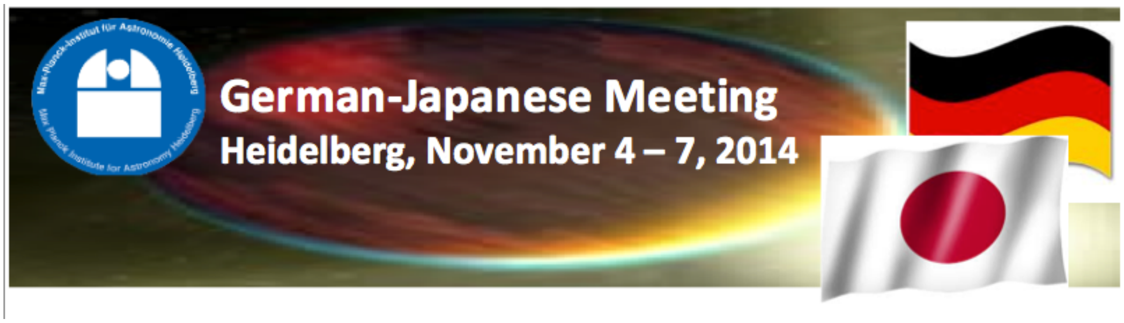


Exo-Planets and their Formation

Haus der Astronomie, MPI-Astronomy Campus

(all talks are 15min. + 5 min. discussion)

Tuesday, Nov, 4th

9:am - 4pm: Collaboration Day (no bus / no catering)

Wednesday, Nov, 5th

9:00 Bus leaves from the Crowne Plaza Hotel
9:30 - Registration
9:45 - Welcome from the Organisers

SESSION: EXO - PLANETS (DETECTION)
9:50 - 11:00 (15+5)

1. Artie P. Hatzes - Detecting Short-period, Earth-mass planets in the Presence of Activity Noise
2. Joachim Wambsganss - Searching for Extrasolar Planets with Gravitational Microlensing: Challenges and Exciting Results
3. Luigi Mancini - Photometric follow-ups of transiting exoplanets with ground-based medium-class telescopes

11:00 COFFEE BREAK
11:30-13:00:

4. Andreas Quirrenbach, CARMENES Consortium - CARMENES: Searching for Blue Planets Orbiting Red Dwarfs
5. Sabine Reffert - Giant Planet Occurrence Rate as a Function of Stellar Mass and Metallicity
6. Motohide Tamura - Subaru Direct Imaging Observations of Exoplanets and Brown Dwarfs
7. Viki Joergens - The formation of free-floating planets

13:15-14:30 LUNCH MPIA Cafeteria

SESSION: DISKS
14:30-16:00:

8. Cornelis Dullemond - Observing dust traps with ALMA
9. Jun Hashimoto - Near-Infrared Imaging Observations of Transitional Disks by the Subaru/SEEDS project
10. Sebastian Wolf - High-angular resolution observations and modeling of circumstellar disks
11. Hideko Nomura - Complex Organic Molecules in Protoplanetary Disks

16:00 COFFEE BREAK

16:30-18:00

12. Semenov Dimitry- Importance of dynamical processes for chemical evolution of protoplanetary disks
13. Th. Henning - Water: From Disks to Planets
14. Takayuki Muto - Protoplanetary Disk Morphology and High-Resolution Imaging Observations
15. Shu-ichiro Inutsuka - The Formation and Early Evolution of Protoplanetary Disks: A Hybrid Scenario of Planet Formation

18:00-19:00 POSTER SESSION
19:15 BUS leaves for DOWNTOWN (Crowne Plaza)

Thursday, Nov, 6th

9:00 Bus leaves from Crown Plaza

SESSION: EXO-PLANETS Characterization
9:30-11:00

16. Jeroen Bouwman, MPIA - Characterization of planetery atmospheres from space.
17. Wolfgang Brandner - Characterisation of cool brown dwarf and planetary atmospheres
18. Masahiro Ikoma - Bulk and atmospheric composition of transiting low-mass exoplanets and their origins.
19. Yan Betremieux - What role does exo-atmospheric refraction play on exoplanet transmission spectra?

11:00-11:30 COFFEE BREAK

11:30-13:00:

20. Hajime Kawahara - Characterization of Exoplanets with High-contrast and High-Dispersion Instruments on Extremely Large Telescopes

21. Yamila Miguel - Hot rocky to gas planets: How host stars and realistic UV flux change the detectable features for Mini-Neptunes and rocky atmospheres
22. Roy van Boekel - The link between planet formation and planet atmosphere spectra
23. Taishi Nakamoto - Bright Galilean Satellites in Jovian Shadow: Light Scattering by Jovian Upper Atmosphere

13:15-14:30 LUNCH MPIA Cafeteria

SESSION: EXO-PLANETS Formation (PART 1)
14:30-16:00:

24. Wurm Gerhard - Collisions of Small Bodies in Protoplanetary Disks: Cold, Hot, and Viscous
25. Jürgen Blum - Per aspera ad planetas – there is hope that we will finally understand planetesimal formation
26. Mario Trieloff - Compositional variety among planets: When and how were compositional gradients established in the early solar system?
27. Satoshi Okuzumi - Electric-field heating of plasmas and its effect on magnetorotational turbulence in protoplanetary disks

16:00-16:30 COFFEE BREAK

16:30-18:00:

28. Taku Takeuchi - Transport of the Magnetic Flux in Protoplanetary Disks and Disk Evolution via MHD Turbulence and/or Winds
29. Hidekazu Tanaka - Fluffy Dust Growth and Planetesimal Formation
30. Hubert Klahr - The Formation of Planetesimals in Starving Mode: Zonal Flows and Vortices in Circumstellar Disks
31. Hiroshi Kobayashi - Importance of collisional fragmentation in planet formation

18:15: Change the venue by bus (from HdA to downtown)
19:00 - 20:00 Dinner and discussion, Heidelberger Kulturbrauerei AG
20:00 - 20:30 Summary of Conference Results
20:30 - 21:30 Strategic Discussions of future German/Japanese Collaborations

Friday, Nov, 7th

9:00 Bus leaves from Crowne Plaza Hotel
SESSION: EXO-PLANETS Formation (PART 2)
9:30-11:00:

32. Eiichiro Kokubo - The Basic Scaling Laws of Terrestrial Planet Formation
33. Willy Kley - Circumbinary Planets: Their properties and formation

34. Mordasini Christoph - Connecting microphysics during formation with exoplanet observations: the impact of grain opacity in atmospheres of protoplanets
35. Rolf Kuiper - Embedded Planet's First Atmospheres

11:00-11:30COFFEE BREAK

11:30-13:00:

