The influences of the companion star for the formation of the Gamma-Cephei planetary system

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The existence of planetary system inside multiple star systems are one of the most intriguing problems of the actual astronomy. With the advance of the observational methods several extrasolar planets was discovered in the past two decades, but the formation of these bodies remains cloudy. As well as the formation of planets in single stars systems, the planets of our Solar System for example, there is many theories for the formation of planets in multiple star systems, but the validation of these theories are often rare, in other words, although there are many theories for describe the formation of these planetary systems, but just a few of then are reliable. In the present work we will investigate the partial formation and migration of the planet Gamma-Cephei b, the only planet of a peculiar binary system called Gamma-Cephei. This system was choosed because the separation between the more assive star and its companion is the smaller among all binary systems discovered. All the planets in binary systems already discovered are orbiting the more massive star, while the companion star acts as a perturber body, these type of orbits are called as S-type, if the planet is orbiting the two stars it is in a orbit called P-type. The secondary star could be a important piece to solve the puzzle of the formation of a planet in systems like Gamma-Cephei, once the separation between the stars is small, the gravitational effects of the secondary star should be strong enough to affect the region where the planet will form, which leads to change the planet formation and its migration. The main purpose of this work is to quantify the effetcs of the secondary star for formation of the planetary system in the binary star system Gamma-Cephei comparing the results with situations where the effects of the secondary star are neglected. It will be used fully hydrodynamical simulations to reproduce the last phase of formation of the planet, far of its actual position, and its migration to near of its real position. We also analize the eccentricity of the planet to see if our results are consistent with what is observed.

Probing the inner regions of protoplanetary disks with infrared CO_2 emission.

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Organic molecules in proto-planetary disks can be important diagnostics tools. Ro-vibrational transitions of these molecules, which are visible in the near- and mid-infrared, can probe the hot inner few AU of protoplanetary disks. They can thus trace the chemistry and physical conditions of the regions of terrestrial planet formation. These lines have been observed but have mostly been interpreted with local thermal equilibrium (LTE) models. The LTE assumption may not be valid due to the high gas densities needed to collisionally thermalise the vibrational levels.
The non-LTE excitation effects of carbon dioxide CO_2 are studied to evaluate (i) what the emitting regions of the different CO_2 ro-vibrational bands are, (ii) if and how the CO_2 abundance and gas density can be traced using CO_2 ro-vibrational lines.
Starting from experimental and theoretical data of level energies, Einstein coefficients and the collisional rate coefficients of CO_2 a molecule model is built. The behaviour of this model is tested using non-LTE slab models. Using a 2 dimensional disk model and a radiative transfer code the CO_2 line formation is modelled. This allows us to study line ratios and the 15 micron Q branch line profile. The model was tailored to the T Tauri disk AS 205(N) where CO_2 is detected in the mid-infrared by the Spitzer Space Telescope.

The protoplanetary disk models suggest that the CO_2 emission from protoplanetary disks comes from regions that are further out and cooler than one would infer from a LTE model. This is due to a combination of factors. The IR continuum emission can excite rotationally cold CO_2 out to a few tens of AU. A large optical depth (tau = 30) for the transitions involving low J levels then creates the broad Q branch observed.

Appropriate solid-body models as initial conditions for SPH-based numerical collision experiments

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(Giant) collisions are ubiquitous processes during all stages of planet formation. To answer questions concerning the transport of volatiles (water), realistic fragmentation behavior, or the formation of the Moon in detail, individual collisions have to be investigated, often by means of SPH simulations.
While planetesimal-scale collisions can be modeled by simple homogeneous bodies, this does not hold for giant impacts anymore, where the bodies' internal (radial) structures generally affect results. In practice some dynamical settling (numerical relaxation) is applied in most cases, either starting from some predetermined radial profile or from scratch. Since this procedure has to be carried out prior to the actual simulation run, it requires potentially high computational resources solely for producing the initial conditions. Beyond the common numerical procedure, a semi-analytical approach for relaxation is introduced and validated in this work, practically eliminating the need for spending significant amounts of valuable computing time solely for the production of a relaxed initial state in a lot of situations. Finally the basic relevance of relaxation itself is studied, focusing on collision simulations in different mass ranges important in the context of planet formation and the transport of water.

