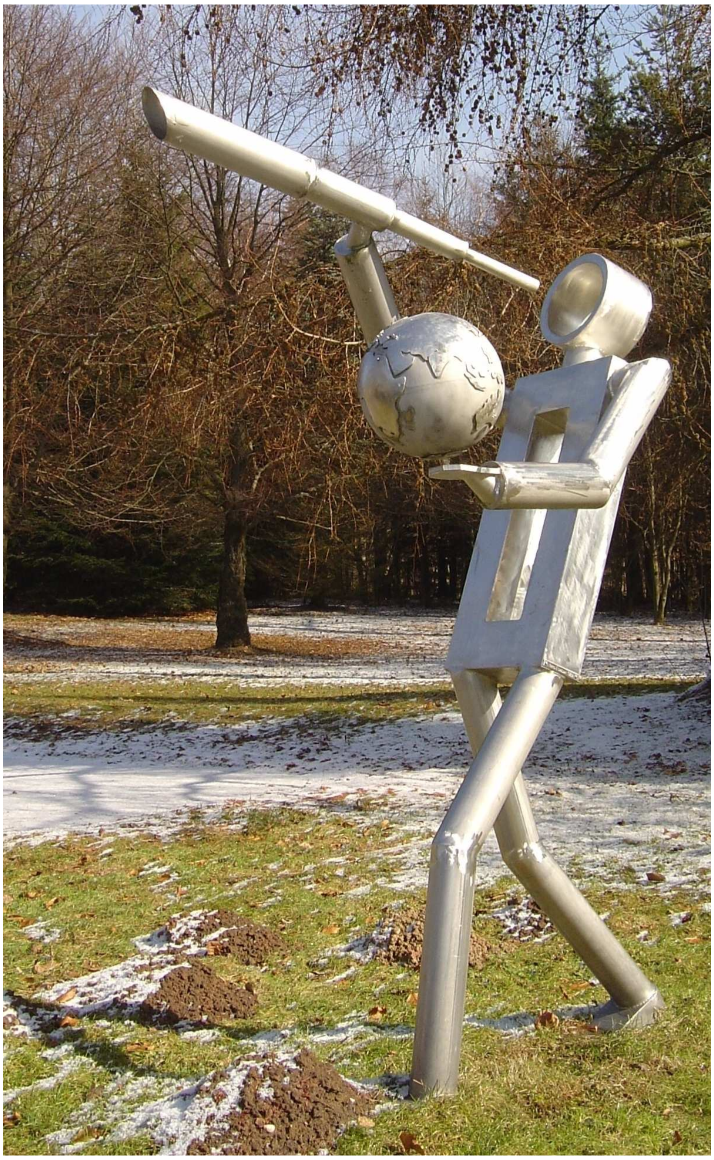
Planet Formation and Evolution Studies: Various Approaches - One Goal



4th Planet Formation Workshop
"Planet Formation and Evolution Studies: Various Approaches - One Goal"

1–3 March 2006 – Heidelberg

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Universität Heidelberg

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MPI für Astronomie, Heidelberg

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Chair: Tilman Spohn

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Chair: Ulrich Christensen

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Abstracts

Simulations about the Expected Number of Transiting Planets in Transit Surveys

C. Afonso

MPI für Astronomie, Heidelberg

Abstract: Planetary transits may yield many propreties of the planetary system: radius of the host star,radius and orbital distance of the planet and inclination angle, provided the light curves have a high photomeric accuracy, a high time sampling and the parent star is well characterized. Currently, the radius of planets can only be determined from transiting planets, representing the principal motivation of this technique. To determine the expected number of transits, we adopt a different approach than the usual predicted number, based on how many stars are in the field (values typically used are 0.4-2 planets per 10,000 stars) which we consider less robust. We performed a Monte-Carlo simulation, by generating transits for a catalog of stars (generated by the Besançon Model of the Galaxy), and running them through a simplified detection pipeline, since we do not create light curves *de facto*. We will present the number of expected transiting planets in various Galactic fields and filters.

Early Earth and the evolving biosphere

M. Bau

Geoscience & Astrophysics, International University Bremen

Abstract: For an astrobiologist, Earth is the backyard s/he is most familiar with and that can be used as the natural lab where to test hypotheses and techniques developed for the search for (fossil) life elsewhere in and beyond our solar system. Geochemists and geologists work in close collaboration with molecular biologists, biochemists, and microbiologists to study topics such as abiotic synthesis of organic compounds, formation and evolution of life, and the interaction of this evolving biosphere with the hydrosphere, atmosphere and upper lithosphere. In this context, one of the major goals of geochemistry is to find "biosignatures" that allow to verify the presence of living organisms from the study of minerals or rocks. Minerals and rocks constitute the "geological record" on Earth, that can be used as an archive which dates back to about 4 billion years ago.

Over the past decade, two issues have drawn particular attention and triggered very fierce and controversial discussion: the antiquity of life (closely related to the question about whether or not there had been a heavy meteorite bombardement of Earth) and the evolution of the redox level of the Earth's atmosphere and oceans (closely related to the question about the antiquity of oxygenic photosynthesis). In my presentation I will give a brief review of current ideas regarding these topics.

Effect of silica on Ni solubility in silicate melts: an experimental study and implications to metal/melt partitioning

A. Borisov[1,2]

[1] IGEM RAS, Moscow, Russia
[2] Institut für Mineralogie und Geochemie, Universität zu Köln

Abstract: We have determined effect of silica on Ni solubility in silicate melts of anorthite-diopside eutectic composition (DA) with variable SiO_2 concentrations. The experiments were conducted by equilibrating Ni loops with silicates at fixed temperatures of 1300, 1400 and 1430°C. To cover a wide range of Ni content in melt the experiments were done at fO_2 from $10^{-9.51}$ atm (ppm-level) to $10^{-5.96}$ atm (up to 13 wt.% NiO in melt).

It was found that at any given T-fO_2 parameters the addition of silica affects Ni solubility in a similar way: Ni solubility increases with silica increasing up to 55-58 wtdecreases again with a further silica increase. This finding is in conflict with Ertel et al.'s (1997) study, who claimed independence of Ni solubility on silica content in the same DA+SiO_2 system. The maximum Ni solubility in silicate melts corresponds to the minimum of NiO activity coefficient, γ_{NiO} at SiO_2 around 57 wt%. It means that the chemical properties of Ni (and probably, other metals) are very different in basic and felsic silicate melts.

The behavior of moderately siderophile elements (Ni, Co, Fe, etc) in the core formation process can be understood from values of Me/melt partition coefficients (D^i), which are functions of pressure, temperature, oxygen fugacity, metal and melt compositions.

Since the value of $D^{N}i$ is proportional to γ_{NiO}, our data are directly applicable to the problem of the effect of melt composition on metal/melt partitioning.

It was suggested (e.g., Righter et al., 1997) that NBO/T may be a good parameter to describe the effect of melt composition on D^{Ni}. Using our experimental data and data of Pretorius and Muan (1992) we demonstrated that NBO/T should be used in such equations with a big caution.

References

Ertel W. Dingwell D.B. and O'Neill H.St.C. (1997) *Geochim. Cosmochim. Acta* 61, 4707-4721.

Pretorius E.B. and Muan A. (1992) *J Am. Ceram. Soc.* 75, 1490-1496.

Righter K., Drake M.J. and Yaxley G. (1997) *Physics Earth Planet. Interiors* 100, 115-134.

Plasma interactions of extrasolar Planets with their stars

J. Büchner[1], S. Preuße[1], A. Kopp[2], and U. Motschman[3]

[1] MPI für Sonnensystemforschung, Katlenburg-Lindau

[2] Universität Bochum

[3] TU Braunschweig

Abstract: In contrast to the situation in our solar system extrasolar planets were observed at much closer distances to their stars. From the plasmaphysical point of view such planets may be located inside the so called Alfven-radius, i.e. a magnetic feedback interaction of the planets and their stars may become possible. One possible consequence of such close relation is the buildup of a current system connecting planet and star. We discuss the consequences of a direct plasma interaction star-planet in the framework of an Alfven-wing model. Enhanced stellar activities might be a potentially observable consequence. We show that, indeed, the Alfven-wing model may explain the phase angle between the planetary rotation and an observed hot spot on HD 179949.

Constraining the stellar dissipation factor by simulating tidal interactions of close-in extrasolar planets (a <0.1 AU)

L. Carone

Institut für Geophysik und Meteorologie, Universität zu Köln

Abstract: Very close-in extrasolar planets are subject to strong tidal interactions with their host star. The effect of tidal interactions on the orbital parameters of close-in extrasolar planets may be give clues on the inner structure of their host stars. The magnitude of tidal interactions depends on the ratio of the stellar dissipation factor and the stellar Love number. Different theoretical predictions and considerations give values which cover five orders of magnitude.

By simulating the evolution of the planetary system into the past and into the future, we constrain the ration of the stellar dissipation fator and the stellar Love number within a range of two orders of magnitudes. The simulation includes also mass loss of the planet by stellar heating and evaporation. We use the system OGLE-TR-56 as an example.

Discovery of a cool planet of 5.5 earth masses through gravitational microlensing

A. Cassan

Astronomisches Rechen-Institut, Heidelberg

Abstract: We report the discovery of a light and cool 6 Earth-mass planet, orbiting a 0.3 $M_{\odot}$ M-dwarf star at a separation of 3 AU. This detection was possible thanks to an intensive monitoring by the PLANET collaboration of the gravitational microlensing event OGLE-2005-BLG-390. Our detection suggests that such cool, sub-Neptune-mass planets may be more common than gas giant planets around M-dwarfs, as predicted by the core accretion theory. In the near future, microlensing offers a very good chance to probe orbits of 1-10 AU around low-mass stars, complementing radial velocity surveys or transit studies.

Eccentricity evolution of embedded protoplanets.

G. Dirksen[1] and P. Cresswell[2]

[1] Institut für Astronomie und Astrophysik, Universität Tübingen
[2] Queen Mary University of London,

Abstract: We investigate the change of the orbital elements of an embedded planet of 20 Earth masses from the torques of the protoplanetary disk. We treat the disk as a 3-dimensional viscous fluid and perform hydrodynamical simulations in which the planet orbit is updated according to the torque exerted by the disk. We observe how the orbital elements of the planet change in time. We find exponential decay of the orbital eccentricity and inclination of the planet on a short time scale for small initial values of e and i. For larger values of e, ($e > 0.1$) we find that the decay time $\dot{e}/e \propto e^{-2}$, which is consistent with theoretical models (Tanaka & Ward, 2004). Also we find that the system has no memory, i.e. when the planet reaches a value of e covered by a different model, the evolution will follow that of the other model. For planets that do not open a gap in the disk, the damping of the orbital elements is so strong that it can be regarded as instantaneous. As such in future simulations such planets can be assumed to move on circular orbits if no other mechanism is at work. This collaboration has been funded by the EU Planets Research Training Network.

Radial velocity variations in K giants

M. P. Döllinger[1], A. P. Hatzes[2], L. Pasquini[1], E. W. Guenther[2], M. Hartmann[2], L. Girardi[3], M. Esposito[2], and A. Weiss[4]

[1] European Southern Observatory, Garching
[2] Thüringer Landessternwarte Tautenburg
[3] INAF-Osservatorio Astronomico di Trieste, Italy
[4] MPI für Astrophysik, Garching

Abstract: G and K giants are a unique class of radial velocity (RV) variables. In order to reveal the reasons of this variability we started in February 2004 a program to observe a northern sample of 62 K giants from the Thüringer Landessternwarte Tautenburg (TLS) with the aim of using accurate radial velocity measurements to determine the fraction of K giants showing short-period variability. Our first results show a typical RV precision of 3–5 $\mathrm{m\,s^{-1}}$. 60 % of the star sample exhibits short-term (night-to-night) RV variations on time scales of several days due to oscillations. 15 % of the star sample exhibits long-term RV variations in a time scale from a couple of hundred days. One of these stars shows long-term variations that may be due to a a sub-stellar companion.

Transit Searches - An Overview

S. Dreizler

Universität Göttingen

Abstract: Ever since the first extrasolar planet discoveries were announced, they have attracted enormous attention. The radial velocity method is currently the most successful way to discover extrasolar planets. It is, however, affected by intrinsic difficulties. Recently, large transit surveys are providing an increasing number of planets which have the potential to significantly improve our knowledge of planet formation and evolution through the access to more physical information (radius, density, atmosphere). In this talk, current and future aspects of transit surveys will be discussed.

Crystallinity of dust as a probe of disk formation history

C. P. Dullemond[1], D. Apai[2], S. Walch[3], and C. Dominik[4]

[1] MPI für Astronomie, Heidelberg
[2] Steward Observatory Tucson
[3] Uni-Sternwarte München
[4] Sterrenkundig Instituut 'Anton Pannekoek', Amsterdam

Abstract: We present a new perspective on the crystallinity of dust in protoplanetary disks. The dominant crystallization by thermal annealing happens in the very early phases of disk formation and evolution. Both the disk properties and the level of crystallinity are thereby directly linked to the properties of the molecular cloud core from which the star+disk system was formed. We show that, under the assumption of single star formation, rapidly rotating clouds produce disks which, after the main infall phase (i.e. in the optically revealed class II phase), are rather massive and have a high accretion rate but low crystallinity. Slowly

rotating clouds, on the other hand, produce less massive disks with lower accretion rate, but high levels of crystallinity. Cloud fragmentation and the formation of multiple stars complicates the problem and necessitates further study. The underlying physics of the model is insufficiently understood to provide the precise relationship between crystallinity, disk mass and accretion rate. But the fact that with 'standard' input physics the model produces disks which, in comparison to observations, appear to have *either* too high levels of crystallinity *or* too high disk masses, demonstrates that the comparison of these models to observations can place strong contraints on the disk physics. The question to ask is not why some sources are so crystalline, but why some other sources have such a *low* level of crystallinity.

