31th Grain Formation Workshop

ABSTRACT Booklet

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Date：7th January, 2015 – 9th January, 2015

Venue:　文部科学省共済組合箱根宿泊所 強羅静雲荘

〒250-0408 神奈川県足柄下郡箱根町強羅1320

Program

7th, January (Wednesday)

13:00-13:30 registration

13:30-13:40 opening remark

13:40-14:20 Takashi Onaka (University of Tokyo)

"Study of interstellar ices based on AKARI observations"

14:20-15:00 Takashi Shimonishi (University of Tokyo)

"Processing of ices in a massive star-forming region"

15:00-15:20 coffee break

15:20-16:00 Tamami Mori (University of Tokyo)

"Capturing the CO molecular emission of mysterious ejecta in G318.05+0.09"

16:00-16:40 Ronin Wu (University of Tokyo)

"Physical properties of molecular gas and dust in the star-forming regions"

16:40-17:20 Mitsuhiko Honda (Kanagawa University)

"Dust sciences in the protoplanetary disks in the 2020s"

17:20-18:00 Posters; C. Kaito (Ritsumeikan Univ.), I. Sakon (Univ. of Tokyo)

18:00-20:00 Dinner

21:00-22:00 Discussion

8th, January (Thursday)

8:00- 9:00 Breakfast

9:00- 9:40 Chiyoe Koike (Ritsumeikan University)

"The infrared spectra of wustite particles and those properties"

9:40-10:20 Akemi Tamanai (Heidelberg University)

"Infrared investigations focused on non-stoichiometric amorphous silicates"

10:20-10:40 Coffee break

10:40-11:20 Aki Takigawa (Kyoto University)

"Isotopes, morphologies, crystal structures, and microstructures of circumstellar oxide dust"

11:20-12:00 Yuki Kimura (Hokkaido University)

"Nucleation processes of cosmic dust particles: Case of iron"

12:00-13:20 Lunch / Poster

13:20-14:00 Seiji Kimura (The University of Electro-Communications)

"Synthesis of nitrogen-bearing carbonaceous material with 220 nm absorption and the structural implication by Raman spectroscopy"

14:00-14:40 Amit Pathak (Tezpur University)

"Spectroscopy of Interstellar Polycyclic Aromatic Hydrocarbons (PAHs)"

14:40-15:20 Rupjyoti Gogoi (Tezpur University)

"The Dust Content and Radiation Fields of sample of galaxies in the ELAIS-N1 field"

15:20-15:40 Coffee

15:40-16:20 Hitoshi Miura (Nagoya City University)

"Evaporation of icy grains in nebular shocks"

16:20-17:00 Kyoko K. Tanaka (Hokkaido University)

"Thermal evolution of planetesimals and dust particles by planetesimal bow shocks"

17:00-17:40 Tetsuo Yamamoto (Kobe University)

"Adhesion of small particles"

18:00-20:00 Dinner

21:00-22:00 Discussion

9th, January (Friday)

8:00- 9:00 Breakfast

9:00- 9:40 Mark Hammonds (University of Tokyo)

"Interstellar PAHs: Emission band profiles and structural variation"

9:40-10:20 Ryou Ohsawa (IoA, University of Tokyo)

"PAH Processing in the HII region: M1-78"

10:20-11:00 Takafumi Kamizuka (IoA, University of Tokyo)

"MIMIZUKU -The mid-infrared camera and spectrograph
on the TAO telescope-"

11:00-11:10 Closing remark

11:10-14:00 Lunch/Discussion

Abstract

7th January, 13:40-14:20

"Study of interstellar ices based on AKARI observations"

Takashi Onaka (University of Tokyo)

The Infrared Camera (IRC) on board AKARI offered an unique capability of high-sensitivity spectroscopy in the near-infrared (2–5 micron), which allows us for the first time a through study of H2O and CO2 ices in the interstellar medium. Based on about 80 lines-of-sight toward PDR-HII complexes, the column densities of H2O and CO2 ices are estimated. They show a clear correlation consistent with previous ISO studies, which support formation of both ices in tandem. They also indicate a possible threshold in Av for the presence of the ices. Spatial variations in objects are also discussed.