The midplane conditions of protoplanetary discs: a study of HD163296

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The mass of protoplanetary discs in gas is a quantity of great interest for assessing their planet formation potential. Disc gas masses are however traditionally inferred from measured dust masses by applying an assumed standard gas to dust ratio of 100.
Here we present a novel approach to study the midplane gas by combining modelling of the spectral energy distribution (SED), CO snowline observations and ALMA C18O line emission. All of the modelling steps are crucial to break degeneracies in the parameter space.
We apply the technique to the disc around the Herbig Ae star HD 163296, with particular focus on the regions within the CO snowline radius (90 au). Our models unambiguously determine the C180 mass within the CO snowline location and favour a notably low gas to dust ratio (g/d~20). With current and upcoming ALMA C18O data, this technique can be applied to a range of discs and opens up the possibility of measuring gas and dust masses in discs without making assumptions about the gas to dust ratio.

Hydrodynamics conditons for the formation of the Gamma Cephei b

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The discovery of the exoplanets showed that many systems have giant planets very close of the stars which orbit. These configurations were a surprise to the scientific community, as the Solar System has giant planets at large distances from the Sun. Jupiter, the gaseous planet closest to the Sun, it is at a distance of 5.20 AU. The Gamma Cephei binary system has your two stars very close, approximately 20 UA of distance. Besides the two stars, the system has a planet at 2.05 UA with a mass nearby of 1.85 Jupiter masses.
In this work, we analyzed the characteristics required in the initial stage of a disk of gas for the formation of Gamma Cephei b. The simulations are performed with FARGO 2D (MASSET, 2000). The results and analyzes are in progress and will be presented during the meeting.

The blue exoplanet atmosphere revisited - Are bright stellar regions (plage) occulted during transit?

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For about 14 years not only extrasolar planets but their atmospheres have been investigated as well. It is crucial to understand the influence stellar activity can have on atmospheric measurements in order to get correct results. Oshagh et al. have shown recently that an increase of planetary radii in the blue part of the spectrum can equally well be explained with the presence of a hot plage region on the stellar surface. We have checked their hypothesis using UVES and HARPS spectra to measure the Ca II H,K-lines that can be associated with plage during and out of a transit. The emission lines should change during transit if plage was occulted and is not distributed uniformly over the whole surface. We have found that in two cases no change in line strength is observable whereas in one case an occultation of plage is possible but needs further investigation.

Supernova enrichment of planetary systems in unusual clusters

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One of the outstanding questions in astrophysics is whether our Solar System is a typical planetary system in terms of chemical composition and its dynamically quiet past. Short-lived radioactive species (SLRs) with half-lives less than 10 Myr, such as 26Al and 60Fe, have been detected in chondrites. Because of the SLRs short half-lives and homogeneous distribution in the Solar System, these isotopes must have entered the protoplanetary disc at early epochs and been produced in an external stellar source. The most probable scenario is that these SLRs were produced in the cores of massive young stars with initial masses >20 Msun that polluted the protoplanetary disc when they exploded as supernovae (SNe). Stars that are born in regions with more than 100 stars per pc3, conditions that are observed in high mass clusters, can expect to undergo significant dynamical interactions with other stars in the first 10 million years (Myr) of their lives, whereas stars in low density regions may experience no close interactions. Simulations of high mass clusters have previously shown that only ~1% of their stellar population is enriched through SNe events and remains unperturbed. I investigate the

hypothesis that unusual low mass clusters containing one or more massive stars might be better environments for creating Solar-like systems, rather than massive clusters due to lower probability of dynamical interactions and weaker external radiation. I will present the results of N-body simulations following the evolution of low mass clusters (50-200 stars) containing two massive stars (>20 M_{sun}) and determine the number of stars that are sufficiently enriched by direct pollution. A range of initial conditions are used to cover many different potential star formation scenarios. We find that low mass clusters enrich only ~10% of their population, making them less efficient at polluting stars than high mass clusters.

Transit Probabilities in Secularly Evolving Systems

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One of the outstanding questions in astrophysics is whether our Solar System is a typical planetary system in terms of chemical composition and its dynamically quiet past. Short-lived radioactive species (SLRs) with half-lives less than 10 Myr, such as 26Al and 60Fe, have been detected in chondrites. Because of the SLRs short half-lives and homogeneous distribution in the Solar System, these isotopes must have entered the protoplanetary disc at early epochs and been produced in an external stellar source. The most probable scenario is that these SLRs were produced in the cores of massive young stars with initial masses >20 Msun that polluted the protoplanetary disc when they exploded as supernovae (SNe). Stars that are born in regions with more than 100 stars per pc3, conditions that are observed in high mass clusters, can expect to undergo significant dynamical interactions with other stars in the first 10 million years (Myr) of their lives, whereas stars in low density regions may experience no close interactions. Simulations of high mass clusters have previously shown that only ~1% of their stellar population is enriched through SNe events and remains unperturbed. I investigate the hypothesis that unusual low mass clusters containing one or more massive stars might be better environments for creating Solar-like systems, rather than massive clusters due to lower probability of dynamical interactions and weaker external radiation. I will present the results of N-body simulations following the evolution of low mass clusters (50-200 stars) containing two massive stars (>20 M_{sun}) and determine the number of stars that are sufficiently enriched by direct pollution. A range of initial conditions are used to cover many different potential star formation scenarios. We find that low mass clusters enrich only ~10% of their population, making them less efficient at polluting stars than high mass clusters.