The Tautenburg Exoplanet Search Telescope TEST – a status report

J. Eislöffel

Thüringer Landessternwarte Tautenburg

Abstract: After the move of the BEST telescope to Observatoire de Haute Provence, Thüringer Landessternwarte has started to set up a new transit search telescope in Tautenburg. This system has many substantial improvements over the original BEST, giving both higher photometric precision and better time coverage of targets and thus promises clearly higher detection rates. This telescope has started manual operations a couple of months ago. Ongoing work aims at making it fully robotic.

Hot Jupiters of young stars

M. Esposito[1,2] and E. Günther

Salerno University & Thüringer Landessternwarte Tautenburg

Abstract: About 25% of the 170 known exo-planets have semi-major axis $\leq$ 0.1 AU (period P$\leq$10 days). A planet orbiting a star at such small distance is substantially heated and thus evaporates partly. Current estimates for the mass-loss rate are $\sim 10^{-8}$ M_J/yr at young ages and $\sim 10^{-12}$ M_J/yr for $t \geq 5$ Gyr. The current estimates of the mass-loss rate thus imply that the hot Neptunes orbiting old stars were hot Jupiters when they were young. If this scenario is realistic, it is expected that the frequency of hot Jupiters orbiting young stars is at least as high as the frequency of hot Neptunes orbiting old stars. In order to test this scenario, a radial velocity survey of 45 young (30 $\div$ 300 Myr), nearby stars began in 2001 at the TLS Tautenburg observatory. We have several young exo-planet candidates. For the other stars we can put firm upper limits for the masses of possible companions. Finally, we estimate the frequency of hot Jupiters orbiting young star.

V1647 Ori: when the disk is unstable

D. Fedele, M. van den Ancker, M. Petr-Gotzens, and N. Ageorges

European Southern Observatory, Garching

Abstract: In November 2003 the young star V1647 Ori went into outburst. The rapid and strong (4 magnitude in I_C) brightness rise resemble that of a FU Orionis object. A FU Orionis outburst is triggered by a disk instability which leads the accretion rate in pre-main sequence stars to increase by more than four orders of magnitude on a time scale of months. Intriguingly, meteoritic evidence suggests that chondritic material has formed when our own proto-solar nebula went through an episode of enhanced temperatures (e.g. Bell et al., Protostars & Planets IV, p. 897). This evidence suggests that the enhanced accretion rate underlying during a FU Ori disk instability may be a "catalytic" process which leads to the condensation of gaseous protoplanetary disk material into solids. Here we report a first analysis of a spectroscopic follow up of V1647 Ori conducted in the optical with FORS2 at the VLT and in the mid-IR with TIMMI2 at the ESO 3.6 m telescope.

How planets could shape the dust disk of β Pictoris

F. Freistetter and A. Krivov

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: The debris disk of β Pictoris is among the most complex and structured disks we know. It was observed many times at different wavelengths during recent years. There exist "warps", "clumps" and belt-like structures. We suggest that at least some of these structures are the result of the perturbations by one or more planets that move inside the disk. Using numerical simulations we show that it is possible to re-create part of these structures by placing planets at special orbits. We show, how the observational data restrict the orbital elements of the planet. There are several configurations of planets that can account for the structure of beta Pictoris but a planet with more than a Jupiter mass at approximately 12 AU seems to be mandatory.

A new Hybrid Code for Protoplanet Formation

P. Glaschke and R. Spurzem

Astronomisches Rechen-Institut, Heidelberg

Abstract: Our work presents new simulations of the protoplanet formation out of planetesimals. This stage is of particular interest, as it links the final planet formation to the early planetesimal formation. Collisions still play a major in the evolution of the system, and the close interplay between the change of the size distribution and the evolution of the velocity dispersion requires a careful treatment of the complete size range.

Small N-Body simulations have been useful in exploring the basic growth mechanisms at the price of a modified time scale and an artificially reduced particle number, while statistical codes explore the limit of large particle numbers in the early phases. An efficient solution would be the combination of these two 'worlds' in one hybrid code to unify the advantages of both methods.

We developed a new hybrid code called NBODY6DISC. It combines the advantages of an N-body approach with a new statistical code which uses recent works on the statistical description of planetesimal systems. The new hybrid code includes a consistent modelling of the velocity distribution and the mass spectrum over the whole relevant size range, which allows the application of a detailed collision model beyond the perfect-merger assumption. We apply this new code to the formation of protoplanets out of 1-10 km sized planetesimals.

Radial Velocity and Transit Search (RATS).

R. Claudi, S. Scuderi, J. Alcala', M. Barbieri, A. Baruffolo, P. Bruno, L. Contri, E. Covino, S. Desidera, F. Favata, **V. Granata**, R. Gratton, G. Martorana, F. Marzari, G.Micela, M. Montalto, G.P Piotto, M. Rebeschini, and D. Strazzabosco

University of Padua

Abstract: The orbital characteristics of the extrasolar planets found up to day, create difficulties to the classical paradigm of the planetary formation. Radial velocities tecnique (which are responsable of 90% of detections) does not allow to have information about the physics of planets which is important to disentagle the dichotomy among core accretion model and disk instability model. CCD Cameras mounted on wide field of view telescope allow to monitor simultaneously a large ammount of star light curves to search for planetary transits. RATS project, started in February 2005, is a collaboration between several INAF Observatories (Padova, Catania, Napoli, Palermo), the Astronomy Department and Physics Department of the University of Padova and ESA, devoted to search for extrasolar planets exploiting the transit photometric technique together with spectroscopic follow up strategy for reconnaissance of false allarms. The photometric survey will conduct with the 67/92 Schmidt Telescope of C.Ekar equipped with the EDDINGTON frame transfer CCD. The spectroscopic follow up will be made using the echelle spectrograph (modified for fiber feding) at the Copernico Telescope at the same site. The aim of the project is twofold. The first aim is to find almost 10 (goal 20) new giant planets in 5 years and the second is to test the observing mode, the data reduction and data archiving of a transit search space mission.

RATS: The photometric data reduction automatic pipeline

V. Granata, M. Montalto, L. Contri, R. Claudi, P. Bruno, and G. Piotto

University of Padua

Abstract: The aim of the pipeline is to obtain the light curves of each star in the planetary transit search field of view within the RATS project (http://www.rats.it/). The pipeline has some input files among which there is a list of fits images taken at Schmidt Telescope of Asiago (INAF), a reference masterlist of stars and three files containing the optional parameters for the DAOPHOT photometry package (P. Stetson (1987), PASP, 99, 191). The masterlist is previously obtained from a photometric characterization of the field and it contains the coordinates and the colors B, V, R and I of the field stars. Iteratively, for each frame we find the center of each defocused star in every image and we match with DAOMATCH and DAOMASTER (P. Stetson (1992), ASPConf. Ser., vol. 25, p. 297; P. Stetson (1992), IAU Colloquium, 136, p. 291) each image with the first one, choosen as a reference frame. Then we transform the coordinate of each stars in the matched frames in the spatial reference system of the masterlist and we re-run DAOPHOT to obtain the new photometry with the transformed coordinates. In the next step we store

the output files with the light curves, one for each star in all the images. Finally, we calculate iteratively the mean magnitude with which we correct the magnitude of the stars.

Changes in Atmospheric Chemistry over the Habitable Zone for Earthlike Planets Orbiting Main Sequence Stars

J. L. Grenfell

DLR, Institut für Planetenforschung, Berlin

Abstract: We have used a coupled radiative-convective photochemical column model to calculate changes in atmospheric biomarkers on a planet having Earth's composition which we situated at the inner, mid, and outer Habitable Zone (HZ) for a solar, F2V and K2V star. The HZ was defined conservatively to be suitable for humans i.e. 0°C< T_{surf} <30°C which led to the model calculating a narrow HZ width of (0.95-1.09) Astronomical Units (AU) for the solar-type star, (1.59-1.80) AU for the F2V star and (0.51-0.59) AU for the K2V star. Despite the narrowness of the HZ the biomarkers H_2O, CH_4 and CH_3Cl varied by large amounts across the solar HZ, for example. Whereas H_2O decreased moving outwards across the HZ due to enhanced condensation in the troposphere, CH_4 and CH_3Cl increased associated with a slowing in $H_2O+O_1D \rightarrow 2OH$, hence less OH, an important sink for these two compounds. Ozone changes were smaller across the HZ. A source-sink analysis suggested the important process was a slowing in the $O_3+h\nu$ sink. We also considered changes in species which impact ozone the so-called family species (and their reservoirs) which can catalytically destroy ozone. HCl, for example is a chlorine reservoir (storage) molecule, which increased by a factor 5-10 on moving outwards over the solar HZ. For the F2V and K2V stars, similar sources and sinks dominated the chemical biomarker budget as for the solar case and columns trends were comparable across the HZ. Ratios of biomarkers are easier to detect than are absolute concentrations. Our results imply that ratios such as (O_3/H_2O) and (CH_4/H_2O) can vary by large amounts and still be consistent with habitability, even for a conservatively-defined HZ.

A HARPS survey for planets of young stars

E. Günther and M. Esposito

Thüringer Landessternwarte Tautenburg

Abstract: Since the first massive planet in a short period orbit was discovered, the question arised how such an object could have formed. There are basically two formation scenarios: migration due to planet-disk or planet-planet interaction. Which of the two scenarios is more realistic can be found out by observing short-period planets of stars with an age between 10^7 and 10^8 yrs. The aim of this project thus is to search for young, close-in planets. Young close-in planets are so bright that they can also be imaged with AMBER, which allows to determine their temperature, radius and true masses. Using HARPS, we monitor 85 young with HARPS. First results of this survey will be presented.

Experimental Studies on the Formation of Chondrules by Electric Discharge

C. Güttler, T. Poppe, J. Blum, and T. Springborn

Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig

Abstract: Chondrules are solidified melt droplets of submillimeter size which are found in primitive meteorites. They witness an energetic process which a large fraction of solar system material underwent in the time of planet formation. The heating mechanism is still unknown and many hypotheses exist. One of those comprises flash–melting by electric gas discharge ("lightning") in the solar nebula and subsequent rapid cooling and solidification as spherules. As chondrule precursors, porous dust aggregates composed of silicatic, micrometer–sized grains are considered. Aiming at the experimental investigation of the lightning hypothesis, we expose porous, millimeter–sized dust samples to electric gas discharges of approximately 500 J between two electrodes in air at atmospheric pressures. Dust samples (silica, iron, olivines, albite, obsidian and mixtures), electrode distance, and energy of the discharge were varied. Almost independently from the parameter setup, the dust samples dispersed in the lightning and many droplets of sizes up to 200 μm were produced and solidified when flying through the experimental chamber. First analysis on these droplets show conspicuous differences in size distribution and melting quota (spherule mass to initial dust sample mass of a few percent) for different materials, which seem to be correlated to the amount of metallic ingredients – in particular iron. Few exemplary spherules of 100 to 200 μm were embedded in epoxy resin to be sectioned. Under the light–optical microscope, they revealed interior bubbles to a varying extent. In the future, we will investigate further materials and material mixtures, perform experiments in low pressure environments, vary the type of gas, and include further analysis methods.

Searching for planets around metal-rich stars

M. Hartmann

Thüringer Landessternwarte Tautenburg

Abstract: The discovery of now more than 170 extra-solar planets seems to show that the frequency of planets increases with the metallicity of their host stars. This correlation has been used as a strong argument for the core accretion scenario as the dominant mechanism of giant planet formation. In order to verify this idea we started a survey of metal-rich solar-like stars as part of our planet search program. Since in previous studies large samples of stars have been observed which necessarily limited the number of observations per star, we surveyed a rather small sample of only 33 stars. Our monitoring also contains a complete sample because we did not exclude active stars nor binaries. The observations are carried out with the 2.0 m Alfred Jensch Telescope at Thüringer Landessternwarte Tautenburg. During the last 4 years we have obtained about 1500 radial velocity measurements of these stars. Here we present the current results which confirm that stars with an overabundance of heavy elements really have a higher frequency of planets. Furthermore, some new extra-solar planet (or brown dwarf) candidates will be presented as well as the calculated upper mass limits of possible companions for the other stars.

Recent Results from the Tautenburg Observatory Planet Search Program (TOPS)

A. Hatzes[1], E. Guenther[1], M. Hartmann[1], M. Esposito[1,2], and M. Doellinger[3]

[1] Thüringer Landessternwarte Tautenburg
[2] Salerno University
[3] European Southern Observatory, Garching

Abstract: The Tautenburg Observatory Planet Search Program (TOPS) has been surveying a variety of stars for extrasolar planets using precise stellar radial velocities (RV) since 2001. This program uses the coude echelle spectrograph of the 2m Alfred Jensch Telescope and an iodine absorption cell as a wavelength reference. TOPS achieves a best RV precision of 2-3 m/s, and has a working precision of about 7 m/s. I will present a status report on the program and precent some recent results. These include:

1. The discovery of a giant planet ($M \sin i = 14 M_J$) around the giant massive star HD 13189. With an estimated stellar mass of 3.5 solar masses this is the highest mass star known to posses an extrasolar planet. The metal abundance for this star is [Fe/H] = -0.6 which makes it one of the most metal poor stars to host a giant planet.
2. Confirmation of the planetary companion to Beta Geminorum. The RV variations for this star were discovered in 1993. TOPS measurements help to confirm that the RV variations are indeed due to a $3 M_J$ mass planet in a 590-day orbit. Beta Gem is thus one of the very first stars known to have an extrasolar planet.

