gas as an external potential. The gas expulsion is approximated by reducing the gas mass to zero on a given timescale, which is treated as a free parameter. Our results are consistent with similar simulations by Lada et al. (1984, ApJ 285, 141) and more recently by Goodwin (1997, MNRAS 116, 351).

In a second set of simulations we used smoothed particle hydrodynamics (SPH) to describe the dynamics of the residual gas. In this case gas expulsion takes place on a short timescale and prevents the evolution of star forming regions with low SFEs to bound clusters.

In both sets the stars were in virial equilibrium with the gaseous environment at first. Adopting stars with an initial zero velocity dispersion leads to a compaction of the cluster during the expulsion phase and may explain the formation of bound systems with SFEs less than 10%.

C 05

The Impact of Tides on Star Cluster Formation

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The homogeneity of metal abundances in clusters suggests that the epoch of star formation must have been short in order to avoid strong gradients in the stellar population, leading to systems with little velocity dispersion at formation. When spherical clusters undergo violent relaxation a good fraction of stars describe nearly radial orbits. This situation likely gives rise to triaxial instability (see e.g. Merritt 1999). Aspherical collapse also results in triaxial equilibria. However a net torque may now be exerted on individual clusters by the host galaxy's tide during radial infall, and induce streaming motion or rotation.

We investigate analytically the collapse of uniform-density spheroids to which we apply model galactic tides. We find that sub-virial clusters non-rotating at birth may yet show appreciable rotation in equilibrium.

C 06

OB Associations: Linking Radioactivities to other Observables

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Observations by the COMPTEL instrument aboard CGRO of the 1.8 MeV gamma-ray line emitted by interstellar ^{26}Al suggest that massive stars are the dominant source of this isotope.

Massive stars are frequently found in OB associations. Our group has developed a model for OB associations which predicts as observables the luminosities in radioactivity gamma rays, ionizing radiation and kinetic energy, as functions of time. A Monte-Carlo algorithm allows the determination of uncertainties in these observables due to statististical sampling of initial stellar masses, i.e. to study the effects of varying richness of the associations. We also discuss systematic model uncertainties from incomplete knowledge of stellar evolution detail. This allows us to evaluate the significance of correlations between observational data and model results.

OB associations embedded in interstellar gas drive the formation of bubbles by the input of kinetic energy through stellar winds and supernova blast waves. Our model follows the evolution of the bubbles' state variables from the driving energy output of the contained association, and for different surrounding interstellar medium.

C 07

Cyanogen Variations in the Second Parameter Globular Cluster NGC 7006

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The metal-poor ([Fe/H] = -1.6 dex) globular cluster NGC 7006 exhibits an unusual red horizontal branch (HB), i.e., it is a "second parameter effect" cluster. A possible second parameter is mixing within red giant branch stars which may result in enhanced mass loss and lead to bluer horizontal branch stars. Rotational-induced mixing may lead to variations in cyanogen abundances in stellar atmospheres due to the dredge-up of nucleosynthesized material. Such variations have been found for quite a few clusters, though it is not clear whether these are caused by primordial or evolutionary effects (Kraft 1994).

We present spectroscopic CN and CH band strengths for 13 giants of NGC 7006 obtained at the Lick 3m telescope. The data reveal the following trends: (i) The scatter in star-to-star CN indices is relatively modest by comparison with the blue horizontal branch cluster M13. (ii) The CH content is independent of the CN, within the observational uncertainties, indicating that the CN abundance variations are driven by N variations. (iii) A possible weak radial dependence of the CN content, although this needs a larger sample of stars for verification. Buonanno et al. (1991) found the HB of NGC 7006 to get bluer towards the inner parts of the cluster. A possible connection to the observed CN radial dependence is discussed.

C 08

Colour Gradients and Dust Extinction in Non-active and Active Spiral Galaxies

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It has been known for a long time that colour gradients exist within the discs of spiral galaxies. However, it is still unclear what causes these gradients. They could be due either to population, age and/or metallicity variations, or they could be due to dust. Furthermore, it is not clear yet whether systematic differences exist between the colour gradients in non-active galaxies and active galaxies.

In this work disc scalelengths r_D in B, V, R and I are determined for a sample of non-active and active spiral galaxies. It is found that the non-active galaxies show significant colour gradients within their discs, whereas the active galaxies do not.

In order to obtain information about the intrinsic colour gradients within the stellar disc and the internal dust extinction, the variation of $r_D(B)/r_D(I)$ with apparent ellipticity is compared to model calculations. For the non-active galaxies, the data are represented best by a model with a stellar disc which has an intrinsic colour gradient and with a central optical depth in the B band for face-on view of $\tau_0^B = 3$. This indicates that the observed colour gradients are caused by a combination of an intrinsic colour gradient and dust extinction. For the active galaxies however, the best agreement between data and models is found for models with a stellar disc with no intrinsic colour gradient and no dust. This indicates that the dust extinction in the discs of active galaxies is negligible.

C 09

The Evolution of the Galactic Disk: The Stellar Component

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We present deep V and I photometry of stellar field populations in several regions of the Galactic disk. They are selected on the basis of large scale surface photometries of the Milky Way (Kimeswenger et al., 1993, A&AS, 97, 517; Hoffmann et al., 1998, A&AS, 128, 417). The observational colour-magnitude diagrams (CMDs) and luminosity functions are analyzed using a revised version of the Padova software described in Bertelli et al. (1995).

The reddening along the line of sight is derived and found to be in reasonable agreement with the maps of Mendez & van Altena (1998, A&A, 330, 910). Structural parameters like the scale height and the scale length of the various populations are discussed. Due to the low galactic latitude of the fields, not much information about the thick disk's parameters could be gained. For the thin disk, values around $h_z = 250 \pm 0.60$ pc have been found for the scale height, the scale length is favoured to be larger than 1100 pc.

The data are very sensitive to the star formation history of the thin disk. A decreasing star formation rate is necessary to reproduce the distribution of the stars in the colour-magnitude diagrams as well as the luminosity functions. Constant or a strongly increasing star formation rates as derived using Hipparcos data for the solar neighbourhood (Bertelli et al. 1999, Balt. Astr., 8, 271) do principally agree with the luminosity functions but do not reproduce the CMDs, as they require too many blue stars. The analysis of field populations gives evidence that star formation rates, derived from the solar neighbourhood, cannot be considered as representative for the whole thin disk.

C 10

The Impact of Bars on Global Spiral Modes in Galactic Disks

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The spiral structure of disk galaxies is one of the most prominent and fascinating large scale features in astronomy. From a theoretical point of view there are two different approaches to understand the evolution of spiral structure: linear stability analysis allows to detect unstable modes and their growth rate, whereas the non-linear regime is only available by numerical simulations, e.g. stellar hydrodynamical calculations.

The detailed stability properties of the disk depend on its specific characteristics, e.g. on its mass and velocity distribution. Typical galaxies are characterized by a dominant $m = 2$ (i.e. two-armed) mode. Here, we investigate the influence of a rotating bar on the global spiral structure in disk galaxies. The dynamical evolution is followed by a 2D multi-component hydrodynamical code which includes also star formation. The bar is described by an external Ferrers bar potential. This approach gives us control on the main bar parameters like its size, mass or pattern speed. We show that already a small bar enhances substantially the growth rates of unstable modes. Additionally, the growth of other modes like $m = 1$ or $m = 4$ can be stimulated, resulting in lopsided or four-armed structures.

C 11

Chemodynamical Evolution of Dwarf Galaxies: Dynamics and Star Formation History

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Because of their low gravitational energy dwarf galaxies are strongly exposed to the energetic impact from processes like stellar winds, supernovae or even stellar radiation. To simulate their chemodynamical evolution in a self-consistent way all relevant processes have to be considered. It is furthermore necessary to distinguish between at least two dynamically separated gaseous and three stellar components. With these chemodynamical simulations the evolution of dwarf galaxies is traced from its beginning.

Here we focus on the different dynamical phases the model passes through and the corresponding star-formation history. Starting from an virialized gaseous system of $10^9 M_\odot$ baryonic matter in a $10^{10} M_\odot$ dark matter halo, we show that the dynamical evolution of dwarf galaxies proceed in different phases that are determined according to the gas dynamics and the star formation. Beside the intrinsic gas exchange with the initial gas reservoir no additional gas infall is assumed. We show the separate evolution of the central region and a surrounding thick disk zone with a patchy star formation distribution but no coherent starburst.

C 12

Orbital Deformation of Satellites by Dynamical Friction in Spherical Halos with Anisotropic Velocity Dispersion

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Deformation of satellite orbits around a spherical galaxy is considered. In general, a satellite sinks into the center of its parent galaxy by dynamical friction. Unless the orbit is exactly circular, the orbital shape changes owing to a difference in decaying rate between energy and angular momentum. This deformation depends on the density and velocity distributions of the surrounding galactic halo. We have made a perturbative analysis of the orbital deformation in a scale-free halo which has a density profile, $\rho \propto r^n (-3 \leq n \leq 0)$, with anisotropic velocity dispersion characterized by $\beta = 1 - \sigma_\theta^2/\sigma_r^2 (-1 \leq \beta \leq 1)$. We classify four major effects on the orbital deformation. The dominant effect originates from the density gradient for $n < -2$ and the gradient of velocity dispersion for $n > -2$. Both effects leads to more circular orbits. Larger β makes the rate of orbital circularization smaller. For positive β (radially dominated anisotropy), initially eccentric orbits conserve their shape during orbital decay when the velocity dispersion is radially dominated.

C 13

Constraints on the Sagittarius Dwarf Galaxy's Tidal Stream

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The Sloan Digital Sky Survey (SDSS) has the goal to scan half of the nothern sky in five pathbands, from UV (352 nm) to near Infrared (911 nm). So far, only a small fraction of the survey is accomplished, including test data along the equatorial stripe ($160^o < \alpha < 250^o$ at $-1.25^o < \delta < 1.25^o$). We use these SDSS test data to spatially trace the tidal stream of the Sagittarius dwarf galaxy (from now on "Sagittarius"), the closest known companion of the Milky Way. Sagittarius is caught in its merging process with the Galactic halo. With a distance of only 25 kpc from the Galactic center, it yields an ideal object to study galactic interaction processes in detail. Recent modells derive the assumed orbit of the companion within the halo, predicting overdensities and velocity structure of the tidal stream. We were now able to see the expected overdensity of stars at the intersection of the SDSS test data with the predicted orbit. There are two important implications for the formation scenario of the Galaxy. First, this is clear evidence for the assumption that the Galactic halo formed (and still forms) due to merging with smaller galaxies, which are tidally disrupted and consumed within the gravitational potential of the Milky Way. Secondly, we would naturally expect to find different populations within the halo due to this formation scenario. Using data from the APM catalog for comparison, we were able to detect the stream over a larger volume in space, but the reconstruction of a large fraction of the orbit has to await the completion of the Sloan survey.

C 14

Numerical Simulations of Tidal Encounters with Barred Galaxies

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Bars are a common feature in disc galaxies and by no means an exception, since about 2/3 of all disc galaxies are believed to harbor a central bar or oval distortion. Furthermore in the last few years near-infrared observations have given clear indications of an even higher fraction of barred galaxies. At present, there are two scenarios for the bar formation that are widely believed. One is the spontaneous bar instability which occurs in relatively cool, rotationally supported discs, the other one is the triggering of bar formation by tidal encounters.

However, it is known for some time, that a central growing mass concentration, e.g. due to gas inflow, could lead to a subsequent weakening of the bar, and ultimately to its "quick" dissolution. The characteristic time-scale for bar dissolution appears to be short in comparison with the Hubble time. This makes it difficult to understand the observed high frequency of bars in disc galaxies.

In this work the scenario for the resurrection of a bar triggered by a tidal ecounter with another galaxy is studied. The target galaxy already has an initial bar, which has been weakened by an substantial gas inflow during its evolution before encountering the perturbing galaxy. In the talk we present preliminary results obtained by a first set of numerical simulations to assess the viability of this hypothesis.

C 15

The Loss-Cone Problem in Dense Nuclei Revisited

Pau Amaro Seoane, Rainer Spurzem
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This is the start-up of a project revisiting the star-gas interactions in young, dense galactic nuclei. Here we present some semi-analytic results following ideas given originally by Frank & Rees (1976), Vil'koviski (1976), Hara (1978), Langbein et al. (1990), and references therein. The heating rate of an assumed supermassive central gas-star object due to loss-cone stars, plunging onto it on elongated orbits from outside is calculated taking into account a possible anisotropy of the surrounding stellar distribution. We discuss for a range of central masses the rate of stars on such loss-cone orbits and their heating effect. Here we assume a simplified model of a galactic nucleus consisting of a Plummer model with an embedded density cusp, using stellar point masses. We plan to extend this investigation to numerical studies, allowing a wider range of possible stellar distribution functions and to take into account gas production by stellar collisions and star formation. A more detailed understanding of that early evolutionary phase of galactic nuclei from basic principles is one of the key features presently missing for the link between cosmology and galaxy formation.

References:
Frank J., Rees M.J., 1976, MNRAS, 176, 633.
Hara T., 1978, Prog. Theor. Phys., 60, 711.
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Vil'koviski E., 1976, Sov. Astr. Lett., 1, 137.

C 16

Investigations on the Merger Scenario of Elliptical Galaxies

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It is widely believed that elliptical galaxies form through mergers of disk galaxies (see e.g., Barnes 1992; Hernquist 1993). Recent simulations of Naab et al. 1999 show a dependency of the isophotal shape on the mass ratio of the merging galaxies.

We use these results to construct a semi-analytical model based on the Extended-Press-Schechter formalism (Bower 1991; Bond et al. 1991). We follow the merginger history of the dark matter halos and calculate merger timescales for the galaxies inside these halos (as in Kauffmann 1998). By following the amount of accreted mass after the merger we can estimate the fraction of the elliptical galaxies turned into disk galaxies.

We show results for different cosmologies, environments and masses of the final halo. We discuss the dependency of the merger rates on the amount of accreted mass and look at the most likely formation times of ellipticals with respect to their isophotal shape.

C 17

Evolution of a Star Cluster with Two Mass Components

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The effect of mass segregation is studied in the simplified case of isolated star clusters containing two mass components. The evolution is followed in time, using the direct force integration method NBODY6++ (Aarseth 1999, Spurzem 1999). We study the collapse time as a function of mass ratio $\mu = m_2/m_1$ between heavy and light particles. The higher masses make up a constant fraction of 10% of the total mass of the system. In extent of the models by Khalisi & Spurzem (2000), we enlarge the particle numbers to 5,000, 10,000 and 25,000 and give ensemble averaged core collapse times. We observe a rapid core collapse for the higher μ due to a segregation of the high mass stars to the centre.

References:

Aarseth S.J. 1999, CeMDA 73, p 127.
Khalisi, E. & Spurzem, R. 2000, in "Dynamics of Star Clusters and the Milky Way", ASP Conf. Ser., S. Deiters, B. Fuchs, A. Just, R. Spurzem, R. Wielen (eds), in preparation.
Spurzem, R. 1999, J. Comp. Appl. Math. 109, p 407.

Splinter Meeting D

Interacting Binaries

Contributed Talks D 01 ... D 06

Chairmen:

Boris T. Gäsicke, Göttingen
Jens Kube, Göttingen

D 01

Monitoring the Black Hole Candidate Cygnus X-1 with RXTE

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We present results of our monitoring campaign of Cyg X-1. Since 1998 weekly or two-weekly observations of this source have been performed, using the pointed instruments on the Rossi X-ray Timing Explorer (RXTE).

X-ray binaries containing a black hole are observed in essentially two different X-ray states, the hard and the soft state. During the monitoring observations, Cyg X-1 has always been in the hard state but with occasional flaring episodes on timescales of weeks. The main goal of our campaign is to study the long term evolution of the hard state timing properties and to compare this evolution to the source behavior during the 1996 soft state.

Of special interest for evaluating accretion models are the Fourier frequency dependent time lags between two lightcurves, s and h, from different energy bands:

$$\tau(f) = \big(\arg\langle \mathrm{FT}[s(t)]^* \mathrm{FT}[h(t)]\rangle\big)/2\pi f$$

We found that 1. the hard and soft state time lag spectra are very similar, 2. during state transitions, the lags in the 1–10 Hz range increase by more than an order of magnitude, 3. enhanced time lags during the flare of 1998 July identify it as a "failed state transition". As we will discuss, these timing observations are not consistent with the expectations from most current accretion models!

D 02

Cyclotron Lines in Accreting Pulsars

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[3] INTEGRAL Science Data Center, ISDC, 1290 Versoix, Switzerland)

Neutron stars exhibit the strongest magnetic fields known in the universe: more than 10^{12} Gauss ($= 10^8$ Tesla). These B-fields are responsible for a very interesting phenomenon: the energy of the electrons is quantized in Landau Levels:

$$E_n = m_e c^2 \sqrt{1 + \left(\frac{p_{||}}{m_e c}\right)^2 + 2n\frac{B}{B_{\mathrm{crit}}}}$$

Therefore photons with the appropriate energy are trapped and cannot escape from the accretion column before being scattered to lower or higher energies. This results in absorption lines at this energy, so called cyclotron lines.

Almost 25 years have passed since the discovery of such a cyclotron line in the spectrum of Her X-1 by Truemper et al. (1978). Since then cyclotron lines have been found in several other sources including Vela X-1 and Centaurus X-3.

We present recent observations with the Rossi X-Ray Timing Explorer of several sources, including 4U0115-63 which shows not only the fundamental line, but also 4 higher harmonics!

D 03

Monitoring the Black Hole Candidates LMC X-1 and LMC X-3 with RXTE

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We present results of monitoring LMC X-1 and LMC X-3 from 1997 through 1999 using the pointed instruments onboard the Rossi X-ray Timimg Explorer (RXTE). These two X-ray binaries are the only known persistent black hole candidates that have almost always shown spectra dominated by the soft accretion disk component. Thus LMC X-1 and LMX X-3 are natural candidates for studying accretion disk behavior in black hole binaries.

Additionally, LMC X-3 displays strong spectral variability and the RXTE monitoring during 1997 and 1998 revealed that the source actually transits to the hard spectral state (Wilms et al., 2000, MNRAS, in press) for short periods of time on a quasi-regular timescale of ~ 150 d. LMC X-3 therefore seems to undergo state transitions more often than any other persistent black hole source!

We present the analysis of all available RXTE data of LMC X-3 using thermal and non-thermal Comptonization models. We compare these data to those from LMC X-1, the only "remaining" soft state source, and discuss the possible cause for the state transitions as well as for the different behavior of LMC X-1 and LMC X-3.

D 04

Early Phases of High Mass Transfer Rate During CV Evolution

K. Schenker (Univ. of Leicester, University Rd., Leicester LE1 7RH, U. K.)

It is likely that some binary systems consisting of a white dwarf (WD) primary and a main sequence companion are formed with a mass ratio exceeding the critical value for stable mass transfer. The case studied here occurs if the secondary star fills its Roche lobe while still on the main sequence. Various aspects of stability issues are presented as well as results of recent numerical evolution calculations.