7th January, 14:20-15:00

"Processing of ices in a massive star-forming region"

Takashi Shimonishi (University of Tokyo)

Chemical reactions in ice mantles differ from gas-phase reactions in various aspects and they play an essential role in the chemical evolution of star-/planet-forming regions particularly in their early evolutionary stage. Understanding the effect of star-formation activities such as outflows or stellar radiation on properties of ice mantles is one of the key issues for ice chemistry. For this purpose, it is important to investigate the spatial distribution of ices in star-forming regions. However, previous observations of ices are mostly limited to single line-of-sight spectroscopy and "ice mapping" observations are currently very few. We performed near-infrared (2.5 -- 5 micron) spectroscopic mapping observations toward a massive star-forming region Cepheus A East using AKARI/IRC. We detect absorption bands of major ice species (H2O, CO2, CO) throughout the observed regions and investigate spatial distribution of ices and spatial variation of ice chemical compositions around high-mass protostellar objects. In this presentation, we discuss the effect of radiation and outflows from protostellar objects on the chemical and physical properties of circumstellar ices based on the infrared spectroscopic data.

7th January, 15:20-16:00

“Capturing the CO molecular emission of mysterious ejecta in G318.05+0.09”

Tamami Mori (University of Tokyo)

Supernovae (SNe) and supernova remnants (SNRs) are attracting a great deal of attention as molecular factories in the universe as well as dust budgets. However, the evolution of molecules and dust in the remnant phase is not well understood yet. G318.05+009 is a ~40' radius radio-shell which is a complex of a possible SNR and several HII regions. From the AKARI/IRC 2-5 um spectroscopy, we discovered one unique object (hereafter "G1") in this system. The spectrum of G1 exhibits emission bands peaking at 4.45 and 4.75 um respectively, which can be well fitted by a CO fundamental band emission model with the temperature of 1800 K and the radial velocity of -4500 km/s. It is difficult to produce such a fast-moving ejecta in Galactic objects other than SNRs, and the absence of hydrogen molecular emission suggests unusual gas abundance. SNR signatures are also reported for this region from radio and X-ray observations. It is highly likely that G1 is a SN ejecta. If it is the case, G318.05+009 is the second SNR for which warm CO emission is detected a long time (~ 1000 years) after the explosion, providing us a rare opportunity to study evolution of molecules and dust in SNRs and their progenitors.

7th January, 16:00-16:40

"Physical properties of molecular gas and dust in the star-forming regions"

Ronin Wu (University of Tokyo)

Since the launch of the Herschel Space Observatory, our understanding about the photo-dissociation regions (PDR) has taken a step forward. In the bandwidth of the Fourier Transform Spectrometer (FTS) of the Spectral and Photometric Imaging REceiver (SPIRE) on board Herschel, ten CO rotational transitions, including J=4-3 to J=13-12, and three fine structure lines, including [CI] 609, [CI] 370, and [NII] 250 micron, are covered. In this talk, I present the relationship between the physical properties of observed warm CO and dust in the nuclear region of M83, at a scale of hundreds of parsecs, and near the young star cluster, Trumpler 14, in the Carina Nebula, at a scale of a few parsecs. Based on these observations, I discuss the possibilities of tracing stellar feedback and dust contents, including the PAH molecules and the carriers of the 22 micron feature, with warm CO.

7th January, 16:40-17:20

“Dust sciences in the protoplanetary disks in the 2020s”

Mitsuhiko Honda (Kanagawa University)

In the 2020s, the next generation facilities such as TMT and SPICA will start operation, and they will open up a frontier of the dust sciences in the protoplanetary disks. We will briefly introduce the candidate instruments for these sciences, and review the science cases suggested so far. We welcome your comments/inputs to the 2020s future science cases to support the canadiate instruments.

7th January, 17:20-17:30

"Characteristic Formation of Ultrafine CaCO3 Grain Crystal"

Chihiro Kaito (Ritsumeikan University)

Cosmic dust grain formation of universe composition were presented oxide rich stars or carbon rich stars. If the value of long (C/O) values are lager one and less than one, carbon rich stars and oxygen rich star formed as presented the sequence of Huffman report. Temperature dependences of carbon rich materials were presented C(2000oC),SiC(1400oC),CaCO3(1200oC),Fe3C (900oC),and Al4C3(900oC).

In the present experiment on the CaCO3 structure have been produced by the evaporation in inert gas of Ar 99 Torr and O2 1Torr mixture film. C powder is heated at 2968K using a carbon rod with a small hole. Above 20 mm, Ca powder on carbon small hole is heated at 1081 K. Coalescence between amorphous C ultrafine particle and bcc Ca ultrafine particle in mixture gas of Ar and O2 showed CaCO3 ultrafine crystal particles less than 50 nm.