Remote Sensing of Venus' atmosphere during the Venus transit in June 2004

P. Hedelt[1], H. Rauer[1], R. Titz-Weider[1], F. Schreier[2], T. Brown[3], W. Schmidt[4], H. Schleicher[4], R. Alonso[5], and M. Collados-Verras[5]

[1] DLR, Institut für Planetenforschung, Berlin
[2] Institue of Remote Sensing Technology, German Aerospace Center (DLR) Oberpfaffenhofen
[3] High Altitude Observatory, National Center for Atmospheric Research, Boulder
[4] Kiepenheuer Institut für Sonnenphysik (KIS), Freiburg
[5] Instituto de Astrofisica de Canarias (IAC), Tenerife

Abstract: Using data collected from the Venus-Sun transit on 8th June, 2004, one can make estimates about the feasability of making positive spectral detections of biomarkers in extrasolar planet atmospheres. During the transit, transmission spectra from Venusian atmospheric layers were measured in three wavelength regions in the near-infrared. Absorption lines of the most abundant molecule, CO2 and its isotopes were detected. The line-by-line, spectrum-resolving radiative transfer program SQuIRRL (Schwarzschild Quadratur InfraRed Line-by-line) was used to calculate and validate the observed absorption lines.

Meteorites and the early solar system

D. Hezel

Institut für Geologie und Mineralogie, Universität zu Köln

Abstract: Chondritic meteorites (chondrites) contain primitive components that formed in the solar nebular prior to planet formation. Radiogenic isotope systems like e.g. ^{26}Al or ^{182}Hf provide evidence for a chemically homogeneous inner solar system.

Recent studies of e.g. Zr-isotopes show slight heterogeneities within individual meteoritic components, however, the bulk meteorites are not anomalous. Presolar material, of which the solar system formed, is chemically and isotopically not homogeneous. The homogenization was probably achieved in a hot, evaporated and gaseous solar nebular. Such an evaporated nebula is sustained by condensation signatures of several components in chondrites, like Ca-, Al-rich inclusions (CAI) and zoned metal and silicate grains. These zoned grains and SiO_2-rich components provide in addition evidence of non-equilibrium (fractional) condensation.

Chondrules are a major component of chondrites. These $\sim$ $20 - 2000\mu$m often spherically objects represent once molten droplets. Petrological studies showed that these formed in brief (minutes to hours) heating and cooling events with peak temperatures of > 2000 K. A reasonable process to produce chondrules are nebular shocks, however, their origin is unknown.

Chondrules are chemically complementary to the matrix of carbonaceous chondrites. The matrix is fine grained (usually $< 1\,\mu$m), Si-, and Mg-poor with Mg/Si-ratios below the solar value. Complementary, chondrules are Si-, Mg-rich with higher Mg/Si-ratios than solar. Together chondrules and matrix exactly match the solar Si-, and Mg-concentration and Mg/Si-ratio. This places important constraints on chondrule formation as it means that matrix and chondrules can not have been mixed together randomly, but that both must have formed in the same nebula compartment, which means, that the matrix somehow was not affected by the chondrule formation process.

Short lived radionuclides like ^{26}Al also provide chronological information. Measurements of ^{26}Mg, the decay product of ^{26}Al, reveal that condensed CAIs (there are also once molten CAIs) formed during a brief period. After CAI formation chondrules formed over a time span of about 2 Ma.

In conclusion, chondritic components formed in two steps: (1) First material condensed from a chemically homogenous reservoir. This material is called "precursor material". (2) In the second step the precursor material was reheated in repetitive, probably ineffective and brief heating and cooling events with peak temperatures > 2000 K over 2 Ma, thereby chondrules and molten CAIs formed.

Modelling Dusty Atmospheres in the Substellar and Planetary Mass Regime

D. Homeier[1], F. Allard[2], H.-G. Ludwig[3], and P. Hauschildt[4]

[1] Institut für Astrophysik, Universität Göttingen
[2] Centre de Recherche Astronomique de Lyon, École Normale Supérieure, Lyon, France
[3] Observatoire de Paris-Meudon, Paris, France
[4] Hamburger Sternwarte, Universität Hamburg

Abstract: We present new atmosphere models for ultracool dwarfs of the spectral types M, L and T. The spectral evolution through these classes, tracing the range from low-mass stars to old field brown dwarfs, is predominantly characterised by varying amounts of condensates in the visible photosphere, with dust signatures peaking in mid-to-late L types. The settling of dust clouds into and depletion of condensable elements from the upper atmosphere is defining the transition from L to T. Observed dispersions in spectral and photometric features of brown dwarfs reveal the influence of an additional parameter besides temperature in this process.

Our models provide the first homogeneous set of theoretical spectra for the entire temperature range from the first formation of condensates to the fully cleared atmospheres of the coolest know brown dwarfs and beyond, probing the regime of "cold Jupiters". The settling of particle clouds is self-consistently described as an equilibrium process between condensation, gravitational sedimentation and convective and turbulent mixing. The calculations predict a strong dependence of the settling on gravity, and can thus explain the differences between the spectral energy distributions of brown dwarfs of equal luminosity as an effect of different mass, in agreement with observed properties of low-mass brown dwarfs. They also correctly predict the even more extreme colours and spectra of planetary-mass objects that have recently for the first time been directly observed. These models can therefore be used to distinguish spectroscopically and by IR photometry between young objects of planetary mass and older brown dwarfs of similar $T_{\rm eff}$.

Terrestrial planet formation constrained by solar wind neon in the Earth

J. Hopp and M. Trieloff

Mineralogisches Institut der Universität Heidelberg

Abstract: The lifetime of protoplanetary disks around young stars sets important constraints on the time scale of accretion. While disk lifetimes as monitored by the infrared excess of fine dust are 3 - 6 Ma (50are more difficult. Dispersal of the gas in inner parts of accretion disks seems similarly fast [2], while in the outer disks cold gas may survive a few tens of Ma [3]. Most studies suggest that formation of asteroid-sized planetesimals in the early solar system occurred within a few Ma [e.g. 4-6], indicating that the building blocks of terrestrial planets were already present when the disk was dissipated. However, it is not yet clear, if full-sized terrestrial planets accreted within the presence of disk gas or not. While for the outer gas or ice giant planets rapid accretion and attraction of disk gas as major constituent is mandatory [e.g. 7], the terrestrial planets obviously needed significantly longer time for complete accretion, as indicated by Hf-W ages of complete core formation of 10 Ma for Mars and 33 Ma for Earth [8].

The question if terrestrial planets accreted with the presence of gas or after disk dissipation can be answered using neon isotopes [9-14], particularly utilizing advances in high precision neon isotope measurements in recent years [10-12]. Neon in the Earth´s mantle has a solar-type isotopic composition [9-14]. If the Earth accreted to its full size before disk dissipation [9], it would have attracted a dense (about 100 bar) solar-type protoatmosphere, and solar helium and neon could have been dissolved into an early magma ocean, and neon would have the isotopic composition of solar gas with 20Ne/22Ne=13.8+-0.1 [9]. Contrary, if the Earth´s precursor planetesimals were small upon loss of the disk gas, the only way to acquire solar neon is implantation as solar wind ions, with an isotopic composition found in meteorites exposed to the solar wind ("Ne-B" with 20Ne/22Ne=12.5+-0.2 [13]). Our most recent studies [11,12] all confirm the first identification [10] of solar wind Ne-B in terrestrial mantle reservoirs (Hawaii, Iceland, Réunion, MORB-mantle). Suggestions [14], that the lower mantle contains some portions still dominated by solar gas acquired in early accretionary epochs are not compelling regarding within uncertainties. The occurrence of solar wind implanted neon (and helium) in planetary interiors tightly constrains accretion scenarios in the inner solar system, as appropriate irradiation conditions must have existed. Several irradiation scenarios are possible: 1) irradiation before disk gas dispersal, due to planetesimal orbits with high inclinations (possibly triggered by gravitational disturbations of Jupiter) 2) late accretion of fine, irradiated dust, e.g. after the moon forming impact 3) Disk gas dissipation 3-4 Ma after CAIs in the inner solar system. Distinguishing these scenarios could be performed by considering early irradiated meteorites. Early irradiation histories had been suggested for carbonaceous chondrites [15]. The amount of solar wind implanted neon increases in the sequence CI-CM-CV-Earth [10] that also is a sequence of decreasing abundances of moderately volatile elements [16]. This probably links early T-Tauri activity of our sun and volatile depletion in the inner early solar system.

References:

[1] Haisch K.E. et al. Astrophys. J. 553, L153 (2001)
[2] Briceno, C., Vivas, A. et al. Science 291, 93 (2001)
[3] Thi W.F., Blake, G.A. et al. Nature 409, 60 (2001)
[4] Amelin Y., Krot A. N. et al. Science 297, 1678 (2002)
[5] Trieloff M., Jessberger E.K., et al. Nature 422, 502 (2003)
[6] Kleine T., Mezger C. et al. Geochim. Cosmochim. Acta 68, 2935 (2004)
[7] Boss, A. P. Science 276, 1836 (1997)
[8] Kleine, T., Münker, C. et al. Nature 418, 952 (2002)
[9] Honda M. et al. Nature 349, 149 (1991)
[10] Trieloff M., Kunz J. et al., Science 288, 1036 (2000)
[11] Buikin A.I., Trieloff M., et al. Earth Planet. Sci. Lett. 230, 143 (2005)
[12] Hopp J., Trieloff M., Earth Planet. Sci. Lett. 240, 573 (2005)
[13] Black D.C. Geochim. Cosmochim. Acta 36, 347 (1972)
[14] Ballentine C.J., Marty B. et al. Nature 433, 33 (2005)
[15] Goswami J.N., Lal D. Icarus 10, 510 (1979)
[16] Palme, H. Phil. Trans. R. Soc. Lond. A 359, 2061 (2001).

When are "active zones" dead and when are "dead zones" active?

M. Ilgner

Queen Mary University of London

Abstract: I will present calculations of the ionisation fraction in α - disc models using a number of chemical reaction network that have appeared in the literature. The primary aims are:

1. to compare the predictions of these networks for the ionisation fraction in identical disc models.
2. to examine the role of gas-grain chemistry in determining the ionisation fraction.
3. to examine the level of grain depletion required to converge toward the pure gas phase chemistry.
4. to examine the effect of turbulent mixing by modelling the diffusion of chemical species.

I will discuss the implications of these results for the existence of MHD turbulence in such discs.

Difference Imaging in TRIPP: First Results

H. Israel

Institut für Astrophysik, Universität Göttingen

Abstract: Difference Imaging is a data reduction technique for obtaining precise photometry in crowded stellar fields where point spread functions (PSFs) are heavily blended. It constitutes a crucial part of the data reduction pipeline for photometric (transit method or microlensing) detections of extrasolar planets. The Optimal Image Subtraction algorithm relies on least-squares fitting of convolution kernels which transform a reference frame of particularly good quality into the PSFs of the time series's images. A

time series of difference images is created by subtracting the convolved frames from the original ones. These frames are empty of PSFs except for signatures stemming from now de-blended variable objects.

We present an implementation of Optimal Image Subtraction designed to be part of the Tripp photometry package. Using simulated data we find only a weak dependence of the kernel accuracy on the number of free parameters given as a function of fixed parameters. A critical value of undersampling exists below which interpolation errors preclude actual de-blending. A comparison of Difference Imaging performed with Tripp and the original implementation shows similar quality of the resulting lightcurves. The new pipeline will be used with small and medium-sized telescopes for photometry of different types of objects.

Ground-based imaging for direct detection of substellar companions to nearby stars

M. Janson, W. Brandner, Th. Henning, R. Lenzen, and S. Kellner

MPI für Astronomie, Heidelberg

Abstract: Detection of extrasolar is a challenging task, and the current lack of an unbiased representation of planetary systems is obviously one of the main obstacles in understanding the process of planet formation. While several different methods exist for detecting extrasolar planets, each has its shortcomings that prevent detection beyond certain limits. For the most intuitive and qualitatively useful case of direct imaging, the main problem is the large brightness contrast and small separation between a star and its planetary companion, casuing the flux from the planet to be strongly dominated by the stellar PSF. This field is however in rapid progress, and the detection limits are continously pushed downwards. Thanks to development and implementation of techniques such as adaptive optics (AO) and spectral differential imaging (SDI), ground-based state-of-the-art facilities and instrumentation surpass present day space-based telescopes in terms of achievable contrast and resolution for a wide range of sources. We present here a number of ground-based surveys for substellar companions to nearby young stars; the methods used, some results and what input they can be expected to give for planet formation scenarios.

Radial Velocity Survey for Extrasolar Planets of young Brown Dwarfs

V. Joergens

Sterrewacht Leiden

Abstract: The current results of the first radial velocity survey for spectroscopic companions to very young brown dwarfs and (very) low-mass stars with a sensitivity to detect giant planets are presented. The obtained statistics and parameter ranges for close low-mass companions and planets around these young late-type M-dwarfs are compared to those of systems found by AO surveys and to those found for stars with earlier spectral types. Furthermore, the results are discussed in the context of current ideas about planet, brown dwarf and star formation.