The violation of the thermal stability criterion leads to the expectation of thermal-timescale mass transfer. Such a scenario has been invoked to explain supersoft X-ray sources (SSS) and WDs growing in mass and thus potentially leading to SN Ia. A crucial parameter is the accretion efficiency η, defined as the fraction of the transferred mass that finally remains on the WD. To improve on *ad hoc* assumptions for η, tabulated results from nova outburst computations (Kovetz & Prialnik, 1995) and optically thick wind models (Kato, 1997) are included in evolutionary calculations.

Current results show that it seems to be rather difficult to reach Chandrasekhar mass in this scenario (unless already starting with a very massive WD). Although the SSS phase in such systems can actually reach lower orbital periods than might be expected, the shortest period SSSs are probably of different origin. Furthermore various unusual CVs (such as AE Aqr) are to be understood as consequences of a thermal-timescale mass transfer history and can now be modelled in considerable detail.

D 05

3D SPH Simulations of Superhumps in the Double Degenerate Helium Binaries AM CVn and CR Boo

Stefan Kunze (Theoretische Astrophysik, Morgenstelle 10, 72076 Tübingen)

The AM CVn stars form a small group of peculiar cataclysmic variables. Their common characteristics, He-rich and H-deficient spectra and photometric periods ranging from 300 to 2000 s, together with the discovery of flickering in some systems lead to the following scenario. AM CVn stars consist of two white dwarfs in such a close orbit that the less massive He WD fills its Roche-lobe and feeds an accretion disk around the more massive and therefore smaller primary through the L_1 point.

In three of the six known members of this group superhumps have been discovered. Superhumps are modulations of the light curve with a period a few percent longer than the orbital period. They were first discovered in SU UMa systems during superoutburst and have been successfully modeled as to be the result of the rapid precession of an eccentric accretion disk in systems with extreme mass ratio $q \leq .25$.

AM CVn ($P_{\rm orb}$ = 1029 s) itself is a permanent superhumper due to its high mass transfer rate. CR Boo ($P_{\rm orb}$ = 1471 s) is the He counterpart of a VY Scl star and shows superhumps during its long bright state, but not during the short dwarf nova-like outburst in its lower state.

We gain masses and mass transfer rates of the stars by extrapolating known relations from CVs connecting the superhump period excess and the mass ratio etc. Using these masses and mass transfer rates in 3D SPH simulations of the He disks produces the expected precessing disks and superhumps. Our SPH code with an implementation of the viscous stress tensor gives superhump periods of 1054 s for AM CVn and 1495 s for CR Boo. This is in excellent agreement with the observed values of 1051 and 1490 s.

D 06

The Simultaneous High Speed UBVRI Photometry of X-RAY Transient XTE 1118+480 in April – July 2000

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For the investigation the behaviour of X-RAY transient XTE 1118+480 in the optical spectral region we obtained in 2000 April – July the simultaneous high speed UBVRI observations of this object with 1.25-m telescope AZT-11 of Crimean Astrophisical Observatory. The time resolution was chosen to be from 2.5 to 25 s. The results of the preliminary analysis of the rapid light oscillations as well as of the variability of the averaged flux level are presented.

Splinter Meeting E
Celestial Mechanics and Applications

Contributed Talks E 01 ... E 03

Chairman:
Thomas Seligman, z. Zt. Heidelberg

E 01

Astronomical Expiration Date of the Gregorian Calendar

Heiner Lichtenberg (Bonn)

Until now celestial mechanicists have not been able to calculate an astronomical expiration date for the Gregorian Calendar. Why? Because one still has difficulties with the long-term prediction of the duration of the average day d, the average synodical month m_{syn} and the average tropical year a_{trop}. But at least the question can be put clearly now. From the calendar equations of the Gregorian Calendar [1] one obtains a domain, in which the values of a_{trop}/d and m_{syn}/d should remain. This domain is called the leap-parameter trapezoid and will be presented.

[1] Lichtenberg, H., and Richter, P.H., Calendars in the Gregorian Spirit, Poster-Abstract, this vol., p. 95

E 02

Planetary Rings with Shepherds: Generic Aspects

L. Benet
(Max-Planck-Institut für Kernphysik, Postfach 103980, D-69029 Heidelberg, Germany)

The existence of narrow rings around planets as different as Saturn, Uranus and Neptune, suggests that these rings may occur under more general circumstances. We shall consider the system of planetary rings with shepherds as a restricted four-body problem neglecting the interactions between ring particles. We show that narrow rings and selection mechanisms actually exist in the case of rotating short-range potentials (both attractive and repulsive). Due to the hierarchical arrangement of the periodic orbits, stable orbits obtained by saddle-center bifurcations are found. In configuration space they lead to patterns similar to planetary rings. The generic character of this mechanism, as well as the application to $1/r$ potentials will be addressed.

E 03

A Tenuous Dust Ring of Jupiter Formed by Escaping Ejecta from the Galilean Satelites

Alexander V. Krivov (Institut für Physik, University Potsdam, Potsdam, Germany und Astronomical Institute, St. Petersburg University, St. Petersburg, Russia)
Harald Krueger and Eberhard Gruen
(Max-Planck-Institut fuer Kernphysik, Heidelberg, Germany)
Kai-Uwe Thiessenhusen (Institut fuer Physik, University Potsdam, Potsdam, Germany)
Douglas P. Hamilton (University of Maryland, College Park, MD, USA)

Dust ring systems surround all of the giant planets in our Solar System. Jupiter, the largest of the giants, is shrouded in diverse dust structures: the main ring and its vertically-extended halo, the two extended gossamer rings, escaping streams composed of tiny high-speed particles, and electromagnetically captured interplanetary grains. Here we discuss yet another jovian dust structure: the ethereal ring between the orbits of the Galilean moons of Jupiter. Recent discovery of dust clouds around the Galilean satellites formed by the impact ejecta from hypervelocity impacts of interplanetary micrometeoroids (Krueger et al. 1999, Nature 399, 558) suggests that a fraction of the ejected particles escape from the source satellites into the circumjovian orbits. We present a model of production and dynamical evolution of the escaping ejecta and conclude that the small debris several tenths of micrometer in radius form a broad dust ring, extending at least from Europa's orbit outward beyond the orbit of Callisto. Our results are directly supported by in-situ measurements of the Galileo spacecraft. Analyzing about 300 impact events recorded by the Galileo detector from 1996 to 1999 outside the orbit of Europa and caused mostly by impacts of particles orbiting Jupiter in prograde orbits, we derive the empirical dust number density distribution that agrees quite well with the theoretical one. The retrograde

Colloquium F

History of Astronomy

Contributed Talks F 01 ... F 09

Chairpeople:

Gudrun Wolfschmidt, Hamburg
Günther Oestmann, Hamburg

Related Poster: P 90 ... P 92

F 01

The 25-foot Reflector of Johann H. Schröter

Felix Lühning (Institut für Geschichte der Naturwissenschaften, Universität Hamburg, Bundesstraße 55, D-20146 Hamburg)

In 1797 Johann Hieronymus Schröter (1745–1816), who was a keen amateur astronomer, built a 25-foot reflecting telescope which was at that time greatly admired in the astronomical world. Schröter, who had started his observations with minor instruments in 1782, was in correspondence with Sir William (Wilhelm) Herschel from whom he also got his first telescope mirrors. Later he began building copies of Herschelian telescopes. Thus his biggest instrument, the 25-foot reflector, was in its optical parts largely inspired by Herschel, but the unusual mounting was developed by Schröter himself, who tried to find a new construction which seemed to him more practical for his purposes.

Especially for the International Scientific Conference of the Astronomische Gesellschaft the author has built not only a 1:200 scale model of the former 'Amtsgarten' in Lilienthal where Schröter had once erected his various instruments, but also a 1:25 scale reconstruction of the famous 25-foot reflector. With the help of these models the author in his lecture will give a description of the Schröter observatory, especially of the 25-foot telescope: how it was used, what observations were made with it, what defects it had and what improvements later became necessary.

F 02

Friedrich Wilhelm Bessel (1784–1846) and the Russian Astronomy

Vera N. Ichsanova (Pulkovo Observatory, St. Petersburg, Russia)

In the first half of the 19th century the foundations of stellar astronomy were established thanks to the German astronomer, geodeticist and mathematician Friedrich Wilhelm Bessel. Internationally estimed and in close relationship with scientists in many countries, especially in Russia, Bessel (although not yet 30 years old) in 1814 became a foreign member of the Petersburg Academy of Sciences. Wilhelm Struve, director of the Dorpat observatory, was in close contact with him. Together they discussed problems of observational procedures and the use of instruments. In 1817 Struve bought the same Reichenbach meridian circle as Bessel used in Königsberg. Both ordered their refractors from the famous Fraunhofer workshop in Munich. Bessel was also involved in the high precision Russian geodetic survey which started in 1816 and which succeeded in connecting the Russian and western European triangulation networks. Struve tried to measure parallaxes using the bright star Vega (α Lyrae); his results were published in 1837. Also in 1837 Bessel, using his Fraunhofer heliometer and the star 61 Cygni, found a result close to modern values, later acknowledged with the Gold Medal of the Royal Astronomical Society. In 1834 Struve was named director of the new Russian observatory in Pulkovo, St. Petersburg. Struve discussed the plans with Bessel and both acquired a Repsold meridian circle. The next aim, begun in the 1840s – after the first determination of stellar distances – was the distribution of stars in space (in the Milky Way). For this, catalogues with not only accurate stellar positions but also brightnesses were necessary. Thanks to Bessel's thorough reformation of measuring and reduction methods, making possible high accuracy telescopic observations, Struve was able to produce important results in stellar astronomy.

F 03

The International Relations of the Struves

W. R. Dick (Otterkiez 14, D-14478 Potsdam, Germany)

At least 10 astronomers in 5 generations belonged to the Struve dynasty, a family having its origin in Holstein and living in Germany, Russia, the USA and other countries. The best known astronomers among them were Wilhelm (1793–1864), Otto Wilhelm (1819–1905), Hermann (1854–1920), Ludwig (1858–1920), Georg (1886–1933) and Otto Ludwig Struve (1897–1963). After a short account of the family's history, its international relations will be regarded, with emphasis on the following aspects: Nationality/citizenship, places of living and work, personal relations to other astronomers including correspondence and cooperation, travels, languages of publications.

Although a comparison of the different members of the family is possible only to a certain degree due to their different role and importance in astronomy, some changes which developed over 150 years can be traced: E.g., Wilhelm Struve published in German, Latin, French, Russian and English, whereas his grandsons and great-grandsons wrote their papers mainly in one language – German or English. Wilhelm had relatively close relations with French astronomers, whereas his great-grandson Georg was the author of verbal assaults on French scientists. Georg published also heavy criticism of the International Astronomical Union, whereas his cousin Otto Luwig later became IAU's President.

F 04

The Internationalization of the 'Astronomische Gesellschaft'

Gudrun Wolfschmidt (Institut für Geschichte der Naturwissenschaften,
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Organized internationalization in astronomy started with a first meeting of 15 European astronomers in Gotha in 1798. Two years later the 'Vereinigte Astronomische Gesellschaft' (VAG) was founded in Lilienthal, near Bremen, to organize the compilation of ecliptic star charts for finding the missing planet between Mars and Jupiter. Also, cooperation was planned for observing comets and variable stars. More than half of the members originated from non-German speaking countries. For publication of the results the 'Monatliche Correspondenz' was founded in 1800 by Franz Xaver von Zach (1754–1832). I will not discuss here the resulting success (discovery of the asteroids and in 1845 the publication of the 'Berliner Akademische Sternkarten').

The problem of reducing the increasing amount of asteroid observations came up in 1857 in the 'Section Geographie und Astronomie' (founded in 1828) of the 'Gesellschaft Deutscher Naturforscher und Ärzte'. From the two roots mentioned, the 'Astronomische Gesellschaft' was founded in Heidelberg in 1863 – again internationally structured: 11 out of 26 members were from foreign observatories, and until the 1930s well over 50% of the members were foreign. Again the main aim was international cooperation, particularly in compiling various catalogues and bibliographies (AGK1 and GuL). A difficult situation arose after World War I when the 'International Astronomical Union' (IAU) was founded, in 1919. But these two international organizations, the AG and the IAU, coexisted because they had different goals. Thanks especially to the Swedish astronomer Svante Elis Strömgren (1870–1947), who was elected president, the 'Astronomische Gesellschaft' still flourished throughout the 1920s.

F 05

Thomas Clausen – a Danish Astronomer and/or Mathematician in Altona and Tartu

Harald Gropp
(Mühlingstraße 19, D-69121 Heidelberg, Germany)

Thomas Clausen was born in Snogbaek in Denmark on January 16, 1801 and died in Dorpat (now Tartu) in Estonia on May 23, 1885. In 1824 Clausen became Schumacher's assistant at Altona observatory. Between 1828 and 1840 he worked in München as successor of Fraunhofer. After two years again in Altona he became observer at Dorpat observatory in 1842. Apart from his activities as astronomer he played a perhaps still underestimated role in mathematics.

In Denmark Clausen seems to be nearly forgotten as an important astronomer. However, the Danish Mathematical Society has one of his drawings as its logo. In Germany Clausen is not so much discussed since Altona was a Danish observatory. The second half of Clausen's life in Estonia is not well known in Central Europe since Tartu is far away from Germany and Denmark.

Clausen's life and work in the century of Olbers and Bessel are discussed, also from the point of view of international relations in astronomy. In particular, Clausen's Danish and Northern German context and the soon approaching 200th anniversary of his birthday in January 2001 were responsible for the choice of my topic.

F 06

The Rediscovery of Ceres in 1801

P. Brosche (Observatorium Hoher List der Sternwarte
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After the discovery by Piazzi, the first known asteroid disappeared in February 1801 at the day sky. Its rediscovery was the result of the combined efforts of a theoretician (Gauß) and a practitioner (Zach). The factual rediscovery took place at the end of 1801: Zach got first *sight* of Ceres on December 7 and gained the *insight* of its planetary nature on December 31. He was succeeded by Olbers, whose corresponding dates were January 1 and 2 of 1802.

F 07

Comets, Minor Planets and other developments: Bode's "Astronomisches Jahrbuch" as an international archive journal

W. Kokott (Institut für Geschichte der Naturwissenschaften der Universität München)

Following the example of the *Connaissance des tem(p)s*, the *Astronomisches Jahrbuch* founded by the Royal Academy of Sciences at Berlin was to include "a collection of the most recent observations, news, remarks and contributions". Established by *J. H. Lambert* and for four decades edited by *J. E. Bode*, this publication from the start became a ranking international publication, with Bode's modest Berlin Observatory serving as a clearinghouse of informations originating from virtually all European countries.

When, in 1792, the backlog of manuscripts became a critical factor, a series of "Supplement" volumes was established. *F. X. von Zach* at Gotha, who vigorously supported this effort, founded (in 1798) the monthly *Allgemeine Geographische Ephemeriden*, which he (with continuing emphasis on astronomy and astronomical geography) two years later replaced by the *Monatliche Correspondenz*. These journals and its successors (*ZfA* and *Corr. astr.*) took the supplementary load off Bode's yearbook and served as speedier means of communication. However, the yearbook retained its original role as a central place of documentation. Only with the publication of Schumacher's *Astronomische Nachrichten* the center of astronomical communication did shift from Berlin to Altona.

Practically all European astronomers of his time and age are represented in the pages of Bode's yearbook. Beside the continuous effort of precise mapping the realm of fixed stars, a very important field were the newly discovered planets Uranus, Ceres, Pallas, Juno, and Vesta; observations and orbits of these objects and the growing number of comets were an important part of the "news and remarks" recorded in the *BAJ*. The names of *Schröter, Olbers, Piazzi*, and *Bessel* may be regarded as representative for many other contributors.

F 08

Leo de Ball and his Contribution to International Astrometry Projects around 1900

P. Habison
(Kuffner-Sternwarte, Johann Staud-Strasse 10, A-1160 Wien, Austria)

Leo de Ball was born in Lobberich at the German-Dutch border in 1853. From 1871 onwards he studied astronomy and physics at the universities in Berlin and Bonn. After having received his doctorate in 1877 he became assistant at the "Herzogliche Sternwarte in Gotha". From 1881–82 he spent two years at the "Sternwarte des Kammerherrn von Bülow" in Bothkamp. There he discovered the minor planet "Athamantis" on 3 September 1882. In 1883 he followed an invitation from Folie to the observatory Ougrée near Lüttich. There he published four remarkable papers on stellar and planetary astrometry.

In 1891 he received a call to Moriz von Kuffners observatory in Vienna and was assigned director of this young institute. In the same year he started to participate in international projects. During that time it was suggested to extend the "Zonenunternehmen der Astronomischen Gesellschaft" also to southern declinations. Leo de Ball contributed to this project and Kuffner Observatory was assigned the southern declination zone from –6 to –10 degrees. This work occupied most of his time from 1892 to 1902. The catalogue of 8468 stars down to magnitude nine was finally published in 1904.

In 1900 Leo de Ball initiated a new project for determining relative parallaxes of 252 stars in collaboration with four observatories in Europe and the United States. Although the project was only partly realized, Leo de Ball published relative parallaxes of 16 stars, observed from 1901–07 with the Vienna heliometer.

The talk will give a brief overview of Leo de Ball's life and will then focus on his work and international collaborations from 1891–1916.

F 09

A Calendar Observatory for the 21st Century

B. Steinrücken, T. Morawe (Westfälische Volkssternwarte und Planetarium,
Stadtgarten 6, D-45657 Recklinghausen, Germany)
R. Vanscheidt (Astronomisches Institut der Ruhr-Universität Bochum,
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In ancient times the calibration of astronomical observations with respect to the local physical horizon provided the possibility to adjust calendar data with high accuracy according to the apparent movement of the sun, the moon and the stars.

To reanimate the lost tradition of 'visual horizon-astronomy', enforcing pedagogical purposes in astronomical teaching and sharpening the public mind for the relationship and interaction of natural cycles, a design study is proposed to build a non-profit and alltime-open calendar observatory for the general public in the northern part of the Ruhrgebiet near Recklinghausen/Herten, Germany. A technical description of the project is given in a poster presentation at this conference (Steinrücken, B. et al.).

Besides educational aspects, practical research in archaeoastronomy may be established at the site. Of astronomical relevance are empirical tests to determine the exact position of the lunar standstill without any knowledge of the heliocentric paths, nodes, and time of declination maximum. A revision of statistical arguments (Thom 1958) is mandatory due to large variations of astronomical refraction near the horizon (Schaefer & Liller 1990). Guided by historical paragons we discuss adequate foresight constructions in order to detect stellar precessional motion within a decade by naked eye observation only. A recently discovered prehistoric observatory in Westphalia, Germany will be introduced linking the idea of a modern calendar observatory to the work of our predecessors.