7th January, 17:30-17:40

"Infrared properties of nitrogen-containing carbonaceous composite & Dust exposure experiment project using ISS/JEM/ExHAM"

Itsuki Sakon (University of Tokyo)

Unidentified infrared (UIR) bands have been observed in various circumstellar and interstellar environment. Although the observed behavior of the UIR bands is generally interpreted based on the polycyclic aromatic hydrocarbon (PAH) hypothesis, the firm identification of the carriers of the UIR bands has not yet been made perfectly. We have started the laboratory experiments to investigate the infrared properties of various laboratory synthesized carbonaceous compounds. Our preliminary laboratory experiments have shown that Nitrogen-Containing Carbonaceous Composites, produced by irradiating nitrogen plasma on PAHs, exhibit infrared spectral characteristics similar to the observed UIR bands. Further laboratory experimental approaches are still useful for the true understanding of the properties of the carriers of UIR bands.

We have started an experimental investigation program using JEM/ExHAM on the International Space Station (ISS) aiming to attain accurate knowledge on the compositional, chemical and physical properties of interstellar dust. One of the major goals of this project is to identify key physical and chemical processes that act on carbonaceous dust and that may produce the true carriers of unidentified infrared (UIR) bands and those of the 2175Å interstellar extinction bump. Various laboratory-synthesized carbonaceous solids including quenched carbonaceous composites (QCCs; Sakata et al. 1983) and nitrogen-Containing Carbonaceous Composites (NCCC) are planned to be brought and exposed to the cosmic environment at ISS orbit for ~1 year by means of JEM/ExHAM. In this presentation, we introduce the current status of our exposure experiment program titled "Quest for the Compositional identification and Chemical evolutional understanding of the Interstellar Carbonaceous Dust based on the experiment using JEM/ExHAM on the ISS".

8th January, 9:00- 9:40

"The infrared spectra of wustite particles and those properties"

Chiyoe Koike (Ritsumeikan University)

The mysterious 21μm emission feature seen in C-rich proto-planetary nebulae remains unidentified since its discovery in 1989 (Kwok, Volk and Hrivnak, 1989), and the candidate carriers have long been the subject of discussion. Among many carrier candidates, the calculated spectra of FeO nano particles closely matched the observed 21μm emission features and seems to be a viable candidate (Zhang et al. 2009). We measured infrared spectra of wustite of synthesized samples and commercial samples and found the peak shifted from sample to sample. We will discuss about difference of spectra among wustite samples and those crystal structure connected defects. Further, we will discuss about 21μm emission feature compared with the results of the present iron oxide particles.

8th January, 9:40-10:20

"Infrared investigations focused on non-stoichiometric amorphous silicates"

Akemi Tamanai (Heidelberg University)

The Fe-Mg silicates are important dust species in both circum- and interstellar environments. In most cases, amorphous silicates found in chondrites have stoichiometries deviating significantly from the stoichiometry of crystalline counterparts e.g. Mg_2SiO_4 and $MgSiO_3$. Based on a relation between the Mg & Fe ratio (Mg/(Mg+Fe)) of olivine and coexisting amorphous silicate in chondrites, the Fe-rich amorphous olivine might undergo crystallization due to metamorphic processing on asteroidal parent bodies or under non-equilibrium thermal processing in the nebula. Additionally, model calculations of dust grain condensation anticipated that in contrast to Mg-rich silicate condensation under equilibrium conditions, Fe-rich silicate condensation more likely occurred under non-equilibrium conditions. However, formation and evolution processes of Fe-Mg silicates have not been well understood yet. We report a result of the vibrational changes in the silicate absorption spectra, especially, Si-O stretching and O-Si-O bending bands so as to achieve a better understanding of the effect of metals on the vibration bands of silicates. The silicates with different Mg:Fe ratio were deposited on Si-wafers by means of pulsed laser deposition technique and the thin film stoichiometry was determined by Rutherford Back-Scattering spectroscopy. The results may help to analyze the nature and composition of silicate dust in protoplanetary disks.

8th January, 10:40-11:20

“Isotopes, morphologies, crystal structures, and microstructures of circumstellar oxide dust”

Aki Takigawa (Kyoto University)

Presolar grains are rare components of primitive chondrites. The isotopic compositions of the presolar grains indicate that they are circumstellar dust grains formed around evolved stars such as AGB stars and SNe. They have survived several processing in the interstellar medium and the early solar system before the incorporation into the parent bodies of the meteorites. Isotopic compositions, morphologies, microstructures, and crystal structures of the presolar grains potentially preserve their formation and evolution history. The recent results of microanalysis of presolar oxide grains will be presented.

