Talk Abstract

Time	Title Name	Abstract
Day 1 (Nov. 25) 10:20 -	Asymmetries in Circumstellar Disks as Signposts for Planet Formation Ya-Wen Tang	Asymmetrical features in disks provide indirect evidences of embedded objects, such as planets. Unless the asymmetry is trivial, we found that there are subtle deviation from symmetric structures in disks, such as in MWC 758 and in the GGTau A system. In this talk, I will present our effort to identify the asymmetric features in both dust continuum and molecular gas. In MWC 758, we found that there is a clear azimuthal dependence in the continuum emission, suggesting spiral-like structures. In the GG Tau A system, we found that there are rings detected in both 12CO and 13CO 3-2 with a hot spot locates at one of the rings. Among the disks where asymmetric features are found, there are only a few disks with firm detection of planets. I will discuss what are the possible difficulties and the implications.
Day 1 (Nov. 25) 11:00 -	FU Ori – A gas/dust rich compact disk heated from the mid-plane Hauyu Baobab Liu	FU Ori is a YSO which has undergone active accretion outburst since ~1936. Based on the rising time and the averaged accretion rate we can know that there is at least few tens of Jupiter mass of gas concentrates to its inner few au, likely full MRI active disk. I will present the new VLTI-GRAVITY observations at ~2 micron band and the JVLA/ALMA observations at 0.87-3.6 cm bands. The VLTI data resolved that the inner <0.4 au region is consistent with a viscous heated disk with a ~1e-4 Msun/yr accretion rate, while the JVLA/ALMA data show that the 0.4-10 au disk is consistent with a viscous heated disk at similar accretion rate. In this case, the disk is predominantly heated from the mid-plane, which appears to have considerably higher temperature than the disk surface. Consistently fitting the JVLA, ALMA, Herschel, Spitzer, and VLTI data requires including a ~10 au scale dusty disk, of which the maximum grain size is ~2 mm at the mid-plane, and is ~0.2 mm at the disk surface. This might be a tentative evidence for vertical dust settling although I am unclear about why we are supposed to see this in a MRI active area.
Day 1 (Nov. 25) 11:20 –	Multiscale view of star, disk and planet formation Daniel Harsono	Stars and planet-forming disks form out of cold and dense clouds. Disks around low-mass stars play the major role in controlling the flow of material from the outer envelope to the star. However, only recently that we are able to detect and study the early stages of disk formation in detail. These details of disk formation rely on understanding the interplay between the large-scale and the disk structure. Such studies also require detailed dust and molecular gas observations at all scales. I will discuss the on-going projects in IR observations, sub-mm observations and theoretical modeling aspects of the early stages of planet formation.
Day 1 (Nov. 25) 11:40 -	Disk structures in line and continuum revealed by the ALMA Lupus surveys Hsi-Wei Yen	Distributions of molecular-line and continuum emission can be used to trace physical and chemical conditions in protoplanetary disks. In the presentation, I will show our results of the 13CO (3-2; 2-1) and CN emission in a sample of protoplanetary disks in Lupus using the ALMA archival data. CN is theoretical expected to show a ring structure in disks, and its distribution is sensitive to UV flux and disk structures. With two 13CO transition, we derived column density and gas temperature profiles. I will discuss the dependence of the CN distributions on these physical parameters. In addition, I will present our follow-up ALMA survey of Lupus disks at <0.1" resolutions. Several disks are resolved to have substructures, like rings and spirals, while several others remain smooth. I will discuss the line and

		continuum intensity profiles in these disks in comparison with the results of the Taurus and DSHARP surveys.
Day 1 (Nov. 25) 13:30 -	Discovery of a localized excess in the millimeter emission of the protoplanetary disk around TW Hya Takashi Tsukagoshi	Planets are formed from dust and gas in circumstellar disks around young stars. Observations of dust and gas in circumstellar disks can provide fundamental information on planet formation processes, and high-resolution (sub-)millimeter imaging is now revealing the dust substructure likely generated by forming planets in disks. Here we report the detection of an excess in dust continuum emission at 233 GHz (1.3 mm in wavelength) in the circumstellar disk around TW Hya, the closest such system to Earth, revealed through deep 3 au resolution observations with the Atacama Large Millimeter/submillimeter Array (ALMA). We have carried out 3 au resolution continuum observations at 233 GHz (Band6) toward the protoplanetary disk (PPD) around TW Hya using ALMA in 2016 and 2017. The sensitivity has been improved by a factor of 3 than that of our previous cycle 3 observations. The overall structure is axisymmetric, and there are apparent gaps at 25 and 41 au as previously reported. The most remarkable new finding is a few au scale excess emission at the south-west part of the PPD. The excess emission is located at 52 au from the disk center and is 1.5 times brighter than the surrounding PPD. The extracted emission after subtracting the axisymmetric PPD emission has a size of 4.4x1.0 au and a total flux density of 250 micro-Jy, corresponding to a dust mass of 0.03 earth masses. Since the excess emission can also be marginally identified in the Band 7 image at almost the same position, the blob is unlikely a background source. The excess emission can be explained by a dust clump accumulated in a small elongated vortex or a massive circumplanetary disk around a Neptune mass forming-planet.
Day 1 (Nov. 25) 13:50 -	Hydrodynamic activity in planet-forming disks Min-Kai Lin	In the last few years, the foundation for planet formation has shifted from classic viscous, turbulent accretion disks to wind-driven, nearly-laminar disk models. In this new context, hydrodynamic instabilities may play an important role in planet formation and evolution by providing a route to sustained (weak) turbulence. I will discuss several examples of hydrodynamic instability in protoplanetary disks: the 'zombie vortex instability', the 'convective overstaility', the 'Rossby wave instability', and the 'vertical shear instability' (VSI). After reviewing their physical nature, I will focus on the impact of the VSI, which is applicable to 10s to 100 au in typical disks. High resolution ALMA observations at these radii, which show prominent gaps and rings, hint at ongoing planet formation. Thus the VSI may be relevant to planet formation at large radii. I will specifically focus on its impact on dust dynamics. I will finish with a brief discussion on possible future directions for modeling hydrodynamic turbulence in PPDs.
Day 1 (Nov. 25) 14:30 -	Effects of Dust Back Reaction on the Dust-Gas Dynamics in Protoplanetary Disks Chao-Chin Yang	In the study of dust-gas dynamics in protoplanetary disks, it has become clear that the back reaction of the dust to the gas drag plays an important active role in the dynamics itself, albeit the dust component represents only a small fraction of the total disk mass. Through the back reaction, the dust component may alter the structure of the underlying gas component and in turn results in a different pattern of the distribution of dust particles. Therefore, to properly interpret the recent high-resolution observations of nearby protoplanetary disks, it is imperative to consider the manifestation of

		dust back reaction on the disk structure before we can relate these observations with the processes of planet formation. In this presentation, I will discuss some of these effects. Specifically, I will describe the axisymmetric structures driven by dust back reaction, the dust-gas dynamics in non-ideal MHD, and the morphological signatures in a dusty disk with an embedded planet.
Day 1 (Nov. 25) 15:50 -	Global simulation of the vertical shear instability with non-ideal MHD effects Can Cui	Understanding mechanisms of angular momentum transport is crucial for the gas dynamics hence the planet formation of protoplanetary disks (PPDs). In the recent years, it has been realized that the magneto-rotational instability (MRI) tends to be suppressed in PPDs due to non-ideal MHD effects, with wind-driven accretion and disk being largely laminar. In parallel, several hydrodynamic mechanisms have been identified that likely also drive disk accretion. We study the interplay between MHD winds in PPDs with the vertical shear instability (VSI), one of the most promising hydrodynamic mechanisms, through 2D global non-ideal MHD simulations. We find that for typical disk parameters, MHD winds can coexist with the VSI, with accretion primarily wind-driven, accompanied by vigorous VSI turbulence. Stronger magnetization leads to slower growth of the VSI. The evolution of turbulence, flow structure in the disk, and the time variability of the winds under the influence of the VSI will also be discussed.
Day 1 (Nov. 25) 16:10 -	Revised description of dust diffusion and secular instabilities creating multiple rings in protoplanetary disks Ryosuke Tominaga	The secular gravitational instability (GI) may have an important role in formation of planetesimals and multiple rings in protoplanetary disks. To discuss the validity of the secular GI, we have to properly take into account dust diffusion in turbulent gas disks because dust diffusion is the most effective process to hinder the growth of the instability. Previous studies modeled the dust diffusion by using the advection-diffusion equation for dust density. Although such phenomenological modeling has been widely used, it violates the angular momentum conservation and renders dust too diffusive. Motivated by this theoretical problem, we reformulated equations to properly describe the dust diffusion in disks. We showed that the angular momentum conserves by introducing an advection term associated with the diffusion in the momentum equations. Such an advection term is naturally derived from the mean-field approximation. We also performed a linear analysis on dusty gas disks by using the reformulated equations. The results show that the secular GI is a monotonically growing mode, which is contrary to previous studies that found it overstable. We also found a new secular instability that we refer to as two-component viscous gravitational instability (TVGI). TVGI is found to be a mechanism for not only concentrate dust grains against diffusion but also creating multiple rings in protoplanetary disks.
Day 1 (Nov. 25) 16:30 -	Kelvin-Helmholtz Instability driven by Dust-Gas interaction in Protoplanetary Disk: Origin and Observational Implication Pinghui Huang	In the recent years, high spatial resolution observations of protoplanetary disks (PPDs) by ALMA have revealed many details that are providing interesting constraints on the disk physics as well as dust dynamics, both of which are essential for understanding planet formation. We carry out high-resolution, 2D global hydrodynamic simulations, including the effects of dust feedback. We find that Kelvin-Helmholtz like instability can occur in PPDs which lead to both the quasi-axisymmetric rings and non-asymmetric dust traps. In particular, we find out the quasi-axisymmetric dust rings could provide several observational signatures that can be tested. These effects are providing additional understanding of dust dynamics in PPDs. We also produce synthetic dust emission images using our simulation results and discuss the comparison between simulations and observations.