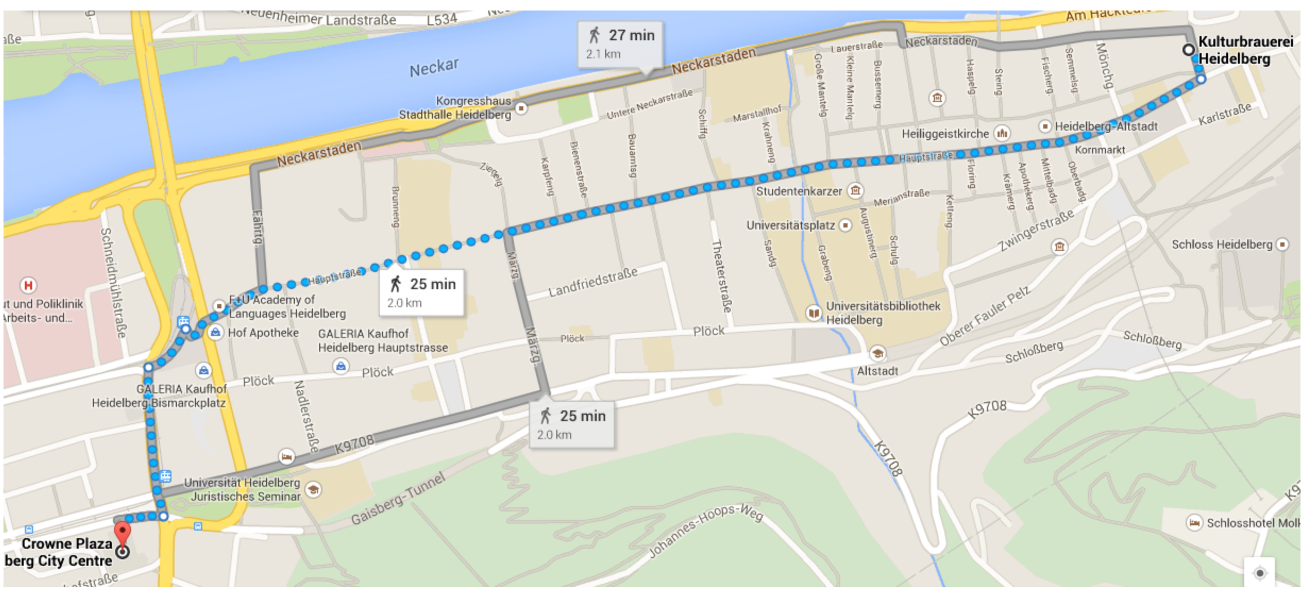
36. Takanori Sasaki - Re-entry of giant-impact fragments and early evolution of the Earth.
37. Hidenori Genda - Collisions in Extrasolar Systems
38. Shigeru Ida - Orbital evolution of distant jupiters: core accretion vs. disk instability
39. Alexander V. Krivov - Debris Disks - First Lessons from Herschel

13:15-14:30 LUNCH MPIA Cafeteria

END OF MEETING

14:30 BUS leaves for Downtown (Crowne Plaza)

Location of Dinner on Thursday: Kulturbrauerei, Leyergasse 6, 69117 Heidelberg



Abstracts German-Japanese meeting:
TALKS

1. **Jürgen Blum**

***Per aspera ad planetas* – there is hope that we will finally understand planetesimal formation**

SESSION: PLANET FORMATION (Planetesimals)

After decades of modeling and experimental work on the growth from microscopically small dust particles to multi-kilometer-sized planetesimals, there are currently three competing scenarios on the market: (1) coagulation of dust to pebble-sized agglomerates, followed by sequences of instabilities which concentrate the dust particles until gravitation instability forms planetesimals, (2) direct collisional growth over the bouncing and fragmentation barriers to planetesimal sizes through the effect of mass transfer in collisions between very large and very small bodies, and (3) direct collisional growth without any barrier to planetesimal sizes, aided by the enhanced stickiness of sub-μm-sized water-ice particles. In my presentation, I will present these three planetesimal-formation models, including the empirical evidence from laboratory experiments they are based upon, and will also discuss the pros and cons of them as well as observational constraints, which can help to solve the mystery of planetesimal formation.

2. **Yan Betremieux**

What role does exo-atmospheric refraction play on exoplanet transmission spectra?

SESSION: EXO-PLANETS (Atmospheres)

As stellar radiation traverses a planetary atmosphere, it is slightly bent by refraction toward the planetary surface. Combined with absorption and scattering from gas and aerosols, the effects of atmospheric refraction have been successfully incorporated in models that analyze observations of stellar occultations by Solar System planetary atmospheres to determine their vertical compositions. However, refraction by exoplanetary atmospheres has been ignored in the interpretation of their transmission spectra. We discuss the factors that determine the degree of light deflection by refraction, and its effects for the geometry of exoplanetary primary transits. We illustrate the impact of refraction on exoplanet transmission spectroscopy with 0.4 – 5.0 µm model spectra of Earth viewed as a transiting exoplanet.

3. **Jeroen Bouwman, MPIA**

Characterization of planetery atmospheres from space.

SESSION: EXO-PLANETS (Atmospheres)

The Hubble and Spitzer Space Telescopes have revolutionized the observational characterization of exo-planets by detecting infrared emission and absorption from hot Jovian atmospheres. These detections have stimulated extensive theoretical work on the atmospheric structure and emission of these planets. Constraining the model predictions for infrared emission from hot Jovian atmospheres is an important motivation for current and future observing programs. Spectral characterization of hot Jovian exo-planets is a high priority and is essential for understanding atmospheric composition and properties. In this presentation I discuss the current observational capabilities with Spitzer and HST and give an outlook into future JWST observations.

4. **Wolfgang Brandner**

Characterisation of cool brown dwarf and planetary atmospheres

SESSION: EXO-PLANETS (Atmospheres)

Today more than 1,500 exoplanets are known. The majority are giant planets detected by radial velocity or transit observations, yielding information on exoplanet masses, orbital periods, and bulk densities (and hence average compositions). The determination of the atmospheric properties like overall metallicity, chemical composition and mixing, vertical temperature profile, and cloud coverage and constituents is considerably more challenging. Directly imaged planets offer the advantage that they are at relatively large distances from their host star, and hence are subject to considerably less radiative forcing than closer-in planets. In addition, unlike the majority of the transiting planets, directly imaged planets are also more readily accessible at all orbital phases. In this talk I will present some of our recent observational results, which enable us to test atmospheric models, and to constrain atmospheric properties of cool brown dwarfs and exoplanets.

5. **Cornelis Dullemond**

Observing dust traps with ALMA

SESSION: DISKS (Observations)

Abstract: Among the most striking observations of protoplanetary disks with the new ALMA array is the lopsided ring structures in a number of transition disks. The most famous examples at present are the IRS 48 disk in which there is a very bright kidney shaped continuum blob on one side of the star, and the HD 142527 disk in which there is a banana shaped half-ring around the star. In both

cases the emission originates from dust grains. I will discuss a theoretical interpretation of these lopsided structures in terms of a huge Rossby vortex in which dust particles are trapped. Dust trapping in vortices was predicted almost 2 decades ago and now appears to be observed in real disks. However, further observational tests, in particular with the new longer baselines of ALMA, will have to be conducted to confirm this.

6. **Hidenori Genda**

Collisions in Extrasolar Systems

SESSION: PLANET FORMATION (Protoplanets)

Collision is a fundamental process of planet formation in extrasolar planetary systems as well as our solar system. Here we focus on many types of collisions between planetesimals, protoplanets, super-Earths, and gas giant planets. We will show our recent results of numerical simulations. For example, in collisions between planetesimals, we re-evaluated the critical impact energy for catastrophic disruption, which affects the growth of protoplanets, and revealed that it was about a half order of magnitude smaller than the previous studies expected. Some types of collisions between super-Earths or gas giant planets would change their compositions, such as water-rock or envelope-core ratios.

7. **Jun Hashimoto**

Near-Infrared Imaging Observations of Transitional Disks by the Subaru/SEEDS project

SESSION: DISKS (Observations)

SEEDS is a strategic project in the Subaru telescope exploring exoplanets and circumstellar disks around 500 stars in the near-infrared wavelengths. The project has started in 2009 and will be completed in this year. Here, we review the project and summarize the major results especially in the survey of protoplanetary disks by near-infrared polarimetric imaging. In observing protoplanetary disks, we mainly focus on transitional disks known as a protoplanetary disk with a cavity in a central region of a disk. Disk-planet interaction would be one of intriguing interpretations potentially responsible for such a cavity-structure. Thus, transitional disks would be unique samples for understanding planet formation in a disk.

As results of tens of observations in transitional disks, we have resolved fine structures in disks such as spirals, gaps, and dips at a radius of tens AU possibly due to gravitational interactions with unseen planet(s). These results may support planet formation at a wide orbit, e.g., GJ 504 b at 43 AU. We also found differences in structures of a cavity observed in the near-infrared and (sub-)millimeter wavelengths, i.e., a clear cavity in (sub-)millimeter wavelengths while no cavity in near-infrared wavelengths. The different behavior between small (sub-micron size) and large (millimeter size) dust grains at the cavity-wall sculpted by planet(s) could result in observing differences. Finally, we mention our scientific activities in ALMA based on SEEDS data.