Breaking the Waves – Computer Simulations of the Kelvin-Helmholtz Instability in Protoplanetary Discs

A. Johansen

MPI für Astronomie, Heidelberg

Abstract: Protoplanetary discs are believed to rotate slower than the Keplerian speed because of a radial pressure gradient through the disc that acts like a diminished gravity. When solids sediment around the mid-plane of the disc, the large amounts of dust force the gas in the mid-plane to rotate at the Keplerian speed. The vertical shear in the gas rotation profile is subject to the Kelvin-Helmholtz instability, so that the mid-plane of the disc becomes turbulent and prevents dust from settling further. In this talk I present numerical simulations of Kelvin-Helmholtz turbulence, considering both 2-D and 3-D models of the protoplanetary disc. We find that the disc gets in a state of self-sustained Kelvin-Helmholtz turbulence, and that the dust-to-gas ratio in this state is very non-axisymmetrical. The clumpiness is caused by another instability, the streaming instability, that arises from the dependence of the rotation speed of the dust on the local dust-to-gas ratio. Such increases in the local dust-to-gas ratio could play an important role in the formation of planetesimals from the gravitational fragmentation of the dust layer.

HI 21 cm line observations of disks: disk extensions and dispersal

I. Kamp[1], W. Freudling[2], and J. N. Chengalur[3]

[1] ESA/STScI
[2] European Southern Observatory, Garching
[3] NCAR, India

Abstract: Even though it is generally believed that planets form in protoplanetary disks, little is known about the process itself. While IR imaging and spectral energy distributions of such disks reveal significant grain growth even in the earliest stages of disk evolution, little is known about the evolution of the gas in those disks. Standard methods of gas detection such as CO submm and H2 near IR lines either trace only one component of the disk (the cold or warm molecular gas) or fail entirely in later stages of disk evolution. The interpretation of such observations and the identification of more suitable gas tracers makes it necessary to develop detailed chemical models of these disks, including all the relevant physics.

It turns out that the surfaces of optically thick disks as well as a large fraction of the tenuous optically thin disks are atomic, thus making HI a viable probe for the disk structure models. We model here the HI 21cm line emission from our 2D disk models and compare them to observed upper limits; this helps to constrain the gas masses of young protoplanetary and old debris disks. It turns out that transition phase disk systems, where the predicted HI/total mass fraction is very large (10-30%), are the best candidates for detecting 21cm flux. Since most candidates are at distances of 100 pc or more, the SKA would be necessary to detect the line emission. We show that - if detected - the HI 21 cm line is a very powerful tracer of disk surface physics and dynamics.

MHD-Simulation

B. Keil

Landessternwarte, Heidelberg

Abstract: Global 3 dimensional magnetohydrodynamic simulations with gravity from the central object on a spherical grid using a modified version of BATS-R-US, a parallel Riemann solver based Finite Volume code with adaptive mesh refinement from the Center for Space Environment Modeling (CSEM) of the University of Michigan, are performed.

Very important is the formulation of the numerical method in conservative form. Therefore a fix to conserve angular momentum had to be implemented in the code, which works fine now. To choose the right boundary conditions is another isssue. Further tests of the code will be performed by comparison with results of other simulation codes.

From the starting point of a steady hydrodynamic solution of a geometrically thin disk, one can investigate disk instabilities (MRI) due to the then switched on magnetic field and other accretion and structure formation processes.

The aim of my work is to prepare and test this simulation code so that it can also be used in the area of star and planet formation.

Present, past, and future in-situ measurements of interstellar dust

S. Kempf[1,2], R. Srama[1], N. Altobelli[3], G. Moragas-Klostermeyer[1], and E. Grün[1,4]

[1] MPI für Kernphysik, Heidelberg
[2] IGEP, Universität Braunschweig
[3] Jet Propulsion Laboratory, Pasadena, USA
[4] HIGP, University of Hawaii, Honolulu, USA

Abstract: Interstellar dust (ISD) was introduced as a topic of astrophysic research in the early 1930s, as the existence of extinction, weakening, and scattering of starlight in the interstellar medium (ISM) became evident. In the late 1960s the detection of in IR bands allowed astronomers to draw conclusions about the composition of ISDs. With the advent of dust detectors on spacecrafts it became possible to investigate dust particles in-situ. In particular, measurements with the detector on the Ulysses spacecraft confirmed the existence of interstellar grains penetrating the solar system. The directionality of the observed flux was compatible with the flow direction of the gas of the Local Interstellar Cloud (LIC) of 252° longitude and 5.2° ecliptic latitude. Remarkably, the ISD size distribution derived from the Ulysses measurements differs significantly from the size distribution of grains embedded in the ISM. It was found that interstellar grains undergo a filtering process during their passage through the heliosphere. Small particles (mass smaller than 10^{-17} kg) are deflected by the solar magnetic field, while grains in the mass range around 10^{-16} kg are subject to radiation pressure forces in the same order of magnitude as gravitational forces.

Here we present a synthetic view on measurements of ISD in the inner solar system by the dust instruments on-board the Cassini, Galileo, Ulysses, and Helios spacecraft. Our data provide clear evidence that the solar system acts as a huge mass spectrometer for interstellar dust grains.

Hot Bubbles around Nascent Planets

H. Klahr

MPI für Astronomie, Heidelberg

Abstract: We perform 3D radiation hydro simulations of Planet-Disk interaction. As a follow up on previous work (Klahr & Kley 2006) we study now the effects of radiation transport for lower mass planets (1-100 Mearth). We discuss the influence of proper thermodynamics on the migration rates and the possibilities to observe the planetary embryos early on in the womb of their mother disk.

OmegaTranS - The OmegaCAM Transit Survey

J. Koppenhöfer

MPI für extraterrestrische Physik, Garching

Abstract: Approximately 10 years ago the first extrasolar planet revolving a main sequence star was found by measuring the periodical change of the star's radial velocity. Up to now (8.2.2006) 163 planets have been found using this method. A complementary approach to find planets is the transit search: if a planet's orbit is seen edge-on from Earth one can detect a periodic dimming of the host-star's brightness by a few percent. Finding planets using this method turned out to be a high observational challenge (especially excluding false detections). No planet was found using the transit-method until 2002.

Now there are nine transiting exoplanets known. Combining the efforts of all existing transit surveys only 4-6 new planets are expected to be found per year. From 2007 OmegaCAM will be available mounted on the VLT Survey Telescope (VST). OmegaCAM is a camera with 1 square degrees field of view and able to monitor more than 100.000 stars simultaneously. Therefore OmegaCAM is the ideal instrument to search for transiting planets.

The OmegaCAM Transit Survey (OmegaTranS), to which several institutes in Italy, the Netherlands and Germany participate, will make use of this capability. Each of the collaborating countries will give one week of bright GTO time per year. With this, the project will be able to find more than 10 transiting extrasolar planets per year.

Simultaneous evolution of water ice and silicates in protoplanetary disk

K. Kornet and S. Wolf

MPI für Astronomie, Heidelberg

Abstract: We have developed and applied a model designed to track simultaneously the evolution and interactions of different types of solids in protoplanetary disks. A number of simplifications and idealizations allows to consider the gas-particle coupling, coagulation, sedimentation, and evaporation/condensation processes. We follow the distribution of solids from an early stage, when all solids are in the dust form, to the stage when most solids are in the form of a planetesimal swarm. Based on that we perform Monte Carlo calculations describing the formation of giant places at different locations in a core accretion gas capture model. We compare our results with the case in which solids of different material evolve separately.

Photophoretic Effects in Emerging Planetary Systems

O. Krauss and G. Wurm

Institut für Planetologie, Universität Münster

Abstract: We report on structure forming, concentration, and sorting processes in late protoplanetary/young circumstellar disks caused by photophoretic forces on dust particles reaching in size from μm to m. The photophoretic effect arises when a particle embedded in a low pressure gaseous environment is irradiated from one side. The inhomogeneous absorbtion of the radiation leads to temperature gradiants across the particle. Gas molecules which are adsorbed to the surface of the particle leave it with different velocities depending on the local surface temperature. Thus, a net momentum transfer occurs from the gas molecules to the dust particle. In the simplest case, when we assume that the radiation is completely absorbed at the surface, the photophoretic force drives the particle away from the radiation source. The strength of this force depends on the absorption properties of the dust particle, its thermal conductivity, and also the gas density. The dust and the gas component of protoplanetary disks evolve on different timescales. In a phase when most of the dust is processed into larger bodies but the gas is still present in its original density, photophoresis can be orders of magnitude stronger than radiation pressure. Especially large and porous dust grains are then very effectively driven outwards. Due to its pressure dependence the photophoretic force decreases with increasing distance from

the star, which leads to an equilibrium with the residual gravity at a specific orbital radius. Thus, particles with similar properties will be concentrated in ring-like structures around the star. This effect offers a simple explanation for several phenomena that are observed in young evolving planetary systems, like the formation of circumstellar dust rings or inner gaps. We will also discuss the implications for the formation of the Kuiper belt and the high concentration of chondrules in bodies of the asteroid belt in the Solar System.

Debris disks, small bodies, and planets

A. V. Krivov

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: Debris disks are optically thin, gas-poor dust disks around main-sequence stars. According to the conventional planetary system formation scenario, planetesimals, planetary embryos, and then planets form in a primordial protoplanetary disk around a young star. Planetesimals, which were neither used to make up planets nor ejected from the system, survive this relatively rapid process ($\sim$ 10 Myr). These leftovers begin to produce dust by mutual collisions and, possibly, comet-type activity, creating a tenuous debris disk. Being continuously replenished by small bodies, the disk can then persist over much of the star's lifetime. This review briefly outlines new observational results on debris disks, summarizes their essential physics, and then concentrates on interrelations between the disks, dust parent bodies, and embedded planets.

New observations.

A handful of disks have been resolved so far at different spectral ranges from visual to sub-mm. New observations of well-known disks (α Lyr, ϵEri, α PsA, β Pic, AU Mic) have brought partly unexpected results and new objects have been resolved (HD32297, HD107146, η Crv, τ Cet). Infrared excesses have been identified in spectra of hundreds of MS stars, enabling statistical analyses that were not possible before.

"Unperturbed" disks.

The internal physics of a debris disk are governed primarily by star's gravity, radiation pressure forces, and mutual collisions of disk particles. I will review models of unperturbed disks and show how these processes can shape size distribution of the dust material and radial profile of the disk.

Disks and planets.

Both global and local distributions of dust are sensitive to the presence of planets in the disk. Non-resonant perturbations, resonances, and close encounters are able to create diverse structures in the disks, some of which could show up in the images and SEDs, allowing one to retrieve information on directly unseen planets. Conventional interaction scenarios will be analyzed and their difficulties pointed out.

Disks and small bodies.

Observed debris disks are intimately connected to their sources, directly invisible populations of planetesimals. Catastrophic and cratering collisions in the planetesimal disk result in its gradual depletion, usually on Gyr timescales. Accordingly, the masses and optical depths of debris disks should decay with time. Recent statistical surveys support this expectation: τ reduces from $\sim 10^{-2}$ for Myr-old stars to $\sim 10^{-7}$ for Gyr-old ones. On shorter timescales of Myr or less, substantial fluctuations in the disk parameters can be expected, most notably from major collisions between large planetesimals in the disk.

Small bodies and planets.

Formation of planet-induced features in debris disks is usually attributed to perturbations that planets exert on dust particles directly. A more fundamental effect is that planets control distribution of dust parent bodies in the system. Over the whole planet formation process, growing and possibly migrating planets heavily affect planetesimals remaining in the system and in that way sculpture planetesimal and cometary belts. One can argue that this "primary" sculpturing may, at least partly, be responsible for the observed substructure in the disks and contribute to the formation of inner gaps.

Size and radial distribution of dust in debris disks

T. Löhne and A. Krivov

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: We present a kinetic model and first results for the evolution of a gas-poor circumstellar debris disk under the influence of fragmenting collisions and radiation pressure. The model processes the radial and size distribution of micron-sized to kilometer-sized material from a given initial state towards an adiabatic steady state. We examine how the convergence towards the steady state depends on the initial conditions. One major result is the size distribution of dust, which is important (i) to undertstand the observed scattered light and thermal emission of the disks and (ii) to model interactions of the dust material with possible planets. As was found before by other groups, a wavy pattern appears due to the lower grain size cut-off for bound orbits. The cross section area is dominated by grains slightly above this limit. Another result is the radial slope of the normal optical depth, which we find to have an upper limit for evolved systems. This slope determines the observed profile of the surface brightness. The disk timescales for reaching the steady state and for suffering from mass depletion were also modeled. For the disk of Vega they are found to lie at around 1 Myr and 1 Gyr, respectively.

Disk-Planet Interactions

F. Masset

Service d'Astrophysique CE-Saclay

Abstract: A protoplanet embedded in the protoplanetary disk out of which it formed tidally interacts with this disk. This modifies its orbital parameters, in particular its semi-major axis (the variation of which is called migration), and possibly its eccentricity. I will review the different migration processes known so far, namely migration types I, II, III and stochastic migration. As migration is a fast process that jeopardizes the build up of giant planet protocores, many efforts have focused on mechanisms that may slow down or stop it. I will briefly review these mechanisms. I will then show how eccentricity is affected by the tidal interaction with the disk, and I will discuss the relevance of these effects for the excitation of the eccentricity of embedded giant planets.

Charge-dipole induced dust gelation – a growth mechanism for protoplanetary dust near sublimation boundaries

F. Mokler and G. E. Morfill

MPI für extraterrestrische Physik, Garching

Abstract: The growth rate of protoplanetary dust still is a lively discussed matter. We approach this topic by introducing the effect of charge-dipole induced dust gelation recently discovered during experiments on the International Space Station. As an additional/alternative growth mechanism of dust in protoplanetary disks (PPDs) we apply the physics of charge induced gelation on dust present at sublimation boundaries. In these regions the dust density and surface charge meet the conditions for the onset of this kind of gelation. It is most effective for micron to mm (maybe even cm) sized dust grains and takes places within timescales a few magnitudes below the lifetime of PPDs. This leaves enough time for planetesimals to grow on larger scales by different mechanisms of coagulation.