Day 1 (Nov. 25) 16:50 -	Dust Settling and Clumping in MRI Turbulent Protoplanetary Disks Ziyan Xu	Streaming instability has been considered as the leading model for planetesimal formation in protoplanetary disks. It results from the backreaction of dust to gas, leading to efficient particle concentration when the local solid abundance is sufficiently high. This can be achieved when the disk is largely laminar, allowing dust to stronlgy settle towards disk midplane. However, the outer disk is expected to be weakly turbulent due to the magneto-rotational instability (MRI). We conduct local 3D non-ideal MHD simulations with ambipolar diffusion to study the interplay between weak MRI turbulence and dust dynamics, taking into account dust feedback. We find that dust settles to thinner layer when feedback is included, and particle clumping is triggered at a solid abundance of a few percent. While this is phenomenologically similar, the underlying physical mechanism is likely distinct from that of the streaming instability.
Day 1 (Nov. 25) 17:10 -	Stability of dusty vortices Francesco Lovascio	Dust plays a pivotal role in all stages of planet formation, from the settling of micron size dust in the young protoplanetary disc, to the growth of dust into pebbles and eventually planetesimals. A model for simulating dust-gas dynamics is crucial in understanding planet formation. Vortices in protoplanetary discs are able to collect dust at their center, making them able to potentially catalyse planet formation. Therefore, the stability of dusty vortices is an area of great interest. We discuss how a terminal velocity approximation one fluid dusty gas model is excellent for the study of dust laden vortices. By formalising the terminal velocity approximation, we are able to study the limitations and strengths of the model, and to extend it to encompass dusty viscous gases without having to modify the governing equations. We also present our implementation of the terminal velocity within the FARGO3D hydrodynamics code. Our most recent simulations of dusty vortices in shearing sheets provide insights into the questions of how much dust can a vortex collect in a protoplanetary disc and how does this affect its lifetime.
Day 2 (Nov. 26) 09:00 -	Magnetic field effects on early disk formation Woojin Kwon	Magnetic fields of young stellar objects have been studied by polarized thermal radiation of non-spherical dust grains aligned in magnetic fields. Although various mechanisms causing polarizations in (sub)millimeter wavelengths like self-scattering and radiative alignment have been recognized recently, still young stellar objects (YSOs) at the earliest stages, the so-called class 0 YSOs, have polarization mainly caused by magnetically aligned dust grains. Observational results of polarization in class 0 YSOs and effects of magnetic fields on early disk formation will be discussed in this talk.
Day 2 (Nov. 26) 09:40 -	Origins of (sub)millimeter disk polarization Haifeng Yang	Disk polarization in (sub)millimeter dust continuum is a rapidly growing field in the ALMA era. Its origin, however, is still under debate, and is likely to be both system-dependent and wavelength-dependent. To date, various systems were observed to show evidences for scattering-induced polarization, with a handful of examples favoring alignment- based mechanisms instead. I will first review how scattering-induced polarization works and why it has the potential to study the grain growth, as well as to probe dust settling, which is hard to do otherwise. I will then focus on the best studied system, the HL Tau system. At Band 7 (0.87 mm), HL Tau provides one of the best examples for scattering-induced polarization. However, as the wavelength increases, the polarization pattern gradually changes to an azimuthal pattern at Band 3 (3 mm). This azimuthal pattern is less likely to be induced by self-scattering and was initially proposed to come from the so-called radiative alignment mechanism. I will discuss the observational features assuming perfect radial radiative alignment of dust grains and explain how it fails to explain the polarization at Band 3 for HL Tau. At the end, I will

		address and discuss the growing tension in grain size estimate based on scattering-induced polarization and other methods, such as beta-index method.
Day 2 (Nov. 26) 10:00 -	Radial variations of grain sizes and dust scale heights of the protoplanetary disk around HD 163296 revealed by ALMA polarization observation Satoshi Ohashi	The HD 163296 disk shows the ring and gap substructure with ALMA observations. In addition, the rings and gaps are spatially resolved in millimeter-wave polarization as well. We performed radiative transfer modeling with taking into account self-scattering polarization aiming to constrain the grain size and its distribution. We found that the grain size and dust scale height are the key parameters to reproduce the radial and azimuthal distributions of the observed polarization signature. Radial variation is mainly determined by the grain size: polarization fraction is high if the particle size is ~ $\lambda/2\pi$ and low if the particle size is larger or smaller than that size. In contrast, azimuthal variation in polarization is enhanced if the dust scale height is increased. Based on our detailed modeling, we found the radial variations of the grain sizes and dust scale heights as follows. The maximum grain size is 140 micron at the gaps while it is significantly larger or smaller in the rings. The dust scale height is less than one-third of the gas scale height inside the 70 au ring, while it reaches two-thirds of the gas scale height outside of the 70 au ring. Furthermore, we constrain the gas turbulence to be $\alpha < 1.5\times10^{-3}$ at the 50 au gap and α ~ 0.015-0.3 at the 90 au gap, respectively. The transition of the turbulent strength at the boundary of the 70 au ring indicates the existence of the dead zone.
Day 2 (Nov. 26) 10:50 -	Unveiling Dust Aggregate Structure in Protoplanetary Disks by Millimeter-wave Scattering Polarization Ryo Tazaki	Dust coagulation in a protoplanetary disk is the first step of planetesimal formation. However, a pathway from dust aggregates to planetesimals remains unclear. Both numerical simulations and laboratory experiments have suggested the importance of dust structure in planetesimal formation, but it is not well constrained by observations. We study how dust structure and porosity alters polarimetric images at millimeter wavelength by performing 3D radiative transfer simulations. Aggregates with different porosity and fractal dimension are considered. As a result, we find that dust aggregates with lower porosity and/or higher fractal dimension are favorable to explain observed millimeter-wave scattering polarization of disks. Aggregates with extremely high porosity fail to explain the observations. In addition, we also show that particles with moderate porosity shows weak wavelength dependence of scattering polarization, indicating that multi-wavelength polarimetry is useful to constrain dust porosity. Finally, we discuss implications for dust evolution and planetesimal formation in disks.
Day 2 (Nov. 26) 11:10 -	Zeroth-order Protoplanetary Disk Gas Dynamics Xuening Bai	Even after decades of study on the gas dynamics of protoplanetary disks (PPDs), we are still left with many fundamental questions that even a zeroth order picture is lacking. I will briefly review theoretical and computational studies and current understandings on the gas dynamics of protoplanetary disks (PPDs), focusing on mechanisms that drive disk accretion and outflows, and global disk evolution. Thanks to improved understandings of disk microphysics, recent studies have pointed to a paradigm shift, with disk accretion and evolution primarily be driven by magnetized disk winds, which are magneto-thermal in nature with significant mass loss. This requires PPDs to be threaded by net poloidal magnetic fluxes. More