Short Contributions CT

Miscellaneous Subjects

Contributed Talks CT 01 ... CT 05

CT 01

The Effect of the 1999 Total Solar Eclipse on a Foucault-pendulum

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A. Wirrer, (Rosittengasse 32a, A-5020 Salzburg)

We present the result of a series of observations of the Foucault-pendulum at the *Technisches Museum Wien* before, during and after the total solar eclipse on August 11, 1999. The progression of the azimuth of the plane of oszillation of the penduum was observed on three days centered around the eclipse as well as 1 day centered around the following new moon. Systematic deviations from the nominal value for the Foucault-effect have been observed resulting in azimuth deviations of a few degrees. Similar values have been reported in earlier experiments. We propose a mechanism, based on pressure-modulated air drag, to account for the observed deviations. An eclipse-effect on a Foucault pendulum can then be explained as air drag modulation caused by the atmospheric pressure modulations due to the moon's shadow.

CT 02

New Phenomena and Statistics of Stellar Long-term Variability

Kroll, P. (Sonneberg), Vogt, N. (Santiago de Chile / Heidelberg),
Braeuer, H.-J. (Sonneberg), Splittgerber, E. (Sonneberg)

Plate archives contain hundreds of thousands of individual images, taken from the beginning of last century up to the present. The Sonneberg Plate Archive, a collection of some 270,000 plates, is in the process of being digitized.

First investigations on the basis of selected fields in the Orion/Taurus/Auriga region have been conducted. 300 more or less randomly chosen stars were examined for variability on about 500 plates taken between 1960 and 1996.

Although the intrinsic photometric accuracy of individual data points is only in the order of 0.1 mag, the findings were a surprise:

1. Among the stars investigated, new types of variability have been detected. We found irregular stars, objects with cyclic variations with peroids of some thousand days and several tens of mag amplitude, and stars of slowly increasing and decreasing brightness of a few hundredths of magnitude over decades.

2. It turned out that significantly more than 50 percent of the stars have to be regarded as variable. A lot of HIPPARCOS-constant stars reveal variability on long time scales.

The talk gives a brief overview about the potential of digitized plate archives from the aspect of detecting and investigating long-term variability and shows first results.

CT 03

The Burst Monitor (GBM) on-board GLAST

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on behalf of the GBM collaboration

The Gamma-ray Large-Area Space Telescope (GLAST) will be the next major NASA mission for high-energy γ-ray astronomy after EGRET. Presently the launch is foreseen for the end of 2005. Its scientific objective will be to observe AGNs, pulsars, SN remnants and interactions of cosmic rays with the interstellar medium from 10 MeV to 300 GeV. Another important objective will be the study of γ-ray burst spectra and time profiles at the high-energy end.

A Burst Monitor ((GBM) will be on board of GLAST and will be built, by a collaboration of MSFC/UAH and the MPE, to enhance the γ-ray burst-detection capability of GLAST considerably. It will measure burst spectra between 5 keV and 30 MeV with an energy resolution between $\approx$3% (at 20 MeV) and $\approx$50% (at 5 keV). Thus an energy range of more than 6 decades will be accessible in burst spectra for the first time. Moreover it will measure the light curves with an absolute time accuracy of 10 μsec. Furthermore the GBM will provide an on-board position to the main instrument for repointing purposes, allowing for an observation of a burst with the main telescope within 10 minutes. Through an energy range similar to that of BASTE continuity with the large data base of γ-ray burst-spectra parameters can be achieved, putting the expected high-energy emission in a better context. In this talk the scientific goals of the GBM and its technical realisation will be presented.

CT 04

A Search for X-ray Transient AGN

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We present ROSAT All-Sky Survey and ROSAT pointed observations (PSPC and HRI) of a complete sample of 113 bright soft X-ray selected AGN. We compare these observations in order to search for extreme cases of flux and spectral X-ray variability - X-ray transient AGN. Among the objects of our sample we found three secure sources to be transients and one possible transient candidate. The other sources show amplitude variations typically by factors of 2-3 on timescales of days. We found a trend that sources that have become fainter in X-rays show harder X-ray spectra. We also present new HRI measurements of our extreme X-ray transients IC 3599 and WPVS007. We discuss possible models that can explain the X-ray transience and the variabilities observed in the more calmer sources.

CT 05

NLTE Spectral Analysis of K 648, the Exciting Star of Ps 1 in M15

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K 648 is the central star (CS) of the apparently small (diameter $1''$) planetary nebula (PN) Ps 1 in the globular cluster M 15 and hence, K 648 is one of only a few presently known halo CSPN.

Based on medium-resolution optical (TWIN spectrograph attached to the 3.5m telescope at the Calar Alto) and UV (FOS and GHRS aboard the Hubble Space Telescope) spectra, we present the results of an ongoing spectral analysis of K 648 by means of state-of-the-art NLTE model atmosphere techniques.

We find an effective temperature $T_{\rm eff} = 40\,{\rm kK}$ and a surface gravity $\log g = 3.9$ (cgs). The photospheric carbon, nitrogen, oxygen, and silicon abundances as well as the iron and nickel abundances appear enriched when compared to solar composition.

P

Poster

Sun, Solar System, Stars,
Interstellar Matter, Galaxy,
Extragalactic Systems, Cosmology,
Instruments

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P 01

Radiation Hydrodynamics Simulations of the Solar Chromosphere

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While heating of the solar corona is commonly attributed to reconnection of magnetic field lines, the mechanism responsible for heating the chromosphere of the quiet Sun, away from active regions, is still under debate[1,2]. The basic question which we will address in this contribution is: Can generation of acoustic waves by turbulent convection in photospheric and subphotospheric layers explain the chromospheric emission of the quiet Sun?

With a new 3D radiation hydrodynamics code[3] we are able to compute models extending from the upper convection zone to the middle chromosphere. The code can handle shocks with a minimum of numerical dissipation. Therefore generation and propagation of acoustic waves can be investigated, permitting the evaluation of wave dissipation in the chromosphere in a physically consistent manner. We present first results and discuss the principal problems and future prospects.

[1] Carlsson, M., Stein, R.F., 1995, ApJ 440, L29
[2] Kalkofen, W., Ulmschneider, P., Avrett, E.H.,1999, ApJ 521, L141
[3] Freytag, B., Steffen, M.

P 02

Direct Imaging Search for Sub-stellar Companions Next to Young Nearby Stars

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We report first results from our ground-based infrared imaging search for sub-stellar companions (brown dwarfs and giant planets) of young (up to 100 Myrs) nearby (up to 75 pc) stars, where companions should be well separated from the central stars and still relatively bright due to ongoing accretion and/or contraction. Among our targets are all members of the TW Hya, MBM 12, and Tucanae associations, as well as other binary and single young stars either discovered recently among ROSAT sources (some of which as yet unpublished) or known before. Our observations are performed mainly with SOFI and SHARP at the ESO 3.5m NTT on La Silla and with ISAAC at the ESO 8.2m Antu (VLT-UT1) on Cerro Paranal, as well as with the ALFA adaptive optics facility on the Calar Alto 3.5m, all in the H- and K-bands. We present direct imaging data and H-band spectra of a several faint objects detected next to young nearby stars, which (if at the same age and distance as the central star), are substellar, with masses from a few to 40 Jupiters. For the brown dwarf companion of TWA-5 we also show optical data taken with FORS2 at the VLT-UT2 with tentative indication for orbital motion.

P 03

VLT/ISAAC Spectroscopy of the (ex?)-Candidate Protoplanet TMR-1C

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We present near-infrared low-resolution spectra (R=3D450) of TMR-1C, a faint object located approximately 10 arcseconds south-east of the class I protobinary TMR-1. The striking location of TMR-1C at the tip of a narrow filament emanating from the nebulosity surrounding TMR-1 suggested a physical association. With the assumption of an association, and from the analysis of their photometric measurements, Terebey et al. (1998) reported that TMR-1C may be a protoplanet of several Jupiter masses, which was ejected from the protobinary system TMR-1.

Our observations were carried out with the ISAAC instrument at the Very Large Telescope (VLT), with the slit positioned on TMR-1C, covering also a large part of the filament. The spectrum of the filament shows strong molecular line emission, as well as a continuum component most likely originating from scattered stellar light. The spectrum of TMR-1C itself is featureless (at the given S/N of the data), and rejects the possibility of it being a very cold, low-mass object. An interpretation of our spectrum of TMR-1C in terms of a field background object is possible, but not unambigious. This is consistent with very recently published results from lower resolution near-infrared spectra taken with the Keck telescope (Terebey et al. 2000).

P 04

Spectroscopic Search for Atmospheric Signatures of Extra-solar Planets

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If the orbital inclination of an extra-solar planet is close to 90°, the planet will transit through the line-of-sight from Earth towards the star. During transit phases, the stellar light will pass through the planetary atmosphere, and absorption lines, caused by atoms/molecules in the planet's atmosphere, may be detected in high-resolution spectroscopic observations.

We have searched for absorption features in spectra of 51 Peg, τ Boo and HD209458 during transits of their planets through the lines of sight. Spectra in the optical wavelength range were taken using the UES spectrograph at the 4m William Herschel telescope at La Palma, Spain.

P 05

The Structure of Self-Gravitating Accretion Disks

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In recent years the HST detected numerous massive disks around young stars and in the centers of galaxies. Furthermore it is likely that disks around black holes in AGN are at least marginally self-gravitating. To compare the observed features of those disks with theoretical models it is necessary to take self-gravity into account – in the vertical direction for all disks with masses above a few percent of the central mass and in radial direction for all disks with comparable mass.

In our theoretical models we assume differentially but not necessarely Keplerian rotating, thin but massive disks, that are in vertical hydrostatic equlibrium. To avoid the disadvantages of standard α-disks in the limit of self-gravitating accretion disks we use for the viscosity the β-ansatz (Duschl et.al., 2000). Our disk models include radiation transport and different kinds of opacity sources, and our disks are allowed to become optical thin.

Applications for these models are protoplanetary disks in early evolution phases before planetesimals build and the azimuthal symmetry breaks down, and massive gaseous and molecular disks around black holes in the centers of galaxies, particularly in the centers of merging galaxies, where the gas is known to collaps inwards very rapidly. Here we present model calculations for these applications.

References

Duschl, W.J., Strittmatter, P.A., Biermann, P.L.; 2000, A&A 357, 1123

P 06

Diffraction-limited Bispectrum Speckle Interferometry and Speckle Polarimetry of the Young Bipolar Outflow Source S140 IRS1

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We present bispectrum speckle interferometry and speckle polarimetry of the deeply embedded infrared bipolar outflow source S140 IRS1, a massive protostellar object in the L1204 molecular cloud. Using the SAO 6 m telescope, we obtained 280 mas resolution polarization maps of S140 IRS1 as well as a K-band image with diffraction-limited resolution λ/D of 76 mas, which is the highest angular resolution image of a young outflow source ever obtained in the infrared. Our data suggest that the central source is marginally resolved with a FWHM diameter of approximately 20 mas ($\sim$ 20 AU). The most remarkable feature in our image is a bright extended and very clumpy structure pointing away from the central source in exactly the same direction as the blue-shifted CO outflow lobe. A centro-symmetric pattern of high polarization in this feature suggests that we see scattered light from the central source. We interprete this feature as the clumpy inner surface of a partially evacuated cavity in the circumstellar envelope around IRS1, which has been excavated by the strong outflow from IRS1.

P 07

Dust Formation in Brown Dwarfs

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Brown Dwarfs provide favorable conditions for the gas-solid phase transition since in its atmosphere low temperatures with high densities are combined. Observations of unexpectedly weak molecular absorption bands indicate the existence of dust in their atmospheres.

Considering stability arguments, high temperature compounds like $CaTiO_3$, $Fe_{2-x}Si_xO_4$ or Al_2O_3 are expected to form first. Another argument for the formation of heterogeneous dust is given by the wide variety of molecular species of comparable abundances in an oxygen-rich gas. The description of the formation of such heterogeneous particles, however, is still a matter of debate since the nominal molecules are only present in negligible amounts or even completely absent in the gas phase. Furthermore, the formation of solid particles has to proceed via the formation of seed particles which is followed by the growth towards macroscopic sizes. Thereby, a large supersaturation has to be achieved which results in a considerable gap between typical nucleation temperatures and the sublimation temperatures of plane solid. Promising astrophysical seed candidates are $(TiO_2)_N$ and $(Fe)_N$ clusters which appears in appropriate amounts in oxygen-rich gases; Fe seeds maybe even more favorable in the densest regions of the atmospheres ($n_{<H>} > 10^{19}\mathrm{cm}^{-3}$).

In this presentation, the efficiency of nucleation and the stability of solid compounds are examined for a typical atmosphere of a Brown Dwarf in comparison to M dwarfs and Jupiter-like planets. We additionally present first results of numerical calculations for Brown Dwarf atmospheres including a detailed time-dependent, phase non-equilibrium description of the formation of core-mantel grains. Dust properties like the amount and the sizes of the solid particles are thereby a result of the calculation.

P 08

The Turbulence Structure in Molecular Clouds

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In order to reveal the turbulence structure of molecular clouds, systematic comparisons between observational signatures of turbulence and simulations of the physical processes driving the formation and evolution of cloud structures are required. The comparison has to rely on some statistical measures for the scaling of the density and the velocity structure that can be determined both in observational data and turbulence simulations. Studies of observational restrictions, like noise, showed that the Δ-variance is probably the most robust measure for the intensity structure. It is also suitable to characterize the velocity scaling when applied to the centroid maps in case of observations where the centroids are reliably determined at most points of the map. For observational data with large regions of low intensity, the combination of a generalized size-linewidth relation and the centroid structure function can be used. We compared observations of the Polaris Flare – a quiescent high latitude cloud – with simulations of uniform decaying and driven turbulence with and without magnetic fields performed with the MHD code ZEUS-3D. Different results for the scaling properties exclude turbulence models with strong magnetic fields, models driven at intermediate scales and decaying turbulence models at late stages. Several models driven at large scales match the observed velocity structure and provide the correct tendency in the density scaling, however, they do not yet reproduce the exact exponent obtained in the observations. More sophisticated turbulence simulations are needed.

P 09

Star Formation in Turbulent Molecular Cloud Cores

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Observations of line-of-sight velocity gradients along cuts across individual turbulent molecular cloud cores do generally not provide a good estimate of their internal specific angular momentum. Because of turbulent movements inside the core the assumption of rigid body rotation is not a good measure of its rotational parameters. However recent investigations, i. e. Burkert & Bodenheimer (ApJ, in press), show that the distribution of the line-of sight velocity gradients of a large sample of cores can be used to determine the distribution of their specific angular momenta. Up to now the structure of turbulent cores has been investigated in a very early stage of evolution. Here we will take a deeper look into the dynamical evolution and gravitational concentration of such cores and analyse how much information about the evolutionary stage is contained in their line-of sight velocity maps.

P 10

Fitting a Turbulent Cloud Model to CO Observations of Starless Bok Globules

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We present observations of five starless Bok globules in transitions of ^{12}CO (J=2-1 and J=3-2), ^{13}CO (J=2-1), and C^{18}O (J=2-1) which have been obtained at the Heinrich-Hertz-Telescope. For an analysis of the data we use the model of Kegel et al. (see e.g. Piehler & Kegel 1995, A&A 297, 841; Hegmann & Kegel 2000, A&A 359, 405) which describes an isothermal sphere stabilized by turbulent and thermal pressure. This approach deals with the full NLTE radiative transfer problem and accounts for a turbulent velocity field with finite correlation length. By a comparison of observed and calculated line profiles we are able not only to determine the kinetic temperature, hydrogen density and CO coloumn density of the globules, but also to study the properties of the turbulent velocity field, i.e. the variance of its one-point-distribution and its correlation length.

We consider our model to be an alternative tool for the evaluation of molecular lines emitted by molecular clouds. The model assumptions are certainly closer to reality than the assumptions behind the standard evaluation models, as for example the LVG model. Our current study shows that that the results obtained from our model can differ significantly from those obtained from a LVG analysis.

P 11

Spectroscopy of Molecular Hydrogen in Outflows from Young Stars

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We present new medium-resolution longslit spectroscopy of near-infrared lines from molecular hydrogen in a number of outflows from young stars. We comment on various H_2 excitation mechanisms of outflows from the literature, and compare them with our observations.

The large-scale shock geometry of the flows is probed both by H_2 position-velocity diagrams and line ratios. Observed excitation variations are best interpreted by magneto-hydrodynamic C-shocks, although we find some locations which display hydrodynamic J-type excitation. VLA 1623, in particular, is accurately modelled by a C-type bow, whereas we favour a planar J-type model for HH 57. HH 1/2, on the other hand, may consist of a collection of molecular bow and planar shocks. Interestingly, the H_2 emission from the leading edge of the HH 1 bow structure is from a low-excitation oblique wing from one of many mini bow shocks rather than from fluorescence or a magnetic precursor.

The jets themselves are also traced in molecular hydrogen emission in two of our objects. In the infrared jet in HH 47C observed radial velocities are consistent with the proper motions, and hint at ballistic motions originating in an eruptive event about 280 years ago. In this jet, as well as in the HH 1 infrared jet, we find the excitation to decline with distance from the source.

P 12

X-ray Luminosity Functions of Young Stars: T Tauri Stars, Pleiades, and Hyades

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We report on coronal activity of pre-main sequence and young main sequence stars in the Taurus region as observed by *ROSAT*. X-rays of late-type stars are related to magnetic structures in the corona which are produced in a dynamo mechanism, generally described in analogy to the solar case. The details of the heating process and temporal evolution of the dynamo efficiency are not well understood.

The sample studied here represents the largest set of X-ray observations in the Taurus region analysed jointly, and provides better sensitivity than the *ROSAT* All-Sky Survey due to the use of *ROSAT* pointed PSPC observations. Our stellar sample is composed of T Tauri stars from the Taurus-Auriga region, and late-type stars from the Pleiades and Hyades clusters. The different ages of these regions allow a study of the evolution of coronal X-ray emission during early stellar phases. We analyse and compare the X-ray luminosity functions (XLF) for subgroups of stars from the above regions to learn more about the influence of age, mass and multiplicity on the observed X-ray emission level. The pre-main sequence stage is characterized by two classes of TTS, classical TTS and weak-line TTS, which show different XLF: in the Taurus region weak-line TTS are X-ray brighter than classical TTS. For stars on the main-sequence the X-ray emission declines with increasing mass (or effective temperature), indicating the importance of the convection zone for the stellar dynamo.

P 13

Influence of the Metal Abundances on the Dust-driven Winds of LPVs

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Dust formation is a widespread phenomenon and has been theoretically studied in the frame work of circumstellar envelopes (CSE) of late type stars with solar metallicity. Dust acts as an important dynamic component in such luminous objects due to its large absorption coefficient (at least $100 \times \kappa^{\rm gas}$). The dust formation itself depends sensitively on the chemical composition of the gas as well as the thermodynamic conditions in the CSE.