Magnetosphären Extrasolarer Planeten

U. Motschmann[1], J.-M. Grießmeier[1], J. Büchner[2], S. Preusse[2], , G. Mann[3], H. Lammer[4], and H. O. Rucker[4]

[1] TU Braunschweig
[2] MPI für Sonnensystemforschung, Katlenburg-Lindau
[3] AIP Potsdam
[4] IWF, Graz

Abstract: Extrasolare Planeten können Typen von Magnetosphären ausbilden, die keine Entsprechung im Sonnensystem haben. Extrasolare Planeten mit sehr nahen Orbits sind einem Sternenwind ausgesetzt, der nicht wie im Sonnensystem bereits auf Überschallgeschwindigkeit beschleunigt ist, sondern sich noch im Unterschallbereich befindet. Zudem ist die in die planetare Magnetosphäre eingetragene Sternenwindenergie sehr hoch. Als Konsequenzen werden die Anregung intensiver Radiosignale, deren Nachweisbarkeit auf der Erde und die Auslösung von Superflares diskutiert.

Multiplicity of Exoplanet Host Stars - the White Dwarf Companions

M. Mugrauer

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: We present new results from our systematic search for visual companions of exoplanet host stars to study their multiplicity and its implication on the longterm stability and orbital parameters of exoplanets. Our IR imaging survey is carried out at UKIRT and Calar Alto Observatory for the northern targets and at La Silla Observatory for southern targets, and can find all stellar and substellar companions ($m > 40M_J$) with projected separations from 50 up to 1000AU. Several new wide companions were detected so far, extending the sample size of multiple stellar systems known to harbor exoplanets. Eggenberger et al. (2004)

have recently compared the statistical characteristics of planets in binary systems with those orbiting single stars. They found that the distribution of the masses of binary-star planets with periods shorter than 40 days is approximately flat, whereas single-star planets exhibit all masses less than $2M_J$. Furthermore, they found that all known close binary-star planets have almost circular orbits, while eccentric orbits are only detected among single-star planets. However, due to the small number of known binary systems among the exoplanet host stars, the significance of these statistical differences is sensitive to any changes of the sample size. We will present the latest list of binaries among the exoplanet host stars and will describe the properties of these systems as well as the longterm stability regions of planets residing in these binaries. Furthermore we will verify the significance of the reported statistical differences on the basis of an almost doubled sample size. Finally we will present first results of our high contrast AO imaging program with SDI and NACO at VLT which we started in 2005. With the used simultaneous differential imaging technique we achieve a much higher contrast compared to standard AO imaging. With NACO SDI imaging and NACO spectroscopy we prove the white dwarf nature of Gl86B, the first known close (20AU) white dwarf companion to an exoplanet host star. This system is the first observational confirmation that planets indeed can survive the post main sequence evolution of a star from which they are separated by only a few tens of AU (giant phase and planetary nebula) as it was expected from theory.

Further observations of GQ Lupi and its companion

R. Neuhäuser[1], M. Mugrauer[1], A. Seifahrt[2], E. Guenther[3], G. Wuchterl[1], and P. Hauschildt[4]

[1] Astrophysikalisches Institut und Universitätssternwarte, Universität Jena
[2] European Southern Observatory, Garching
[3] Thüringer Landessternwarte Tautenburg
[4] Uni Hamburg

Abstract: The have obtained new imaging and spectroscopic observations of the classical T Tauri star GQ Lupi A in the Lupus I cloud and its sub-stellar companion GQ Lupi b, which may be a planet imaged directly. With VLT/NaCo, we have taken new images in May and August to follow the orbit of b around A and to measure the parallaxes of both. With optical and IR photometric monitoring in April 2005, one month with observations each night (0.9m Smart telescope at CTIO), we have found the rotational period of GQ Lupi A to be 8.4 days; from the luminosity, temperature, and projected rotational velocity v sin i, we can then calculate the inclination i to be around 25 degree from pole-on; this is probably also the inclination of the disk around GQ Lupi A, and possibly also of the orbit of b around A. Then, in Sept 2005, we have taken a high-S/N K-band spectrum of GQ Lupi b with VLT/Sinfoni with resolution R=4000. We will show first preliminary results regarding the surface gravity of GQ Lupi b.

Ablation of planetesimals by gas flow in protoplanetary disks.

G. B. Paraskov, G. Wurm, and O. Krauss.

Institut für Planetologie, Universität Münster

Abstract: It is widely accepted that planet formation takes place in protoplanetary disks and the building blocks of the planets are km-sized dusty bodies, so-called planetesimals. Beside the dust, in the early phases of disk life gas is present in the disk. The solids move faster than gas and they experience a headwind with tens of meter per second. Large planetesimals interacting by gravity with each other might significantly change orbits and increase eccentricities. For these objects also relative velocities with the gas strongly increase. We consider under which circumstances the gas flow is energetic enough to erode a dusty bodies rapidly.

In order to study the interaction between gas flow and dust bodies we carried out a series of wind channel experiments. Our analysis is based on experiments on cm-size dust targets at gas pressures between 0.1 mbar and 4.5 mbar and at laminar gas flow of 63 m/s. We compare the results to numerical calculations of gas flow through porous bodies and the resulting drag forces on dust aggregates at the surface. Our studies imply that a dusty body is efficiently eroded if the dynamic gas pressure of the surface flow exceeds gravity and/or cohesion.

Applied to protoplanetary disks we find that objects on circular orbits might be relatively safe against erosion (ablation). Only in the innermost part in very dense disks the head wind is strong enough to ablate a dusty surface. If a body is moving on an eccentric orbit, it will be destroyed easily. A km-size body might loose few % of its mass on each orbit and is reduced to m-size in a short time. We discuss the importance for planetesimal eccentricities, dust production and planet formation.

Nucleation processes under the atmospheric conditions of jovian–like extrasolar planets

A. B. C. Patzer and S. Gebauer

Zentrum für Astronomie und Astrophysik, TU Berlin

Abstract: Especially, the formation of solid particles and/or liquid droplets has significant effects on the dynamic, thermal, and chemical structure of the atmospheres of extrasolar giant planets. In particular, the appearance of the planets depends on the character and distribution of such atmospheric condensates. The first (preliminary) classification of extrasolar giant planets (class I to V), for example, is based on the likely condensates in their atmospheres (cf. Sudarsky et al. 2003, ApJ, 588, 1121). In case of jupiter and of jovian-like extrasolar (class I) planets thermodynamic considerations reveal ammonia ice to be the outermost condensate to form a cloud deck at less than one bar (e.g. Ackerman & Marley 2001, ApJ, 556, 872, Weidenschilling & Lewis 1973, Icarus, 20, 405). Based on the so–called scaled nucleation theory (Hale 1986, Phys. Rev. A, 33, 4156) a theoretical description for the heterogenous deposition nucleation of NH_3 molecules yielding solid ammonia has been derived here in analogy to the heterogeneous nucleation concept for water ice in the terrestrial atmosphere by Pruppacher and Klett (*Microphysics of Clouds and Precipitation*, Atmos. and Ocean. Scie. Lib., 2nd ed., 1996). This approach is applied to typical atmospheric situations of jovian-like planets and first results are discussed e.g. in comparison to the observed depletion of NH_3 molecules in the troposphere of Jupiter.

Quantitative criterion for the discrimination of planets from minor bodies (and its application in the Solar System)

B. Pecnik

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: In our previous work (Pecnik & Wuchterl, A&A, 2005) we have developed a concept for a global static critical core mass. We make use of this concept to provide a planethood criterion to distinguish between a planet and a lesser body, such as a planetoid, or an asteroid. Within the same framework, we provide the working definitions for gas giants and telluric planets. We apply the planethood criterion to celestial bodies in the Solar System.

The Effect of Encounters in the ONC

S. Pfalzner[1], C. Olczaka[1], and R. Spurzem[2]

[1] Universität zu Köln
[2] Astronomisches Rechen-Institut, Heidelberg

Abstract: Combining two different types of numerical simulation the protoplanetary disc destruction is investigated for the example of the Orion Nebula Cluster (ONC). The two numerical studies consist of i) a parameter study of star-disc encounters giving the upper limits of the mass loss of the discs in star-disc encounters and ii) star-cluster simulations to model the stellar dynamics of the ONC. The latter are used to investigate the frequency of encounters, the mass ratio and separation of the stars involved, and the eccentricity of the encounter orbits. The results show that interactions that could influence the star-surrounding disc are more frequent than previously thought. Disc destruction is dominated by encounters with high-mass stars. In the Trapezium cluster the fraction of discs destroyed due to stellar encounters can reach 10-15%, which is in agreement with observations by Lada et al. (2000) who determined a stellar disc fraction of 80-85%. Therefore it can be concluded that stellar encounters do have a significant effect on these protoplanetary discs, which in turn will affect the formation of planetary systems.

Mid-IR Spectroscopy of Calcium-Aluminium rich inclusions

Th. Posch[1,2], H. Mutschke[2], Th. Henning[3], M. Trieloff[4], and H. Richter[1]

[1] Institut für Astronomie, Wien
[2] Astrophysikalisches Institut und Universitätssternwarte, Universität Jena
[3] MPI für Astronomie, Heidelberg
[4] Mineralogisches Institut der Universität Heidelberg

Abstract: Calcium is among those elements which are extremely depleted in the interstellar gas. This fact is usually ascribed to a strong consumption of calcium by dust formation processes. In other words, an especially large fraction of the available calcium should be 'locked' in (crystalline or amorphous) solids.

This is, however, not in perfect accordance with the current knowledge on cosmic dust mineralogy. Solids containing the metals Fe, Mg, Si and Al have been identified in circumstellar and interstellar environments based on their spectral features, while the identification of calcium-containing minerals such as diopside and calcite cannot yet be considered as widely accepted, since they are based on one single IR band in both cases. Hence, the question arises: Are we missing calcium-bearing minerals in cosmic dust?

Calcium-aluminium-rich inclusions (CAIs) in meteorites may give a hint how to answer this question and may reveal infrared bands, related to calcium-rich minerals, which should be looked for in dusty regions such as protoplanetary disks, circumstellar shells, brown dwarf atmospheres etc.

Motivated by this idea, we measured the mid-infrared reflectance spectrum of a 4x5mm^2 CAI contained in a thin section of a piece of the Allende meteorite. Three main reflectance band complexes can be discerned in our spectra: a 10, 15 and 20 micron band complex, each having a double-peak-structure (the individual peak positions are 10.3, 11.4, 14.4, 15.0, 19.5 and 21.1μm).

The polycrystallinity of our sample made it impossible to derive optical constants in the strict sense (which would require to take into account the anisotropy of the crystals contained in the CAI). However, mean (orientationally averaged) optical constants could be derived by means of a Lorentz oscillator fit.

From these orientationally averaged optical constants, absorption efficiencies for different grain shapes have been derived. Together with EDX measurements, the absorption efficiency maxima permit the identification of the main minerals of our sample, and the band shapes contain information on their degree of crystallinity.

Our results are supposed to serve as a guideline for further studies of CAI mineral analogs in the laboratory. Currently, it seems that those solids (e.g. calcium containing silicates) which resemble the dominant CAI minerals most closely (in terms of composition and degree of crystallinity) are not yet sufficiently studied by methods of infrared spectroscopy. This task will be crucial, however, for the identification of calcium-bearing solids in cosmic dust

Collisional Velocities & Collisional Rates in Debris Disks with Embedded Planets

M. Queck and A. V. Krivov

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: We consider a debris disk around a star with an embedded planet. It is well known that dust particles, steadily migrating inwards due to drag forces such as the Poynting-Robertson force, reach resonant locations and occasionally get trapped in mean-motion resonances with the planet. The resonance trapping results in formation of structures in the disk. Such structures could be observable and, therefore, help to pinpoint planets unseen directly.

The structures, however, may be smeared by grain-grain collisions. Our idea is to consider an annulus in the disk around the location of a given mean motion resonance and to develop a kinetic description of resonant structures. In such a way we consistently combine the resonant dynamics with mutual collisions. We choose a subset of orbital elements, most adequate for the resonant dynamics, and use them as phase space variables. The phase space distribution, i.e. the distribution of these orbital elements, "mirror" the essential dynamics in resonance.

With this method, we investigate how the collisional velocities and collisonal rates are modified by the resonances. We then estimate the critical optical depth of the debris disk, above which the resonant structures are smeared by collisions.

First results from Berlin Exoplanet Search Telescope at OHP

H. Rauer and the BEST team

DLR, Institut für Planetenforschung, Berlin

Abstract: The Berlin Exoplanet Search Telescope (BEST) is a small-aperture, wide-field telescope system, dedicated to the search of photometric transits of Jupiter-sized planets on close-in orbits. It is operated as a ground-based support facility in the framework of the COROT mission (CNES), the first satellite designed to actively search for extrasolar planets. Due to similarities in the field of view as well as acquisition and data analyzing sequences, BEST is well suited to perform preparatory ground-based variability characterization of the target fields of the space mission.

The system was commissioned in 2001 and regular observations of several target fields have been performed between 2001-2003 at the Thüringer Landessternwarte Tautenburg (TLS), Germany. Planetary transit candidates have been found and followed further with radial velocity measurements. In addition, a substantial number of variable stars have been detected and the complete data-set will be made available as a public domain database. During the late fall of 2004 an upgraded version of BEST was relocated to Observatoire de Haute-Provance (OHP), France. Regular observations of the COROT target fields as support for the mission have been ongoing since the spring of 2005.

The present status of the BEST systems as well as the first results based on the observations performed at OHP will be discussed.