		fundamental question is related to the global evolution of such poloidal magnetic fluxes, which is likely connected to how disk is truncated and merges into the interstellar environment.
Day 2 (Nov. 26) 11:50 -	Magnetic spirals and other features of circumstellar disk formation with misaligned magnetic fields and rotation axes Miikka Väisälä	Magnetic fields play a significant part of what leads to the formation of a protostellar disk. Currently, while we know that circumstellar disks do form, there is no consensus on how it can happen without compression and torques of the magnetic field leading to the so-called magnetic braking catastrophe, where no disk will form. However, there are a number of potential non-exclusive solutions - namely turbulent reconnection diffusion, non-ideal MHD effects and misalignment of magnetic field and rotation - which appear to make disk formation possible. I will present an analysis of misaligned magnetic collapse, leading to protellar disk formation. We used radiative transfer tool Perspective to estimate observational characteristics of Li, Krasnopolsky & Shang et al. (2013) set of MHD models in polarized continuum emission. We could characterize the resulting systems into four basic types, two of which form a disk. Of these two, the one with the stronger magnetic field experiences precession of the disk plane and ring-like perturbations. We also witness magnetically directed spiral inflow, demonstrating that spiraling behavior in a disks can also be related to magnetic field, without gravitational instability. The systems are in a continuing state of transition, and therefore we deem that kinematic signatures could trace features of spiraling collapse as an alternative to polarization.
Day 2 (Nov. 26) 13:30 -	Analytical description of magnetic braking for weakly magnetized star-forming core Sanemichi Takahashi	Since dust grains in protoplanetary disks start to grow in disk formation stage, the planet formation process cannot be separated from the disk formation. In other words, it is difficult to give the initial conditions for planet formation as an isolated protoplanetary disks. To solve this problem, continuous calculation from the disk formation to the planet formation is important. Such a long term calculation is, however, difficult for three-dimensional numerical simulations which is widely used for the investigation of the disk formation. Therefore, we aim to develop the analytic model to calculate disk formation. As a first step, we develop the analytic model of the infalling envelope. Especially, we derive the analytical description of the magnetic braking for weakly magnetized cloud core in this work. Since magnetic braking transfers the angular momentum from the infalling gas to surrounding gas, it strongly affects the radius of the protoplanetary disk. We evaluate the structure of the magnetic field approximately based on the model for the non-magnetized collapsing core developed in our previous work (Takahashi et al. 2013). The magnetic torque acting on the infalling gas can be derived from the magnetic field. We compared the time evolution of the angular momentum of infalling gas obtained from our model calculations and from three-dimensional MHD simulations, and found that the model can reproduce the angular momentum obtained from the simulations well.
Day 2 (Nov. 26) 13:50 -	Evolution of the Water Snowline in Magnetized Protoplanetary Disks Shoji Mori	Proper estimation of the time evolution of the snowline location provides a reliable constraint for the formation time and place of water-depleted planets. We investigate the migration of the snowline with the basis of our nonideal magnetohydrodynamic (MHD) simulations. The simulations show that nonideal MHD effects make disks laminar and that the accretion heating is significantly less

		efficient than that in a turbulent disk. We propose an empirical model for the disk temperature based on MHD simulations, and then revisit the time evolution of the snowline location. The result shows that the snowline passes inward the current Earth's orbit at 0.2 Myr after the star formation, whereas the time for the conventional turbulent disk is 2 Myr. This implies the bulk of water-depleted planets should either have formed early, or have formed at a closer-in orbit, followed by outward migration.
Day 2 (Nov. 26) 14:10-	Three-dimensional MHD Simulations of Accretion onto Magnetized Stars Shinsuke Takasao	The observational signatures in the vicinity of the central stars, such as the emissions from accretion shocks and winds, are used as an indicator of the evolutional stages of the protoplanetary disks. Generally it has been assumed that the presence of a fast (close to the escape velocity) accretion is a manifestation of the magnetospheric accretion. People have implicitly assumed this picture, and estimate the accretion rate. However, observations indicate that fast accretion also occurs even in a weakly magnetized stars like Herbig Ae stars, which poses a question about the classical picture. We have been developing a 3D MHD star-disk model to reveal the accretion process in the vicinity of a central star. We investigated the accretion processes around stars with and without a magnetosphere. We found that fast accretion to a high-latitude, which is similar to the magnetospheric accretion, is possible even without the magnetosphere. In addition, the accretion process around a star with a magnetosphere is found to be different from that of the classical picture. We will discuss the updates of the accretion structures in the vicinity of the stars, which could be important to interpret the observational signatures of accretion.
Day 2 (Nov. 26) 14:30-	Dust growth in protoplanetary disks: Are grains sticky or nonsticky? Satoshi Okuzumi	How large dust particles in protoplanetary disks can grow is a long-standing question in the theory of planet formation. It is conventionally assumed that icy particles outside the snow line are sticky, whereas silicate particles inside the snow line are poorly sticky. However, this conventional view has recently been challenged by new theoretical and experimental studies pointing to sticky silicates and nonsticky ice. In addition, the conventional view neglects the role of organics in the growth of protoplanetary dust particles, despite the fact that interstellar dust particles of cometary origin are generally glued together by organics. In this talk, I will review the recent developments in the study of the stickiness of protoplanetary dust particles (silicates, ices, and organic-coated particles). I will then discuss how the new picture of particle sticking can change our understanding of protoplanetary dust evolution and planetesimal formation.
Day 2 (Nov. 26) 16:10 -	Collisional properties of cm-sized high-porosity ice and dust agglomerates to understand early planet formation Rainer Schräpler	In dead zones of protoplanetary disks it is assumed that micrometer-sized particles grow by Brownian motion, sediment to the mid-plane and drift radially. When collisional compaction sets in, the growing aggregates collect slower and therefore smaller particles. This sedimentation of highly porous ice and dust particles is simulated in our laboratory experiments in which we obtained mm- and cm-sized ice aggregates with a porosity of 90% as well as cm-sized dust agglomerates with a porosity of 85%. We modelled this process in an analytical calculation to find the agglomerate sizes in a protoplanetary nebula. Once the agglomerates have reached the mid-plane, they form a thin dense layer and gain relative velocities by the streaming instability or the onset of shear turbulence. Therefore, we performed collision experiments with the aggregates formed in a runaway growth experiment and determined their mechanical parameters including their sticking threshold velocity, which is important for their further collisional evolution on their way to form

		planetesimals. Finally we developed a method to calculate the packing density dependent fundamental properties of our agglomerates, the Young modulus, Poisson ratio, shear viscosity and bulk viscosity from compressive measurements of agglomerates. With this parameters it was possible to calculate a coefficient of restitution, which fits our measurements.
Day 2 (Nov. 26) 16:30 -	Tensile Strength and Rotational Disruption of Highly Porous Dust Aggregates in Protoplanetary Disks Misako Tatsuuma	In recent years, polarized emission at millimeter wavelength in protoplanetary disks has been observed, some of which are interpreted as thermal dust emission from aligned elongated dust grains, which requires some rotational motion of the dust grains. In this work, we measure and formulate the tensile strength of porous dust aggregates by using N-body simulations and apply this to the situation in protoplanetary disks to investigate if dust grains can be disrupted by the rotational motion. We consider two torque sources that may excite the rotational motion: radiation pressure and ram pressure of the disk gas. As a result, we find that highly porous dust aggregates with their mass larger than 10^8 g are rotationally disrupted.
Day 2 (Nov. 26) 16:50 -	Dust morphology in comets and protoplanetary disks Prithish Halder	Protoplanetary disks are the nurseries of planetesimals, where smaller micron size grains grow into larger chunks through hit and stick collisional mechanisms. The grains grow into larger clusters of aggregated particles which later on evolve into planetesimals. The porosity of the aggregates is a key property that determines its physical morphology as well as its fate on collision with other aggregates or particles. The light scattering studies of such aggregated and porous particles reveal some of the fundamental physical properties of the dust that governed our early Solar System. The traces of the pristine early solar system dust particles can be found in the comets and asteroids. Thus, studying the dust properties of comets and asteroids shall be useful to infer crucial information on the solids that evolved in the solar proto-planetary disk. We have carried out light scattering calculations to study the dust properties and match it with observed parameters (mainly optical polarization as a function of wavelength and phase angle at the time of observation). All the numerical light scattering calculations in this study are carried out using T-matrix method, DDA, etc. executed on the VIKRAM-100 HPC having 2328 CPU cores, at PRL, Ahmedabad. In this presentation we discuss how size, composition, fractal dimension and the porosity of dust particles affect the observed polarization and other scattering matrix parameters. The presentation also deals with the observed variation in properties with varying porosity such as BCCA, BPCA, DLA, DLCA, RLA, RLCA, Fillipov and Polydisperse aggregates. Finally, we interpret some of the characteristics of the dust observed in protoplanetary disks and compare the results with those observed in comets and asteroids.
Day 3 (Nov. 27) 09:00 -	Planet growth after planetesimals Chris Ormel	Thousands of exoplanets have been discovered and their diversity is astounding. Exoplanet (systems) virtually fill all the phase space: from hot Jupiters to cold Neptunes, and solar-system architectures to the ultra-compact. Explaining this diversity demands robust assembly process(es). I will review the state-of-the art theory on how planet formation proceeds, focusing on the stages after planetesimals have been formed, where bodies grow from kilometer to thousands of kilometers. There remain many challenges that must be overcome before a full understanding of planet formation has been obtained.