This presentation concerns time-dependent models of dust forming long-periodic variables (LPVs, see Fleischer et al.) which exhibit a non-solar metallicity designed to resemble that of the Large Magellanic Cloud (LMC). The elemental abundances affect the composition of the molecular gas and thereby the dust formation via the amount of condensible material but also the temperature and density structure of the CSE via radiative transfer effects. Models of different metallicities (solar and LMC), where the gas opacity has been approximated by its Planck mean, are examined with regard to the changes in the efficiency of the mass loss of dust-driven winds.

P 14

Circumstellar Dust Shells of Pulsating Red Giants as Dynamical Systems

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Miras and long-period variables (LPVs) are highly evolved, pulsating stars on the Asymptotic Giant Branch (AGB) with massive outflows and prominent circumstellar dust shells (CDSs). A CDS, driven by the stellar pulsation, can be considered as a dynamical system which reveals various kinds of complex phenomena like spatio-temporal instabilities, bifurcations, multiperiodicity and transition to chaos.

In order to analyze the temporal behavior of the CDS standard methods known from the theory of non-linear dynamical systems are applied. We have developed a spherical symmetric, multi-zone description for the CDS which includes the important physical interactions by means of non-linear coupling terms. The corresponding Hamiltonians are derived.

We present Poincaré maps for several models with a different number of zones in order to characterize their dynamical stability. The role of pulsation and dust formation for the development of the dynamical structure of the CDS is investigated. In addition, the linearized approximation of an one-zone model is discussed with respect to the Kolmogorov-Arnold-Moser and the Poincaré-Birkhoff theorems.

P 15

On the Dynamic Stability of Small Dust Particles in Circumstellar Environments

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The high-resolution spectra of ISO have revealed the possible existence of crystalline silicate dust components in the circumstellar environments of oxygen-rich AGB and post-AGB objects (see e.g. Waters *et al.*, A&A, **315**, p. L361ff, 1996; Sylvester *et al.*, A&A, **352**, p. 587ff, 1999). The formation of such crystalline structures is rather puzzling, because it is usually accepted that the small particles formed in the outflows of AGB stars exhibit an amorphous structure, which is evident from the broad spectral features e.g. around 9.7μm. Therefore a process is required to "rearrange" the particle structure into a crystalline configuration.

In order to take a first step to investigate this intriguing problem, we study the dynamic stability of small sized inorganic particles by means of molecular dynamic simulations. Using an ionic potential model for the interchange energy in these grains and a standard Verlet velocity algorithm we calculate dynamic and structural properties for some exemplary particle sizes at different temperatures which are typical for the physical conditions in such circumstellar environments. We address the question, which kind of structures of very small grains are to be expected: crystalline or so called *surface-melted* structures? Some consequences for the dust formation process and the mineralogy of circumstellar dust are discussed.

P 16

Stellar Evolution with Rotation: Mixing Processes in AGB Stars

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We included diffusive angular momentum transport and rotationally induced mixing processes in our stellar evolution code and studied the influence of rotation on the evolution of intermediate mass stars ($M_* = 2 \ldots 6\,\mathrm{M}_\odot$) towards and along the asymptotic giant branch (AGB). The calculations start in the fully convective pre-main sequence phase and the initial angular momentum was adjusted such that on the zero-age main sequence $v_{\mathrm{rot}} = 200\,\mathrm{km/s}$ is achieved. The diffusion coefficients for the five rotational instabilities considered (dynamical shear, secular shear, Eddington-Sweet (ES) circulation, Solberg-Høiland-instability and Goldreich-Schubert-Fricke (GSF) instability) were adopted from Heger et al. (2000, ApJ 528, 368). Mixing efficiency and sensitivity of these processes against molecular weight gradients have been determined by calibration of the main sequence width. In this study we focus on the abundance evolution of carbon. On the one hand, the surface abundance ratios of $^{12}\mathrm{C}/^{13}\mathrm{C}$ and $^{12}\mathrm{C}/^{16}\mathrm{O}$ at the base of the AGB were found to be $\approx 7 \ldots 10$ and ≈ 0.1, resp., being a factor of two lower than in non-rotating models. This results from the slow but continuously operating rotationally induced mixing due to the ES-circulation and the GSF-instability during the long main sequence phase. On the other hand, $^{13}\mathrm{C}$ serves as neutron source for interior s-process nucleosynthesis in AGB stars via $^{13}\mathrm{C}(\alpha, n)^{16}\mathrm{O}$. Herwig et al. (1997, A&A 324, L81) found that a $^{13}\mathrm{C}$ pocket is formed in the intershell region of $3\,\mathrm{M}_\odot$ AGB star if diffusive overshoot is considered. Our calculations show, that mixing processes due to rotation open an alternative channel for the formation of a $^{13}\mathrm{C}$ pocket as found by Langer et al. (1999, A&A 346, L37). Again, ES-circulation and GSF-instability are the predominant rotational mixing processes.

P 17

Observations of Mira Stars with the IOTA/FLUOR Interferometer and Comparison with Mira Star Models

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We present K-band observations of five Mira stars with the IOTA interferometer. The interferograms were obtained with the FLUOR fiber optics beam combiner which provides high-accuracy visibility measurements in spite of time-variable atmospheric conditions. For the Mira stars X Oph, R Aql, RU Her, R Ser, and V CrB we derived the uniform-disk diameters 11.7mas, 10.9mas, 8.4mas, 8.1mas, and 7.9mas (± 0.3 mas), resp. Simultaneous photometric observations yielded the bolometric fluxes. The derived angular Rosseland radii and the bolometric fluxes allowed the determination of effective temperatures. For instance, the effective temperature of R Aql was determined to be $3072\,\mathrm{K} \pm 161\,\mathrm{K}$. A Rosseland radius for R Aql of $250 R_\odot \pm 63 R_\odot$ was derived from the angular Rosseland radius of $5.5\,\mathrm{mas} \pm 0.2\,\mathrm{mas}$ and the HIPPARCOS parallax of $4.73\,\mathrm{mas} \pm 1.19\,\mathrm{mas}$. The observations were compared with theoretical Mira star models of Bessel, Scholz & Wood (1996) and Hofmann, Scholz & Wood (1998) (D/P model Rosseland radius $= 255 R_\odot$).

P 18

The VLT Interferometer and its AMBER Instrument: Simulations of Interferometric Imaging in the Wide-Field Mode

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We present computer simulations of interferometric imaging with the VLT interferometer and the AMBER instrument. These simulations include both the astrophysical modelling of a stellar object by radiative transfer calculations and the simulation of light propagation from the object to the detector (through atmosphere, telescopes, and the AMBER instrument), simulation of photon noise and detector read-out noise, and finally data processing of the interferograms. The results show the dependence of the visibility error bars on the following observational parameters: different seeing during the observation of object and reference star (Fried parameters $r_{0,\mathrm{object}}$ and $r_{0,\mathrm{ref.}}$ ranging between 0.9 m and 1.2 m), different residual tip-tilt error ($\delta_{\mathrm{tt,object}}$ and $\delta_{\mathrm{tt,ref.}}$ ranging between 0.1% and 20% of the Airy disk diameter), and object brightness (K_{object}=3.5 mag to 13 mag, $K_{\mathrm{ref.}}$=3.5 mag). Exemplarily, we focus on stars in late stages of stellar evolution and study one of its key objects, the dusty supergiant IRC +10 420 that is rapidly evolving on human timescales. We show computer simulations of VLT interferometry of IRC +10 420 with two ATs (wide-field mode, i.e. without fiber optics spatial filters) and discuss whether the visibility accuracy is sufficient to distinguish between different theoretical model predictions.

P 19

Pre-Main Sequence Evolution of Massive Population III Stars

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The very first generation of stars in our universe, the hypothetical Population III stars, are thought to have formed from gas extremely deficient of metals ($Z > 2$). Particularly the absence of the elements **C**, **N** and **O** leads to peculiarities in the energy generation mode of massive stars.

We investigate those peculiarities within the framework of an extended time-dependent nuclear reaction network being coupled to stellar structure calculations.

P 20

Betelgeuse – Towards Numerical Simulations of an Entire Supergiant

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The brightness of the well-known red supergiant Betelgeuse varies on time-scales of weeks, months, and years. For a dedicated observer these fluctuations are even visible with the naked eye. In 1975 Martin Schwarzschild attributed them to huge convection cells, each of them covering a significant fraction of the stellar surface, so that the individual fluctuations result in an overall non-vanishing variation of the stars luminosity.

Starting about 10 years ago, numerous interferometric observations in the visible wavelength regime revealed the existence of large-scale brightness inhomogeneities on the surface of Betelgeuse, typically described as 0 to 3 unresolved "hot spots" on a cooler circular stellar disk, varying with time in number, intensity, and position. HST demonstrated deviations of the stellar UV image from spherical symmetry.

Nevertheless, the observations have still a poor resolution, resulting in surface "images" with only a handful of pixels. And there has been some debate about the nature of the detected surface features: Are they of convective origin due to the action of granules or supergranules? And what is the role of shocks, stellar rotation, or magnetic fields?

To improve the theoretical understanding of the surface phenomena of Betelgeuse, a new radiation hydrodynamics code has been written with the aim to include the entire star in the computational box. It employs special inner (for the stellar core) and outer boundaries appropriate for this particular geometry. Starting with down-scaled toy models and approaching the parameter regime appropriate for Betelgeuse, some results about the dynamics of large convective cells on a spherical stellar surface will be presented.

P 21

The Orbit(s) of the RS CVn-star UX Arietis

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UX Ari belongs to the class of very active RS CVn-stars and has recently been the target of surface (Doppler) imaging. Although this technique needs a quite accurate determination of the orbit (in order to have the correct period for phasing and the correct Doppler shift correction of the line profiles) we found only one, quite old orbit solution, which has subsequently been used by everyone.

We used all published radial velocities (RVs), supplemented by a large number of our own recent, high-accuracy RVs of both the primary (K0 IV) and the secondary (G5 V) to improve the orbit of UX Ari. Additional to the improved set of parameters, we found that *the γ-velocity of the system is systematically changing over time*. It seems that UX Ari is a triple system. Actually, a third star is weakly present in the spectrum. It is, however, very doubtful that this star is really a member of the system; it is more likely a background object, *whose RV is also changing*. Additionally, conclusions about the *physical parameters* of the objects from the orbits are presented.

P 22

Periodic Variations in RW Aur A: Non-axisymmetric Accretion

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Spectroscopic and photometric monitoring of the young star RW Aur was carried out at the Nordic Optical Telescope in 1995–1999. We discovered periodical modulations in many spectral features related to accretion of the circumstellar gas onto the star. The radial velocities of the photospheric lines and those of the narrow emission lines of He I vary in anti-phase, with a period of 2.77 days. The same period is found in the strengths of the red-shifted absorption features formed in the streams of the accreting gas. The strength of these accretion features correlates with the intensity of the He I line, which suggests that this line is formed in a hot shock at the footpoint of the acrretion column, where the gas hits the stellar surface at the infall velocity of 400 $\mathrm{km\,s^{-1}}$. The photospheric spectrum is highly veiled, presumably by continuum radiation of the hot spot, but the expected correlation between the veiling and the brightness of the star was not found. We suggest two models of a *non-axisymmetric accretion*, where the asymmetry is caused either by a low-mass companion orbiting the star, or by a misalignment of the magnetic and rotational axes of the star.

P 23

Numerical Simulations of Stellar Pulsations in Two Dimensions – Technique and First Results

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We report on the status of the development of a numerical code for the simulation of non-radial stellar instabilities and pulsations. This work is subject of a collaboration between the Institute of Mathematics of the Academy of Sciences of Moldova and the Universitäts-Sternwarte Göttingen. It was motivated by the discovery of strange-mode instabilities in luminous stars which do not only affect radial but also nonradial perturbations. 1D calculations (spherical geometry) of their evolution into the nonlinear regime have shown that these instabilities lead to high velocity amplitudes and may imply direct mass loss thus strongly suggesting an extension of such studies to multidimensional simulations.

The numerical scheme is based on a Lagrangean description and adopts a triangular grid. Time differentiation is done in an implicit way. These properties allow the scheme to be fully conservative and guarantee unconditional numerical stability. Moreover, free boundaries can be treated easily and the time step is not limited by the CFL condition. Apart from standard tests (e. g., Noh's test) the code satisfies various additional requirements which we believe to be indispensable, if it is to be applied to stellar stability and pulsation problems. One of them consists of a perfect reproduction of independently determined linear results, i. e., in an unstable situation the code has to identify the correct unstable mode from a hydrostatic initial model without an additional external perturbation. First results concerning strange-mode instabilities in luminous stars (massive objects, Wolf-Rayet stars) will be presented.

P 24

The Variability of Emission Lines in Shocked M Mira Atmospheres

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One of the outstanding problems concerning M Mira variables is the basic mass loss mechanism and its relation to stellar pulsation and dust formation. Theoretical works suggest that the substantial mass loss can be explained by the pulsation of the star producing shock waves which levitate the outer atmosphere and thereby trigger the dust formation, which in turn can amplify the shock waves. One way to probe the hydrodynamical conditions in different layers of the atmosphere influenced by the passing shock wave is to analyse a time resolved series of emission lines profiles. In particular emission lines appearing late in phase are good candidates to study the hydrodynamical conditions of the dust producing layers, since they appear when the shock wave has reached the outer atmosphere.

A sample of six M Miras (RR Sco, R Aql, R Car, R Leo, S Scl and R Hya), which range in period from 281 to 389 days, have been observed from maximum to minimum visible light. We obtained time resolved, high resolution spectra in the optical wavelength region (3600–5700 Å) of the Balmer emission lines H_γ, H_δ, H_ζ, H_η and several metal emission lines, namely Mg I, Mn I, Si I, Fe I, Fe II and [Fe II]. The variation with phase of the emission line profiles, the velocity shifts and fluxes are analysed in detail. Emphasis is put on metal emission lines which appear around the minimum light, in particular the [Fe II] lines, which are good candidates to probe the outermost atmospheric layers.

P 25

Time-resolved Spectroscopy of the Cataclysmic Variable CW 1045+525

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Although it still lacks a proper variable star designation, the system CW 1045+525 was classified as a dwarf nova already in 1988. This is based on the spectral characteristics which show the typical strong emission lines of the Balmer and Helium series. However, to our knowledge, no outburst has been reported so far for this system. Furthermore, the lightcurve shows a rather smooth ellipsoidal variation with a period of 6.5 h, which can be attributed to the secondary star. On the other hand, the two maxima of the lightcurve have different strength, which is indicative for the presence of a bright spot in the system. There are thus several mismatches (strong emission lines, but no outbursts – faint disk, if any, but long orbital period – polar-like lightcurve, but negligible HeII), which makes a thorough observation of this system worthwhile.

We here present time-resolved spectroscopy of the system. The data were taken during two observing runs in March and April 2000, with the 1.82 m telescope at Mt. Ekar, Asiago, using the AFOSC system. Our measurements cover both a blue ($\lambda 4500 - 6600$ Å) and a red ($\lambda 6300 - 8400$ Å) part of the spectrum, with a resolution of 9 Å and 8 Å, respectively. In our poster we will study the variations of the radial velocities in comparison to the photometric lightcurve, and address the question of the contribution of the secondary.

P 26

Nova CI Aquilae in Decline

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CI Aquilae was discovered due to an outburst recorded on Heidelberg plates in June 1917 (Reinmuth 1925, *AN* 225, 385) and classified as a possible nova by Dürbeck (1987, *Space Sci. Rev.* 45, 1). The measured maximum of the outburst was about $m_{\rm pg} \approx 11^{\rm m}$ and thus rather low, but it is possible that the real maximum has been missed. On April 28, 2000 Takamizawa et al. (*IAUC* 7409, 1) discovered a probable nova in Aquila with $m_{\rm V} \approx 10^{\rm m}$ which seems to be identical with the 1917 nova. It reached its peak in the beginning of May at about $8\overset{\rm m}{.}7$ ($7^{\rm m}$ above quiescent phase). Thus it would be a recurrent nova with one of the longest known periods.

We present several near-infrared photometries of this object obtained with the ESO 1m-telescope and the DENIS instrument in the period from beginning of May (about 10 days after outburst) to beginning of July. We investigate low and high frequency variations in the declining light curve with additional data from the literature.

Furthermore, we obtained a spectrum of CI Aql with the Innsbruck 60cm-telescope on May 14. This spectrum shows a flat continuum from 4000 to 9000 Å and strong emission lines (1.5 to 9 times the continuum). The emission line profiles vary significantly between the different species. The velocities range from 3400 km/s FWHM (in case of H_α) up to 7400 km/s. The lines showing higher velocities are flat-topped.

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P 27

Non-LTE Abundance Analysis of Late B Stars

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Due to their shallow surface convection zones, the composition of main-sequence A and B stars responds sensitively to any 'contamination' by processes of diffusion or accretion. Accurate surface abundances and a sensitive search for circumstellar lines permits to trace the photospheric signatures of accretion differentially and at high sensitivity.

Extending our previous work on A stars (see references) to higher temperatures we have determined abundances of He, C, O, Ne, Mg, Si, Ca, Fe, Sr and Ba in 27 B5-B9 stars. Non-LTE corrections were taken into account. Our program stars occupy the interesting temperature regime where the transition between diffusion dominated atmospheres of A stars and massive radiative-driven winds of OB stars occurs. Therefore they provide an excellent tool to investigate the theoretically predicted onset of weak stellar winds producing mild overabundances of certain elements (Landstreet et al. 1998). In terms of diffusion and weak stellar winds we discuss results based on high S/N spectra obtained at La Silla, Chile and Terskol Observatory, Russia.

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P 28

Neon as a Tracer for the Detection of Weak Stellar Winds: NLTE Abundance Corrections for B Stars

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Weak stellar winds in B stars can influence the chemical composition of the stellar atmosphere. In the temperature range of late B stars theoretical models predict neon to be a tracer for the detection of these stellar winds. Therefore detailed NLTE abundance calculations are necessary. The modelling of neon became more reliable since the Opacity Project provided new atomic data, though only a few spectral lines exist, which can be used for reliable abundance determinations.

We present a Ne I/II model atom and show the results of a parameter study for the range of B stars. Our calculations show that NLTE corrections are indispensable for the search of weak stellar winds. This is strengthened by the results obtained for several B stars (see poster by Hempel et al.), the model atom also was used for.

P 29

Metal Oxide Clusters in Circumstellar Shells around Oxygen-rich Long-period Variable Stars

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The formation of metal oxide clusters, which are of significant importance for the condensation process of 'silicates' in the circumstellar shells oxygen-rich long-period variables (LPVs), is investigated.

There has been considerable interest in metal oxide clusters, that are important in many areas of physics, and all of which disclose an amazingly rich structural diversity of strongly bound neutral and charged isomers. For a study of dust condensation processes under the conditons of circumstellar shells around oxygen-rich LPVs, the information about the thermochemical quantities of the involved gas phase species is required. The relevant molecular properties were determined in the small cluster size regime by detailed quantum-mechanical *ab initio* and Density Functional Theory calculations.

Several energetically low-lying stationary points of small mixed isolated metal oxide systems were investigated. Energies, harmonic vibrational modes, and geometric parameters are used to calculate thermochemical data for the various species. Based on these information obtained, the formation processes of the corresponding metal oxide clusters are discussed.