Radiative transfer calculations of protoplanetary disks with embedded planets

S. Richling

IAP, Paris

Abstract: We investigate the influence of gaps and luminous planets on the appearance of protoplanetary disks by means of 3D radiative transfer calculations. The disk models consider irradiation by the central star and assume an additional luminosity emitted at the position of the planet. We find that a rather high accretion powered luminosity of the planet is necessary in order to increase the temperature of the disk in the vicinity of the gap sufficiently so that a hot spot appears in emission maps.

Modeling the resonant system HD 128311

Zs. Sandor[1] and W. Kley[2]

[1] Eotvos University, Budapest
[2] Institut für Astronomie und Astrophysik, Universität Tübingen

Abstract: A significant amount of the multiple exoplanetary systems are resonant containing a pair of giant planets in a low order mean motion resonance. This resonant condition protects the dynamics of these planets resulting in very stable orbits. According to recent studies the capture into a resonance is the result of a planetary migration process induced by the interaction of the planets with a gaseous protoplanetary disk. If the migration is slow enough (adiabatic) next to a mean motion resonance, the two planets will also be in apsidal corotation, which means that their osculating orbital ellipses rotate with a same mean angular velocity.

The recently refined orbital parameters of the system HD128311 suggest that the two giant planets are in a 2:1 mean motion resonance without exhibiting apsidal corotation. Thus the evolution of this system can not be described by an adiabatic migration process alone. In this contribution we discuss two possible evolutionary scenarios: (i) fast migration of the outer planet and a sudden dispersal of the protoplanetary disk, and (ii) moderate-speed migration of the outer planet and scattering with an already existing planet (similar to the proposed evolution of the multiple system Ups Andromedae).

Our qualitative results obtained by N-body and hydrodynamical calculations show that the recent behaviour of the system HD128311 may be explained by such evolutionary processes.

The inner region of circumstellar disks around T Tauri stars

A. Schegerer and S. Wolf

MPI für Astronomie, Heidelberg

Abstract: We present the results of modeling circumstellar disks around low-mass young stellar objects. The main goal of our study is to simultaneously simulate the spectral energy distribution and mid-infrared visibilities that we obtained with the mid-infrared Interferometer (MIDI) at the VLTI. The spectroscopically resolved visibility is a complex function of the circumstellar disk density distribution, the dust properties, and stellar parameters. Thus, a proper quantitative analysis can only be achieved by comparison with radiative transfer simulations for circumstellar disk models, which we perform with our three-dimensional continuum radiative transfer code MC3D.

Furthermore, the spectroscopic mode of MIDI allows to examine the Si-O stretching and bending feature of amorphous and crystalline silicate grains at 10 μm. The occurence and shape of this feature trace the size and chemical composition of circumstellar dust which are indicative for the evolutionary stage of circumstellar disks. We use MIDI to derive the radial density distribution of silicate grains of different sizes and chemical compositions which are expected to depend sensitively on the location in the protoplanetary disk. The radial dependence of the grain size distribution is a result of the radial dependence of the density distribution: grain growth occurs on much shorter timescales in the inner, dense region of circumstellar disks than in the less dense outer regions or even in the circumstellar envelope.

The annealing of silicate grains, i.e. their transformation from amorphous to crystalline grains is affected by the temperature distribution in the innermost disk region. We compare the spectra of the entire disk with those of the innermost regions in which, besides fast grain growth a fast chemical evolution and significant radial mixing processes are expected.

On the rotation period of GQ Lup A

T. Schmidt and Ch. Broeg

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: Recently, Neuhäuser et al. (2005) discovered a sub-stellar companion around the classical T Tauri star GQ Lup in the Lupus star forming region by direct detection. The companion orbits GQ Lup at a distance of $\sim$ 100 AU. Further planet candidates at closer distances are searched for by the radial velocity technique. Unfortunately, classical T Tauri stars can exhibit strong spot activity. This can mimic radial velocity signals of an orbiting planet.

We have observed GQ Lup A photometrically and took archival data into account. It was our goal to determine the rotational period that could be compared to a possible radial velocity signal.

Indeed we were able to determine a very likely periodicity of the brightness variations. By comparing the photometric amplitude in different wavelength bands we were able to ascribe the variations to surface activity of the star and could therefore determine the rotational period of roughly 8.4 days. Moreover we looked for photometry on GQ Lup A in archival data and were thus able to confirm the rotational period of about 8.4 days.

Assuming a luminosity of $1.55\,L_\odot$, a temperature of 4060 K for this K7V star and the newly found period of 8.4 days, the equatorial rotational velocity is about 15.2 km s^{-1}. With the $v\,\sin i = 6.8 \pm 0.4$ km s^{-1} from Guenther et al. (2005) this implies an inclination of GQ Lup A of about 27° and thus an almost pole-on view onto the star.

References:

Guenther, E. W., Neuhäuser, R., Wuchterl, G. et al. 2005, AN, 326, 10, 958

Neuhäuser, R., Guenther, E. W., Wuchterl, G. et al. 2005, A & A, 435, L 13

Bulk Chemistry of the Inner Solar System

Th. Schönbeck

Institut für Geologie und Mineralogie, Universität zu Köln

Abstract: The bulk chemical composition of chondritic meteorites resembles the element ratios of the solar photosphere. Hence, bulk compositions of meteorites provide an unique opportunity to precisely determine the chemical composition of the formation region of the terrestrial planets. However, the mineralogical and textural appearance of meteorites is highly variable. Gradual differences in the bulk chemical composition of chondrites are therefore the result of either heterogeneous sampling of the source region or - more likely - chemical fracionation trends that occurred early in the solar nebula. The chemical composition of meteorites has been determined by various methods such as instrumental neutron activaton analysis (INAA) or x-ray fluorescence (XRF). Although INAA provides access to a vide range of elements, XRF is better suited to study the bulk composition of meteorites with respect to major elements such as Mg, Si or Ti. Mg/Si ratios in chondrites are significantly different, independent of the mineralogical composition of the different carbonaceous chondrite classes. This demonstrates a Mg/Si fractionation during the formation of the chondrite components. In addition, Ca/Al ratios are constant in carbonaceous chondrites, whereas Ca/Ti and Al/Ti ratios are variable, possibly due to the addition or substraction of refractory components in chondrites.

Cooling history of a H chondrite: constraints on the decay constants used in K-Ar dating

W. Schwarz and M. Trieloff

Mineralogisches Institut der Universität Heidelberg

Abstract: In radiometric dating the constants used for age calculation are an important source of systematic error. For the K-Ar dating technique (based on the decay of ^{40}K to ^{40}Ar and ^{40}Ca) different constants are in use for decay, the branching and the 40K/K ratio. Geochronology uses values defined by [1] but e.g. in the physics community constants given by [2] are used. These values differ by about 1%, which is occasionally not precise enough to get reliable age data for e.g. interpretation of cooling of rocks or meteorites. Cooling histories of rocks can be constructed, because the radiometric dating system (e.g. U/Pb, K-Ar) are started in specific minerals (e.g. phosphate, feldspar, merrillite(MRL), orthopyroxene(OPX)) at different closure temperatures when diffusion of parent or daughter nuclides stops. Several samples of the H6 chondrite Guarena were measured via the $^{40}Ar/^{39}Ar$ step heating technique. The mean age for all samples was 4.438 ± 3 Ga (against flux monitor NL25 hornblende, t = 2.660 ± 11 Ga). Together with literature data for a Pb-Pb (phosphate, [3]) and a Pu fission track age (merrilite [4]) a time vs. temperature cooling diagram can be constructed (see figure, grey symbols). Additionally the Allende CAI age as the start of asteroid formation [5], the begin of the cooling and the metal cooling rate given by [6] is added. For the grey symbols it could be clearly seen, that the metal cooling rates are not in agreement with the radiometric age data points and that the cooling is not smooth but has staircases. Shifting the data points of the Ar-Ar measurement (and thus also the Pu FT age) by about 30 Ma (black points) would result in a smooth cooling of the asteroid parent body and is also in agreement with the metal cooling rate. Measurements

on other meteorite samples (3 H6, 4 H5, 3 H4 and one R chondrite, see [7] and unpublished data) led to the same conclusion, that the Ar-Ar age (compared to the Pb-Pb age) is wrong by about 20-40 Ma. This is an age shift by about 0.7%, resulting in changed constants for K-Ar dating. Additional measurements of terrestrial samples (age range 1 to 2.6 Ga, unpublished data) lead to the conclusion, that the total decay constant used in geoscience [1] is nearly correct, but the branching ratio for the dual decay to 40Ar and 40Ca and/or the 40K/K ratio has to be changed by about 1%.

References:
[1] Steiger R.H., Jäger E. (1977) Earth Planet. Sci. Lett. 36, 359-362;
[2] Endt P.M., v.d. Leun C. (1973) Nucl. Phys. A 214, 1-625;
[3] Göpel C. et al. (1994) Earth Planet. Sci. Lett. 121, 153-171;
[4] Trieloff et al. (2003) Nature 422, 502-506;
[5] Amelin Y., Krot A. N. et al. (2002) Science 297, 1678;
[6] Taylor G.J. et al. (1987) Icarus 69, 1-13

Non-Stationary Chemistry in Protoplanetary Disks

D. Semenov

MPI für Astronomie, Heidelberg

Abstract: Transport processes play crucial role in the global evolution of protoplanetary accretion disks. Likely, they are responsible for the presence of crystalline silicate dust in outer disk regions (e.g., van Boekel et al. 2005) and in comets and meteoritic bodies in our solar system (e.g., Wooden et al. 2005), and non-thermal broadening of the observed molecular lines (e.g., Dartois et al. 2003). However, the influence of transport phenomena on the chemical evolution of protoplanetary disks has not yet been studied in detail. In my poster, I will present first, qualitative results of theoretical study of that kind. Briefly, the time-dependent disk chemistry over 1 Myr is modeled, using a disk structure with vertical temperature gradient, a gas-grain chemical network with surface chemistry, and several chemical models with and without turbulent mixing included. Overall, the turbulent diffusion in both radial and vertical directions does not affect significantly the abundances of many simple molecules and ions produced by photochemistry in the disk, but is very important for more complex molecules and deuterated species whose evolution is governed by surface chemistry.

Disk and Accretion at the Ages of Planet Formation

A. Sicilia-Aguilar

MPI für Astronomie, Heidelberg

Abstract: Multiwavelength observations of populous samples of young low-mass stars aged 3-12 Myr reveal important hints of ongoing disk evolution, suggestive of disk clearing, grain growth/dust settling, and maybe planet formation. Results from optical and ultraviolet photometry and optical spectroscopy (low- and high-resolution), together with near- and mid-IR photometry and spectroscopy with Spitzer reveal interesting characteristics for the "older" population of young stars and their disks. The IR excesses at shorter wavelengths (<6 microns) decrease faster than the excesses at larger wavelengths, suggesting that disk evolution (dust settling/grain growth) timescales are more rapid in the innermost part of the disk. A decrease in the accretion rates is observed together with the decrease in dust emission, which could be a signature of a correlation in the gas and dust evolution. The number of disks with inner "gaps" or "transitional disks" (disks with no IR excesses at wavelengths shorter than 6 microns) is larger in older regions, but always represent a small fraction, suggesting a rapid dissipation of the outer disk (of the order of 10^5 years) once the inner disk has developed dusty "gaps". Given that all the disks with inner IR "gaps" show very low accretion rates ($<10^{-9} M_\odot$/yr) or are consistent with no accretion, the decrease in small dust grains in the innermost disk responsible for the absence of IR excesses seems parallel to a decrease in the accreting gas of the disk, which could be related to the growth of dust to form planetesimals or even planets.

Giant planet candidate around an evolved star

R. Silvotti[1], R. Janulis[2], S. Bernabei[3], R. Ostensen[4], J.-E. Solheim[5], S. Schuh[6], I. Bruni[3], R. Gualandi[3], T. Oswalt, A. Bonanno, B. Mignemi, and the Whole Earth Telescope collaboration

[1] INAF-Osservatorio Astronomico di Capodimonte, Napoli, Italy
[2] Institute of Theoretical Physics and Astronomy, Vilnius University, Lithuania
[3] INAF-Osservatorio Astronomico di Bologna, Italy
[4] ING, La Palma, Canary Islands, Spain
[5] Institute for Theoretical Astrophysics, Oslo University, Norway
[6] Georg-August University, Goettingen, Germany

Abstract: It is well known that the O-C diagram can be used to detect planets around compact pulsating stars like the hot subdwarf B stars and the white dwarfs. In this talk we show with a concrete example that the method can indeed produce interesting results and we propose the first candidate planet around a star that has already passed through the red giant phase.

Simulations of Collisions Between Porous Preplanetesimals

R. Speith and Ch. Schäfer

Institut für Astronomie und Astrophysik, Universität Tübingen

Abstract: The knowledge of the outcome of collisions between preplanetesimals is crucial for the understanding of the formation of terrestrial planets and the cores of the giant planets. Former simulations of collisions between meter-sized objects in the solar nebula have shown erosion or fragmentation for rocky materials. However, recent studies indicate that the preplanetesimals are rather porous agglomerates with differing material properties. Using the Lagrangian particle method Smooth Particle Hydrodynamics, we study the collisional outcome of such agglomerates and discuss the relevant differences to rocky materials and the impact on the growth from preplanetesimals to planetesimals.