Investigation of A- and F-type pulsators in a multiple star system

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In the study of planet formation, a thourogh understanding of stellar structure and evolution is indispensable. This can be accomplished through the analysis of multiple star systems which provides us with precise observational constraints on fundamental parameters such as mass and radius.
Moreover, by performing a detailed spectroscopic analysis, not only the orbital parameters, but also other important quantities such as the temperature, the metallicity, the log g, and the v sin i can be determined.
By contrast, asteroseismology, the analysis and modelling of stellar pulsations, allows us to probe the interior stellar structure and is complementary to the study of binary stars.
Therefore the combination of all these methodologies is a powerful tool for the characterization of binary stars and multiple star systems in general.

We apply asteroseismic and spectroscopic techniques to a multiple system composed of A- and F-type pulsating stars and here we present the preliminary results of the analysis of the unprecedented high-quality light curves from the Kepler mission along with the HERMES high-resolution spectra available for this object.

A PCA-based approach for modeling background emission in thermal infrared images

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Ground-based observations in thermal infrared suffer from strong background radiation due to the sky, telescope and warm surfaces of the instrument. This makes it much more difficult to observe faint sources around distant stars in M-band or even longer wavelengths. The main purpose of this work is to reveal this background in one particular set of infrared imaging data, show how it can be subtracted from the data and how this improves the detection of a planet in high contrast imaging.
An innovative new algorithm that uses principal component analysis (PCA) for modeling and subtracting the IR background is explained and analysed in detail. The algorithm was applied to archived high contrast M-band ADI data of β Pictoris in order to investigate the potential signal-to-noise gain due to adding this extra step to the data reduction chain. The stellar point spread function (PSF) was also subtracted with a PCA-based method to reveal the planet signal. The final results are compared to the results from a conventional mean background subtraction applied to the same dataset.
The signal-to-noise gain for β Pictoris b is around 30 %. The signal-to-noise increases because the standard deviation of the noise goes down in the final image and the PSF becomes more stable after applying the PCA-based background subtraction. The signal-to-noise benefits from a more stable PSF because there are less principal components needed for modeling and subtracting the stellar PSF, therefore, there is less subtraction of the planet signal in the final image.

A dynamical study on the origin of the Moon

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The process of the formation of the Moon still yields many open questions. The generally accepted scenario proposes a giant impact of a Mars-sized body onto the proto-Earth between 70 to 120 million years after the formation of the terrestrial planets. According to popular theories the Moon formed from the debris disk generated by this late giant impact. The goal of our dynamical studies is to find the initial orbit of the Mars-sized impactor (Theia) by investigating the regarding probability of a collision with Earth. Due to previous studies it is assumed that Theia formed between Earth and Mars at the same time as the other terrestrial planets did. Then the planet has to stay on a stable orbit for tens of millions of years till it may collide with the Earth leaving the rest of the inner solar system almost unaffected. In order to investigate the most probable origin of Theia we did n-body simulations starting a Mars-sized object with semi-major axis between 1.065 AU to 1.205 AU at low inclination altering the mean anomaly for each starting position from 0° - 360°. Additionally, simulations with an initial position of Theia inside the orbit of Earth (semi-major axis between 0.875 AU and 0.940 AU) were carried out. In total up to 10000 scenarios were calculated. The used model consists of an inner solar system with Venus, Earth and Mars at their known positions and the additional Theia as well as Jupiter and Saturn at their present orbits. The system was calculated up to 100 million years finding three possible outcomes namely collision with Earth, ejection or stability for the whole calculation period for Theia. Our results place the possible origin of Theia at 1.145 AU where most collisions happen after more than 70 million years. Additionally, the results of the dynamical n-body studies provide important data of the impact such as impact velocity and impact angle which will serve as basis for further detailed investigation of the impact itself by SPH (Smooth Particle Hydrodynamics) computations.

Introduction of an effective feed-back and steering mechanism for human societies

Wolfgang Scheffler
Solare Bruecke e.V., Germany

My research work is very practical and related to the organisation of world society.