P 30

Circumstellar Dust Shells around Oxygen–rich Long-period Variable Stars

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We present a consistent model for circumstellar dust shells (CDS) around O-rich long-period variable stars (LPVs). Since almost all carbon is locked up in the chemically inert CO molecule in an O–rich environment, the grains only can be formed from molecules containing the remaining oxygen and the less abundant elements Mg, Si, S, Fe, Al, Ti. This leads to a heterogeneous element composition of the emerging dust component.

Assuming chemical equilibrium in the gas phase, we describe the formation of the seed particles by means of a modified classical nucleation theory. The most promising seed nuclei appear to be TiO_2 clusters, which grow by addition of those molecular species which have a stable solid phase under the local thermodynamic conditions prevailing in the CDS. For calculating the nucleation rates, the Gibbs free energies of Ti_xO_y clusters are used, resulting from quantum mechanical Density Functional Theory calculations of their structures.

We present the results of a consistent dust shell model characterized by $L_* = 2 \cdot 10^4 L_\odot$, $T_* = 2000\,K$, $M_* = 1 M_\odot$, $\Delta u_p = 5 kms^{-1}$, $P = 300\,d$, and solar element composition. This model produces a mass loss rate of $\dot{M} \approx 5 \cdot 10^{-5}\,M_\odot yr^{-1}$ and an outflow velocity of $v_\infty \approx 15\,kms^{-1}$. The radii of most of the dust grains range between 0.01 and 0.1μm. The chemical composition and temporal evolution of the resulting dust grains and their influence on the generation of massive outflows from oxygen-rich LPVs will be discussed.

P 31

Dynamical Model Calculations of AGB Star Winds Including Time Dependent Dust Formation and Non-LTE Radiative Cooling

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Stars on the Asymptotic Giant Branch (AGB) are pulsating objects in a late evolutionary stage. The stellar pulsation creates sound waves which steepen up to shock waves in the upper atmosphere and lead to a time dependent levitation of the outer atmosphere. Thereby, the stellar pulsation triggers and facilitates the formation of dust close to the star. The dust is accelerated by radiation pressure and drags the gas outwards due to frictional forces which is identified to provide the basic mass loss mechanism.

A longstanding problem concerning the modelling of these physical processes is the influence of the propagating shock waves on the temperature structure of the wind, which strongly influences the dust formation. We have therefore improved our numerical models of AGB-star envelopes by including
(i) a detailed calculation of non-LTE radiative heating and cooling rates, predominantly arising from atomic and molecular lines and
(ii) atomic and molecular exitation aswell as ionisation and dissociation in the equation of state.

First results, presented here, show that the cooling time scales behind the shock waves are usually rather short, but the binding energies of molecular hydrogen provide an important energy buffer capable to delay the radiative heating or cooling. Thus considerable deviations from radiative equilibrium may occur in the important inner dust forming layers.

P 32

Effects of Mg/Si Abundance Variations on Dust in AGB Stars

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Main sequence F and G stars show a considerable scatter in the abundances of Mg and Si (Edvardsson et al. A&A 275, 101). There exists, however, a strong correlation between the abundances of the two elements and the metallicities of the stars. Nearly 10% of the 189 stars contained in the study of Edvardsson et al. have magnesium abundances less than their silicon abundances, in some extreme cases the Mg/Si abundance ratio seems to be as low as 0.6, while the average cosmic Mg/Si abundance ratio equals 1.08.

If the stars enter the AGB stage of their evolution they form silicate dust minerals in their circumstellar envelopes as long as third dredge up has not yet turned them into C stars. For stars with Mg/Si < 1 there is insufficient magnesium to condense the Si completely into magnesium silicates ($MgSiO_3$). The excess of Si over Mg would condense in this case in chemical equilibrium into solid quartz grains (SiO_2).

It is unclear whether there really exist stars with the opposite composition extreme where the Mg/Si abundance ratio exeeds a value of two, in which case insufficient Si is available to condense all Mg into silicates (Mg_2SiO_4). In this case the excess Mg would condense in chemical equilibrium into solid periclase (MgO).

We discuss the dependence of the mineral composition in oxygen rich dust shells on the Mg/Si abundance ratio in chemical equilibrium and present results of non-equilibrium model calculations for the formation of silicates, quartz, periclase and other dust components in a stellar wind for varying Mg/Si abundance ratios.

P 33

The Nonradial Stability of Wolf-Rayet Stars

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Models for Wolf-Rayet stars are known to provide the most extreme examples for the occurrence of strange-mode instabilities. In the linear nonadiabatic stability analysis complete sequences of strange modes with growth rates in the dynamical range can be identified. Due to extremely short thermal time-scales in the stellar envelopes of these stars strange modes occur in almost complex conjugate pairs and the NAR-approximation (zero heat capacity) proves to provide even quantitatively correct results. Simulations of the evolution of the instabilities into the nonlinear regime show that velocity amplitudes of the order of ~ 100 km/sec are reached. Even if direct mass loss is not observed, this result indicates that strange-mode instabilities may be the origin of strong mass loss in these stars.

So far the stability analysis of Wolf-Rayet stars was restricted to the consideration of spherically symmetric perturbations. Both a model for the mechanism of strange-mode instabilities and the analogy with massive stars, where strange-mode instabilities are also predicted and found in the spectrum of nonradial perturbations, strongly suggest performing a nonradial nonadiabatic stability analysis of Wolf-Rayet stars, which is also supported by the observation of clumpy and filamentary structures in Wolf-Rayet winds. First results of a study in this direction are presented essentially proving the conjecture, that strange-mode instabilities do also occur in the nonradial spectrum.

P 34

Synthetic Spectra of Very Cool White Dwarfs in the Infrared

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Recent investigations on brown dwarfs and related objects show strong band and line absorption in the infrared region, where, of course, polyatomic molecules and grains are involved, as the temperatures go down to 1000 K. For white dwarfs, the effective temperatures are unlikely to be lower than 4200 K, due to the age of the solar neighbourhood. Thus the temperatures in the outer layers go down to 3000 K, yet the backwarming is also caused by strong opacities in the IR.

With a grid of new helium-rich model atmospheres with small amounts of carbon, hydrogen, oxygen, nitrogen, magnesium, silicon and calcium, log g = 8.0, T_{eff} = 5000 K, 4800 K, 4500 K and 4250 K, detailed spectra in the infrared have been calculated. The differences between very cool white dwarfs and brown dwarfs for spectra of low resolution can be clearly demonstrated.

P 35

The Search for White Dwarfs in the Hamburg Quasar Survey

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The Hamburg Quasar Survey has produced objective prism spectra of several hundred thousand stellar UV-excess sources. We present the results of a new, automated search for white dwarfs in the database of digitized spectra. We have developed a method for the transformation of flux-calibrated spectra from atmosphere models or observations to photographic density spectra that allows us to fit each plate spectrum to a grid of templates including models for hydrogen-rich (DA) white dwarfs as well as for other hot stars. Thus we can compare the likelihood of being a white dwarf for each object in a quantitative way, and also estimate $T_{\rm eff}$ from the Balmer line strengh and continuum slope.

We expect to be able to identify 2 000–3 000 white dwarfs down to a limiting magnitude of $B = 17\overset{\rm m}{.}5$ from this database. The automatic classification of the spectra has been shown to recover 70–90% of all known white dwarfs within the survey limits. The temperature determination is generally accurate to $\sim 20\%$. The best results have been obtained for DA white dwarfs of $10\,000\,{\rm K} \leq T_{\rm eff} \leq 20\,000\,{\rm K}$.

This sample will be the largest source of optically selected white dwarfs and can help to improve the determination of space densities, the luminosity function and mass distribution of white dwarfs. The good sensitivity to DA of $\sim 12\,000\,{\rm K}$ also makes it an efficient tool for the search for variable white dwarfs in the ZZ-Ceti instability strip, which are of high interest for asteroseismological studies of the interior of these stars. For an unambiguous classification and accurate determination of the atmospheric parameters of these candidate white dwarfs, however follow-up spectroscopy is still required.

P 36

HST Observations of the DAB White Dwarf HS 0209+0832

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The DAB white dwarf HS 0209+0832 is one of the few white dwarfs with detected helium in the DB gap between 28 000 and 45 000 K. We have obtained ultraviolet and optical spectra with the Hubble Space Telescope (HST). The analysis results in an effective temperature of about 35 000 K and a helium abundance of about 1%. The presence of C IV at 1548 Å, which was earlier detected by the International Ultraviolet Explorer (IUE), is confirmed. Additionally, we could identify more than 140 photospheric and 12 interstellar metal lines. For the first time we have found aluminum, calcium, titanium, nickel, and zinc, which cannot be supported by radiative levitation at such a low effective temperature. With stratified model atmospheres we tested, whether HS 0209+0832 has a very thin layer of hydrogen ($\approx 10^{-16}\,M_{\odot}$) on top of the helium envelope so that it is not thick enough to hide all the helium as is usually assumed to explain the DB gap. From the detailed shape of the He II 1640 Å line we could exclude such a model and conclude that diffusion equilibrium has not yet been reached; all observations are compatible with almost homogeneously mixed atmospheres, as would also be expected from the presence of metal lines. The most probable explanation is that HS 0209+0832 is still accreting matter from an interstellar cloud and that helium and metals would sink downwards, if no longer supplied from the surrounding medium. The finding by Heber et al. that the He I line at 4471 Å has been weaker by a factor of two or three for several months would fit into this scenario, if we assume that HS 0209+0832 travels through an inhomogeneous medium.

P 37

Element Abundances in Cool DZ White Dwarfs

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The standard explanation for the presence of photospheric metals in white dwarfs of spectral type DZ and related types is a combination of episodic accretion from the interstellar medium and diffusion of heavy elements downwards in the atmosphere on time scales of typically 10^6 years. Much of the empirical data on atmospheric parameters and element abundances available in the literature is based on International Ultraviolet Explorer spectra with low signal-to-noise and on atmospheric modeling, which does not include recent advances in input physics. We have therefore decided to address this problem again, using modern UV observations of the Hubble Space Telescope, if available, and a new generation of theoretical models.

In this poster we present the results for L 745-46 A, Ross 640, and van Maanen 2. The first two objects are key objects since they contain both hydrogen and metals in their atmospheres. For the first time, we could also establish hydrogen in van Maanen 2. For all objects we have determined the atmospheric parameters $T_{\rm eff}$ and $\log g$ as well as hydrogen abundances and abundances of several heavy elements. The results are in good agreement with the theoretical predictions.

P 38

SWAS [CI] Observations toward MCLD 123.5+24.9

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We present observations of the $^3P_1 \rightarrow {}^3P_0$ fine-structure transition of neutral carbon ([CI]) made with the Submillimeter Wave Astronomy Satellite (SWAS) toward MCLD 123.5+24.9, a translucent molecular cloud at high Galactic latitudes. The [CI] map contains 80 spectra, observed with a beam spacing of 3.2 arcmin ($\approx$ main beam FWHM). [CI] emission is detected at 60 positions with the line peak intensity between 0.2-0.7 K ($T_{\rm mb}$; the rms noise per 0.623 km/s channel is $\leq$0.14 K). The comparison to ground based CO observations indicates a low [CI] to ^{12}CO J=2$\rightarrow$1 ratio of 0.13$\pm$0.05 for the line integrated intensity. The [CI] to ^{13}CO J=2$\rightarrow$1 ratio covers a wider range with typical values between 0.5 and 1.5. Using a PDR model for spherically symmetric clumps, we find that the observed ratios are consistent with dense clumps ($n_{\rm H} > 5\,10^4 {\rm cm}^{-3}$), illuminated by the mean interstellar radiation field.

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P 39

Quantification of Molecular Cloud Structure using the Δ-variance

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We present a quantitative study of the spatial structure in observed molecular cloud images using the Δ-variance. Introduced by Stutzki et al. (1998; A&A 336,697) the Δ-variance allows to study the spatial drift behavior of scalar functions, such as the intensity distribution of molecular cloud tracers. For images with a power law power spectrum and random phases, known as *fractional Brownian motion (fBm) structures*, the Δ-variance analysis allows to determine the spectral index β of the power spectrum. Compared to the power spectrum itself, the Δ-variance is more robust with respect to edge-effects.

We apply the Δ-variance to spectral line maps observed in the rotational transitions of ^{12}CO and ^{13}CO. For the velocity integrated maps, the spatial structure of the emission is well characterized by a power law power spectrum. We find that the spectral index is remarkably uniform for different molecular clouds and linear scales larger than $\sim$0.5 pc ($2.5 \leq \beta \leq 2.8$). Significantly larger indices ($\beta \geq 3$) are found for observations made at higher spatial resolution toward the Polaris Flare, a translucent cloud at high Galactic latitudes, suggesting that the structure is soother at smaller scales.

In addition, a Δ-variance analysis of the channel maps is presented for the ^{13}CO(1-0) map of Orion A. Here, the index β shows systematic variations across the line profile. Typically, β is between 2.3 and 2.6 for most of the channel maps, except for $11 \leq v \leq 12$ km/s where a systematically larger β close to 3 is found.

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CO Multiline Observations near the Galactic 5kpc Ring with KOSMA

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We present first results of a low-J CO survey of an extended region at the edge of the 5kpc Galactic Ring. These ongoing observations were started in August 1999 with the KOSMA 3m telescope using the on-the-fly modus. At present, we have observed a 0.4 deg^2 region in ^{13}CO 2–1 and in ^{12}CO 3–2 comprising 6534 positions. Observations of other isotopomers and extensions of the present area are planned.

The 5kpc ring of our Galaxy shows up prominently on the Columbia Milky Way survey and is known for its high star formation rate. The FCRAO has started to map the ring in ^{13}CO 1–0. To study excitation conditions and their variation, we selected one extended filament showing up at $\sim 60\,\mathrm{kms}^{-1}$, the velocity of the Galactic Ring at a distance of 10 kpc. In addition, the selected region shows emission of almost local material at $\sim$20 kms^{-1}. This study thus allows to compare different parts of the Milky Way simultaneously, allowing for a good relative calibration accuracy.

Observations of the 2–1 and 3–2 CO transitions traces the denser and warmer material along the lines of sight, since their critical densities and upper level excitation temperatures reach $10^4\,\mathrm{cm}^{-3}$ and 33 K. Our observations thus allow to distinguish between extended, quiescent gas and localized regions, influenced by star formation.

Please visit our web site at `www.ph1.uni-koeln.de/5kpc` for further information of the current status.

P 41

An Efficient Parallelization of a Tree-code: Results and Performances

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In this work, the features and the performances of a parallelization method for a tree-code are described. Such method consists in a "dynamic" decomposition of the computational domain, carried out conjointly by all the processor elements, exploiting the adaptivity of the same hierarchical spatial subdivision in boxes which the tree-code is based on. This ensures a good efficiency in the domain decomposition during the whole system evolution. The method shows also low computational costs, thanks to the fact that it is performed 'on the fly' during the construction of the tree logical structure. Moreover, it can be implemented both on SMP computers and on clusters of workstations by means of message passing routines.

P 42

A New Code for SPH and N-Body Simulations

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We present a new code for the simulation of N-Body systems and hydrodynamic processes using the SPH formalism.

Several well established numerical techniques are combined in order to speed up the computations. Gravity is calculated by using a specialized binary tree structure. This can be done on a parallel supercomputer or in combination with the GRAPE-3 or GRAPE-5 special purpose hardware. The optimized SPH code makes full use of the improved communication speed of the GRAPE-5 by using its neighbour list feature.

In order to speed up the computations further, an individual timestep scheme for the particles is used.

P 43

The Stars in the Nucleus Region of the Ursa Major Kinematical Group

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We have to do the subset of 22 stars with positions inside the nucleus of the Ursa Major star kinematic group in space. Using the careful proper motions and parallaxes from Hipparcos catalogue was shown that the nucleus are not kinematicaly uniform and two subgroups exist within it borders.

P 44

Spatial Structure of Per OB2 Star Forming Complex

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A new Compiled Catalogue (CC) has been constructed for a photometric and astrometric survey covering the star forming region of more than 300 sq. degrees around the Per OB2 association with the center at $(\alpha, \delta)_{J2000} = (3^h87, 34^{\deg}4)$. The CC is based on recently published astronomical catalogues, e.g. Hipparcos and Tycho-2, and supplemented by relevant astrophysical data from numerous sources. The CC is complete down to $V = 10.6$ mag, in general, and to $V = 19.5$ mag in the one square degree field around the IC 348 cluster.

We consider the proper motion distribution as the main criterion for the cluster membership determination.

Since the analysis of proper motions and spectra gives an estimate of the distances for most stars in the CC, we can study the distribution of absorbing matter and of the stars in the region. Estimates of the radii of Per OB2 and IC 348, respectively derived from the density profiles, are also given.

P 45

Cyanogen Variations in the Second Parameter Globular Cluster NGC 7006

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The metal-poor ([Fe/H] $= -1.6$ dex) globular cluster NGC 7006 exhibits an unusual red horizontal branch (HB), i.e., it is a "second parameter effect" cluster. A possible second parameter is mixing within red giant branch stars which may result in enhanced mass loss and lead to bluer horizontal branch stars. Rotational-induced mixing may lead to variations in cyanogen abundances in stellar atmospheres due to the dredge-up of nucleosynthesized material. Such variations have been found for quite a few clusters, though it is not clear whether these are caused by primordial or evolutionary effects (Kraft 1994).

We present spectroscopic CN and CH band strengths for 13 giants of NGC 7006 obtained at the Lick 3m telescope. The data reveal the following trends: (i) The scatter in star-to-star CN indices is relatively modest by comparison with the blue horizontal branch cluster M13. (ii) The CH content is independent of the CN, within the observational uncertainties, indicating that the CN abundance variations are driven by N variations. (iii) A possible weak radial dependence of the CN content, although this needs a larger sample of stars for verification. Buonanno et al. (1991) found the HB of NGC 7006 to get bluer towards the inner parts of the cluster. A possible connection to the observed CN radial dependence is discussed.

P 46

Gas Expulsion from Star Forming Regions and the Formation of Globular Clusters

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Shortly after the formation of a globular cluster (GC) the remaining gas will be expelled by ionizing radiation, stellar winds or supernova explosions during a few dynamical timescales. As a result of this gas expulsion phase some or all stars in the cluster will get unbound. The fraction of finally bound stars is mainly determined by the efficiency of star formation and the timescale of the gas expulsion. Our results allow us to quantify the star formation efficiency (SFE) necessary for forming bound GCs.

Two sets of numerical N–body simulations are presented: As a first simplified approach we treat the residual gas as an external potential. The gas expulsion is approximated by reducing the gas mass to zero on a given timescale, which is treated as a free parameter. Our results are consistent with similar simulations by Lada et al. (1984, ApJ 285, 141) and more recently by Goodwin (1997, MNRAS 116, 351).

In a second set of simulations we used smoothed particle hydrodynamics (SPH) to describe the dynamics of the residual gas. In this case gas expulsion takes place on a short timescale and prevents the evolution of star forming regions with low SFEs to bound clusters.