8. **Artie P. Hatzes**

Detecting Short-period, Earth-mass planets in the Presence of Activity Noise

SESSION: EXO-PLANETS (Detection)

The radial velocity (RV) jitter due to stellar activity can often be the limiting factor in our ability to detect Earth-mass planets with the Doppler method. For highly active stars this intrinsic variability can have amplitudes of a few to tens of m/s. I introduce the Floating Chunk Offset method for detecting short-period low mass exoplanets in the presence of activity noise. In this method RV data with good temporal sampling are divided into chunks with time intervals shorter than the expected periods from activity. An orbital fit is then made at a given period allowing the velocity offsets in the chunks to vary. This method has been employed on transiting planets with known periods. The FCO method can also be used as a periodogram that acts as an effective "low-pass" filter of activity noise thus allowing planets with unknown orbital periods to be detected. The FCO method is applied to RV data for the transiting rocky planets CoRoT-7b and Kepler-78b. The resulting K-amplitude due to Kepler-78b is slightly lower than published values and implies a planet mass of 1.31 ± 0.24 M_Earth. The nominal planet density of 4.5 ± gm cm$^{\wedge-3}$ is consistent with a low iron structure (Moon-like) although the error is large enough to encompass an Earth-like structure. More RV data are needed to distinguish between the models.

9. **Th. Henning**

Water: From Disks to Planets

SESSION: DISKS (Observations)

I will shortly summarize recently obtained observational constraints on the distribution of water vapour in protoplanetary disks. The talk will present the spectroscopic discovery of water ice in disks around Herbig Ae stars at far-infrared wavelength with Herschels. We will use this discovery to constrain the formation pathway of water ice. In addition, I will discuss the origin of water on Earth using chemical models for the solar nebula including turbulent mixing.

10. **Shigeru Ida**

Orbital evolution of distant jupiters: core accretion vs. disk instability

SESSION: PLANET FORMATION (Fragmentation)

We have studied orbital evolution of clumps formed by disk instability in outer disk regions. The detection of wide separation jupiters by direct imaging challenges conventional core accretion model and revived disk instability model has been proposed for formation of these planets. However, hydrodynamical simulations suggest that the clumps formed by disk instability rapidly migrate inward. Because hydrodynamical simulations cannot follow the orbital evolution on long timescales, we followed the evolution by orbital calculation, taking into account dynamical friction and disk turbulence. We will show that final orbital distributions of the clumps to discuss origin of wide separation direct-imaged Jupiters.

11. **Masahiro Ikoma**

Bulk and atmospheric composition of transiting low-mass exoplanets and their origins.

SESSION: EXO-PLANETS (Atmospheres)

Recent transit measurements of exoplanets have revealed that there are a significant number of low-density low-mass planets with short orbital periods. I will talk about our recent theoretical studies of accumulation and secondary loss of the atmosphere of short-period low-mass planets. Also, to gain deeper understanding of the composition of short-period exoplanets, we have recently done modeling of the atmosphere and, furthermore, performed multi-wavelength transit measurements with several Japanese telescopes. So I want to talk about our recent status of the characterization of the atmosphere of several transiting exoplanets.

12. **Shu-ichiro Inutsuka**

The Formation and Early Evolution of Protoplanetary Disks: A Hybrid Scenario of Planet Formation

SESSION: DISKS (Modelling)

The formation and early evolution of protoplanetary disks are described in this talk. Recent advance in the modeling with resistive magneto-hydrodynamical codes with various numerical techniques has enabled our understanding on the formation of protostars with outflows/jets and the formation of protoplanetary disks in a self-consistent manner from molecular cloud cores. This provides improved description for the realistic environments for planet formation in the gaseous disks. We find that gaseous planetary-mass objects can be formed by gravitational instability in the regions that are de-coupled from the magnetic field and surrounded by the injection points of the magneto-hydrodynamical outflows during the formation phase of protoplanetary disks. Magnetic de-coupling enables massive disks to form and these disks are subject to gravitational instability, even at ~10 AU. The frequent formation of planetary mass objects in those disks suggests the possibility of constructing a hybrid scenario of planet formation, i.e., the rocky planets form later under the influence of the giant planets in the protoplanetary disk. Our recent N-Body simulations of the new scenario shows a new mechanism by which resultant rocky planets possibly gravitationally push the giant planet towards the central stars. This "crowding-out" mechanism may explain the observed lDiack of companion planets in HJ systems.

13. **Viki Joergens**

The formation of free-floating planets

SESSION: DISKS (OF EXO-PLANETS)

We show that the coolest known object that is formed in a star-like mode is a free-floating planet. We discovered recently that the free-floating planetary mass object OTS44 (M9.5, ~12 Jupiter masses, age ~2 Myr) has significant accretion and a substantial disk. This demonstrates that the processes that characterize the canonical star-like mode of formation apply to isolated objects down to a few Jupiter masses. We detected in VLT/SINFONI spectra that OTS44 has strong, broad, and variable Paschen beta emission. This is the first evidence for active accretion of a free-floating planet. The object allows us to study accretion and disk physics at the extreme and can be seen as free-floating analog of accreting planets that orbit stars. Our analysis of OTS44 shows that the mass-accretion rate decreases continuously from stars of several solar masses down to free-floating planets. We determined, furthermore, the disk mass (30 Earth masses) and further disk properties of OTS44 through SED modeling based on far-IR Herschel data. We find that objects between 14 solar masses and 0.01 solar masses have the same ratio of the disk-to-central-mass of about 0.01. Our results indicate that OTS44 is formed like a star and suggest that the increasing number of young free-floating planets and ultra-cool field T and Y dwarfs are the low-mass extension of the stellar population.

14. **Hajime Kawahara**

Characterization of Exoplanets with High-contrast and High-Dispersion Instruments on Extremely Large Telescopes

SESSION: EXO-PLANETS (Detection)

High-contrast instruments with future planned 30-40 m class telescopes such as TMT, GMT, and E-ELTs will expand our knowledge of exoplanets. I will talk about our recent study of characterization techniques of exoplanets assuming these instruments. One is the feasibility study of the oxygen 1.27 micron feature of planets in the HZ around the lath-type stars. We investigate the noise from terrestrial atmosphere for the 1.27 micron, especially night airglow of terrestrial oxygen. We found that its emissivity significantly decreases an order of magnitude by midnight. The future detectors for which the detection contrast is limited by photon noise can detect this feature (Kawahara+2012 ApJ 758, 13). We also consider an application of the high-contrast instruments to the spectroscopic detection of close-in planets (e.g. Brogi+2012 Nature 486, 502, Rodler+2012 ApJL 753,25) with the high-dispersion instruments. So far, CO and water have been detected for nearby hot Jupiters. The high-contrast instruments will extend the target to warm Juptiers and Neptune-size planets with the 1 mas rms tip-tilt correction (Kawahara+ ApJS submitted arXiv:1404.5712). The tip-tilt error is crucial for this type of observations. If we can correct the tip-tilt error within 0.3 mas (rms), we have ~30 times larger gain in the S/N. It will enable us to perform precise measurements of the planetary radial velocity, which can be used for detections of the planetary wind and rotation for the close-in planets(e.g. Kawahara ApJL 760, 13).

15.Hubert Klahr

The Formation of Planetesimals in Starving Mode: Zonal Flows and Vortices in Circumstellar Disks

SESSION: PLANET FORMATION (Planetesimals) / DISKS (Modelling)

The formation of kilometer-sized planetary building bricks, called planetesimals, is still a hotly debated problem. However a quantitative model on when and where what sizes of planetesimals do form is the key to any self consistent formation model for gas giants as well a terrestrial planets.