If humans cooperate effectively, they can solve every problem.
If they work against each other, they can create every problem.

The results of both behaviours we can observe on our planet.
The question is: How can cooperation be organised effectively in any size of group and across societies worldwide. A scientifically proven method for this exists since 43 years. The method of **Citizen's report with planning cells** was invented by Professor Peter C. Dienel in Germany in 1973. His solution was to create time-limited miniature societies, in which informed and thoroughly discussed views are able to emerge.
For every problem to be solved, the method uses 8 random samples of 25 citizens each, who will sit for four days in a very structured and time controlled process. It consists of a continuous rotation between information input, intense discourse in random sub-groups of 5, ranking of results and again information input for the next round. Everybody exchanges his views with everybody else. There is no leadership of opinion, all discussion happens on an equal level. The experience shows that under this conditions common sense prevails, and decisions are favoured which are for the common good.
This is the climate we need for successful cooperation on every level of society.
14000 German citizens have taken part since 1973, proving the above statements of the effects of this method.
My work is on increasing the awareness about this method, and to make it standard for all decisions to be taken. Last year I took the step to make the method eligible for voters in Germany. The next step will be to promote it on international level.
I think you will like this far reaching theme about the conservation of the only non-extrasolar habitable planet.
More information under: www.buergerInnengutachtenpartei.de

Robustness of N_2H^+ as tracer of the CO snowline

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In the midplanes of protoplanetary disks, the temperature becomes so low that molecules freeze out from the gas phase onto dust grains. The midplane radius at which this happens for a certain molecule is defined as its snowline. Snowlines can enhance the growth of dust particles, and thus planet formation efficiency. Furthermore, because the gas and ice reservoir compositions change at a snowline, and elemental ratios correspondingly, the bulk composition

of planets may depend on where in the disk they are formed. Determining snowline locations is thus key to understanding planet formation.
Since the CO snowline is difficult to observe directly with CO emission, its location has been inferred in several disks from spatially resolved ALMA observations of N_2H^+. N_2H^+ is considered to be a good tracer of the CO snowline based on astrochemical considerations predicting N_2H^+ to be abundant only when CO is frozen out. In this work, the robustness of N2H+ as tracer of the CO snowline is investigated using a simple chemical network in combination with the radiative transfer code LIME.
The results show that the N_2H^+ distribution, and the resulting emission with respect to the CO snowline, is very sensitive to initial chemical and physical conditions. The relation between CO snowline and N_2H^+ emission are thus more complicated than initially expected and chemical modeling, as outlined in this work, rather than column density fitting thus seems necessary to translate N_2H^+ emission into a CO snowline location.

Dust Settling in Protoplanetary Disks

Yoshinori Miyazaki and Jun Korenaga
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The evolution of protoplanetary disks has been studied since 1960s in astrophysics and cosmochemistry, through theoretical analysis in astrophysics and through meteoritic observations in cosmochemistry. The physical and chemical aspects of the disk evolution, however, have been investigated mostly independently to each other, and the theory that can account for both aspects in a satisfactory manner is yet to be developed. The interplay between physics and chemistry is likely to have an important role in the disk evolution, possibly affecting the chemical structure of the disk as a whole. Our preliminary results indicate that the time scales of elemental physical processes such as vertical settling could change drastically by incorporating chemistry.
We have investigated the effects of condensation and evaporation on vertical dust settling. Dust evaporates as they sink into a hotter region and forms a “condensation front”, above which dust-composing elements, Mg, Si, and Fe, are concentrated. Modeling results show that repeating evaporation at the front inhibits grain growth, resulting in a longer settling time for Mg, Si, and Fe bearing dust. The predicted time scale could be longer than 10^5 years, while an order of 1000 years is suggested by the standard astrophysical theory of planetary formation. The new model also suggests that the ratio of refractory elements in chondrites, Al/Si in particular, can possibly be explained by this dust concentration above the condensation front, whereas the existing explanation with incomplete condensation fails to explain the ratio.

Catalog of stars in embedded and open clusters suitable for infrared interferometric observation

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Many aspects of the early phases of star formation are still poorly understood, in particular for high-mass stars. Despite most high-mass stars are found in binary and multiple systems, it is still not clear how binarity/ multiplicity evolves in time. With this in mind, we aim at understanding how binarity/multiplicity changes at different evolutionary stages in different types of clusters forming high-mass stars: essentially a number of embedded (EC) and open clusters (OC), younger than 16 Myr, and located at distances > 1 kpc. For this, interferometric observations at different wavelengths are required to resolve multiple systems and study them during their formation (emitting strongly in the sub-millimeter) and once they are already formed (emitting strongly in the near- and mid-infrared). With the advent of new facilities like VLTI and ALMA, this research is now possible. However, as a preparatory step, it is a must to select and identify proper cluster candidates to characterize the multiplicity content. In this work, we present the methods developed to select the best candidates to perform high-angular resolution observations with VLTI and ALMA.