In both sets the stars were in virial equilibrium with the gaseous environment at first. Adopting stars with an initial zero velocity dispersion leads to a compaction of the cluster during the expulsion phase and may explain the formation of bound systems with SFEs less than 10%.

P 47

The Impact of Tides on Star Cluster Formation

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The homogeneity of metal abundances in clusters suggests that the epoch of star formation must have been short in order to avoid strong gradients in the stellar population, leading to systems with little velocity dispersion at formation. When spherical clusters undergo violent relaxation a good fraction of stars describe nearly radial orbits. This situation likely gives rise to triaxial instability (see e.g. Merritt 1999). Aspherical collapse also results in triaxial equilibria. However a net torque may now be exerted on individual clusters by the host galaxy's tide during radial infall, and induce streaming motion or rotation.

We investigate analytically the collapse of uniform-density spheroids to which we apply model galactic tides. We find that sub-virial clusters non-rotating at birth may yet show appreciable rotation in equilibrium.

P 48

Global Spiral Modes in the Multi-Component Disks

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Using 2D fluid dynamical numerical simulations, we study the global stability properties of multicomponent gravitating disks. Components with lower velocity dispersions strongly affect the stability properties of gravitating disks which is illustrated by the comparison with the stability properties of one-component disks with similar axisymmetric equilibria. A ten percent admixture of a cold gaseous component which is coupled by gravity to the stellar disk increases the growth rate of the fastest growing spiral mode more then twice. Additionally, it enhances the spiral saturation level on the nonlinear stage of instability. The processes of mass and momentum exchange in a star-forming gravitating disk drastically change its stability properties. If the characteristic time for mass and momentum exchange processes exceeds the growth time of the instability, the growth rates and the saturation levels of the unstable modes are determined by the properties of the pre-existing gaseous disk.

P 49

The Vertical Disk Structure and the IMF

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The determination of the IMF in the solar neighbourhood is strongly connected to the vertical structure of the stellar disk. For the conversion of local number counts to surface densities the effective thickness of the stellar distribution need to be known. It depends in a complicated way on the star formation history and the dynamical evolution of the disk. The dynamical evolution is well known from kinematical data of nearby stars. The velocity dispersion increases continously with age of the stellar population resulting in a non Gaussian velocity distribution function dependent on the star formation rate, the dynamical heating function, and the life time of the stars. Published IMF determinations adopt in some reasonable way the effective thickness of the distribution as a function of stellar mass, but they are not consistent with a dynamical disk model.

We compute a self-consistent model for the present day vertical structure of the stellar disk including self-gravity, and the gravitation of the gas component (important for the local depth of the potential well) and of the dark halo (influencing the surface densities of older populations). Beside the star formation rate and the dynamical heating function, the vertical gravitational potential depends additionally on the mass loss of the stellar component. Mass loss if a function of the IMF and of the chemical enrichment, since the lifetime of the stars depends strongly on metallicity (variing up to a factor of 2). The model fits the constraints on local densities, vertical profiles, surface densities given in the literature. The essential new aspect is to fit also the shape of the local velocity distribution functions for different samples of stars. This gives strong constraints to the star formation rate history allowing for a self-consistent determination of the IMF.

P 50

Flattened Dark Matter Halos and the Holmberg Effect

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Holmberg (1969) observed that satellites of disk galaxies orbit preferentially on near-polar orbits. Up to now, no convincing mechanism has been found to explain Holmberg's result. A recent study by Quinn & Goodman (1986, ApJ 309, 472) of satellites on prograde orbits in the potential of a live disk and static halo showed that the inclination of the orbital plane with respect to the disk plays an important role with regards to the time of decay of the orbit and the disruption of the satellite. However, they conclude that dynamical friction from the disk alone can not account for Holmberg's observations. We have found that a live, flattened dark matter halo may be responsible for the strong anisotropy in the distribution of satellites. Satellites with small inclinations are forced to the galactic plane by gravitational torques exerted by the halo, the more efficiently so the smaller the inclination angle. Furthermore, satellites with near-polar (highly inclined) orbits have a longer survival time compared with those in a spherical halo on the same orbit, an effect we attribute to the reduced dynamical friction at high latitude. Satellites orbiting in the galactic plane are quickly destroyed by the combined disc and halo tidal forces, while the lifetime of satellites on polar orbits are prolonged, a result that concurs with Holmberg's data.

P 51

Galaxies and Genes: How to Model Interacting Galaxies

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The observed features of interacting galaxies (e.g. tidal tails) provide a lot of information on the dynamics of such a system. Dark matter halos, for example, play an important rôle for the dynamical evolution of galaxies so that they should obviously have perceptible effects on the interaction. Unfortunately, the problem of modeling interacting galaxies from observational data suffers from an extended parameter space. Recently it has been shown that a Genetic Algorithm (GA) can be applied to this problem (Wahde 1998; Theis 1999).

The general idea of a GA is to mimic natural evolution: A population of individuals which correspond to single points in parameter space (i.e. single N-body simulations) is evolved according to the principle of "survival of the fittest". The fitness is calculated by a comparison of observed intensities with the numerical model. New populations are created by "sexual reproduction" whereas individuals with a higher fitness reproduce themselves more often. This breeding process is repeated until a sufficient fit is achieved.

Until now the GA has been applied to a chosen reference model (i.e. a preferred set of parameters) as in the case of NGC 4449 (Theis 1999). An automatic procedure for the selection of a suitable set of parameters on the basis of observational data is highly desirable. A first step in order to achieve this goal is an "idealized" observation which can be computed from a self-consistent N-body simulation. By this not only the parameters of the interaction are in control but one can also adjust the quality of the observational data allowing to check the general applicability of the GA to observational data.

P 52

Deep Wide Field Imaging of the Sextans Dwarf Spheroidal

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All but one of the Galaxy's nine dwarf spheroidal (dSph) companions have been studied in depth in order to understand their star formation and chemical enrichment histories. The lone companion that has not been studied in detail is Sextans. The deepest existing CMDs barely reach the main sequence, with large errors, and cover only a tiny fraction of this galaxy, yielding only hints of what stellar populations might be present.

We present the first photometry of Sextans that reaches below its main-sequence turnoff. The data were obtained with the wide-field MOSAIC2 camera at CTIO's 4-m Blanco telescope and Washington filters. The field coverage is 0.5°^2}.

The resulting color-magnitude diagram shows that Sextans contains a dominant old population while prominent younger populations are absent. The broadening of the red giant branch indicates a non-negligible metallicity spread. Sextans contains a prominent blue straggler population. The horizontal branch does not exhibit the pronounced spatial second-parameter variations observed in other dSphs.

P 53

The Effects of Cosmic Expansion on Relaxation of Systems of Galaxies

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The effects of cosmic expansion for the two-body relaxation time of galaxies in the Einstein-de Sitter universe are examined. We reformulate the scattering problem so that the time change of the cross section due to cosmic expansion can be taken into account. Next we calculate numerically the orbits of encounters to various sets of orbital parameters while specifying the initial states of the encounters: initial separation, impact parameter, and initial relative velocity between two galaxies. By combining the results of these studies, we obtain the two-body relaxation time as a function of the relative velocity v_0 at the initial epoch and the number density n of galaxies within proto-clusters of galaxies. The relaxation time is roughly the free-fall time for a small relative velocity, $v_0 \leq 300$ km s$^{-1}(m/10^{11}M_\odot)^{1/3}[11/(1+z)]^{1/2}$, while it is proportional to ${v_0}^3$ for a high relative velocity. The effects of the cosmic expansion make the relaxation time longer than that in non-expanding systems, especially for proto-clusters of galaxies with the number density $n < 3 \times 10^3$ Mpc^{-3} $(10^{11}M_\odot/m)[(1+z)/11]^3$, where m is the mass of a galaxy and z is its redshift

P 54

Stellar Activity in the Open Cluster NGC 2451

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We present first results of the analysis of X-ray data (ROSAT PSPC and HRI pointings) and optical observations of the open cluster NGC 2451. This object consists of two different clusters A and B in the same line-of-sight at distances of 190 and 360 pc, respectively. NGC 2451A is one of the 10 nearest clusters, but has been little studied because of strong contamination by field stars. In order to improve this situation, we used X-ray observations to identify cluster members, a method proven to be very succesful at several other clusters. To identify the X-ray sources with optical counterparts we performed CCD photometry with the ESO 0.9m Dutch telescope.

Altogether, 188 X-ray sources were found down to X-ray luminosities of a few 10^{28} erg s^{-1}. Based on positional coincidence (i.e., offset $< 25''$) 122 of them could be identified with optical counterparts with magnitudes between V = 3 and 20, most of them ranging from 11 to 18. Of these 122 stars, 105 are possible members of clusters NGC 2451A or NGC 2451B, as derived from their position in the Colour-Magnitude-Diagram. Four stars showed strong flares during the X-ray observations, and we present a short analysis of the flare parameters. NGC 2451 A/B is especially interesting since it is a rather young (50 Myrs) and possibly metal-deficient cluster very close to us.

P 55

Do Compact High-Velocity Clouds Have Stellar Counterparts?

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Compact high-velocity clouds (CHVCs) are a subset of high-velocity H I clouds with angular sizes of only about 1 degree on the sky. They show infall motion with respect to the barycenter of the Local Group, and preliminary estimates place them at distances of 0.5 to 1 Mpc in contrast to the extended, nearby HVC complexes (Braun & Burton 1999). CHVCs are rotationally supported and appear to be dark-matter dominated with total masses of a few 10^8 $M_\odot$.

Are CHVCs the missing Local Group satellites predicted by hierarchical structure formation scenarios? Are they proto-galactic gas clouds, or do they contain stars as well? The detection of stars would help to refine the H I distances and allow us to study the star formation history of a new, very dark, very low-density type of dwarf galaxy.

We present results from a targeted optical wide-field imaging survey for stars in carefully selected CHVCs. While the resulting images appear to indicate the presence of a red giant branch of an old stellar population at the expected distance, contamination by starburst galaxies with z>0.2 is a concern.

P 56

An Hα Emission Line Survey in the Large Magellanic Cloud

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Be stars are non-supergiant B-type stars with Hα emission. What causes stars to become Be stars is not yet understood. Surprisingly a number of young Magellanic Cloud star clusters have been found to be richer in Be stars than comparable Galactic open clusters (Keller et al. 1999, Maeder et al. 1999). It is unclear whether the apparently higher Be star fraction is related in some way to the cluster environment or to the lower metallicity in the Magellanic Clouds. Very little is known about the Be star content among young Magellanic field stars. A meaningful comparison between Be star fractions in the Milky Way and in the Magellanic Clouds requires comprehensive knowledge of the Be star content in both clusters and the field.

We conducted an Hα emission-line survey of a $1.5^\circ \times 1.5^\circ$ field above the bar of the Large Magellanic Cloud. The Hα data were taken with the Wide Field Imager at the ESO/MPIA 2.2-m telescope at La Silla, Chile. Broadband *UBVI* data were obtained with a drift-scan camera at the 1-m Swope telescope at Las Campanas Observatory, Chile as part of the Magellanic Clouds Photometric Survey (Zaritsky et al. 1997). Balmer emission line objects were identified using two-color diagrams. We will discuss preliminary results.

P 57

Tracing the Sagittarius Dwarf Galaxy's Tidal Stream

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We use Sloan Digital Sky Survey (SDSS) test data along the equatorial stripe ($160^o < \alpha < 250^o$ at $-1.25^o < \delta < 1.25^o$) as well as APM catalogue data to spatially trace the tidal stream of the Sagitarrius dwarf galaxy. Sagittarius is caught in its merging process with the halo of the Milky Way. With a distance of only about 25-50 kpc from the Galactic Center the stream yields an ideal object to study tidal stripping. We compare the overdensities in the stellar halo population with recent modells of the Sagittarius dwarf galaxy's orbit.

P 58

Detection of the Tidal Tail of the Globular Cluster Pal 5 with SDSS Commissioning Data

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We have analysed commissioning data of the Sloan Digital Sky Survey (SDSS) in a 2.5° wide equatorial band in order to search for tidal debris around the distant halo globular cluster Palomar 5. SDSS provides deep multi-color photometry in the u', g', r', i' and z' bands. These data have been used to locate the cluster population in multi-color-magnitude space and to efficiently separate extratidal cluster stars from the field population by means of a cell-count algorithm. The tidal extension of the cluster is traced by stars from about 0.5 mag above to 2 mag below the cluster main-sequence turn-off. We find clear evidence for a symmetrical two-sided tail which extends at least 1.5° in north-eastern and south-western direction and is likely to continue further on beyond the edges of the currently available field. The orientation of the tail which is along constant galactic latitude provides an efficient constraint on the direction of the clusters tangential space motion. The spatial structure of the tail closely resembles the characteristic structures seen in numerically simulated cluster tails. Integrating the overdensity of stars in the region of the tail we find that the extra-tidal part of the cluster population equals about 50% of the current stellar content inside the cluster in the same magnitude range. We conclude that the cluster has experienced very heavy mass-loss during the last passages through the inner Galaxy.

P 59

FIR and Sub mm Observations of Extremely Cold Dust in M31

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The discovery of protostellar cores in the Milky Way has been most successful by means of cold dust observations in the mm, submm and extreme far-infrared wavelength regimes. Temperature and luminosity of the dust provide clues to the heating mechanism and whether star formation has already onset, or whether the dust clouds are still in a very cold protostellar phase. Similar protostellar cores should exist also in other galaxies.

In order to find protostellar cores in the nearby Andromeda galaxy, best candidates are provided by the ISOPHOT 175 μm map (Haas et al. 1998, A&A 315, L64). This map is dominated by a concentric ring structure with numerous individual knots. The investigation of these knots (Schmidtobreick et al. 2000, submitted to A&A) yielded some exotic objects, very dense and cold cloud complexes with high luminosities. One of these strange objects is knot #23 northwest of M31's centre. With 31.45 Jy, it is by far the brightest 175 μm region of M 31. Despite this dominant appearance, the object is not suspicious at other IR wavelengths, nor at other tracers like CO, HI or radio continuum. At least two dust components with different temperatures are necessary to fit the 60 μm, 100 μm and 175 μm fluxes. Fixing the warmer component to 40 K, the temperature of the cold component could be estimated to be 16.5 K. However, up to 175 μm, the flux density is increasing, so that an even colder dust component could be suspected. To check for it, new measurements at longer wavelengths have been conducted. Here we present first results from 850 μm data taken with SCUBA at the JCMT, Hawaii in november 1999.

P 60

The IMF of Open Star Clusters with Tycho–2

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We present the stellar initial mass function (IMF) of several nearby open star clusters derived on the basis of the Tycho–2 catalogue (Høg et al., 2000, A&A 355, L27). Tycho–2, computed from the original Tycho catalogue (ESA, 1997, SP–1200) and ground based first epoch data, provides positions, stellar proper motions, and B_T and V_T photometric data.

With the help of the proper motions, we distinguished between the members and non-members of the clusters; from the stellar magnitudes we derived the initial stellar masses.

Since the catalogue becomes incomplete around $V_T = 11$ mag, we were restricted to a small magnitude (and hence mass) interval, so that we chose to study nearby ($(m-M)_0 \leq 7.5$ mag) open star clusters with – according to Robichon et al. (1999, A&A 345, 471) – a clear separation of field and cluster proper motions, restricting our sample to 8 objects.

The IMF computed from $m \approx 1 M_\odot$ up to the main sequence turn off point could be well represented by power laws with exponents from $\Gamma = -0.85$ to $\Gamma = -2.36$ (when Salpeter's (1955, ApJ 121, 161) value is $\Gamma = -1.35$). Within the errors (which are comparably high for some of the objects due to their low numbers of members), this is in good agreement with the range of IMF slopes as given, e.g., by Scalo (1998, ASP Conf. Series 142, 201).

Regarding upcoming missions of astrometry satellites (FAME, DIVA, GAIA), this kind of IMF study based on a uniform all-sky data sample will play a more important role in the future: The limiting magnitudes of these instruments will be fainter, proper motions will be available for all detected objects (in contrary to, e.g., the HIPPARCOS catalogue, the proper motions of which were determined for the stars of an input catalogue only) and will become independent of ground based observations, so that their quality will be higher.

P 61

Discovery of a Globular Cluster in M31's Dwarf Spheroidal Companion Andromeda I

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We report the serendipitous discovery of a faint globular cluster found on archival *Hubble Space Telescope* images of Andromeda I, a dwarf spheroidal (dSph) companion of M31. Of the 17 dSph galaxies in the Local Group, only the two brightest companions of the Milky Way were previously known to contain globular clusters, while none had been found in M31's six dSph satellites. And I is the least luminous galaxy in which a globular cluster has been detected so far. The horizontal branch luminosity of the globular cluster puts it at the same distance as And I though we cannot exclude that we are seeing an outlying globular cluster of M31 projected against, and physically very close to, And I. The globular cluster appears to be of similar age and metallicity as the underlying field population in And I. Assuming membership, the resulting specific globular cluster frequency for And I is $S_N \sim 19$. The cluster resembles the sparse outer halo globular clusters found around the Milky Way and lies just outside the core radius of And I.

P 62

The Complex X-ray Spectrum of the Quasar MR 2251–178

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MR 2251–178 was the first quasar initially discovered in X-rays, and the first one found to host a warm absorber. MR 2251–178 turned out to be an outstanding object in many respects. It has a high ratio of $L_{\rm x}/L_{\rm opt}$, and is surrounded by a giant HII envelope observed in [OIII] emission. Here, we present results from an analysis of the X-ray spectral, temporal, and spatial properties of this source based on deep ROSAT observations: The mean source countrate was 3.1 cts/s, a factor of 3 higher than during the *ROSAT* all-sky survey observation performed 3 yrs earlier. Short-timescale variability of order 20% on the timescale of 1000 sec is detected. A single powerlaw spectral fit to the data gives $\Gamma_{\rm x} = -2.3$ and $\chi^2_{\rm red} = 5.4$, completely unacceptable. Among various non-powerlaw spectral models compared to the data (like a powerlaw plus soft excess, or Raymond-Smith emission), we failed to obtain any acceptable fits. The presence of a warm absorber markedly improves the fit. Performing a two-edges fit with edge energies fixed at the theoretical values of OVII and OVIII we obtain $\tau_{\rm OVII} = 0.26 \pm 0.12$, $\tau_{\rm OVIII} = 0.20 \pm 0.12$, and $\Gamma_{\rm x} = -2.20 \pm 0.02$. Next, a warm absorber model based on photoionization calculations with the code *Cloudy* (Ferland 1993) was applied. We find an ionization parameter of $\log U = 0.5$ and a column density of the warm absorber of $\log N_{\rm w} = 22.6$. We then split the total data set in three subsets according to flux-state of the source, and fit these data separately. The best-fit parameters remain the same within the error bars; no changes in the warm absorber are detected. Preprints of this and related papers can be retrieved at
http://www.xray.mpe.mpg.de/∼skomossa/

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Consequences of Super-solar Metallicity in a Narrow-line Quasar: PG1404+226

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PG 1404+226 at a redshift $z_{em} = 0.098$ belongs to the class of Narrow-Line Seyfert 1 galaxies which are characterized by steep soft X-ray spectra, narrow optical Balmer lines and strong FeII emission. The X-ray spectrum of PG 1404+226 shows an interesting peculiarity: an absorption feature around ∼1.1 keV (Ulrich & Molendi 1996) of presently unclear origin. *Warm absorbers*, observed in the X-ray spectra of many AGN, do show such features, but the strongest absorption edges in case of *solar* metal abundances are those of Oxygen located at lower energies, around 0.74 (OVII) and 0.87 (OVIII) keV. In addition, the UV spectrum of PG 1404+226 exhibits a quite strong absorption line of NV. We explore interpretations of these unusual UV-X-ray properties in terms of non-solar metal abundances of the absorbing gas. X-ray spectral fits are combined with a UV curve of growth analysis, employing the equivalent widths measured by Ulrich et al. (2000). We then examine how the multiphase broad-line-region cloud equilibrium changes in dependence of elemental abundances and X-ray continuum shape. Finally, we discuss consequences for the evolutionary state of PG 1404+226 and Narrow-line Seyfert 1 galaxies in general, based on the recent work of Mathur (2000).