Interior structure and evolution of the terrestrial Planets

T. Spohn

DLR, Institut für Planetenforschung, Berlin

Abstract: The terrestrial planets have iron rich cores, silicate rock mantles and crusts distilled from the mantle by partial melting. At least that is what common wisdom says. A definite proof and an accurate determination of the radii of these shells are difficult to impossible without seismic data. The cores and the primordial crusts formed early and rapidly as Hf-W isotope data suggest. The terrestrial planets have likely been cooling since their formation with heat being mostly transferred by convection in the deep interior and by conduction in the outer shell. The peculiarities of convection, a highly non-linear process, allows for time variations in cooling rate including the possibilities of brief heating periods of e.g., the mantle or the core. It is generally believed that the cores have liquid outer shells or are completely liquid. The inner cores are freezing out of the core alloy and grow as the planet cools. Bouyancy released upon the freezing of the core should be an efficient driver of a dynamo mechanism generating a planetary magnetic field, e.g., Earth and Mercury. It is possible that thermal buoyancy drives a dynamo, but model calculations suggest that the core may soon become stably stratified unless it starts to grow an inner core. This may explain the present lack (and early presence) of magnetic fields on Mars and Venus. The hypothesis would easily be testable if seismic data were available: their cores should lack an inner cores. But other explanations for the absence of magnetic fields are conceivable. Occams Razor? Plate-tectonics as on Earth is highly efficient in cooling the core and providing for a magnetic field. Life and plate tectonics only on Earth, just a coincidence?

Laser melting experiments on chondrule formation

T. Springborn[1], C. Güttler[1], T. Poppe[1], J. Blum[1], and J. Wasson[2]

[1] Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig
[2] Institut of Geophysics, UCLA, Los Angeles, USA

Abstract: Chondrules are abundant solidified melt droplets of submillimeter size which are found in primitive meteorites and which were formed in the time of planet formation by rapid heating. The heating process is still unknown, and many hypotheses exist. Some of them propose heating by electromagnetic radiation. Pouros dust aggregates consisting of micrometer-sized silicatic

grains are regarded as chondrule precursors. We perform melting experiments with a 30 W IR laser. As dust samples we use micrometer-sized porous samples of a few milligrams which are irradiated for several seconds before they are released and cool in freefall. We varied gas pressure (down to 10 e-4 mbar), dust material (fayalite, albite, obsidian, peridot, silica), and initial mass. Partially, the samples exploded, partially they formed spherules of different diameter up to millimeter size, depending mainly on pressure and material variation. A few spherules had voids. The sample analysis comprises light microscopy, sectioning by grinding and polishing spherules embedded in epoxy resin, and the use of an electron microprobe. In future experiments we intend to use further materials and material mixtures and to improve the analysing methods.

Parameterising a temperature-dependence of biogenic source gas emissions across the HZ for earthlike exoplanets.

B. Stracke[1], J. L. Grenfell[1], B. Patzer[2], R. Titz[1], and H. Rauer[1]

[1] DLR, Institut für Planetenforschung, Berlin
[2] Zentrum für Astronomie und Astrophysik, TU Berlin

Abstract: The Habitable Zone (HZ) is defined as encompassing the range of distances from a star for which liquid water can exist on a planetary surface. This is based on the possibility for life as we know it. In this work we define the HZ more conservatively to be suitable for humans with a surface temperature range of the surface between 0°C and 30°C. To investigate the effect on atmospheric biomarkers across the HZ for a planet having Earth´s composition we have used a coupled radiative-convective photochemical column model. In our model surface fluxes for biogenic compounds such as methane (CH_4) were those needed to produce their mixing ratios in the present-day atmosphere. Using these fluxes is equivalent to assuming that biological production of trace gases is exactly the same as on Earth and that it is not affected by such things as changes in the surface UV flux. In this work we have allowed for changes in surface biogenic gas emissions across the HZ arising e.g. from temperature changes.

A search for planetary-mass companions to young brown dwarfs in the solar neighbourhood

M. Stumpf, W. Brandner, and Th. Henning

MPI für Astronomie, Heidelberg

Abstract: We present the first results of the search for planetary-mass companions to young brown dwarfs with the direct detection technique of spectral differential imaging. The data we use were obtained with the Hubble Space Telescope (HST/NICMOS1) in the two narrow band filters F108N and F113N at the same time, where simulations indicate that these filters are situated particularly well for differential imaging: a giant planet shows a molecular (H2O) absorption band longward of 1.10 micron where the continuum flux drops significantly. Therefore subtraction of the two narrow-band images will cancel out any primary without strong spectral features while the flux of a planet companion is still visible.

Since any planetary-mass companion to an old brown dwarf is relatively cool and low of luminosity, we focused on young objects (< 1 Gyr) in the solar neigh- bourhood (<30pc). As targets we chose 12 young isolated (with no known close companions so far) L-dwarfs which still show Lithium in their athmosphere. With these assumptions several theoretical evolutionary tracks and atmospheric models indicate that a planetary-mass companion with a mass down to 6 Mj at a projected separation of 3 AU out to a distance of 10pc or 9 AU at a distance of 30pc should be bright enough for a direct detection.

Our first results include the detection of two new brown dwarf binary systems and a possible planetary mass companion candidate.

Experimental Infrared Spectroscopy of Agglomerate Dust Grains in Aerosol: Silicates

A. Tamanai[1], **H. Mutschke**[1], and J. Blum[2]

[1] Astrophysikalisches Institut und Universitätssternwarte, Universität Jena
[2] Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig

Abstract: Silicate dust particles are the dominating refractory component of protoplanetary disks. Agglomeration of these particles to larger aggregates is the first step of planet formation. Infrared spectroscopy can possibly provide information about this process in the initial stages, if laboratory data measured on analog materials under appropriate conditions are available for comparison.

We carried out laboratory measurements on the infrared spectra of silicate dust particles of different structures and morphologies. In order to avoid influences of embedding media on the IR band profiles, we dispersed the particles in air and measured the transmission through the aerosol filled into a 20m pathlength gas cell. The silicate band profiles show a substantial shift of the

peak positions with respect to measurements on embedded particles, which so far have been standard. Furthermore, a strong dependence of the band profiles on the particle shape is demonstrated.

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Experimental studies on impacts of chondrules into porous dust agglomerates under microgravity conditions

J. Teiser and J. Blum

Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig

Abstract: A lot of meteorites found on earth consist of millimeter-sized spherules, so-called chondrules, which are embedded in a highly porous, dusty matrix. Chondrules are believed to have formed in the early solar system by melting of small dust agglomerates. The growth process which leads to this kind of meteorites, the so-called chondrites, is still not understood.

It is believed that chondrites are formed by impacts of chondrules into highly porous dust agglomerates as they existed in the early solar system. To understand this growth process, impact experiments in microgravity conditions are necessary. On the simulationexperiments we used glass spherules as chondrules and highly porous dust aggregates as targets, which are similar to the predicted early solar system bodies and produced by random ballistic deposition. To achieve microgravity conditions, experiments were performed in the Drop Tower in Bremen.

Dependent on impact velocity and impact angle, different results were obtained. At high impact angles (for example about 60° with respect to the target normal) and velocities lower than 1.8 m/s, no embedding process took place. The glass spherules intruded into the dust aggregates and compressed the first dust layers, but left again and dragged dust material along with them. At higher velocities or lower impact angles, the spherules intruded into the dust aggregate, formed a cylindrical intrusion canal and stuck.

Our experiments suggest that the formation of chondrites by dust aggregates collecting chondrules on their way through the preplanetary accretion disk requires either high relative velocities between dust aggregates and chondrules (higher than 1.8 m/s) or low impact angles (between 0° and 30°). Impacts with low velocities and oblique impacts (for example $v < 1.8$ m/s and $\theta = 60°$) may even decrease the mass of the main body.

Hydrodynamical influence on formation of HCN/DCN molecules in hot cores

C. Tornow

DLR, Institut für Planetenforschung, Berlin

Abstract: HCN emission or absorption lines observed in the environment of low and high mass protostars indicate abundances relative to H_2 which range from 10^{-9} to 10^{-6}. These large variations are caused by the physical conditions in the surrounding envelope where the molecules are excited. In addition to the gaseous properties, the amount of UV radiation and the cosmic ray ionisation rate influence the formation efficiency of the HCN molecules. In order to study the impact of a temporally changing gas density and temperature a reduced chemical network derived from the UMIST data base of LeTueff et al., 2000 is combined with a real hydrodynamical model of a collapsing sphere. Using a very general initial element distribution the question is discussed whether a gas phase chemistry coupled to the ice phase is able to reproduce the measured variability of the HCN abundances as well as the DCN/HCN ratio observed in hot cores. The differences in the produced chemical composition of the molecular gas calculated for a hydrodynamical and a hydrostatic model are discussed as well.

Early solar system chronology

M. Trieloff

Mineralogisches Institut der Universität Heidelberg

Abstract: Radioisotope chronologies from both long-lived nuclides (^{238,235}U-^{206,207}Pb, ^{40}K-^{40}Ar [1,2,3]) and short-lived radionuclides (^{129}Xe from ^{129}I; half-live $T_{1/2} = 16$ Myr [4,5], excess ^{26}Mg from ^{26}Al; $T_{1/2} = 0.73$ Myr [6], ^{53}Cr from ^{53}Mn; $T_{1/2} = 3.7$ Myr [7], ^{182}Hf from ^{182}W; $T_{1/2} = 9$ Myr [8,9]) provide a framework for the formation of solids in the early solar system. We present an early solar system chronology based on the calibration of short-lived isotope chronometries to several tie points (CAIs, H chondrites, Acapulco), and planetesimal heating in the early solar system [3,10].

Conditions of formation of the first solids in the solar nebula varied - most probably due to p, T differences imposed by the early Sun - with radial distance and/or time, and caused the compositional variety of planetesimals concerning refractory and volatile elements, metals, Mg-rich silicates, and probably also oxygen isotopes [10,11,12]. Radiometric dating and chemical composition

suggest that individual planetesimals grew rapidly in the asteroid belt (within < 1 Myr), but different planetesimals formed over a time interval of 4 million years [3,9,10], well within the lifetime of protoplanetary dust disks in extrasolar systems [13,14]. Early planetesimals were heated to varying degrees by decay heat of short-lived nuclides (primarily ^{26}Al) [3]. This caused melting and differentiation in early (within < 2 Ma after CAIs) formed planetesimals and led to the formation of iron cores and basaltic rocks, while planetesimals that accreted later remained undifferentiated [3,9,10]. Chondritic parent bodies experienced severe thermal metamorphism in the case of ordinary chondrites, and aqueous alteration (further modifying the oxygen isotopic composition) in the case of carbonaceous chondrites. As most chondrules were immediately consumed in accreting planetesimals, they were only preserved in unmelted chondritic parent bodies and their age distribution is biased to the formation time interval of chondrites 2-3 Ma after CAIs [10].

The formation of solids in the early solar system (CAIs, chondrules, planetesimals and terrestrial planets) are still insufficiently linked to astrophysically constrained processes like early protostellar activity, disk dissipation, formation and migration of gas planets interacting with young disks [13,14]. Models of Earth and Mars formation based on ^{182}Hf -^{182}W core formation ages estimate the presence of planetary embryos of 60% the size of Mars after 2-4 Ma [15]. This requires the early presence of Jupiter to effectively prevent the formation of a proto-planet in the asteroid belt. Planetesimal formation in the asteroid belt and the terrestrial planet formation zone at <3 Ma after CAIs was likely accompanied by inner disk clearing permitting solar wind irradiation (and possibly volatile element depletion) of terrestrial - and partly asteroidal - precursor planetesimals [16]. Inner disk gas loss may also have been responsible for preventing the migration of Jupiter into the inner solar system.

References:

[1] Alle'gre C.J., Manhe's G., Göpel C. Geochim. Cosmochim. Acta 59, 1445 (1995)
[2] Amelin Y., Krot A. N. et al. Science 297, 1678 (2002)
[3] Trieloff M., Jessberger E.K., et al. Nature 422, 502 (2003)
[4] Brazzle R.H., Pravdivtseva O.V., Meshik A.P., Hohenberg C.M. Geochim. Cosmochim Acta 63, 739 (1999)
[5] Gilmour J.D., Saxton, J.M. Phil. Trans. R. Soc. Lond. A 359, 2037 (2001)
[6] Bizzarro, M., Baker, J. A., Haack, H. Nature 431, 275 (2004).
[7] Lugmair G.W., Shukolyukov A. Geochim. Cosmochim. Acta 62, 2863 (1998)
[8] Kleine, T., Münker, C. et al. Nature 418, 952 (2002)
[9] Kleine T., Mezger C. et al. Geochim. Cosmochim. Acta 68, 2935 (2004)
[10] Trieloff M., Palme H. in: PLANET FORMATION 2004 - Observations, Experiments and Theory (Eds. H. Klahr & W. Brandner), Cambridge University Press, in press
[11] Clayton, R. N. Annu. Rev. Earth Planet. Sci. 21, 115 (1993).
[12] Palme, H. Phil. Trans. R. Soc. Lond. A 359, 2061 (2001)
[13] Haisch K.E. et al. Astrophys. J. 553, L153 (2001)
[14] Briceno, C., Vivas, A. et al. Science 291, 93 (2001)
[15] Jacobsen, S.B. Science 300, 1516.
[16] Trieloff M., Kunz J. et al., Science 288, 1036 (2000)

Observations of inter-planetary dust cloud complex and ASTRO-F project

M. Ueno

Department of Earth Science & Astronomy, University of Tokyo

Abstract: We are promoting observations of interplanetary dust cloud at visible and infrared wavelength. We developed a new observation system WIZARD. Since the zodiacal light is faint and very extended all over the sky, WIZARD employs a sensitive CCD and a wide field optics with sufficient spatial resolution to measure the contribution of integrated flux of the individual stars. WIZARD is designed to measure the absolute brightness of the diffuse sky at visible wavelength and to have good stability of the system zero-level as well as low noise feature. The first light of WIZARD was performed in 2001 at Mauna Kea, Hawaii, and the first scientific image of the gegenschein was taken in 2002 under collaboration with SUBARU observatory. We have been promoting extended observations of the zodiacal light along the ecliptic plane, for three years at NASA/ IRTF site. We present the design and the performance of WIZARD system, and also the preliminary results of our observations. ASTRO-F, which will be launched on Feb. 21 THIS year, is designed to realize a super IRAS survey from 9-170 micron, as well as pointing observations like SST. We are going to conduct several projected observations with wide coverage in astronomical interests. I will present observation plans on two topics; observations of interplanetary dust cloud and extended survey of proto-planetary disks.