A pure hit and stick model of dust grains faces several adversaries: from drift barrier, to bouncing and fragmentation barrier to finally the 10km barrier. Thus, models have been invoked that lead swiftly to 100km sized planetesimals from centimeter sized objects via turbulent concentration and gravitational collapse. In this talk I will highlight the role of zonal flows in magneto-hydrodynamical (MHD) active regions of the disk and vortices in the MHD-dead zones. In the latter radial and vertical stratification are the key of understanding the hydro-dynamical stability of these disks. The fact that these features are able to scratch the tiniest amount of small dust together in an amount sufficient, to trigger a streaming and gravitational instability enables us to work on a size distribution for initial planetesimals that resembles observational findings in the asteroid and Kuiper belt.

16. **Willy Kley**

Circumbinary Planets: Their properties and formation

SESSION: PLANET FORMATION / DISKS (Modelling)

Circumbinary planets form a special subclass of exoplanets where the planets orbit around a central binary star. Due to the presence of a secondary, the circumbinary discs are dynamically excited and the planet formation process is made more difficult than around single stars. Additionally, their subsequent evolution is influenced by the disc dynamics. In the talk I will summarize the observational properties of circumbinary planets and will present recent results in modelling such systems.

17. **Hiroshi Kobayashi**

Importance of collisional fragmentation in planet formation

SESSION: PLANET FORMATION / DISKS (Modelling)

Runaway and oligarchic growth produces a large planetary embryo in each annulus of a protoplanetary disk. Planetesimals stirred by large embryos have great random motions, resulting in collisional fragmentation between planetesimals. Further collisions between fragments grind them down until fragments of ~10m are removed by radial drift due to gas drag. As a result, the embryo growth is significantly stalled by collisional fragmentation. On the other hand, the collisional fragmentation might explain the size distribution of minor bodies in the Solar System and debris disks. I will discuss the formation condition for planets, asteroid belt, and debris disks, taking into account collisional fragmentation.

18. **Eiichiro Kokubo**

The Basic Scaling Laws of Terrestrial Planet Formation

SESSION: PLANET FORMATION (Embryos)

The recent exoplanet surveys show that small close-in planets are more common than hot Jupiters in the Galaxy. Most of them are considered as terrestrial (rocky) planets. Thus it becomes increasingly important to generally understand the formation of terrestrial planets.
In the standard scenario of terrestrial planet formation the final stage is the giant impact stage after the dispersal of a gas disk where protoplanets or planetary embryos formed by oligarchic growth collide with one another to complete planets. We have been investigating this stage by using N-body simulations. In the present paper, we review the basic scaling laws of terrestrial planet formation and discuss the formation of close-in super-Earth systems.

19. **Rolf Kuiper**

Embedded Planet's First Atmospheres

SESSION: PLANET FORMATION

In the core accretion paradigm of planet formation, gas giants only form a massive atmosphere after their progenitors exceeded a threshold mass: the critical core mass. Most (exo)planets, being smaller and rock/ice-dominated, never crossed this line. Nevertheless, they were massive enough to attract substantial amounts of gas from the disc, while their atmospheres remained in pressure-equilibrium with the disc. Our goal is to characterize the hydrodynamical properties of the atmospheres of such embedded planets and their implication for their (long-term) evolution.
We investigate the properties of an isothermal and inviscid flow past a small, embedded planet by conducting local, 2D and 3D hydrodynamical simulations.
Paper I: In 2D, the flow is steady and bound. Relating the amount of rotation to the gas fraction of the atmosphere, we find that more massive atmospheres rotate faster -- a finding consistent with Kelvin's circulation theorem. Rotation therefore limits the amount of gas that planets can acquire from the nebula. Dependent on the Toomre-Q parameter of the circumstellar disc, the planet's atmosphere will reach Keplerian rotation before self-gravity starts to become important.
Paper II: In 3D, Compression of gas is shown to reduce rotational motions. Contrasting the 2D case, no clear boundary demarcates bound atmospheric gas from disc material; instead, we find an open system where gas enters the Bondi sphere at high latitudes and leaves through the midplane regions, or, vice versa, when the disc gas rotates sub-Keplerian. The atmosphere is characterized by a time-varying velocity field and the timescale to replenish the atmosphere by nebular gas can be understood in terms of a modified Bondi accretion rate.

20. **Alexander V. Krivov**

Debris Disks - First Lessons from Herschel

SESSION: DISKS (Observations)

Debris disks, belts of invisible planetesimals and their observable dust, are thought to be remnants of the planet formation process. These disks have been observed at far-infrared wavelengths in several large-scale and smaller programs of the Herschel Space Observatory. Herschel observations have revealed the presence of debris disks around at least 20% of stars across and post the main sequence, and increased the number of spatially resolved disks from about two dozens to approximately one hundred. Resolved images along with densely sampled SEDs allow one to more tightly constrain the properties of the disks. First statistical analyses of Herschel-resolved disks suggest a two-component structure (a Kuiper-like belt plus an asteroid-like belt) to be more common than a single-component architecture. The disk radii do not appear to correlate with the stellar luminosity, which might pose additional constraints on the planetesimal formation mechanisms. In-depth collisional modeling of a few selected bright, well-resolved disks uncovers some previously unexpected trends, too. The disks of A-type stars (e.g., Vega, beta Pic, HR 8799) are compatible with an active collisional cascade in a narrow, massive, Kuiper-like planetesimal belt with a pronounced inner gap and a broad dust halo extending outward. In contrast, the disks of solar-type stars (q1 Eri, HD 207129, HIP 17439) show sharper outer edges and an additional emission closer to the star. This emission can be equally well explained by inward drag of dust inward from a single narrow planetesimal belt, dust production across an extended planetesimal disk, and an additional inner disk. In all cases, the models suggest low dynamical excitation of the main belt, i.e. disks that are collisionally quiescent rather than active. It remains unclear, however, which mechanism is actually at work in these systems. Nor is it clear what causes the difference between the disks of earlier- and later-type stars, and to what extent possible planets in the disks are responsible for the observed disk properties.

21. Luigi Mancini

Photometric follow-ups of transiting exoplanets with ground-based medium-class telescopes

SESSION: EXO-PLANETS (Detections)

It is now well ascertained that those extrasolar planets that transit in front to their parent stars deserve extensive follow-up observations because they are the only ones for which we can directly measure all their physical parameters. These information currently provide the best route to constructing the mass-radius diagram of exoplanets, which channels the theoretical formation/evolution models in the right path. However, many of the discovered transiting planets do not have high-quality light curves, so their physical properties are poorly known. In this perspective, we are leading a large program to obtain ultra-high-precision photometry of transit events, which are analyzed to accurately measure the physical properties of know planetary systems. Besides measuring and refining the physical properties of the planets and their parent stars, we also try to obtain additional information from the light curves, by identifying particular features of the systems (e.g. stellar activity) and investigating the composition of the planetary atmospheres by transmission photometry. In my contribution, I will present several observational strategies that we adopt to achieve these goals.

22. **Yamila Miguel**

Hot rocky to gas planets: How host stars and realistic UV flux change the detectable features for Mini-Neptunes and rocky atmospheres

SESSION: EXO-PLANETS (Atmospheres)

Recent ground and space surveys resulted in the detection of many hot extrasolar planets. These planets are interesting targets for current and future observations, therefore, addressing their atmospheric structure and composition is a major issue and the aim of my work. For the hot potentially rocky exoplanets with an outgassed atmosphere we developed a simple approach to find their atmospheric composition according to their observable data (radius, semi-major axis and stellar effective temperature). For hot mini-Neptune and giant planets's atmospheres, we calculated an atmospheric grid that links astrophysical observable parameters - orbital distance and stellar type - with the atmospheric species expected in exoplanet atmospheres. We link a 1D code that calculates the atmospheric thermal structure with a photochemical model that includes disequilibrium chemistry and explore the effect of empirical model parameters on the results, for planets around a wide range of stellar types from F to M, including the effect of high FUV radiation on their atmospheres. Our results can be applied to current and future observations to characterize exoplanet atmospheres and serves as a reference to interpret atmospheric retrieval analysis results.