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Diffuse X-ray Emission in the Magellanic Clouds

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The diffuse X-ray emission in the Magellanic Cloud regions is studied using all the ROSAT PSPC data obtained from pointed observations. For this purpose emission from the point and point like sources in the ROSAT HRI and PSPC source catalogues is eliminated and periods of high solar activity are excluded.

PSPC spectra are analyzed in 0.25 deg × 0.25 deg fields on grids covering the SMC and the LMC to measure the temperature gradient. Characteristic temperatures of 10^6 – 10^7 K are determined for the diffuse emission in both Magellanic Clouds mainly along the optical bright regions. Correlation between the H α regions and regions with higher X-ray temperature is found. The spatial variation is compared to the distribution of distinct sources within the Magellanic Clouds with main focus on the interaction between the SNRs and the ISM.

P 65

Hot Gas in Starburst Galaxies: X-rays from NGC 2903 and NGC 4569

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Observations of so-called X-ray halos are difficult, due to their very low density of typically $\leq 10^{-3}$ cm^{-3} and their relatively low temperature of typically 0.2 keV. In this soft regime the X-ray flux is easily absorped by Galactic and intrinsic HI. Up to now, diffuse X-ray emission in the halos of spiral galaxies is only detected in edge-on galaxies.

NGC 2903 and NGC 4569 are two candidates for galaxies at intermediate inclination with detected X-ray halos. Both objects contain a very soft diffuse component extended up to 8 kpc perpendicular to their major axis. In the case of NGC 4569 this diffuse X-ray component coincides with a prominent Hα filament having a projected diameter of 8 kpc. Since the nuclei of both objects contain central starburst activity, the cause of the diffuse X-ray emission is thought to be outflowing hot gas from multipe type II supernova explosions and stellar winds from massive stars in the starburst regions.

In both objects the total 0.1–2.4 keV flux of about 10^{40} erg s^{-1} is dominated by the nucleus, while a significant fraction is also located in the galactic disk. The X-ray halo luminosities in NGC 2903 and NGC 4569 amount to $\sim 10^{-39}$ erg s^{-1}. In each case, the halo is detected only on one side of the disk. The other part of a possible bipolar outflow would probably be absorbed by the disk, due to the intermediate inclination of both galaxies.

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Doppler-mapping of the Asynchronous Polars BY Cam and V1432 Aql

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We present, for the first time, Doppler-maps of the asynchronous polars BY Camelopardalis and V1432 Aquilae. BY Cam and V1432 Aql belong to a four member subclass of asynchronous polars, where orbital and spin period of the white dwarf differ by $\sim 1\,\%$. Contrary to their synchronized relatives, the ballistic accretion stream encounters a changing orientation of the magnetic-field during a beat cycle. As a consequence, infalling matter should be threaded onto different field lines, and directed to the energetically favoured pole.

We obtained sets of high resolution (≈ 0.7Å), phase-resolved ($\Delta\phi \approx 0.01$) spectra of both systems at the 3.5 m telescope at Calar Alto with the TWIN spectrograph. The resulting Doppler-maps for both stars show no clear signatures of the ballistic and/or magnetic accretion stream frequently detected in tomograms of synchronized systems. Instead the emission is spread over a wide range of velocities. This is most probably an indication of matter not accreted in a single stream, but via a curtain extending over a wide range in azimuth.

We also find evidence for the heated side of the secondary star for BY Cam, from which the Doppler-maps could be phased.

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Optical Spectroscopy of two Double-degenerate Polar Candidates

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RX J0806.3+1527 and RX J1914.4+2456 are two peculiar magnetic CVs which have been discovered during optical identification programmes of soft X-ray sources from the ROSAT All-Sky Survey (Beuermann et al. 1999, Motch et al. 1996). Both systems have similar X-ray spectra and show a strong pulsation of the soft X-ray flux with a modulation of $\sim 100\,\%$ and periods of 5.4 min and 9.5 min, respectively. While these systems have originally been suggested to be further members of the ROSAT-discovered class of soft X-ray intermediate polars, arguments have been put forward that they could be double-degenerate polars (Ramsay et al. 2000, Burwitz & Reinsch 2000).

We present the first optical spectra of the $V \sim 21$ mag and $V \sim 19$ mag objects obtained with FORS1 at the ESO VLT UT1/Antu and with CAFOS at the Calar Alto 2.2 m telescope, respectively, and re-discuss the nature of these objects.

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P 68

Structural Parameters of Peanut Shaped Bulges

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We have studied a sample of ~ 1350 edge-on galaxies derived from the RC3 (de Vaucouleurs et al. 1991) using the Digitized Sky Survey (DSS) and additional CCD observations. In this sample we find 40 peanut shaped bulges (Lütticke et al. 2000, A&AS in press). This number leads to the result that 4 ± 1 % of all bulges in edge-on disk galaxies (S0-Sd) have such a shape. 12 of these bulges are characterised as peanut shaped for the first time.

In order to quantify the peanut structure, also called X-structure, we use three known as well as two newly introduced objective parameters: 1. The angle θ is measured between a branch of the X-structure and the major axis ($\theta = 40 \pm 10°$). 2. The a_4 isophote shape parameter describes the deviations from perfect ellipses. Therefore the minimum of a_4 is useful for quantifying the degree of the peanut shape. The most extrem bulges show values up to $a_{4\mathrm{MIN}} = -7$ %. 3. The fitting of the galaxy by disk and bulge component (Pohlen et al. 2000, A&AS 144, 405) with a following subtraction of the model and an elimination of structures near the galactic plane leads to an isolation of the excess luminosity (EL) of the peanut distortions. The total EL correspond to 1-5 % of the observed total bulge luminosity (BL). 4. The maximum of excess to bulge luminosity ($\mathrm{EL/BL_{MAX}}$), measured in radial intervals from the galactic center, has a large range and reaches values up to 24 %. 5. The maximal depression of the isophotes along the minor axis can be measured by an angle (ψ), which has a size of 7° for the most prominent peanut bulge.

Finally, we also discuss the feasibility of a general classification of bulge shapes in edge-on galaxies with these parameters.

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First Results from an HST Snapshot Survey for Nearby Dwarf Galaxy Candidates

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We are carrying out a comprehensive multi-wavelength study of dwarfs galaxies in the Local Volume (< 5 Mpc), many of which were discovered only recently. In addition to ground-based observations for the determination of global integrated properties, of structural parameters, and of the H I content we are using a 200-orbit HST snapshot survey to measure distances to the dwarf galaxy candidates using the tip of the red giant branch, to derive initial photometric metallicities from the slope of the red giant branch, and to study stellar content and recent star formation history based on luminous young and intermediate-age stars. The distances help us to determine whether our targets are likely members of nearby galaxy groups and clusters and allow us to derive the three-dimensional structure of these groups. This enables us to carry out detailed studies of the morphology-density relation and to investigate the influence of environment on galaxy evolution. Furthermore, our data allow us to augment the faint end of the galaxy luminosity function, to improve the census of globular clusters in dwarf galaxies, and to study the universality of the relation between mean metallicity, central surface brightness, and luminosity for different types of dwarf galaxies.

P 70

Evolutionary Synthesis Models for the Formation of S0 Galaxies in Clusters

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Rich galaxy clusters in the local Universe show a large population of S0 galaxies ($\sim$ 40 %). With increasing redshift the fraction of this S0 galaxy population is observed to strongly decrease (e.g. by a factor $\sim$ 4 to z = 0.5 in favor of the spiral galaxy fraction while the number of bright ellipticals does not seem to change. The infalling field galaxy population that successively builds up the cluster also is spiral rich and S0 poor. It has hence been suspected that galaxy transformation processes – either due to galaxy – galaxy or to galaxy – ICM interactions are responsible for this change. Ignoring any dynamical or morphological aspects, we use evolutionary synthesis models describing various possible effects of those interactions on the star formstion rate of the infalling spirals. We study the effects of starbursts of various strengths as well as of the truncation of star formation on the colour and luminosity evolution of model galaxies of various spectral types. Comparison with observed properties of the local S0 galaxy population is used to constrain possible S0 formation mechanisms. Our results are in agreement with a study of spectral features of cluster S0s but allows for stronger constraints.

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Optical Survey for LSB Galaxies in the Arecibo Strip

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We present optical follow-up observation of a 30 deg^2 large part of the HI survey field called Arecibo Strip. This 65 deg^2 large strip was observed during 1993 and 1994 with the 305m single dish Arecibo radio telescope (Zwaan et al. 1997). With this blind HI search Zwaan et al. (1997) found 66 galaxies up to a distance of cz = $7500\frac{\mathrm{km}}{\mathrm{s}}$. This implies a surface density of 1 galaxy deg^{-2}. On the other hand the surface density for Low Surface Brightness (LSB) galaxies alone, derived from optical searches with similar depth, is a factor of 4 higher (e.g. O'Neil et al. 1997).

To investigate the selection effects of HI blind surveys we undertake a optical survey of a 30deg^2 large subregion using the Calar Alto 1.23m telescope equipped with the WWFPP focal reducer and a large format thinned CCD. We search for LSB galaxies in the Johnson B and Cousins R band. As a preliminary result of this program we derive a surface density of 6 LSB galaxies deg^{-2}, consistence with the only other CCD-based survey for field LSB galaxies (O'Neil et al. 1997).

This implies that blind HI searches for galaxies do not give a complete picture of the galaxy- and especially the LSB galaxy-population. A reason for this discrepancy could lie in the limited cz depth or the sensitivity of the HI surveys, leading to a loss of galaxies which are HI poor, low mass dwarfs, and/or galaxies with slightly larger distance than the HI search limit.

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Chemodynamical Mixing Cycles in Dwarf Galaxies

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Observations of dwarf irregular galaxies show no significant metal abundance gradients throughout the galaxies what can only be produced reasonably by large-scale mixing of gas phases. Additionally, in several starburst dwarf galaxies (SBDGs) large HI reservoirs envelope the luminous galactic body (e.g. in NGC 4449 and I Zw 18) and obtrude that the starburst is fuelled by enhanced gas infall. Therefore, a possible mechanism is the mixing of metal-enriched and expelled supernova (SN type II) gas with almost pristine or slightly metal-enriched infalling clouds from the gas envelope.

Here we present a quantitative analysis of the gas mixing cycles occuring in chemodynamical evolution simulations of dwarf galaxies evolution. We show the presence of an 'inner', local and an 'outer', large-scale mixing cycle and investigate the influence of different mixing timescales on the chemical evolution.

The three main conclusions which can be drawn from chemodynamical models are: 1) While often an selective outflow of oxygen is assumed to explain observed N/O abundance ratios, chemodynamical models show that both ejecta from SNe II and Planetary Nebulae are mixed efficiently; 2) Not more than 20 % of the total metal content leaves the galaxy; 3) The chemodynamical mixing cycle lies between the local mixing on shortest timescales and a galactic fountain where large-scale dynamics of hot gas with cooling determine its fall back.

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Induced Star Formation in Markarian Galaxies

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From a submm study to characterize the global star formation in a FIR flux limited sample of Markarian galaxies, it has been found that the L_{IR}/M_{gas} is a factor of 20 larger than for normal spiral galaxies. Such high value was interpreted in terms of an enhancement in the efficiency of star formation in Markarian galaxies. An inspection of the selected galaxies in the DSS shows that most of them present important dynamical perturbations in the form of tidal tails, bridges with nearby companions, double nuclei, etc. The presence of bright knots along the tidal tails can be related to the formation of dwarf systems in them.

Here we report the still preliminary results obtained for three galaxies: Mrk 538, Mrk 496 and Mrk 708. Their common property in the three cases is the large event of star formation occuring in their nuclei which extends beyond the central main body of the galaxy. Among the most interesting results we want to point out that the bulge of the companion galaxy of Mrk 538 has been resolved in three knots which show spectra typical for a poststarburst event. In the same system also a star formation bridge connecting both galaxies has been detected. For Mrk 496 we have detected a double nucleus and the reported spectra show characteristics typical for a large burst of star formation on the top of a rather normal galaxy. Mrk 708 shows a very extended star formation event following the bar direction. Most of the compact objects surrounding the galaxies have been analyzed and all the redshifts are reported. We have discovered three new BAL QSOs with redshifts larger than 3, and a large amount of dwarf systems with redshifts mostly between 0.1 and 0.6.

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Large Scale Structure in the Calar Alto Deep Imaging Survey

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The Calar Alto Deep Imaging Survey (CADIS) combines a deep emission line survey carried out with an imaging Fabry-Perot interferometer with a multicolor survey using three broad-band and up to 13 medium-band filters. The combination of different observing strategies facilitates not only the detection of emission line objects, but also to derive photometric spectra of all objects without time consuming single slit spectroscopy. In three fields, each measuring $\approx 1/30\ \square^\circ$, we identified a sample of 2779 field galaxies with $I < 23$, $0.2 < z < 1.07$, for which photometric redshifts were available, and an emission-line selected sample of 69 galaxies in two fields, at a mean redshift of 0.24, with a redshift accuracy of 120 km/s.

Both samples can be used to examine the spatial distribution of galaxies, and the evolution of galaxy clustering between $z = 1$ and the local universe.

For the emission line galaxies we present measurements of the spatial two-point correlation function, for the field galaxies we have calculated the projected correlation function (Davis & Peebles 1983) to avoid errors due to the redshift-space distortions.

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Variable Narrow Emission Line Galaxies

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Spectroscopic follow-up observations of QSO candidates from the variability/proper motion survey in the 10 square degree field around M92 revealed an unexpectedly large fraction of 33 nearby ($z \leq 0.3$) galaxies with prominent emission lines. Among them are 6 Seyfert 1 galaxies and 27 narrow-emission line galaxies (NELGs). Significant optical variability is measured for all of the NELGs with amplitudes of about 1 mag.

The physical nature of these variable NELGs remains unclear. The distributions of their emission line widths, absolute magnitudes and colours argues against a random sample of typical star forming field galaxies. Their images on Schmidt plates are nearly star-like. On higher resolution images, we found indications for double nuclei and/or disturbed morphology in the underlying galaxy. According to the diagnostic line ratios [OIII]λ5007/Hβ, [NII]λ6583/Hα and [SII]$\lambda\lambda$6716, 6731/Hα, the NELGs are located near the dividing lines between HII galaxies and AGNs. However, the uncertainties of the measurements from the available low-dispersion spectra are too large for definitive conclusions. Clearly, the lightcurves are the most remarkable property of the NELGs. We suspect that the strong variability is related to AGNs, at least for a substantial fraction of the sample. On the other hand, there are no indications for long-term variability on time-scales of months or longer, in contrast to what we found as typical for QSOs and Seyfert 1 nuclei. Hence, the variable NELGs may represent a special subclass of AGNs. Their luminosities are compatible with (narrow-line) Markarian-Seyfert 1 nuclei for about 60% of the sample, and with low-luminosity AGNs for the rest. The presence of short-term variability is indeed expected for low-luminosity AGNs, the high amplitudes however are very surprising.

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Variability and Proper Motion Selected QSOs in the M92 Field

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The combination of photometric variability and zero proper motion is expected to provide a powerful tool (VPM survey) for finding QSOs without strong selection bias. Based on 208 fully digitised Tautenburg Schmidt plates, we performed a VPM search in a 10 square degrees region centred on M92. The huge number of plates with a maximum epoch difference of 34 years results in absolute proper motions and variability measurements reaching accuracies of $0.5\,\mathrm{mas\,yr^{-1}}$ and 0.03 mag, respectively. In addition, the dense coverage of the time space for epoch differences between one day and more than three decades allows a close investigation of the QSO variability properties.

Spectroscopic CAFOS and TAUMOK observations of the candidate sample revealed a total of 58 QSOs, 6 Seyfert 1 and 27 narrow emisson line galaxies. We discuss the properties of the QSOs and the selection effects of the survey. The by far most important selection criterion turned out to be the photometric accuracy of the measurements. Although the VPM search strategy is completely different from the conventional multicolour and spectroscopic surveys, the resulting sample of QSOs does *not* show *any* significant difference in their properties, neither in their colours and spectral indices, nor in their equivalent widths of the emission lines or the presence of the Baldwin effect. Virtually all VPM-QSOs would have been discovered by multicolour surveys as well. Moreover, we find no evidence for the presence of a substantial fraction of "red" QSOs brighter than $B \approx 19.5$, the limit of our survey. The VPM-QSO sample is well-suited for the investigation of long-term light curves, the variability time scales and their implications for the origin of the long-term QSO variability (e. g. source-intrinsic or gravitational microlensing).

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IRAS Galaxies in the Perseus Cluster A 426

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Both morphology and star formation activity of galaxies in a cluster environment may be influenced by various mechanisms: ram pressure gas stripping, turbulent/viscous stripping, low-velocity encounters within substructures, successive high-speed encounters in the core, and gravitational interaction with the whole cluster potential. The spatial distribution of the galaxies with elevated star formation rates (SFRs) provides constraints for the relative importance of these processes. We discuss the IRAS galaxies within about one Abell radius of the Perseus galaxy cluster. With $z = 0.0183$, this cluster is well suited for such a task. We identify 19 galaxies from the optical catalogue (Brunzendorf & Meusinger 1999, A&AS 139, 141) with sources from the IRAS PSC. According to redshifts, 17 galaxies are likely cluster members. Their sample averaged FIR excess is higher than is expected for normal galaxies. Estimated dust temperatures and SFRs support the assumption of moderate starbursts as the source of FIR activity. The study of galaxy morphology on images in the B band and in the redshifted Hα reveals signs of distortions for a substantial fraction of the sample. A correlation of the strength of distortion with the SFR is indicated. On the other hand, there are galaxies which are distorted, but do not show evidence for elevated SFRs. Both the IRAS galaxies and the distorted non-IRAS galaxies are preferentially located out of the high-density cluster core. For the IRAS galaxies, in particular, we find a strong radial segregation which can not be explained as due to the morphological segregation between early-type and late-type galaxies in A 426. The processes that trigger star formation activity of galaxies in clusters obviously work predominantly outside the core radius.