Photophoresis of protoplanetary dust

I. von Borstel

TU Braunschweig

Abstract: Photophoresis plays an important role in the late stages of a protoplanetary disk. We will present results from experiments performed in the 2005 DLR parabolic flight campaign that investigate the strength of the photophoretic effect for dust agglomerates in a rarefied gas environment. In particular, the dependance of the photophoretic drift velocity on the agglomerate mass as well as on the ambient gas pressure will be reported. Implications of the findings for late protoplanetary nebulae will be discussed and compared to recent theoretical predictions [1].

[1] Krauss, O. and Wurm, G.: Photophoresis and the pile-up of dust in young circumstellar disks, ApJ 630, 1088-1092, 2005.

Signatures of Planets in Protoplanetary and Debris Disks

S. Wolf[1], A. Moro-Martín[2], and Gennaro D'Angelo[3]

[1] MPI für Astronomie, Heidelberg

[2] Department of Astrophysical Sciences, Peyton Hall, Ivy Lane, Princeton University

[3] School of Physics, University of Exeter, UK

Abstract: We discuss selected possibilities to detect planets in circumstellar disks. We consider the search for characteristic signatures in these disks caused by the interaction of giant planets with the disk as the most promising approach. Numerical simulations show that these signatures are usually much larger in size than the planet itself and thus much easier to detect. The particular result of the planet-disk interaction depends on the evolutionary stage of the disk. Primary signatures of planets embedded in disks are gaps in the case of young disks and characteristic asymmetric density patterns in debris disks.

We present simulations which demonstrate that high spatial resolution observations performed with instruments/telescopes that will become available in the near future will be able to trace the location and other properties of young and evolved planets. These observations will allow to directly investigate the formation and evolution of planets in protoplanetary and debris disks.

Towards a general theory of planet formation: Understanding GQ Lupi and predicting COROT's planets

G. Wuchterl

Astrophysikalisches Institut und Universitätssternwarte, Universität Jena

Abstract: Planet formation is a multi-step process with many physical regimes. Incomplete descriptions, weak empirical constraints and models loaded with technical difficulties as well as the stochastic nature of a number of phases make it difficult to derive results with a predictive power that is sufficient to catch up with exoplanet-observations.

I present a new approach that is centered around the structure and dynamics of self-gravitating gas spheres and a classification of their equilibria. A physical description based on the radiation-fluid dynamics with convection is developed and calibrated to the Sun. The equations are then applied to all plausible "nebula" or "cloud" conditions in an effort to derive all possible resulting celestial bodies. Thus a general framework for star, brown dwarf and planet formation is set up and used to derive properties of the resulting populations.

Two applications are shown for illustration: (1)The origin and nature of the GQ Lupi system (2)Predicting properties of COROT's planetary population

From Dusk to Dawn: Experiments on Planetesimal Formation

G. Wurm

Institut für Planetologie, Universität Münster

Abstract: A dust particle that sets off as a single grain in a protoplanetary disk eventually finds itself in a km-size planetesimal. The basic question is: Can we trace the way this particle takes to become a part of the planetesimal? The particle might collide, stick, get compressed, see decompaction, take part in disruption, being transported inwards or outwards, be heated, melted, get charged, be picked up by wind, stay in the dark, see some light in short do quite a roller coaster ride.

Many experiments with respect to this question deal with collisions between two dust aggregates. This is a crucial process for

all sizes of aggregates, and it is studied in Earth and space bound setups. Some experiments focus on charges and charging, e.g. by collisions, and yet another group of experiments considers the effect gas drag might have on the evolution of larger aggregates.

It also has to be noted that not all processes occur in optically thick disks (after dusk). At later stages and at the inner edge protoplanetary disks might get transparent to light (after dawn). As recently shown, photophoresis will act on particles with dramatic effects of destroying, concentrating, and forming small bodies. This opens a whole new playground for experiments.

The chances are good that we might eventually figure out the history of a dust grain or, as we call it more frequently, the process of planetesimal formation.

Constraints on planet system formation from the chemical evolution modelling of the Galaxy

S. Zhukovska and H.-P. Gail

Institut für Theoretische Astrophysik, Universität Heidelberg

Abstract: The evolution of dust content of the interstellar medium (ISM) is studied using chemical evolution modeling of the Galaxy. We consider injection of carbon, iron, silicate and SiC dust species to the ISM by AGB stars and SNe. Further processing of dust in the ISM, grain growth through accretion in cold molecular clouds and destruction by SN shocks, is modeled. We study variation of ammount and composition of dust in the ISM with Galactocentric radius during galactic evolution. Resulting dust-to-gas ratio contrains the location in the galactic disk and moment of planet system formation.

Participants

1.	Cristina Afonso	*MPI für Astronomie, Heidelberg*
2.	Rainer Altherr	*Mineralogisches Institut der Universität Heidelberg*
3.	Clément Baruteau	*CE-Saclay, France*
4.	Michael Bau	*International University Bremen*
5.	Jürgen Blum	*Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig*
6.	Alexander Borisov	*Institut für Mineralogie und Geochemie, Universität zu Köln*
7.	Silvia Brandert	*Institut für Astrophysik, Universität Göttingen*
8.	Frithjof Brauer	*MPI für Astronomie, Heidelberg*
9.	Jörg Büchner	*MPI für Sonnensystemforschung, Katlenburg-Lindau*
10.	Ludmila Carone	*Institut für Geophysik und Meteorologie, Universität zu Köln*
11.	Arnaud Cassan	*Astronomisches Rechen-Institut, Heidelberg*
12.	Ulrich Christensen	*MPI für Sonnensystemforschung, Katlenburg-Lindau*
13.	Gerben Dirksen	*Institut für Astronomie und Astrophysik, Universität Tübingen*
14.	Michaela Döllinger	*European Southern Observatory, Garching*
15.	Stefan Dreizler	*Universität Göttingen*
16.	Kees Dullemond	*MPI für Astronomie, Heidelberg*
17.	Jochen Eislöffel	*Thüringer Landessternwarte Tautenburg*
18.	Massimiliano Esposito	*Salerno University & Thüringer Landessternwarte Tautenburg*
19.	Davide Fedele	*European Southern Observatory, Garching*
20.	Florian Freistetter	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
21.	Ovidiu Furdui	*Astronomisches Rechen-Institut, Heidelberg*
22.	Hans-Peter Gail	*Institut für Theoretische Astrophysik, Universität Heidelberg*
23.	Patrick Glaschke	*Astronomisches Rechen-Institut, Heidelberg*
24.	Valentina Granata	*University of Padua*
25.	John Lee Grenfell	*DLR, Institut für Planetenforschung, Berlin*
26.	Eberhard Grün	*MPI für Kernphysik, Heidelberg*
27.	Eike Günther	*Thüringer Landessternwarte Tautenburg*
28.	Carsten Güttler	*Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig*
29.	Michael Hartmann	*Thüringer Landessternwarte Tautenburg*
30.	Artie Hatzes	*Thüringer Landessternwarte Tautenburg*
31.	Pascal Hedelt	*DLR, Institut für Planetenforschung, Berlin*
32.	Daniel Heißelmann	*TU Braunschweig*
33.	Thomas Henning	*MPI für Astronomie, Heidelberg*
34.	Dominik Hezel	*Institut für Geologie und Mineralogie, Universität zu Köln*
35.	Derek Homeier	*Institut für Astrophysik, Universität Göttingen*
36.	Jens Hopp	*Mineralogisches Institut der Universität Heidelberg*
37.	Tim-Oliver Husser	*Institut für Astrophysik, Universität Göttingen*
38.	Martin Ilgner	*Queen Mary University of London*
39.	Holger Israel	*Institut für Astrophysik, Universität Göttingen*
40.	Markus Janson	*MPI für Astronomie, Heidelberg*
41.	Elmar K. Jessberger	*Institut für Planetologie, Universität Münster*
42.	Klaus Jockers	*MPI für Sonnensystemforschung, Katlenburg-Lindau*
43.	Viki Joergens	*Sterrewacht Leiden*
44.	Anders Johansen	*MPI für Astronomie, Heidelberg*
45.	Inga Kamp	*ESA/STScI*
46.	Berhard Keil	*Landessternwarte, Heidelberg*
47.	Sascha Kempf	*MPI für Kernphysik, Heidelberg*
48.	Hubert Klahr	*MPI für Astronomie, Heidelberg*
49.	Wilhelm Kley	*Institut für Astronomie und Astrophysik, Universität Tübingen*
50.	Johannes Koppenhöfer	*MPI für extraterrestrische Physik, Garching*
51.	Kacper Kornet	*MPI für Astronomie, Heidelberg*
52.	Maya Krause	*TU Braunschweig*
53.	Oliver Krauss	*Institut für Planetologie, Universität Münster*
54.	Alexander Krivov	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
55.	Harald Krueger	*MPI für Sonnensystemforschung, Katlenburg-Lindau*

56.	Martin Kürster	*MPI für Astronomie, Heidelberg*
57.	Katharina Lesch	*Institut für Astrophysik, Universität Göttingen*
58.	Hendrik Linz	*MPI für Astronomie, Heidelberg*
59.	Torsten Löhne	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
60.	Frederic Masset	*Service d'Astrophysique CE-Saclay*
61.	Alexey A. Mints	*Astronomisches Rechen-Institut, Heidelberg*
62.	Felicitas Mokler	*MPI für extraterrestrische Physik, Garching*
63.	Uwe Motschmann	*TU Braunschweig*
64.	Markus Mugrauer	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
65.	Reinhard Mundt	*MPI für Astronomie, Heidelberg*
66.	Harald Mutschke	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
67.	Ralph Neuhäuser	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
68.	Ulrich Ott	*MPI für Chemie, Mainz*
69.	Herbert Palme	*Universität zu Köln*
70.	Georgi Paraskov	*Institut für Planetologie, Universität Münster*
71.	Beate Patzer	*Zentrum für Astronomie und Astrophysik, TU Berlin*
72.	Bojan Pecnik	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
73.	Susanne Pfalzner	*Universität zu Köln*
74.	Thomas Posch	*Institut für Astronomie, Wien*
75.	Dionyssia Psychoyos	*Department of Physics, University of Thessaloniki*
76.	Martina Queck	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
77.	Andreas Quirrenbach	*Sterrewacht Leiden*
78.	Heike Rauer	*DLR, Institut für Planetenforschung, Berlin*
79.	Sabine Richling	*IAP, Paris*
80.	Veronica Roccatagliata	*MPI für Astronomie, Heidelberg*
81.	Florian Rodler	*MPI für Astronomie, Heidelberg*
82.	Maria Victoria Rodriguez Ledesma	*MPI für Astronomie, Heidelberg*
83.	Zsolt Sandor	*Eotvos University, Budapest*
84.	Christoph Schäfer	*Institut für Astronomie und Astrophysik, Universität Tübingen*
85.	Alexander Schegerer	*MPI für Astronomie, Heidelberg*
86.	Tobias Schmidt	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
87.	Thorbjörn Schönbeck	*Institut für Geologie und Mineralogie, Universität zu Köln*
88.	Katharina Schreyer	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
89.	Winfried Schwarz	*Mineralogisches Institut der Universität Heidelberg*
90.	Dmitry Semenov	*MPI für Astronomie, Heidelberg*
91.	Aurora Sicilia-Aguilar	*MPI für Astronomie, Heidelberg*
92.	Roberto Silvotti	*INAF*
93.	Roland Speith	*Institut für Astronomie und Astrophysik, Universität Tübingen*
94.	Tilmann Spohn	*DLR, Institut für Planetenforschung, Berlin*
95.	Tilman Springborn	*Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig*
96.	Barbara Stracke	*DLR, Institut für Planetenforschung, Berlin*
97.	Eva Stueeken	*International University Bremen*
98.	Micaela Stumpf	*MPI für Astronomie, Heidelberg*
99.	Jens Teiser	*Institut für Geophysik und Extraterrestrische Physik, TU Braunschweig*
100.	Ruth Titz	*DLR, Institut für Planetenforschung, Berlin*
101.	Carmen Tornow	*DLR, Institut für Planetenforschung, Berlin*
102.	Mario Trieloff	*Mineralogisches Institut der Universität Heidelberg*
103.	Munetaka Ueno	*Department of Earth Science & Astronomy, University of Tokyo*
104.	Nikolai Voshchinnikov	*St. Petersburg University, Russia*
105.	Ingo von Borstel	*TU Braunschweig*
106.	Joachim Wambsganss	*Universität Heidelberg*
107.	Patrick Weise	*MPI für Astronomie, Heidelberg*
108.	Sebastian Wolf	*MPI für Astronomie, Heidelberg*
109.	Günther Wuchterl	*Astrophysikalisches Institut und Universitätssternwarte, Universität Jena*
110.	Gerhard Wurm	*Institut für Planetologie, Universität Münster*
111.	Svitlana Zhukovska	*Institut für Theoretische Astrophysik, Universität Heidelberg*