Day 3 (Nov. 27) 09:40 -	The inner disc and the formation of super-Earths Marija Jankovic	The main aim of our project is to explore if and how the close-in super-Earth-sized exoplanets could form at their short orbital periods. This requires understanding the structure of protoplanetary discs at such short orbital distances. These innermost regions of protoplanetary discs accrete onto the star via the magneto-rotational instability (MRI). In our first study, we develop a model which self-consistently couples the structure of the gas in the inner disc with the MRI-driven accretion. In a follow-up study, we use the obtained structure of the gas disc to explore the viability of the in situ formation of the super-Earths in two ways. First, we show that the MRI leads to accumulation of dust in the inner disc, as necessary for the formation of solid planet cores. Second, assuming that solid cores do form in the inner disc, we consider accretion of planetary atmospheres and their subsequent evolution, and compare our results to the observed planet properties. In the ongoing work, we consider dust effects on the gas thermal and chemical structure, and on the MRI, to accurately and self-consistently investigate the evolution of gas and solids, and planet formation in the inner disc.
Day 3 (Nov. 27) 10:00 -	Formation of compact systems of super-Earths via dynamical instabilities and giant impacts Sanson Poon	NASA's Kepler mission discovered ~700 planets that reside in multisystems containing 3 or more transiting planets, many of which are super-Earths and mini-Neptunes in compact configurations whose origins are not yet understood. Using N-body simulations, we examine the final stage assembly of multiplanet systems through the collisional accretion of protoplanets. Our initial conditions are constructed using a subset of the Kepler 5-planet systems as templates, and apply to the epoch after gas disc dispersal. Two different prescriptions for the outcomes of planetary collisions are adopted. The simulations address a number of questions: do the results depend on the accretion prescription?; do the resulting systems resemble the Kepler systems and do they reproduce the observed distribution of planetary multiplicities when synthetically observed?; do collisions lead to significant modification of protoplanet compositions, or to stripping of gaseous envelopes?; do the eccentricity distributions agree with those inferred for the Kepler planets? We find the accretion prescription is unimportant in determining the outcomes. On average, the final planetary systems look similar to the Kepler templates we adopted, but the simulations do not reproduce the observed distributions of planetary multiplicities or eccentricities, because gravitational scattering does not dynamically excite the systems sufficiently. In addition, we find that approximately 1% of our final systems contain a co-orbital planet pair in horseshoe or tadpole orbits. Post-processing the collision outcomes suggests they would not lead to significant changes of the water fractions of initially ice-rich protoplanets, but significant stripping of low mass gaseous atmospheres appears likely. Hence, it may be difficult to reconcile the observation that many of the low mass Kepler planets appear to have H/He envelopes with a formation scenario that involves giant impacts after dispersal of the gas disc.
Day 3 (Nov. 27) 10:50 -	Planets in inviscid discs can avoid trapping in mean-motion resonances Colin McNally	Convergent migration involving multiple planets embedded in a viscous protoplanetary disc is expected to produce a chain of planets in mean motion resonances, but the multiplanet systems observed by the Kepler spacecraft are generally not in resonance. Under equivalent conditions, where in a viscous disc convergent migration will form a long-term stable system of planets in a chain of mean motion resonances, migration in an inviscid disc often produces a system which is highly dynamically unstable. This difference is due to the dependence of disc-planet interactions on the disc turbulent viscosity, as a series of our recent two and three dimensional

		simulation campaigns have explored. I will present an overview of our new understanding of planet migration in low-vicsosity discs. If planets are massive enough to significantly perturb the disc surface density and drive vortex formation, the smooth capture of planets into mean motion resonances is disrupted. As planets pile up in close orbits, not protected by resonances, close encounters increase the probability of planet-planet collisions, even while the gas disc is still present. While inviscid discs often produce unstable non-resonant systems, stable, closely packed, non-resonant systems can also be formed. The important role of the detailed disc dynamics poses technical challenges to producing predictions from planet formation theories.
Day 3 (Nov. 27) 11:10 -	The Size and Shape of Planetary Proto-Atmospheres Tobias Moldenhauer	Protoplanets formed by core accretion can become massive enough to accrete gas from the disk they are born in. If the planetary proto-atmosphere exceeds a critical mass, runaway gas accretion starts and the planet collapses into a gas giant. In recent years, many close-in super-Earths have been observed which raises the question on how they avoided becoming hot Jupiters. We use three-dimensional radiation-hydrodynamics to simulate the proto-atmosphere in the local frame around the planet. The simulations converge to a quasi-steady state where the velocity field of the gas does not change anymore. In post-processing we then use tracer particles to calculate the shape of the atmosphere and the recycling timescale. Recycling of the atmosphere counteracts the collaps by preventing the gas from cooling efficiently.
Day 4 (Nov. 28) 09:00 -	An unbiased-ish survey of protoplanetary disks in Taurus Gregory Herczeg	The disk substructures revealed from remarkable high-spatial resolution imaging have transformed our view of disks. We performed a high resolution (~0.1 arcsec, 15 au) ALMA survey at 1.3 mm for an unbiased sample of 32 disks in Taurus, of which 12 have rings and gaps. These substructures are preferentially detected in larger disks, although we find no trend with either stellar mass or disk brightness. The location of the rings and gaps are inconsistent with creation by ice lines. If the disk gaps are carved by planets, then low-mass (Neptune-mass) planets are preferred. Many of the disks in our sample are compact, with radii less than 40 AU. Half of these compact disks are around single stars. The disks of these stars are similar to the inner regions of the larger disks with substructures. Other compact disks are likely truncated by binaries, with truncations that point to eccentric orbits. We discuss these results in terms of possible differences in initial conditions and evolutionary pathways for the disk.
Day 4 (Nov. 28) 09:40 -	Substructure in magnetized wind-launching disks Scott Suriano	Recent observations suggest that large-scale magnetic fields are responsible for launching disk winds and driving accretion in circumstellar disks. We investigate how these magnetic fields can lead to the formation of rings and gaps in disks using 3D MHD simulations with ambipolar diffusion (AD). We find rings and gaps can be formed in disks by the reconnection of the poloidal magnetic field as it is dragged radially inward through a thin current sheet at the disk midplane. This reconnection creates magnetic loops where the net poloidal magnetic flux is reduced and dense rings can grow, and neighboring regions where the stronger poloidal magnetic field can form gaps. The rings and gaps remain stable in 3D for at least a few thousand years, making them possible sites for trapping large dust grains. We also consider the observational implications of the slow MHD disk winds that are launched from the disk substructure. First, we simulate the resulting vertical distribution of dust grains launched by the winds to find which grain sizes can be blow away in the wind and which can be suspended above the disk surface. Using

		this dust distribution, we then produce spectra and images with the radiative transfer code RADMC-3D and find that the dusty winds launched from azimuthal clumps in the dense rings can explain the concurrent infrared brightening and optical fading in some YSOs.
Day 4 (Nov. 28) 10:00 -	Using Deep Neural Networks to constraint the mass of a planet from gap profiles in protoplanetary disks Sayantan Auddy	The observed gaps in the protoplanetary disk are often considered an imprint of planets orbiting around the central star. The width and the depth of the gaps depend on the mass of the planet along with the disk properties, for example, aspect ratio, viscosity, and dust-to-gas ratio. We run a large number of two-dimensional hydrodynamic simulations in FARGO3D using GPU clusters to compute the gaps induced by planets in a dusty disk for a wide parameter range. The dataset is then used to train a Deep Neural Networks to predict the planet mass from an observed disk gap in a protoplanetary disk. This machine learning technique provides an edge over the existing empirical relations as our model can be trained for any number of relevant parameters and complex disk system. Our trained neural network provides an accurate prediction of the planet mass for an observed gap in a disk in much-reduced computing time.
Day 4 (Nov. 28) 10:50 -	Volatiles in protoplanetary disks Kenji Furuya	Volatiles (gaseous and icy molecules) are important components of protoplanetary disks; a significant fraction of heavy elements, such as carbon and oxygen, is present as volatiles and they ultimately become raw materials of planetary systems. In addition, molecules provide diagnostic of physical conditions where they reside, because molecular abundances are sensitive to temperature, density, ionization rate, etc. I will review our current understanding of volatiles in protoplanetary disks. The main focus of this talk will be put on volatile elemental abundances of carbon and oxygen. Recent observations have revealed that carbon and oxygen are depleted in the outer regions of protoplanetary disks compared to the ISM. The volatile element depletion is likely caused by dust evolution (in particular, radial drift of large dust grains coated with ice mantles) and/or chemical reactions. I will introduce relevant observational results and recent modeling effort to couple chemical reaction network models with dust evolution models.
Day 4 (Nov. 28) 11:30 -	Photoevaporation of Protoplanetary Disks: Metallicity Dependence and Lifetimes Riouhei Nakatani	Recent observations suggest that lifetimes of protoplanetary disks are approximately less than a million yr in low-metallicity environments (Yasui et al. 2009, 2010), while they have been considered to be several million yr in the solar neighborhood. Photoevaporation has been proposed as an important disk-dispersing mechanism that can explain the Myr-order disk lifetimes. We perform a suite of radiation hydrodynamics simulations of photoevaporating disks with various metallicities to study the metallicity dependence of the mass-loss rates and its effects on the lifetimes. Our simulations self-consistently solve hydrodynamics, radiative transfer, and nonequilibrium chemistry. We also consistently determine dust-grain temperatures. As photo-heating sources for the gas, we take account of far-ultraviolet, extreme-ultraviolet, and X-ray. Prior works have discussed their relative importance to drive photoevaporation but the conclusions have diverged. Our results show at sub-solar metallicities, the photoevaporation rate increases as metallicity decrease owing to the reduced opacity of the disk medium. It is consistent with the observational trend that the lifetimes are shorter in low metallicity environments. In contrast, the photoevaporation rate decreases at even lower metallicities, because dust-gas collisional cooling remains efficient compared to far UV