23. **Mordasini Christoph**

Connecting microphysics during formation with exoplanet observations: the impact of grain opacity in atmospheres of protoplanets

SESSION: PLANET FORMATION (Embryos)

The number of extrasolar planet with an accurately measured mass and radius has recently increased very rapidly. This has allowed to constrain for the first time observationally the hydrogen/helium fraction as a function of a planet's mass. This relation is of high interest for planet formation theory: it allows to constrain the mechanisms that govern gas accretion during formation. A key quantity controlling gas accretion is the opacity due to tiny dust grains suspended in the atmosphere of protoplanets. If it is high, only tiny primordial H/He envelopes can be accreted. In the opposite case, already low-mass cores can accrete much H/He. In this talk I will present a newly developed analytical model for the grain opacity. It predicts very low grain opacities. I will then shown the population wide consequences of different magnitudes of the grain opacity. Low grain opacities lead to gas-rich low-mass low-density planets, not unlike the ones detected in large numbers by the Kepler satellite. I will show that the observed mass-radius relationship indeed also points to low grain opacities in protoplanetary atmospheres. The consequences for giant plant formation are discussed as well as for the transition from solid to gas-rich low-mass planets.

24. **Taishi Nakamoto**

Bright Galilean Satellites in Jovian Shadow: Light Scattering by Jovian Upper Atmosphere

SESSION: EXO-PLANETS (Atmospheres)

It was found that Europa, Ganymede, and Callisto are bright around 1.5 micron even when they are in the Jovian shadow (Tsumura et al. 2014). Their eclipsed luminosity was about 10^-7 to 10^-6 times of their uneclipsed brightness. Here we demonstrate that those satellites are illuminated by the light that is scattered by the Jovian upper atmosphere. This scattering is caused by “haze” particulates in the tenuous atmosphere, not by gaseous molecules.

25. **Hideko Nomura**

Complex Organic Molecules in Protoplanetary Disks

SESSION: DISKS (Observations)

We investigate the synthesis of complex organic molecules (COMs) in protoplanetary disks using a large gas-grain chemical network including COMs together with a 2D steady-state physical model of a disk irradiated by UV and X-rays from the central star. We find COMs are efficiently formed on cold and warm grains in the disk midplane via grain-surface reactions through efficient migration of icy species on grain surface. Radiation processing on ice forms reactive radicals and helps build further complexity. Part of the icy molecules are photodesorbed into gas and their transition lines become observable. We also perform ray-tracing calculations to predict line spectra of complex organic molecules and suggest CH3OH should be readily observable in nearby protoplanetary disks with ALMA. We also find the grain-surface abundances predicted by our calculations are consistent with those derived from cometary comae observations providing an evidence for the hypothesis that comets and other planetesimals formed via the coagulation of icy grains in the Sun's natal disk.

26. **Satoshi Okuzumi**

Electric-field heating of plasmas and its effect on magnetorotational turbulence in protoplanetary disks

SESSION: PLANET FORMATION / DISK (Modelling)

The electric conductivity of the gas is a key parameter of magnetohydrodynamics (MHD) in low-temperature astronomical objects like protoplanetary disks. It is commonly assumed that the conductivity is independent of the strength of the electric field (as measured in the neutral-gas rest frame), and this assumption leads to the conventional linear Ohm's law. However, the linear Ohm's law breaks down when the electric field is so strong that heating of plasma particles is non-negligible. In fact, an order-of-magnitude estimate based on the results of recent MHD simulations suggests that the plasma heating is indeed significant in MRI-driven turbulence in some outer parts of protoplanetary disks. We construct a charge reaction model that takes into account plasma heating by electric fields as well as plasma capture by dust grains. We find that plasma heating leads to a reduction of the ionization degree, and hence to an enhancement of the magnetic resistivity, unless the electric-field strength is below the discharge threashold. This occurs because the electron--grain collision frequency increasing with increasing the random velocity of electrons. This effect may limit the saturatation amplitude of MRI-driven turbulence near the outer edge of the conventional dead zone.

27. Andreas Quirrenbach, CARMENES Consortium
CARMENES: Searching for Blue Planets Orbiting Red Dwarfs

SESSION: EXO-PLANETS (Detection)

CARMENES (Calar Alto high-Resolution search for M dwarfs with Exo-earths with Near-infrared and opti-cal Echelle Spectrographs) is a next-generation instrument currently under construction for the 3.5m tele-scope at the Calar Alto Observatory by a consortium of eleven Spanish and German institutions (see also Quirrenbach et al. 2010; 2012). CARMENES will conduct a 600-night exoplanet survey targeting ~300 M dwarfs. An important and unique feature of the CARMENES instrument is that it consists of two separate échelle spectrographs, which together cover the wavelength range from 0.55 to 1.7 µm at a spectral resolu-tion of R = 82,000. The spectrographs are fed by fibers from the Cassegrain focus of the telescope. For late-M spectral types, the wavelength range around 1.0 µm (Y band) is the most important wavelength region for radial velocity work. Therefore, the efficiency of CARMENES will be optimized in this range.
The main scientific objective of the CARMENES project is to carry out a survey of late-type main sequence stars with the goal of detecting low-mass planets in their habitable zones (HZs). In the focus of the project are very cool stars later than spectral type M4 and moderately active stars. In particular, we aim at being able to detect a 2M⊕ planet in the HZ of an M5 star. A long-term radial velocity precision of 1ms−1 per measure-ment will permit to attain such goals. For stars later than M4 (M < 0.25M☉), such precision will yield detec-tions of super-Earths of 5M⊕ and smaller inside the entire width of the HZ. The CARMENES survey will thus provide a comprehensive overview of planetary systems around nearby Northern M dwarfs. By reaching into the realm of Earth-like planets, it will provide a treasure trove for follow-up studies probing their habitability.

28. **Sabine Reffert**

Giant Planet Occurrence Rate as a Function of Stellar Mass and Metallicity

SESSION: EXO-PLANETS (Detection)

Based on our precise Doppler survey of a sample of G and K giant stars, which we have carried out at Lick Observatory over more than 12 years, we examine the planet occurrence rate as a function of stellar mass and metallicity. In particular, we probe the stellar mass range from about 1 to 3 solar masses, which is neither being fully explored by main-sequence nor subgiant stellar samples. We find the well-known planet-metallicity correlation, as well as a strong dependence of planet occurrence on stellar mass. Interestingly, there is a peak in the giant planet occurrence rate for masses between about 1.5 and 2.0 solar masses. For masses in the range from 2.5 to 3.0 solar masses, the giant planet occurrence rate drops rapidly to zero, at least for those giant planets to which our survey is sensitive. We conclude that giant planet formation is suppressed around higher mass stars, possibly due to faster disk depletion in combination with a longer migration timescale.

29. **Semenov Dimitry**

Importance of dynamical processes for chemical evolution of protoplanetary disks

SESSION: DISKS (modelling)

Protoplanetary disks are birth sites of planetary systems. A better characterization of their physical and chemical structure, which are needed to understand initial phases of planet formation, is currently one the major goals of modern astrophysics. Their studies are complicated by their compact sizes and low masses, and their dynamical activity. In this presentation we investigate the importance of dynamics on the chemical structure of disk's gas and dust. We find that dynamics enhances abundances of many gas-phase species and ices, particularly, complex hydrocarbons involved in slow X-ray-driven CO destruction. Particularly affected by dynamics are the inner, planet-forming disk regions, with strong gradients of temperature and high-energy radiation intensities. We show how evolving chemistry affects the global C/O gas and solid composition and why it may matter for planet formation processes.