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Spatial Orientation of 914 Galaxies in the Core of the Shapley Concentration

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We present an analysis of the spatial orientations of 914 galaxies in the core of the Shapley concentration, the richest nearby supercluster of clusters of galaxies. The core of the Shapley concentration is a chain formed by the ACO clusters A3558, A3562, and A3556 and the two poor clusters SC 1327–312 and SC 1329–313. We classified the total sample into 4 subsamples: the main clusters A3558, A3562, A3556, and the zone between the clusters A3558 and A3562 (the region of the two poor clusters). This zone is considered as an 'interaction zone' between the clusters A3558 and A3562. We used the 'position angle – inclination' method to find the polar and azimuthal angles of the galaxy rotation axes. To analyse the distribution of the polar and azimuthal angle of the galaxy rotation axes and to check for anisotropy or isotropy we have carried out three statistical tests: chi-square-, fourier-, and auto correlation-test. We assumed spatial isotropic distribution to examine non-random effects. Within the main cluster A3558 a strong tendency can be seen: spin vectors tend to lie parallel to the LSC plane. The projections of these spin vectors tend to point towards the Virgo cluster centre. The clusters A3562 and A3556 show isotropy in the polar angle distribution. In the azimuthal angle distribution, the cluster A3556 shows isotropy, whereas A3562 shows weak anisotropy. The zone between the clusters A3558 and A3562 shows weak anisotropy in both polar and azimuthal angle distribution. However, the general trend (total sample and all subsamples) is, that spin vectors tend to lie parallel to the LSC plane, their projections tend to point towards the Virgo cluster centre.

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Spin Vector Orientation of 1192 Disk Galaxies in the Region $19^h26^m00^s \leq \alpha \leq 20^h19^m00^s$, $\delta = -65^o \pm 3^o$

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We present an analysis of the orientations of 1192 galaxies found in the region $19^h26^m00^s \leq \alpha \leq 20^h19^m00^s$, $\delta = -65^o \pm 3^o$. In the region considered here we investigated two Abell clusters (A3652 and S0846) and 606 background galaxies. We classified each cluster region into three subsamples: $1^o \times 1^o$, $2^o \times 2^o$, and $3^o \times 3^o$ around the cluster center. Further, we classified the total sample into 21 subsamples on the basis of their axial ratios and major diameters. Our aim was to examine non-random effects in the galaxy orientations within the clusters. To analyse the distribution of the polar and azimuthal angles of the galaxy rotation axes and to check for anisotropy or isotropy we have carried out three statistical tests: chi-square-, fourier-, and auto correlation-test. This was done for the total sample as well as for all subsamples individually. Anisotropy of the distribution of the polar and azimuthal angle was found for the total sample as well as for 12 subsamples. Spin vectors of galaxies in the cluster region A3652 and S0846 show a weak tendency to lie parallel to the Local Supercluster plane. However, the spin vector projections tend to point towards the Virgo cluster center. The orientation of face-on and edge-on galaxies are found to be identical. The subsample T ($a \geq 14$ arcsec) upto which the optical search for galaxies is complete, shows strong isotropy in its polar angle distribution.

We intend to continue our investigations for other rich Abell clusters which will be published in due course.

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Interacting Galaxies Behind the Milky Way

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Galaxy – galaxy encounters, interactions and mergers offer us spectacular examples of Universe small scale instabilities, as they are triggering processes which strongly modify morphology and physical properties of the involved galaxies. During the last decades both observational and theoretical studies have been devoted to the understanding of such phenomena – e.g. studies on interaction-starburst and interaction-activity connection (Mihos & Larnquist 1996, ApJ 464, 641; Schmitt et al. 1998, A&AS 193, 608) – but still much of this subject has to be learned and more interacting systems have to be analyzed.

We are currently undertaking a campaign of observation of new promising candidate double and multiple systems of galaxies, emerging from numerous surveys carried out during the last years and dedicated to the search for galaxies in the Zone of Avoidance (for a review see e.g. Kraan-Korteweg & Lahav 2000, A&A Rev., in press).

We present here preliminary photometric and spectroscopic analysis[1] of such systems: CGCG 559-004, a spiral galaxy showing a luminous bar with extended emission line regions at its ends and having a close candidate companion; IRAS 02443+4437 (data from Calar Alto observatory), an evidently interacting pair with an almost face-on galaxy and the other inclined and apparently warped; finally, the pair ZOAG G129.34+06.41 and ZOAG G129.41+06.39, two spiral galaxies one of which clearly barred and with at least one ring, both showing Hα emission at the same redshift (data from Asiago observatory, Italy).

[1] Partly based on observations made with the Nordic Optical Telescope, operated by Denmark, Finland, Iceland, Norway, and Sweden, in the Spanish Observatorio del Roque de los Muchachos of the IAC.

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On the Way to Stability: CG J1720–67.8, a Highly Evolved Compact Galaxy Group

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Compact Groups of galaxies (CGs) are the ideal environment where effects of interactions on the dynamical evolution of galaxies, from morphological disturbances and star formation enhancement to the final merging into field ellipticals, can be observed. This may be the fate of CGs: recent HST observations of ULIRGs, which appear to be the result of CGs' collapses (Borne et al. 2000, ApJL 529, 77), and X-ray observations of CGs and ellipticals (e.g. Jones et al. 2000, MNRAS 312, 139) support a hierarchical galaxy formation scenario.

In the present study, the recently found very compact system CG J1720-67.8, whose properties point to a highly advanced evolutionary stage (Weinberger et al. 1999, ApJL 522, 17), is analyzed in detail.

In BVRIJHK images and derived optical and near-IR colors, beside appearing with a peculiar morphology dominated by an extended tidal tail, the group exhibits blue regions indicating young stellar populations particularly at the tips of the tail, and a mixture of young and old populations both in the member galaxies and along the tail. These properties are confirmed by the emission line spectra, witnessing a remarkable star formation activity in a low metallicity environment (metal abundances $\sim 0.1 - 0.2$ solar, as indicated by the ([OII]λ3727 + [OIII]λ4959+5007)/Hβ ratio). Emission-line based diagnostic diagrams indicate the HII-like and/or starburst nature of all the group members.

Our data are based on observations with the 3.6m telescope operated on La Silla by the European Southern Observatory.

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The Dusty Warp of the Milky Way – Preliminary Results from the Analysis of the Distribution of Galaxies in the "Zone of Avoidance"

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In 1957 radio observations of the HI distribution beyond the solar circle first revealed the layer of neutral hydrogen to be warped systematically from the mean Galactic plane. Since then the Galactic warp has been detected in the distribution of the stellar and dusty component, too. However, evidence for the warped distribution of dust is limited and is based on the emission of dust only.

In the past few years a systematic search on POSS I plates for galaxies hidden in the "zone of avoidance" has been carried out at the Institute of Astrophysics in Innsbruck. The surveyed region extends from $l = 20°$ to $l = 240°$ with latitude extensions $-10° \leq b \leq 10°$ in the region $20° \leq l \leq 130°$ and $-5° \leq b \leq 5°$ in the region $130° \leq l \leq 240°$. During this search about 10 000 galaxy candidates have been discovered.

The distribution of these galaxies both in Galactic longitude and latitude clearly shows an asymmetry, which may be attributed to a Galactic dust warp. We present preliminary results from the analysis of the galaxy distribution and draw conclusions on the shape of the Galactic dust layer.

P 83

Radiative Transfer Equation: Analytical Solution in the Two-stream Approximation

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Starting with the papers of A. Schuster and K. Schwarzschild in the beginning of the century much work has been dedicated to the radiative transfer equation and its solution. But to our knowledge all analytical solutions of the transfer equation have been derived with the assumption of a constant de-excitation coefficient epsilon or – in more complicated cases – by a piecewise constant function. With powerful computers it became possible to consider media with a large variety of epsilon. However, such an approach is not efficient enough to deal with media with many strong density inhomogeneities. Therefore, it seemed necessary develop new analytical methods which can be used in such situations.

Starting with the analytical solution of the radiative transfer equation with a linear depth dependence of epsilon we got solutions for a large class of continuous epsilon distributions and for inhomogeneous media that can only be treated statistically. We present these new solutions and discuss possibilities for the solution of the inverse problem, i.e. the deduction of the internal distribution of epsilon from observational data.

P 84

How Consistent are FK5 and Hipparcos Proper Motions with the Correction of the Luni-solar Precession?

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Several recent and independent studies resulted in the correction of the luni-solar precession of approximately –3 mas/yr (e.g., Charlot et al., 1995). Assuming inertiality of the ICRF, to which the Hipparcos positions and proper motions have been related, it is expected that the comparison of the FK5 and Hipparcos proper motions confirms this correction of the precession.

Using 1151 FK5 stars having reliable single star Hipparcos solutions we obtained from the proper motion differences by weighted least squares estimation $\Delta n = -0.64 \pm 0.07$ mas/yr and $\Delta k = 0.78 \pm 0.08$ mas/yr. Thus, $\Delta p = -1.61$ mas/yr and $\Delta e = -2.26$ mas/yr, the latter suggesting 18% diminuition of the customary value (e.g. Fricke, 1982), while the former is significantly different from the expected value. A relative rotation of the FK5 and Hipparcos frames by only 0.5 mas/yr would entail $\Delta p = -2.87$ mas/yr in agreement with the favoured precession correction.

The above-mentioned estimation method, if applied to the same stars distributed by declination zones, ranges of right ascension, and parallaxes, allows the conclusion that most of the inconsistency may be due to the FK5. Imperfections, however, of the Hipparcos link and submilliarcsecond distortions of the ICRF cannot be excluded.

Ref.: Charlot, P., Sovers, O.J., Williams, J.G., Newhall, XX: 1995, AJ **109**, 418
Fricke, W.: 1982, A&A **107**, L13

P 85

Temperature-anisotropy Driven Instabilities in Astrophysical Plasmas

N.S. Dziourkevitch, C.-V. Meister
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In this paper a detailed analysis of the excitation conditions of mirror and cyclotron waves in space plasma is done. There are found analytical expressions for the dispersion relations of the waves in case of parallel and perpendicular propagation of the modes with respect to the mean magnetic field. These relations may be used in future to develop the corresponding nonlinear theories of the turbulent plasma. The nonlinear theories result into formulae for the relaxation time of the turbulent space plasma, which has to be known to interprete recent satellite data.

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Nonlinear Theory of Ion-acoustic Waves in the Solar Atmosphere

C.-V. Meister (Astrophysical Institute Potsdam, Germany)
A.V. Volosevich (State University Mogilev, Belarus)

Basing on recent models of the solar atmosphere, the excitation of collisional ion-acoustic turbulence in the region of the solar temperature minimum with about 4200 K is investigated. At this temperature minimum both the charged particle densities and the neutral particle densities are high. An instability may occur because of electrical currents or charged particle beams. There, the energy of the electron drift motion transferred to the waves is larger than the energy loss caused by the ion viscosity. In the present paper, taking into account wave and Joule heating effects, the evolution of the ion-acoustic instability in the weakly-collisional solar plasma is modelled within the frame of magnetohydrodynamics. The formation of nonlinear stationary waves is numerically studied for different intensities of turbulence.

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Dispersion of Waves in Anisotropic Space Plasmas with Particle Drifts

C.-V. Meister (Astrophysical Institute Potsdam, Germany)
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The calculation of relaxation times of waves in plasmas with temperature anisotropy and charged particle drifts is very important for the interpretation of recent satellite data obtained for the solar wind and the earth's magnetosphere. In this paper a general expression for the tensor of the dielectrical susceptibility in an anisotropic plasma with particle drifts is derived, and the dispersion equation is found for waves propagating in arbitrary direction with respect to the mean magnetic field. The dispersion equation is solved for the case of electromagnetic ion-cyclotron waves. It is found that strong plasma instability may occur so that, e.g. in the auroral plasma of the earth, the value of the growth rate of the waves equals the order of the wave frequency.

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BUSCA: First Results of Simultaneous Photometry at the Calar Alto Observatory

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After the pre-Calar Alto tests from September 1998 to January 2000 at Hoher List Observatory, BUSCA ("Bonn University Simultaneous CAmera", Reif et al., 1999) had its "First Light" at the 2.2m telescope at Calar Alto in April 2000. We were able to integrate BUSCA into the Calar Alto environment, the new auto-guiding unit, the instrument control and data acquisition. The BUSCA optics did perform as expected even at sub-arcsec seeing. At the end of 2000 the thinned 4K×4K 15μ CCD–Chip for the UV–channel will be available. We expect that BUSCA will become a regular instrument at the 2.2m telescope in the observing period autumn 2001.

We present as a first scientific result a metallicity calibration of red giant branch stars with the BUSCA Strömgren system. With this calibration we are able to detect CN variations in giant stars, which were observed by spectroscopy previously. Observing many globular clusters will help us to solve the question whether these variations are triggered by primordial abundance variations or by evolutionary mixing processes.

The poster shows the current status of the instrumentation project and presents the first results of the April run.

Reif, K., Bagschik, K., de Boer, K.S., Schmoll, J., Müller, Ph., Poschmann, H., Klink, G., Kohley, R., Heber, U., Mebold, U., 1999, SPIE Vol. 3649, 109–120
(or `http://www.astro.uni-bonn.de/~ccd/busca/ei99/busca.html`)

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The New Control System for the 1 m Cassegrain Telescope at the Hoher List Observatory

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The 1m Cassegrain (f/14.5) telescope of the Hoher List Observatory – operated by the Sternwarte of Bonn University – is the largest instrument on site. It was built in 1965 and its ancient electro-mechanical control had been in use until the end of last year.

During the course of the last year, a new computer based control system has been developed in order to improve the pointing/tracking performance and as the basic step towards remote control and maintenance. It provides corrections for various effects, e.g. refraction, polar motion, and mechanical imperfections – which could not be addressed by the old control system.

The new system is operational since the end of 1999 in preliminary form.

The telescope control system is based on high performance encoders and general purpose industrial automation motor control units. A CAN bus connects the motor control (and eventually autoguider and dome control) units to a Linux PC running the control software. This control PC is integrated in the Hoher List LAN together with other instrumentation control and data reduction computers.

The poster explains the system design and describes the current status with results from pointing and tracking tests obtained using a first telescope pointing model.

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A Practical Approach to Ancient Astronomy

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Current astronomical measurements analyzing every passband of the electromagnetic spectrum imply a wealth of extremely sophisticated techniques with respect to accumulation, detection, and subsequent data processing. Thus, naked eye observations have become obsolete for research purposes in modern astrophysics.

Nonetheless, the foundation and development of astronomy in the history of mankind are related to thorough recording and preserving of phenomena directly visible with the naked eye. Architectural relics of ancient cultures prove that astronomical concepts played a major role in the religious and social life of our ancestors. The scientific discussion contributing astronomical, historical, anthropological, and archaeological aspects to elucidate cultural meaning and technical methods of early astronomy still remains controversial.

Transcending the historical debate the authors have inaugurated an 'observatory' designated to reconstruct fundamental techniques of ancient astronomy. The main unit of the anticipated observatory at Recklinghausen/Herten consists of a plateau with central immersion (height 170 m, diameter 100 m) creating an almost perfect mathematical horizon. The central observer is guided due to the construction of arcs indicating the meridian and the celestial equator. Gnomon and foresights are arranged to transform diurnal, annual, and secular dynamical aspects of planetary and stellar objects into a lively experience. Embedded in a 'science-park' the observatory will create a unique opportunity to motivate and develop astronomical culture based on observational experience for the general public.

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Frederik Kaiser (1808–1872) and the Modernisation of Dutch Astronomy

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Frederik Kaiser was the director of Leiden Observatory from 1837 until his death in 1872. Educated by his German-born uncle Johan Frederik Keyser (1766–1823), who was a proficient amateur astronomer, Kaiser proved to be a real observational talent. Despite the poor conditions in which he worked, his observations soon rivalled with the best in the world.

Kaiser's contributions to astronomical practice include the foundation of a new, completely up-to-date observatory building in Leiden, and the introduction of statistics and precision measurements in daily practice at the observatory. Moreover he was the author of several bestselling books on popular astronomy.

Kaiser had an extensive correspondence with colleagues all over Europe, mostly in Germany. Correpondents include Airy, Argelander, Von Auwers, Bessel, Encke, John Herschel, LeVerrier, Von Littrow, Schumacher, Otto W. Struve, as well as several geodesists and instrument makers.

Preliminary research indicates that Frederik Kaiser played a crucial role in the revival of Dutch astronomy in the second half of the 19th century.

This project aims at analysing and explaining Kaiser's activities in science, institutionalisation and popularisation, in the context of national and international developments in 19th-century astronomy and scientific culture.

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Calendars in the Gregorian Spirit

Heiner Lichtenberg (Bonn) and Peter H. Richter (Bremen)

The Gregorian Calendar is an adaptable cyclic, lunisolar time-reckoning system [1]. It assumes the following equations:

$$\begin{aligned} a_{\mathrm{trop}} &= 1461/4 - s/(100 \times P1) \quad \text{days} \\ m_{\mathrm{syn}} &= a_{\mathrm{trop}}/(235/19 + e/(3000 \times P2)) \quad \text{days} \end{aligned}$$

for the average tropical year a_{trop} and the average synodical month m_{syn}, respectively [2]. s is the number of leap years reverting to common years at the secular boundaries of the period $P1$, measured in centuries. e is the number of (net) adjustments of the epact at the secular boundaries of the period $P2$, measured in centuries.

The particular form of this rational approximation characterizes the Gregorian spirit; the standard integers $s = 3$, $P1 = 4$, $e = -43$, $P2 = 100$ are open for adjustment. Truncated continued fraction expansions should be used to successively improve the accuracy. For $a_{\mathrm{trop}} = 365.2422d$ and $m_{\mathrm{syn}} = 29.530588d$, we find that $s = 3$, $P1 = 4$, $e = -19$, $P2 = 44$ is slightly better than the standard values. Its fundamental equation $2,508,000\, a_{\mathrm{trop}} = 31,019,639\, m_{\mathrm{syn}} = 916,028,190\, d$ defines a period about half as long as for the usual Gregorian calendar, $5,700,000\, a_{\mathrm{trop}} = 70,499,183\, m_{\mathrm{syn}} = 2,081,882,250\, d$ [3].

[1] Clavius, Chr., Rom. Cal. Explic., Rome 1603, (= Op. math., tom. V, Mainz 1612).
[2] Lichtenberg, H., The Gregorian Calendar: An Adaptable Cyclic Lunisolar Time-reckoning System for the Millennia, Hum. Welf. Stud., vol. 2 (1999), pp. 137 - 148.
[3] Explan. Suppl. Astron. Almanac, ed. P. K. Seidelmann, Mill Valley, Ca., 1992.

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