		photoelectric heating. The net cooling in the interior of the disk suppresses the photoevaporation. Our results imply the lifetimes of protoplanetary disks are longer in the extremely low-metallicity environments than in the solar metallicity environments.
Day 4 (Nov. 28) 13:30 -	From dust to dust: Remnants of planetary systems Odette Toloza	White dwarfs are the final fate of 95 per cent of all stars, including our Sun. Planets and planetary bodies that survived this metamorphosis of their host star can venture close to the left-over stellar cores (i.e. white dwarf) where tidal force results in their disruption. A debris disc is formed and its material accretes onto the white dwarf. Spectroscopy of white dwarf can provide the chemical composition and estimates of the masses and sizes of the disrupted bodies. This type of analysis represents currently the only method to measure the bulk abundances of extra-solar planetesimals, and can provide important input into planet formation theories. Here, I will present our most important discoveries, which highlight a diverse range of compositions.
Day 4 (Nov. 28) 13:50 -	The surprisingly low carbon mass in the debris disk around HD 32297 Gianni Cataldi	ALMA has detected CO in a number of debris disks at levels comparable to protoplanetary disks. The origin of this gas is still under debate. It was recently suggested that these CO-rich debris disks can be explained by secondary gas production from evaporating cometary bodies, if neutral carbon is shielding CO from rapid photo-dissociation. We present the most advanced model of secondary gas production and evolution in debris disks developed so far. We then confront our model to our new ALMA band 8 observations of neutral carbon towards the CO-rich debris disk around HD 32297 (Cataldi et al. 2019). The data reveal a surprisingly low carbon mass. Our model requires very high CO production rates and/or fast removal of C by a yet unknown mechanism to explain the low C/CO ratio. More observations and modeling efforts are required to fully understand these CO-rich system. Their study clearly has the potential to enhance our limited understanding of the late stages of planet formation.

Poster Abstract

No.	Title Name	Abstract
1	Dielectric Modelling of Lunar Surface Ankita Vashishtha	Moon is a natural satellite of the planet Earth which completes its revolution in 27 days, 7 hours, 43 minutes and 11.5 seconds. Also, Moon takes 29 days, 12 hours 44 minutes and 2.9 seconds to complete one rotation at its axis. So basically rotation time and revolution time around the Earth is almost the same. That is why only one face of the Moon is visible from the Earth. In astronomical terms, this process is called tidal locking. So any observation of Moon done from Earth is not complete. Till date, various missions had been launched and large amount samples of Lunar surface had been obtained. Many of these samples strongly indicate the presence of elements like Potassium, Oxygen, Magnesium, Silicon, Calcium, Titanium, and Iron. Samples also show the presence of radioactive elements like Thorium, Uranium, and Helium-3. From Chandrayan-1 data set analysis, the possibility of finding water ice in the permanently shadowed region of Lunar surface is being strengthened. In early stages, extraterrestrial studies began with the moon because of its nearest position to earth and moon surface being five to eight times older than as that of earth. So the study of moon surface helps to understand the early processes that contributed to the formation of the earth. Extraterrestrial bodies are beyond the limit of physical contact of human beings. Remote sensing methods are applied to explore extraterrestrial bodies. Dielectric characterization of lunar regolith is an ongoing research field. Each and every substance is having different values of dielectric parameters like dielectric constant, loss tangent, regolith thickness. So by evaluating these dielectric parameters, a chemical constituent of regolith of the region of interest can be predicted. SAR (Synthetic Aperture Radar) is particularly sensitive to dielectric parameters. Dielectric modelling includes firstly producing realistic value of dielectric constant by applying Integral Equation Method and then doing Inversion modelling to retrieve actual dielectric constant as per varying surface roughness. So, this paper deals with doing dielectric modelling on lunar craters in north pole and south pole for finding out the possibility of water ice.
2	Comparing the complex organic molecules in protoplanetary disks with comet 67P/C-G Chen-En Wei	The Rosetta mission opens the new pages of cometary science. Since comets are regarded as the pristine material which might carry the clues of solar system formation, we would like to investigate the relation of chemical compositions between protoplanetary disks and cometary coma. In the current study of ice chemistry, we consider the reactions occur only on the topmost layer of ices and diffusion is thought to be very limited in the ice mantle, meaning that the mantle species are thought to be completely unreactive. However, the laboratory experiments demonstrate a strong correlation between the reaction kinetics in bulk ices and their structural evolution, which is expected to increase the complexity and the production rate of interstellar complex organic molecules. These mantle reactions become efficient when the temperature is high. We consider the FU Ori outbursts increase the temperature in the disk and further enhance the mantle reactions making complex organic molecules in the ice mantle, e.g., Carboxylic acids (R-COOH) along with NH_4^+ ion which explain the broad absorption band centered at 3.2 μm detected by VIRTIS (visible infrared thermal imaging spectrometer) aboard Rosetta towards comet for the first time.

3	Evolution of Dust Traps in Planet-Forming Discs Daniel Cummins	High-resolution imaging of dust continuum emission in protoplanetary discs has revealed both axisymmetric and non-axisymmetric substructure. Perhaps the most striking observation is the presence of large-scale crescent-shaped features, which have been interpreted as large quantities of dust trapped in anticyclonic vortices. Such regions of high dust-to-gas ratios are expected to promote planet formation processes, so understanding their formation and evolution is key to understanding the influence they have on planet formation. Gas-only hydrodynamics simulations have demonstrated the generation of such vortices, triggered by the thermal feedback on the disc from a planetary embryo undergoing pebble accretion. However, the ability for such a vortex to trap dust and the impact this has on both the vortex and the forming planet are yet to be investigated. I will present results from hydrodynamics simulations of discs containing both gas and dust, showing the efficiency with which dust grains of different sizes become trapped in a vortex triggered by pebble accretion, and discuss the consequences this has for the growth of the planetary embryo.
4	Parameterizing the Perturbed Rotational Velocities of Planet-induced Gaps Han Gyeol Yun	Recent submillimeter observations of ALMA reveal that many proto-planetary disks contain substructures like gaps or rings. The disk-planet interaction is believed to be the most likely gap formation scenario, and most previous numerical work attempted to constrain the planet mass using the density profiles of gas in the gaps. Since the dust and gas distributions likely differ from each other in protoplanetary disks, however, perturbed rotational velocities that directly probe the gas would give a more reliable estimate to the planet mass. In this work, we run two-dimensinal hydrodynamic simulations to measure the amplitudes and widths of rotational velocity perturbations induced by planets with different mass. We present the parametric relations of the gap widths and depths as functions of the planet mass and disk properties. We also apply our relations to HD 163296 to infer the masses of embedded planets.
5	Long -time Survival of ALMA Rings without Pressure Maxima Haochang Jiang	Recent ALMA observations show that a majority of protoplanetary disks contain azimuthal features ("rings") with significant contrast between the peak and background. Because of the high concentration of dust, these rings are thought to be relevant to the planet formation process. Usually, these rings are understood to be associated with a maxima in the gas pressure, resulting from, for example, planet, iceline or magnetic field. Here, we investigate an alternative scenario, which involves only dust-gas interaction in a smooth gas disk to establish a model of the disks and rings in line with observations. The disk model is assumed 1-D and azimuthally symmetric. We numerically solve for the time-dependent radial dust distribution evolution of the ring structures. We estimate the lifetime of the dissolution of an existing ring and find that the mass loss from the ring is independent of the ring properties. We investigate the conditions in which the particle rings can be maintained on long timescale.
6	Non-axisymmetric linear analysis for Streaming Instabilities in protoplanetary disks Hiroaki Kato	It is recognized that planets are formed from planetesimals in protoplanetary disks, but how planetesimals are formed has not been completely elucidated yet. In formation of planetesimals, one of the important physical mechanisms is streaming instability occurred by interpenetrating streams of dust and gas in a Keplerian disks, which promotes dust concentration. It is thought that modes in the r-z plane are responsible for the streaming instability, and its evolution has been well studied (r, phi and z are the radial, azimuthal and vertical direction, respectively). However, recently, numerical simulations limited to the r-phi plane found that dust clamps occur even in the absence of vertical wave propagation, so response of two-fluid systems to non-axisymmetric perturbations is getting attention. In this study, we perform linear analysis considering non-axisymmetric perturbations in a Keplerian discs composed of dust and gas. As a result, unstable non-axisymmetric modes exist even