30. **Takanori Sasaki**

Re-entry of giant-impact fragments and early evolution of the Earth.

SESSION: PLANET FORMATION (embryos)

The late stages of Earth's formation remain a mystery. No building blocks remain in Earth's orbit and no geological evidence is available for the first 700 million years Earth's history. Clues have been found, but some of them seem paradoxical. Herein we propose that protoplanetary fragments produced by the giant impacts may reconcile those apparently conflicting facts. Our new scenario present an exhaustive framework of early evolution of terrestrial planets, and impact our understanding of whether planets like Earth are common in extrasolar systems as well. I'm looking forward to discussing with German researchers at the meeting!

31. **Takayuki Muto**

Protoplanetary Disk Morphology and High-Resolution Imaging Observations

SESSION: DISKS (Observations)

Understanding protoplanetary disks is important in understanding planet formation processes. Recent observations by Subaru and ALMA have revealed that protoplanetary disks are rich in detailed structures, and the gas and dust are distributed differently. We present results of recent observations by ALMA and Subaru and modeling efforts of protoplanetary disks. We especially focus on non-axisymmetric structures such as spirals or horse-shoe-like dust condensations, and discuss what we can derive from such structures. We also mention about prospects of future high-resolution imaging observations by 30-meter class telescopes or full ALMA capability.

32. **Taku Takeuchi**

Transport of the Magnetic Flux in Protoplanetary Disks and Disk Evolution via MHD Turbulence and/or Winds

SESSION: PLANET FORMATION / DISKS (Modelling)

I present our recent works on the transport of the magnetic flux which is originally from the interstellar magnetic field and threads the disk. Then, I discuss disk evolution that is controlled by the magnetic flux via MHD turbulence and/or winds. Recent several MHD simulations have suggested that the mass accretion rate driven by the MRI or disk winds is controlled by the magnetic flux threading the disk. This means that quantifying the magnetic flux is essential for studies on the disk accretion. We analyzed a simple model of the mean poloidal field in a thin disk. We show that there is an upper limit on the magnetic flux threading the disk, and consequently there is also an upper limit on the mass accretion rate. I also discuss the evolution of protoplanetary disks whose accretion rates are determined by the magnetic flux. An interest finding is that, contrary to previous expectations, dead zones do not always suppress the mass accretion rate. Even in an inner part where a dead zone exists, if the magnetic flux is high enough, the mass accretion rate can be as high as or even higher than that at the outer active region. Such stronger accretion at the inner part is expected especially at late stages of disk evolution. This mechanism possibly explains an inner hole of some transitional disks.

33. **Hidekazu Tanaka**

Fluffy Dust Growth and Planetesimal Formation

SESSION: PLANET FORMATION (Planetesimals)

Planetesimal formation is one of the major problems in planet formation theory. Rapid direct growth of fluffy icy dust is a hopeful model for planetesimal formation. In this model, the key point is the mechanical property of dust aggregates (i.e., their stickiness and compressibility). I will talk about recent progress on dust aggregate simulations in our group and discuss planet formation, too.

34. **Motohide Tamura**

Subaru Direct Imaging Observations of Exoplanets and Brown Dwarfs

SESSION: EXO-PLANETS (Detection)

SEEDS (Strategic Explorations of Exoplanets and Disks with Subaru) is the first Subaru Strategic Program, whose aim is to conduct a direct imaging survey for giant planets as well as protoplanetary/debris disks at a few to a few tens of AU region around 500 nearby solar-type or more massive young stars devoting 120 Subaru nights for 5 years. The targets are composed of five categories spanning the ages of ~1 Myr to ~1 Gyr. Some radial velocity planet targets with older ages are also observed. The survey employs the new high-contrast instrument HiCIAO, a successor of the previous NIR coronagraph camera CIAO for the Subaru Telescope. We describe the outline of this survey and present its results on exoplanets and brown dwarfs. The survey has published ~30 refereed papers by now. The main results on exoplanets are as follows: (1) Detection and characterization of the most unequivocal and possible lowest-mass planet around the Sun-like star, GJ 504b, via direct imaging. It is so
far the only exoplanet whose atmospheric methane features make their color “blue” among the other directly imaged “red”-color exoplanets. (2) Detection of a super-Jupiter around the most massive star ever imaged, kappa And b. (3) Detection of planet or brown dwarf around Sun-like star, GJ 758b, and several brown dwarfs in Pleiades. (4) Detection of companions around retrograde exoplanet, HAT-P-7B, which supports the Kozai mechanism for the origin of retrograde orbit. Preliminary statistics in each category are also mentioned.

35. **Mario Trieloff**

Compositional variety among planets: When and how were compositional gradients established in the early solar system?

SESSION: PLANET FORMATION (Planetesimals)

Our solar system is clearly divided in rocky planetary bodies in the inner solar system, and gas and ice giants planets in the outer solar system.
While this roughly corresponds to expectations from condensation temperatures prevailing in the solar nebula, governed by the protosun and protoplanetary disc dynamics, many details concerning the compositional diversity of solar system objects are unknown, even after decades of research in cosmochemistry.

One important question is how homogeneous the initial disk material was, particularly the dust component inherited from the interstellar medium (ISM). While certain interstellar grains definitely represent isotopically anomalous circumstellar dust, it is not clear, what their mass fraction in the ISM is, and what fraction was homogenised in the ISM by evaporation and recondensation processes.

However, even if highly heterogeneous grain populations dominated the solar nebula, large scale mixing of submicron sized interstellar grains should have cancelled out large scale chemical heterogeneities. Indeed we know that certain primitive extraterrestrial matter represented by CI chondrites represent a first order average composition of solar or cosmic element abundances.
On the other hand, there are chondrite classes that are characterised by
1) moderately volatile element depletions
2) intra-silicate (olivine/pyroxene) fractionation
3) metal-silicate fractionation
which is generally interpreted as being a result of (mainly thermal) processing in the solar nebula, along with gas-solid phase separation before planet formation started.

While such fractionation processes within a protoplanetary disc are feasible, there are mixing processes simultaneously at work, which should counteract differentiation.
For example, mixing processes are evident from the presence of high temperature material such as CAIs or refractory forsterites in cometary material, implying radial transport form hot inner to the cold outer disk regions.

The composition of volatile-rich exoplanets is frequently explained by planetary migration processes, implying that their material could not have accreted in their present day's orbital position.
Such conclusions can only be properly established, if the chemical (and isotopic) compositon of protoplanetary material in the respective feeding zones can be modelled by means of (chemical) disc fractionation and counteracting radial

mixing processes at the preplanetary stage.

36. **Roy van Boekel**

The link between planet formation and planet atmosphere spectra

SESSION: EXO-PLANETS (Atmospheres)

The composition of a planet and its atmosphere are governed by its formation history in the circumstellar disk and its further evolution. During the early formation phase a rocky core is formed, which may subsequently accrete a gaseous envelope once the core mass succeeds a critical value, forming a giant planet. While Hydrogen and Helium dominate the mass of the envelope and atmosphere of giant planets, their spectral appearance is dominated by the abundance of heavy elements needed to build spectroscopically active molecules (e.g. water, methane). The molecular composition of mature exoplanet atmospheres depends on the relative abundances of heavy elements in the envelope, which follow from the accretion history during the formation phase. In this talk we will present model calculations of the formation of giant planets, following which kind of material is accreted depending on the formation location in the disk. We will focus on the circumstances under which an oxygen-rich or a carbon-rich chemistry results. We also show the resulting atmospheric spectra of mature planets, and simulated observations of transiting systems with which the discussed cases can be distinguished.”