Pressure trapping solids in proto-planetary disks

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Small dust grains are vital in the study of proto-planetary disks by defining their observational structure, as well as forming the main actors in the process of planet formation.
To in situ form terrestrial planets within a few AU of the host star, the dust grains have to be concentrated. So how can we trap those particles in the inner part of a proto-planetary disk? One answer can be pressure. Small grains, with sizes up to a few meter, are bound to move to the nearest local high pressure region and therefore can be trapped there.
We conduct 3D hydrodynamical simulations with the PLUTO code, wherein small dust grains are treated as a second fluid in the short friction time approach. By this method, we can create dust distributions in disks which are turbulent do to pure hydro instabilities like Goldreich-Schubert-Fricke and Convective Overstability, forming vortices inside the disk and thus enable dust grains to be trapped.
We present our latest results from our numerical simulations while discussing the prospects of forming planetesimals inside those traps.

The early phase of planet formation in Binary Systems.

Preliminary work: implementation of a 3D hydrodynamical tree-based code for the numerical investigation of the evolution of radiative self-gravitating gaseous disks.

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At present, the study of the evolution of matter around young binary systems is a key issue which can provide important answers on the possibility of forming planets in stable orbits around two stars.
In the context of my PhD work in Astronomy, Astrophysics and Space Science, me and my research group aim at studying the conditions for stability of gaseous disks revolving around binary stars, during the earliest phases of planet formation, when no km-sized planetesimal has been constituted yet and the circumbinary matter is still made up of just gas and dust. The stability of such systems, maintained for a sufficiently large time-scale, will be a crucial condition for matter condensation and for the following planet constitution.
For this purpose, we intend to perform several 3D high resolution simulations by implementing a Smoothed Particle Hydrodynamics tree-based code, suitably designed to take efficiently into account both the selfgravity of the system and the influence of the stellar radiation.
Previously, few works focused their attention to this problem and, to overcome several issues due to computational efforts, some approximations have been used. Despite important constraints for the regions of stability have been obtained, no characterization in high details on the structure of the disk nor clear informations about its symmetry have been given.

By contrast, our code will be realized to take into account several physical processes, relevant for disk stability, exploiting some suitable numerical techniques previously developed by several authors. In particular, self-gravity and stellar radiation absorption, which in many cases have been considered in a simplified theoretical scheme, are thought to play a crucial role. Our algorithm is designed to be flexible, due to its lagrangian structure, and efficient, since it will run in multi-node architectures.
During the meeting, i will show the preliminary part of our work which consists in the realization of a serial version of the code, able to simulate the hydrodynamical evolution of a gas system which interacts gravitationally with two stars (represented by point mass objects). Some preliminary applications will be shown.

Characterizing the properties of HD 179218's disk using GTC imaging and spectroscopy

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We observed the intermediate-mass star HD 179218 at 240 pc using the CanariaCam instrument installed on the 10-m GTC (Gran Telescopio CANARIAS), which delivers imaging and spectroscopic observations in the mid-IR. HD179218 is a well-known Herbig Be object with a circumstellar disk inferred from mid-IR excess. Our aim is to characterize the circumstellar emission around the stellar object HD 179218 in the 8.6 and 11.3 *µm* PAH bands (Polycyclic Aromatic Hydrocarbons) and in the nearby Silicate band continuum at 12.5 *µm* filters using high-resolution imaging and low-resolution spectroscopy. We partially resolve the disk emission in the PAH bands and derive characteristic radius of ≈ 10-12 AU, comparable to what is found by Fedele et al. (2008) based on mid-IR interferometric observations. Surprisingly the emission appears unresolved at 12.5 *µm*, although a disk size would be expected in the continuum at longer wavelengths. On-going modeling should clarify if the resolved emission at 8.6 and 11.3 is dominated by PAH in a flared-disk scenario or if a certain level of blending with the silicate solid-state bands is subsisting. The LR spectrum measured with CanariCam is in very good agreement with the Spitzer and ISO spectra of the same source, with the detection of the different features identified in earlier observations. We find that HD179218 is a pre-transitional disk that shows strong similarities with the case of HD97048 (Lagage et al. 2006).