		in the absence of vertical wave wavenumber, and maximum growth rate of the non-axisymmetric modes is larger than that of the axisymmetric modes.
7	Inferring the planet population at birth James Rogers	The California-Kepler Survey (CKS) has released a wealth of precise planetary radii measurements that have the potential to reveal the nature of the underlying planet distribution in our galaxy. One of the key results of the CKS program was the revelation that the radius distribution of small, close-in exoplanets is bimodal. Such bimodality was expected from the photoevaporation model of close-in mini-neptunes, where some planets are completely stripped of their primordial H/He atmospheres, whereas others retain them. It has been suggested that comparisons between the photoevaporation model and observed planetary populations have the power to unveil details of the planet population inaccessible by standard observations, such as the core mass distribution and core composition. However, to date, only phenomenological work has been done to constrain these distributions, leaving large uncertainties in our knowledge of planet populations. In this work, we present a full Bayesian Hierarchical analysis on the radius distribution of close-in exoplanets using the photoevaporation evolution model. This approach is used to place key constraints on the planetary distributions for core composition, core mass, initial envelope mass fraction, cooling timescale and additional dependencies on orbital period. This new information can then be used to refine a new, effective planetary formation model.
8	Planetesimal Dynamics in the Presence of a Giant Planet Kangrou Guo	The standard models of planet formation explain well how planets form in axisymmetric, unperturbed disks in single star systems. However, it is possible that giant planets could have already formed when other planetary embryos start to grow. In other words, the early evolution of planetesimals can be affected by strong perturbations from the massive planets in the system, and thus deviate from the standard scenario. Using N-body simulations, we investigate the dynamics of planetesimals, including the distribution and evolution of their orbital elements, in a system with the presence of nebular gas and a giant planet perturber located at 5.2 AU. We aim at finding out the impact of the perturber on the formation of giant planet cores exterior to the orbit of the perturber. While confirming the results from Kortenkamp and Wetherill (2000), we find that the orbits of particles distributed in $\sim 9-15$ AU, except for the MMR locations, are generally aligned. The typical velocity dispersions of identical- mass particles are on the order of 10 m/s in this region. While the mass-distribution generally imposes high relative velocities between different-massed bodies, the mass discrepancies between particles in different mass groups have smaller impact on relative velocities when m1 and m2 are both on the larger-end. Within a reasonable degree of approximation and uncertainty, our results show that the dynamical features of planetesimals displayed in certain parts of the disk makes them "accretion-friendly" regions where planetary growth is accelerated.
9	The detection of dust gap-ring structure in the CR Cha protoplanetary disk Seongjoong Kim	We observe the dust continuum at 225 GHz and CO isotopologue (12CO, 13CO, and C18O) $J = 2-1$ emission lines toward the CR Cha protoplanetary disk using the Atacama Large Millimeter and Submillimeter Array (ALMA). The dust continuum image shows a deep and wide gap in the dust disk. Using the Gaussian fitting, we find that the dust gap is centered at ~ 90 au radius with $\sim 34\%$ gap depth and ~ 10 au width. A faint dust ring is also detected around 120 au beyond the dust gap. The CO isotopologue lines indicate that the gas disk is more extended than the dust disk. The peak brightness temperature of the 13CO line shows a small bump around 130 au while 12CO and C18O lines do not show. We investigate two possible mechanisms for reproducing the observed dust gap, ring, and a gas temperature bump. First, the observed gap structure can be opened by a sub-Jupiter mass planet using the relation between the planet mass and the

		gap depth and width. Meanwhile, the radiative transfer calculations based on the observed dust surface density profile show that the observed dust ring could be formed by dust accumulation at the gas temperature bump, that is, the gas pressure bump produced beyond the outer edge of the dust disk.
10	Effects of planetary migration and accretion on the long-term orbital stability of a multi-planetary system: case of HL Tau Shijie Wang	It is well known that the observed exoplanets exhibits large diversity. Many previous studies on dynamical evolution have shown that the orbital instability plays a vital role in shaping the planetary configurations after the disk dispersal. However, their results are often biased towards unstable initial conditions, and it is not clear whether such configurations can be produced through planet-disk interactions. Important clues brought by ALMA observation on HL Tau in 2015 suggest the potential presence of a nascent multi-planetary system in its primordial configuration. Pioneering work from Simbulan et al. (2017) connected HL Tau to planetary initial conditions and evolved the system to Gyr timescale. We performed improved simulations incorporating realistic planetary migration and mass accretion that are missing in their study, and adopted a disk profile taking account of feedbacks due to evolution of multi-planets. We successfully produced a variety of super-Jupiter planets by varying disk parameters. Our result show that the majority of planetary systems remain stable for at least 10 Gyr after the disk dispersal, which is roughly consistent with the instability time prediction. We will also discuss how migration and accretion together can stabilise the planetary system by smoothly delivering the planets to near-resonance position.
11	How large was the Milky Way 13 billion years ago? Sujan Prasad Gautam	The size distribution of the galaxies holds clues to their assembly history and relationship with their dark matter holes. The size of the galaxies are known to be vary with stellar mass, star formation rate, and red shifts and have been studied extensively. We used SExtractor, ds9, GALFIT, Aladin and python programming for analysing the morphology of luminous (L>L*) star forming galaxies observed ~650 Myr after the big bang (z~8) galaxies in the rest frame optical (IRAC 3.6 um and 4.5 um bands). They are like a progenitors of the massive galaxies observed in our local universe, such as our Milky Way. Size measurement of galaxies z>4 have been performed in the rest-frame UV. However, the rest UV mostly traces star-forming regions, potentially understimating the size. Access to rest-frame optical is required in order to better trace the stellar content of these galaxies. Lower resolution of IRAC data compared to the ground based nake the measurement of sizes very challenging. Because of this difference in resolution, we adopted an improved method. First we fit the source and then neighbours in the H-band then the results for the neighbours of the IRAC. It is important to include the neighbour sources for the fitting because their light profile may influence that of the target source. We handed each and every parameters of SExtractor and GALFIT carefully. But we got some difference in sizes (~ 0.9 kpc for IRAC 3.6 um and ~ 2.5 kpc for IRAC 4.5 um). It may be due to systematics that still need to be taken care of it a more refined analysis. Another possibility is that in IRAC 4.5 um, we have strong emission lines (OIII + Hbeta with EW~1000 AA), so a large size might be indicative of large amount of gases surrounding the galaxis.
12	Scattering-induced intensity reduction: large mass content with small grains in the inner region of the TW Hya disk Takahiro Ueda	Dust continuum observation is one of the best ways to constrain the properties of protoplanetary disks. The recent theoretical studies suggested that the dust scattering potentially reduces the observed intensity, which results in an underestimate in the dust mass. We investigate whether the dust scattering indeed reduces the observed intensity using the ALMA archive data of the TW Hya disk at band 3, 4, 6, 7 and 9. We find that, in the inner region of the disk, the observed intensities at band 7 and 9 are significantly lower than those estimated from the intensity at band 6 with assuming the spectral index of 2. To investigate the disk