37. **Joachim Wambsganss**

Searching for Extrasolar Planets with Gravitational Microlensing: Challenges and Exciting Results

SESSION: EXOPLANETS (Detection)

Gravitational microlensing is a powerful method for the detection of extrasolar planets. In particular its sensitivity to low mass planets and its potential for global statistical analyses are highly relevant. The basics of this technique and its current mode of operation will be explained as well as its advantages and disadvantages compared to other planet-search methods. About three dozen microlensing planets have been discovered so far. A couple of microlensing detections will be presented and reviewed in detail. A recent statistical analysis on the Galactic abundance of extrasolar planets will be presented and discussed, with particular emphasis on the result that “Planets are the rule, not the exception!”. In a brief outlook, the immense potential of gravitational microlensing for detections of Earth- and Mars-mass planets, of exomoons and of free-floating planets will be highlighted.

38. Sebastian Wolf

High-angular resolution observations and modeling of circumstellar disks

SESSION: DISKS (Observation)

Observations of circumstellar disks around young stars are the key to better understand and to refine existing hypotheses for the various phases of the planet formation process. I will present modeling approaches based on observations in various wavelength ranges at low to high spatial resolution. Exemplary case studies will be discussed which illustrate state-of-the-art observations and subsequent radiative transfer modeling of protoplanetary and debris disks.

39. Wurm Gerhard

Collisions of Small Bodies in Protoplanetary Disks: Cold, Hot, and Viscous

SESSION: PLANET FORMATION (Planesimals)

The physics of silicate collisions at moderate temperatures has been treated extensively in the past decades showing the potential and limits in planetesimal formation. The microphysics of more extreme environments with high and low temperature has mostly been restricted to numerical modeling and only recently emerges in experiments. We currently exploit some aspects here. We measure ice contact forces for nm to μm grains, study the evolution of contact forces and collisions with increasing temperatures toward 1000 K, and study collisions of viscous particles as chondrule analogs. I will sketch our latest evolution on these topics

POSTERS

1. **Simona Ciceri - MPIA**

Kepler-91 n & KOI-1299 b: Two massive planets in orbiting close-in two red giant stars

We confirmed the planetary nature of two Kepler candidates: Kepler-91 b and KOI-1299 b. We accurately constrained their properties by combining the photometric data obtained by the Kepler satellite and the spectroscopic measurements obtained with the CAFE spectrograph at the CAHA 2.2-m telescope.
We found that Kepler-91 b is a hot Jupiter transiting a red giant star in 6.25 d. It has a mass of Mp = 1.09 ± 0.20 MJup and radius of Rp = 1.184 ± 0.054 Rjup.
KOI-1299 b is a dense transiting exoplanet, having a mass of Mp = 4.87 ± 0.48 MJup and radius of Rp = 1.120 ± 0.036 Rjup. It revolves around a K giant star every 52.5 d, moving on a highly eccentric orbit (e = 0.535 ± 0.030).

Together with Kepler-56, Kepler-91 and KOI-1299 occupy an almost-desert region of parameter space, which is important to constrain the evolutionary processes of planetary systems. Both of them, are indeed found to circle their parent star with an orbit closer than 0.5 AU, unlike the other giant star's planets.

2. Hans Baehr - MPIA
Investigating the Numerical Convergence of Self-Gravitating Disks

Self-gravitating disks are subject to gravitational instability given that the disk is massive enough and that it can lose energy fast enough. The first condition is met with the Toomre parameter Q, which leads to fragmentation when Q is roughly less than 1. Using a simple cooling law, recent attempts to determine a critical cooling time have found the problem that this value changes with resolution, which means the simulations are not consistent. The goal is to modify this cooling law in an attempt to attain convergence of the critical cooling time.

3. Yui Kawashima - University of Tokyo
Transmission spectrum models of exoplanet atmospheres with haze

Recently, transmission spectra of several transiting exoplanets have been obtained. Transmission spectrum provides information of absorption and scattering by molecules and small particles such as haze and clouds in the planetary atmosphere. Thus, comparison between the observational and theoretical transmission spectra can constrain the composition of the planetary atmosphere. In this study, we have modeled theoretical transmission spectra of exoplanets orbiting close to their host stars. In calculating theoretical spectrum models, we have taken into account the vertical distribution of molecular abundances in chemical and radiative equilibrium, in addition to absorption and scattering of the incident radiation from the host star by molecules and haze particles in the planetary atmosphere. Then, applying the calculated spectrum models to a few exoplanets (e.g., WASP-80b), we discuss the property of the atmospheres of the planets.

4. Takanori Kodama - University of Tokyo
Evolution of Terrestrial Water Planets with Water Loss

Planets with liquid water on their surface are classified in two modes: the aqua planet mode and the land planet mode. An aqua planet is a planet covered with ocean globally. On a land planet, the distribution of ground water is controlled by the atmospheric circulation, thus, water accumulates in the cool region of the planet. Because of the difference in the water distribution, a land planet maintains liquid water at much larger isolation than an aqua planet.
The increase of stellar luminosity causes warming of the planets and enhancement of water vapor in their atmosphere and drives the loss of water into

the space. For the evolution path of an aqua planet, both of them are thought to terminate the habitable world. However, if an aqua planet evolves to a land planet by a rapid water loss before the onset of the runaway greenhouse, it can maintain liquid water on its surface for another 2Gyr or so.

We focus on a change of the amount of water by the water loss and the stellar evolution and discuss the planetary evolution path. From our results, an aqua planet with 0.1 present Earth's ocean on its surface can evolve to a land planet. Our results mean that the amount of water, which planets have initially, is important for their evolution paths and for their habitability.

5. Kenji Kurosaki - University of Tokyo
Impact of the compositional gradient on the theoretical estimate of the hydrogen-helium mass fraction of hot-Neptunes

Observational techniques have enabled us to discover exoplanets that have a few Earth masses and radii. From the mass-radius relationship for the low-mass planet like a hot-Neptune, we can infer the bulk composition for the planet. Especially, an estimate for the hydrogen-helium mass fraction is a critical problem to discuss the origin and evolution of planets. Previous studies for estimating bulk compositions of planets are assumed to be homogeneous envelopes whose temperature gradients are described by adiabatic ones. However, if there is a compositional gradient in their envelopes due to the pollution, the efficiency of the heat transport decrease and their temperature gradients become super-adiabatic ones. There are no studies to taking into account the effects of the compositional gradient focusing on the estimate of the hydrogen helium mass fraction. We evaluate the effect for the hydrogen-helium mass fraction taking into account the compositional gradient in the case of hot-Neptune planets. Given a mass-radius relation, that effect causes smaller hydrogen-helium mass fraction than the case of no compositional gradient in their envelope. The compositional gradient will have significant impact on the theoretical estimate for the hydrogen-helium mass fraction of the hot-Neptunes.

6. Aiara Lobo Gomes - MPIA
Vortex formation and evolution in discs under thermal relaxation and with a high mass planet embedded

Vortices are structures that can be formed in several fluid systems. In the particular case of a protoplanetary disc they are known to play a role for planet formation, angular momentum transport, and type I migration. In this project we study the formation and evolution of vortices induced by a high mass planet embedded in a disc under thermal relaxation. For this purpose we perform 2D-HD simulations of planet-disc interaction using the PLUTO code. We study the lifetime of vortices as a function of the cooling timescale, as well as the migration behavior of both vortices and the high mass planet.

Additionally we model the Oph IRS 48 system, a place where a vortex is claimed to be detected by ALMA data.

7. Mykola Malygin - MPIA
Thermal relaxation in pronto planetary disks

We perform linear analysis of resolved temperature perturbations in protoplanetary disks. We map the thermal relaxation time over the disk volume for different linear sizes of the perturbation and for different disk masses for a given disk structure. This has an essential impact on the development of hydrodynamic instabilities as well as on the disk fragmentation.

8. Gabriel Marleau - MPIA
Constraining the initial entropy of directly-detected exoplanets

The post-mass-assembly, initial entropy S_i of a gas giant planet is a key witness to its formation history and a crucial quantity for its early evolution. However, formation models are not yet able to predict reliably S_i, making unjustified the use of traditional cooling tracks ("hot starts") to interpret direct-imaging results and calling for an observational determination of initial entropies to guide formation scenarios.
Using a grid of models in mass and entropy, we show how to place joint constraints on the mass and initial entropy of an object from its observed luminosity and age. Moreover, we demonstrate that with mass information, e.g. from dynamical-stability analyses or radial velocity, tighter bounds can be set on the initial entropy. We apply this procedure to beta Pic b and find that it must have formed with S_i > 10.5 kB/baryon, using the radial-velocity information. This initial entropy is ca. 2 kB/baryon higher than predicted in Marley et al. 2007, thereby quantitatively ruling out the coldest starts for this object and putting joint constraints on the mass of the core and the efficiency of the accretion shock (Marleau & Cumming 2014, MNRAS 437, 1378; Bonnefoy, Marleau et al. 2014, A&A 567, L9).

9. Paul Mollière - MPIA
A new code for atmospheric structures and spectral calculations

Understanding planetary atmospheres and analyzing planetary spectra and abundances is currently one of the most exciting fields of exoplanetary research.
We will introduce our new plane parallel code for finding self-consistent atmospheric structures of irradiated planets. The current capabilities of the code, as well as some preliminary results, will be shown. Furthermore an outline of planned future applications will be given which will, e.g., connect the planet’s formation and evolution to its observable spectrum.

10. Shoshi Mori - Tokyo Institute of Technology
Plasma Heating by MRI-induced Electric Fields and Its Effect on Dust Growth in Protoplanetary Disks

Magnetorotational instability (MRI) is a powerful mechanism of driving turbulence in regions of protoplanetary disks with a high ionization fraction. However, the ionization fraction is not necessarily constant in MRI-driven turbulence, because turbulence-induced electric fields heat up free electrons and thereby affect the ionization balance. In particular, in the presence of small dust grains, the ionization fraction decreases with increasing electric field strength (Okuzumi & Inutsuka, 2014), suggesting that MRI turbulence may not fully develop even outside the dead zone. We estimate how much this affects the saturation level of turbulence in protoplanetary disks. For a minimum-mass solar nebula with 1% of its mass consisting of 0.1um-sized dust grains, we find that the strength of MRI turbulence is significantly suppressed inside 70 AU from the central star. We also find that the grains in the region are so negatively charged that the resulting Coulomb repulsion likely inhibits their collisional growth.

11. Takao Sato - Tokyo Institute of Technology
Excessive water delivery to terrestrial embryos by ice pebble accretion

Accretion-disk models suggest that the snow line once migrated inside Earth's orbit in a late stage of the solar nebula evolution (e.g., Oka et al., 2011). This raises the question why the Earth was born so dry (water content ~ 0.1wt%). A plausible scenario would be that Earth's embryos must have formed early *and* have accreted little ice material after the migration of the snow line. To examine this scenario, we calculate the evolution of the water abundance of terrestrial embryos in late evolutionary stages assuming that the embryos accrete ice pebbles that drift in from outer disk regions. We use the simplified version of the Okuzumi et al. (2012)'s dust growth-drift model to compute the size and radial mass flux of ice pebbles as a function of time. The pebble accretion cross section of an embryo is calculated using the detailed formula by Guillot et al. (2014). We find that the total mass of ice pebbles that are accreted by an embryo exceeds 1% of the initial embryo mass unless the embryo forms later than about 4 Myrs after disk formation. Our results suggest that, as long as ice pebbles drift in from outer disk regions in late evolutionary stages, terrestrial embryos are likely to acquire too large amount of waters to be consistent with the water-poor Earth. Mechanisms preventing icy pebbles delivery to Earth's orbit, such as gap formation by gas giants, might be needed.

12. Andreas Schreiber - MPIA
From Dust to Planetesimals - High Resolution Simulations of Planet Formation Processes

We investigate Planetesimal formation in starving mode: The total amount of planetesimal precursor gravel is too low to trigger streaming instability and gravitational collapse. But the radial flux of gravel is sufficient to accumulate critical densities at trap locations in the disks like zonal flows and vortices. Here we determine the efficiency of the conversion from dust to planetesimals in high resolution studies of concentration in zonal flows and the resulting size spectrum of planetesimals.

13. Tetsuo Taki - Tokyo Institute of Technology
Pressure Bump Deformation Due to the Accumulation of Dust Particles

In the process of planetesimal formation, the radial drift barrier is one of the most serious problem. Dust trapping by the radial pressure bumps is a prospective mechanism to bypass the barrier. As the dust particles accumulate at the bump, however, the dust drag force becomes more effective in gas density evolution and deforms the pressure bump.
We investigate the gas density evolution process due to the accumulation of dust boulders at the bump. We found that the dust drag force is sufficient to deform gas profile when dust-to-gas mass ratio reaches to ~1, and the gas density profile becomes quasi-steady state when the radial pressure gradient reaches to ~0.

14. Richard Teague - MPIA
Deuterium Fractionation in DM Tau

This poster explores the deuterium fractionation of HCO+ in DM Tau. Deuterium fractionation is typically used as a probe of an environment's thermal history as the efficiency is drastically reduced in temperatures above ~25 K. We observe in DM Tau both HCO+ and DCO+ and, using an LTE radiative transfer code, are able to derive radial column density profiles for both molecules. We find an enhanced level of deuteration relative to both cosmic values and those found in starless cores suggesting continued gaseous processing within the disk. With a suite of chemical models of DM Tau we also explore additional physical parameters, such as ionization sources and CO depletion, which can alter the abundance of these molecules and thus skew the observed deuterium fractionation value.

15. Takahiro Ueda - Tokyo Institute of Technology
Migration of a giant planet induced by eccentricity damping and gravitational turbulence

Recently, the gravitational instability (GI) model has been revisited as the formation of giant planet and brown dwarf because of the detection of long-period giant planets with small eccentricity (e.g. Marois et al. 2010). With GI, giant planet is formed from the fragment of a gravitationally unstable disk which has a few to tens of Jupiter mass and large semi major axis above 50AU.
We have investigated the migration of a giant planet considering eccentricity damping and gravitational turbulence using orbital integration. For the random torques due to disk turbulence, we used the semi-analytical formula developed by Laughlin et al.(2004) and modified by Ogihara et al.(2007). The random torques excite the orbital eccentricity of a planet. When there is a relative velocity between planet and disk gas, gravitational interaction force which is known as "Dynamical Friction" arises between them. Dynamical fiction force changes angular momentum and energy of planet. In high eccentricity regime, we can assume the conservation of angular momentum, even if the torque is always exerted on the planet. As a result, semi-major axis and eccentricity decrease due to energy dissipation. Repeating these eccentricity excitation and dumping, giant planet can migrate inward 100 times faster than Type II migration and it suggests that it is difficult to form a giant planet with wide orbit via GI.

16. Shoji Ueta - Tokyo Institute of Technology
Surface H2O conditions of cold terrestrial planets

A lot of extrasolar terrestrial planets and free-floating planets have been discovered. Whether terrestrial planets with liquid water exist is an important question to consider, especially in terms of their habitability. Even in a globally ice-covered state, geothermal heat from the planetary interior is likely to melt the interior ice, so that an internal ocean beneath the surface ice shell could exist. In this work, we argue the conditions for terrestrial planets to have an internal ocean on the timescale of planetary evolution. In addition, we verify the structure of surface H2O layers of ice-covered planets with considering the effects of ice under high pressure (high-pressure ice). The planetary mass and water abundance on the surface strongly restrict the conditions that an extrasolar terrestrial planet has an internal ocean and hold no high-pressure ice layers under the ocean. The habitability of a planet might be influenced by the existence of such high-pressure ice layers under the internal ocean.