		properties that can reproduce the ALMA observations, radiative transfer simulations are performed with RADMC-3D. We find that it is hard to explain the observed intensity in the inner region of the disk if the dust scattering is switched off. If we take the dust scattering into account, the observed intensity in the inner region of the disk can be reproduced by the model with the maximum dust size of 300 um with the surface density of 19 g/cm^2 at 10 au, which is 35 times higher than the MMSN model. The high dust surface density might trigger the planetesimal formation via the streaming instability in the inner region of the TW Hya disk.
13	Spiral-Arm Sub-Structures in the Asymmetrical Dust Ring in the Circumstellar Disk MWC 758 Patrick Koch	Asymmetrical features in disks can provide indirect evidences of embedded objects, such as planets. Observed with the Atacama Large Millimeter/submillimeter Array (ALMA), the circumstellar disk in MWC 758 traced with thermal dust continuum emission at wavelengths of 0.9 mm with an angular resolution of 15 au exhibits an asymmetrical dust ring with additional features. We present an analysis that — instead of averaging radial profiles — searches and traces features along the azimuthal direction. As a result, we identify three spiral-like arm structures that are robust even above a 10 sigma threshold. Using the spiral density wave theory we predict planet locations and disk aspect ratios. Finally, comparing to higher-resolution ALMA observations in MWC 758, we note that differences in analysis techniques and resolutions lead to different conclusions on the underlying sub-structures in this source.
14	Investigating the gas-to-dust ratio in the protoplanetary disk of HD 142527 Munetake Momose	We present ALMA observations of the 99 GHz dust continuum and the 13CO J = 1 - 0 and C18O J = 1 - 0 line emissions of the protoplanetary disk associated with HD 142527. The 99 GHz continuum shows a strong azimuthal-asymmetric distribution similar to that of the previously reported 336 GHz continuum, with a peak emission in dust concentrated region in the north. The disk is optically thin in both the 99GHz dust continuum and the C18O J =1−0 emissions. We derive the distributions of gas surface density, dust surface density, and the spectral opacity index of dust grains (β) in the disk from ALMA Band 3 and Band 7 data. The G/D varies azimuthally with a relation G/D $\propto \Sigma_g^{-0.53}$, and the β-index is derived to be ≈ 1 and ≈ 1.7 in the northern and southern regions of the disk, respectively. These results are consistent with the accumulation of larger dust grains in a higher pressure region. In addition, our results show that the peak of dust surface density is located ahead of the peak gas surface density. If the latter corresponds to a vortex of high gas pressure, the results indicate that the dust is trapped ahead of the vortex, as predicted by some theoretical studies.
15	Observational signatures of a fast inward migration planet and its impacts on planet formation Kazuhiro Kanagawa	A planet is formed in a protoplanetary disk. By interacting with surrounding gas and capturing the surrounding dust and gas, the orbital radius and planet mass change with time. Recent ALMA observations have discovered gap/ring structures which could be induced by the disk-planet interaction. Since the mass of the observed protoplanetary disk is relatively massive, these planets must experience a fast inward migration. In previous works, the gap shape has been investigated by hydrodynamic simulations, with a fixed planetary orbit. In this case, the radial position of the gap (location with the minimum surface density within the gap) always corresponds to the planetary orbital radius. However, when a turbulent viscosity of the disk is quite small and the mass of the disk is relatively massive, the locations of the planet and the gap can be different because the planet migrates inward before the gap fully opens. To address this issue, we carried out hydrodynamic simulations. We found that the difference in the locations of the planet and the gap becomes significant with the lower viscosity and a larger mass of the disk. We also found an empirical formula between the difference of the radial locations of the planet and the gap as a function of the migration timescale and the gap formation timescale. By using this formula, we can constrain the viscosity when the radial difference between the planet location and gap location is observed.

		We also found that the outer edge of the gap is modified by the fast inward migration. This modification of the outer edge can significantly affect the pebble (relatively large dust grains) trap at the planetary gap. We carried out two-fluid hydrodynamic simulations and investigate impacts of the fast migration on the pebble isolation mass. As a result, we found that in the case where the migration is fast enough, the pebbles can accrete onto the planet even if the planet mass reaches the pebble isolation mass in the case with a slow migration. This effect can change the orbital and mass evolutions of the planets within the protoplanetary disk. We will show the above two topics in the poster and discuss the implications of the disk evolution and planet formation.
16	Modelling Infrared Line Spectra of Complex Organic Molecules in Protoplanetary Disks Hideko Nomura	Protoplanetary disks are the natal place of planets. Understanding chemical components of gas, dust and ice in the disks is essential to investigate the origins of materials in our Solar system and other planetary systems. 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. COMs are efficiently formed on cold and warm grains in the disk midplane via hydrogen adding as well as radical-radical reactions on grain surface. Radiation processing on ice forms reactive radicals and helps build further complexity. ALMA observations have detected CH3OH from cold outer regions of protoplanetary disks, which suggests that the molecules are non-thermally desorbed from grains. Based on our model calculations, we perform ray-tracing calculations to predict line spectra of CH3OH observable with SPICA, which shows that detectable lines traces warm inner region of the disk where radical-radical reactions and thermal desorption take place. Also, we discuss possible connection of COMs in protoplanetary disks to those in the Solar system objects, such as comets.
17	Breaking resonant chains: Effects of mass evolution after disk gas depletion Yuji Matsumoto	Recent observations reported that some extrasolar systems composed of close-in super–Earths are in resonant chains (e.g., Mills et al., 2016; Luger et al., 2017). Formation of such resonant chains was also predicted by N-body simulations that consider orbital migration (e.g., Ogihara & Ida 2009; Izidoro et al., 2017; Bitsch et al., 2019). Based on a theoretical study of the orbital stability of the resonant chain (Matsumoto et al. 2012), planets stay in the resonant chain when the number of planets in the resonant chains is small. On the other hand, when the number of planets exceeds the critical number, planets cause orbital instability. Izidoro et al. (2017; 2019) investigated both the fraction of the resonant systems and the number of planets in resonant chains and found that these are smaller in the observed systems than those predicted by N-body simulations and the previous study of the orbital stability (Matsumoto et al. 2012). As a possible solution to this discrepancy, we focus on the mass evolution after formation. The masses of planets and stars would evolve after disk gas depletion. For example, planetary envelopes escape from planets by stellar EUV irradiation (e.g., Valencia et al., 2007; Owen 2018). Stars lose their mass by the stellar wind and coronal mass ejection (e.g., Wood et al., 2005; Aarnio et al., 2012). We have investigated the orbital stability of planets in resonant chains considering the mass evolution of planets and stars. We find that planets cause orbital instability even when the number of planets is smaller than the critical number estimated by Matsumoto et al. (2012). In particular, when the number of planets is slightly less than the critical number, the orbital instability can be triggered by only small changes (~1%) in mass. In conclusion, the observed properties of the resonant chain can be explained by the mass evolution of planets and stars after gas depletion.

18	Constraining the Formation of the Four Terrestrial Planets in the Solar System: No Success in Narrow Protoplanetary Disks Patryk Sofia Lykawka	Reproducing the terrestrial planets Mercury, Venus, Earth, and Mars remain elusive. To address that question, we performed N-body simulations of protoplanetary disks representative of typical models in the literature. From the analysis of our obtained terrestrial planet systems, we found that compared to the real planets, truncated disks based on typical outcomes of the Grand Tack model have serious difficulties in reproducing the four terrestrial planets. The situation is similar for similarly narrow disks considered by other models. Therefore, our results strongly suggest that such disks cannot explain the formation of terrestrial planets. In this presentation, we will also discuss the conditions that a protoplanetary disk must satisfy in order to form simultaneously the four terrestrial planets.
19	Final Masses of Giant Planets: Effect of Photoevaporation and a New Planetary Migration Model Hidekazu Tanaka	We develop a new simple model for giant planet formation, which predicts the final mass of a giant planet born in a given disk, by adding the disk mass loss due to photoevaporation and a new type II migration formula to our previous model. The proposed model provides some interesting results. First, it gives universal evolution tracks in the diagram of planetary mass and orbital radius, which clarifies how giant planets migrate at growth. Giant planets with a few Jupiter masses or less suffer only a slight radial migration. Second, the final mass of giant planets is approximately given as a function of only three parameters: the initial disk mass at the starting time of accretion onto the planet, the mass loss rate due to photoevaporation, and the starting time. On the other hand, the final planet mass is almost independent of the disk radius, viscosity, and initial orbital radius. The obtained final planet mass is similar to or less than 10% of the initial disk mass. Third, the proposed model successfully explains properties in the mass distribution of giant exoplanets with the mass distribution of observed protoplanetary disks for a reasonable range of the mass loss rate due to photoevaporation.
20	Trigger for rocky planetesimal formation inside the snowline of protoplanetary disks Yukihiko Hasegawa	We investigate the most probable formation process of planetesimals from rocky dust inside the snowline of the protoplanetary disk with weak turbulence. As the planetesimal formation models, we consider three instabilities, the dynamical and secular gravitational instabilities of the dust layer and the streaming instability of the disk, and evaluate the critical dust-to-gas ratio required for each process as a function of disk parameters. We show that for the realistic dust size distribution, the critical dust-to-gas ratio required for the secular gravitational instability is the smallest in the three models if the Stokes number of dust is less than unity. We find that for the minimum-mass solar nebula model, only the critical dust-to-gas ratio required for the secular gravitational instability is smaller than the dust-to-gas ratio inside 2 au, which suggests that the secular gravitational instability is the dominant mode for the trigger for planetesimal formation.
21	Evolution and growth of dust grains in protoplanetary disks with magnetically driven disk wind Tetsuo Taki	Magnetically driven disk winds (MDWs) are one of the promising mechanism of dispersal processes of protoplanetary disks (Suzuki et al. 2010, Bai 2013). When the DWs play a key role, the gaseous component of protoplanetary disks evolves in a different manner from that of the classical viscous evolution. As a result, the subsequent planet formation is also affected by the MDWs. In this work, we investigate the effects of the MDWs on the radial drift of solid particles with the size of 0.1μm - 1km. We propose that the MDWs is a possible solution to the "radial drift barrier" of collisionally growing dust grains, which is a severe obstacle to the planet formation (e.g., Nakagawa et al.1986). We calculated an approximate coagulation equation of dust grains with time-evolving disks that consist of both gas and solid components by a one-dimensional model. We discovered a new growth regime in which inwardly drifting dust particles collisionally grow to larger bodies against the radial drift barrier. If the radial profile of the gas pressure has an inflection point because of the removal of the mass and/or the angular momentum by MDWs, there is a

		region where the inward dust flow converges. As a result, a local concentration of dust particles is created, and eventually rapid collisional growth is triggered because the timescale of the collisional growth becomes sufficiently shorter than the timescale of the radial drift. These consecutive processes are realizable even though a clear bump of the gas pressure, which has been highlighted as a viable mechanism to build up solid particles, is not formed. An outcome of this mechanism is a ring-shaped concentration of planetesimals, which is expected to play a vital role in the subsequent planet formation.
22	CHONDRULE FORMATION THROUGH COLLISIONS BETWEEN PLANETESIMALS CONTAINING VOLATILE MATERIALS Sin-iti Sirono	From a physical point of view, the two most important quantities of chondrules still to be understood are size and cooling rate. Although many models have been proposed, consistent explanation of these two quantities is still lacking. The collision of molten planetesimals is a promising candidate mechanism for chondrule formation. However, the nebula gas is too rarefied to break the silicate melt ejected by the collision down to chondrule size (0.1 – 2 mm). Here we show that collisions of low temperature planetesimals containing volatile material naturally explain the size and cooling rate of chondrules. Rapidly heated volatile material quickly expands and break up the silicate melt down to the required small sizes.
23	Magnetic stellar activity during planetary system formation Wing-Huen Ip	Magnetohydrodynamical processes might have played very important effects in the evolution of the protoplanets and the corresponding planet-disk interaction. In this study, we explore whether the disk-locking effect might be linked to planet formation and its possible signature.
24	Numerical simulation for the distribution of small bodies in circumplanetary disks supplied from the protoplanetary disk Keiji Ohtsuki	Small bodies likely existed in the late stage of planet formation either as remnants of the planetesimal formation stage or as fragments produced by impacts between larger planetesimals. Using orbital integration that incorporates the gas flow around the planet obtained by hydrodynamic simulation, we examine delivery of small bodies in the protoplanetary disk into circumplanetary disks. Large bodies can be captured when they experience sufficient energy dissipation due to gas drag, thus they are captured near the midplane of the inner dense region of the circumplanetary disk. Small bodies initially confined within the midplane cannot accrete into the circumplanetary disk, because gas in the midplane does not accrete into the circumplanetary disk. On the other hand, small particles stirred off the midplane of the protoplanetary disk can be delivered into the circumplanetary disk with the vertically accreting gas, and are captured near the surface of the circumplanetary disk, where they experience strong gas drag. We will also discuss dynamical evolution of particles after their capture in the circumplanetary disk.
25	A Highly Structured Accretion Disk around the High-Mass Protostar IRAS 18089-1732 Vivien Chen	Dynamical instability in disks around high-mass protostars affects their accretion process and mass growth rate. Using the SMA at 850 um and ALMA at 1.3 mm, we resolve, for the first time, the highly structured accretion disk around the nearby (d=2.34 kpc) and luminous (L=1.3x10^4 Lsun) massive protostar IRAS 18089-1732 with an angular resolution of ~0.35", equivalent to ~820 AU. The continuum emission in both wavebands show similar structures resembling spiral arms in the disk. Emissions of multiple CH3CN lines reveal a rotating structure with steeper velocity gradient in emission of higher excitation, suggesting a disk with spin-up rotation. We further derive temperature distribution from multiple CH3CN lines of greatly different upper-level excitation. Intriguingly, a good fraction of disk region exhibits doubly-peaked spectral profiles. We will discuss the disk instability and plausible origins of the arm-like structures as well as the doubly-peaked spectral features.

26	Imaging Substructures in Protoplanetary Disks with the ngVLA Diana Blanco	Protoplanetary disks, planar, rotating structures composed of gas and dust, are a natural byproduct of stellar formation. Over the span of a few million years, the collisional assembly of dust grains (mm/cm sized particles) in disks surrounding young stars are thought to condense into planetesimals (km sized). Numerous physical processes have been suggested to explain the evolution of protoplanetary disks. However, several observational limitations arise due to the insufficient sensitivity and resolution of current telescopes. The Next Generation Very Large Array (ngVLA), thanks to its unprecedented sensitivity and angular resolution would allow us to detect, for the first time, structures in the disk predicted by physical processes which are thought to be responsible for the formation of planetesimals, the building blocks of planets. In this poster, I will present new results derived from ngVLA simulations using disk models that capture some of these physical processes.
27	Accretion of pebbles into the circumplanetary disk of a giant planet Natsuho Maeda	Regular satellites such as the Galilean satellites are considered to be formed by accumulation of solid particles supplied into the circumplanetary disks. Since small particles are easily affected by gas flow around the planet, we have to take account of the gas flow around the planet obtained by hydrodynamic simulation to examine how they are delivered into the circumplanetary disk to form satellites. Tanigawa et al. (2014) examined accretion of solid particles into circumplanetary disks using gas flow around the planet whose mass is 0.4MJup (MJup is mass of Jupiter) obtained by hydrodynamic simulation. However, satellites observed today were likely formed in the late stage of the formation of the host planet. In this study, we examine gas flow around a Jupiter-mass planet obtained by isothermal, local hydrodynamic simulation, and accretion of pebbles into the circumplanetary disk under the influence of such a gas flow, and compare with the case of a planet with mass of 0.4MJup examined in the previous work (Tanigawa et al. 2012). As shown in the previous study, the gas mainly flows into the Hill sphere from high latitudes and flows out at the midplane. This picture is similar to that of 0.4MJup case (Tanigawa et al. 2012). However, gas accretion band is several times larger than that of the 0.4MJup case. On the other hand, since the Hill radius of a Jupiter-mass planet is larger than the scale height of the protoplanetary disk, the net flux of gas inflow at high latitudes is smaller than that of the 0.4MJup case. Furthermore, there is a deep gas gap around the orbit of Jupiter-mass planet. We will discuss how these differences of gas fields affect accretion processes of pebbles into circumplanetary disks.
28	Planet Migration in Inviscid Dusty Protoplanetary Disks He-Feng Hsieh	We perform two-fluid simulations to study planet migration in inviscid dusty protoplaentary disks via FARGO3D. For Stokes number equals to 1e-3, a low-density region could form beyond the planet in the dust phase. The low-density region may slow down the migration rate due to the varied differential torques from the dust phase. For cases of higher Stokes number (St ~ 1e-1), we found the planet could induce some instabilities (not identified yet) and create numerous high-denisty blobs in the dust phase. The interaction between the planet and blobs could revert the migration direction transiently and cause the planet behaves chaotically
29	Global Non-ideal MHD Simulations of Protoplanetary Disks: Dead Zone Boundaries Kazunari Iwasaki	In this work, focusing on the inner dead-zone boundary, we investigate the evolution of protoplanetary disks by using global non-ideal MHD simulations taking into account Ohmic resistivity and Ambipolar diffusion. We found that gas accretion is driven by the MRI turbulence in the inner MRI-active region and by the wind stress in the outer dead zone. The magnetic field in the dead zone close to the dead-zone boundary has a complex structure because the turbulent magnetic field in the upper regions penetrates into the dead-zone due to magnetic diffusion. Moreover, ring and gap structures appear around the dead-zone boundary. These structures arise from the difference of angular momentum transport mechanisms across the dead-zone boundary.