8th January, 11:20-12:00

"Nucleation processes of cosmic dust particles: Case of iron"

Yuki Kimura (Hokkaido University)

Nucleation is a process to form stable particles by self-assembly of atoms, molecules or ions and to overcome a free energy barrier to generate a new surface. There is a lots of matters for debate in this process, because it passes through the size of meso-scale. We, therefore, believe physical properties and singular phenomena of nanoparticles must be taken into account to understand the nucleation process and also formation process of cosmic dust particles. In order to understand the nucleation process, we started new experimental projects based on in-situ observation of temperature and concentration using an interferometer, and infrared spectra by FT-IR spectrometer during nucleation from a vapor phase. Here, we show our recent results related to formation and evolution of cosmic dust particles accompanying with stellar life.

8th January, 13:20-14:00

"Synthesis of nitrogen-bearing carbonaceous material with 220 nm absorption and the structural implication by Raman spectroscopy"

Seiji Kimura (The University of Electro-Communications)

We have produced N-bearing carbonaceous materials by exposing nitrogen plasma to graphitic substrate and coronene in order to identify the structural factors of 220 nm absorption obtained experimentally. Raman spectra of N-bearing materials show extra peaks in addition to G- and D-peaks resulting from vibrational modes of an ordered graphitic lattice and disordered carbon only when the absorption wavelength positions 220 nm peak. This result is consistent with results of QCCs, coal, mesophase with 220 nm absorption as reported in previous GFWS, indicating that local carbon structures such as conjugated double bonds (-C=C-C=C-) play an important role in determining the UV absorption near 220 nm. The interpretation on the peculiar locality can account for origin of the similar 220 nm absorption without depending on variations of carbonaceous materials. Considering that interstellar dust should consist of a diversity of population distribution in different interstellar environments, the experimental facts may be suited for explaining the universally observed constancy of the interstellar 217.5 nm feature. In this report, we present results of the synthetic experiment and discuss an origin of the 217.5 nm feature on the basis of the experimental results.

8th January, 14:00-14:40

"Spectroscopy of Interstellar Polycyclic Aromatic Hydrocarbons (PAHs)"

Amit Pathak (Tezpur University)

Polycyclic Aromatic Hydrocarbon (PAH) molecules have been suggested to be an important constituent of the interstellar medium having up to 10% of the total carbon content of the universe. PAH family is said to be the carrier of the mid-IR emission bands, could contribute to the 217.5 nm absorption feature and the far-UV rise of the extinction curve as well as may be the carrier of some of the Diffuse Interstellar Bands (DIBs). I will be discussing the spectra of PAHs in the mid-IR and the visible bands in context with some of the above mentioned research problems of the ISM.

8th January, 14:40-15:20

“The Dust Content and Radiation Fields of sample of galaxies in the ELAIS-N1 field”

Rupjyoti Gogoi (Tezpur University)

The Mid-IR colors of galaxies together with their IR-UV correlations can be used to get an insight into the dust and stellar content of galaxies. The ELAIS-N1 field contains thousands of galaxies which do not have optical spectra but have been observed in the Mid-IR by Spitzer and UV by GALEX making it ideal for these studies. We have selected a sample of galaxies from the field which have photometric redshifts from the SDSS database and found that there is reasonable correlation between the Mid-IR and the UV luminosities. Also, we try to divide the sample into different radiation field groups based on their 8micron/24micron ratios.

8th January, 15:40-16:20

"Evaporation of icy grains in nebular shocks"

Hitoshi Miura (Nagoya City University)

Gravitational collapse of a molecular cloud is a transient process to form protostars and protoplanetary disks. The infalling envelope onto the Keplerian disk often induces accretion shocks at their boundary. Recent ALMA observations suggested evaporation of icy grains at the shocked region. According to the observations, some molecular species are enhanced at the radius of the centrifugal barrier. The icy grain evaporation would considerably affect the chemical environment of the nebula, however, the shock conditions for the icy grains to evaporate, such as shock velocity and gas number density, have not been investigated systematically. We numerically simulated the shock heating and evaporation of icy grains in a wide range of the shock conditions that would be realized in the nebular environment. We adopted a one-dimensional plane-parallel shock code that we have developed to investigate the formation of chondrules. We assume icy grains composed of a single component, such as CO, CO2, or H2O, for simplicity. The shocked region is assumed to be optically thin for both of the molecular line emissions and continuum thermal emission. Our results suggest that CO2 and H2O grains hardly evaporate by the accretion shock with typical shock velocities and gas densities. The shock diagram that we obtained provides criteria of the shock conditions for icy grain evaporations.

8th January, 16:20-17:00

"Thermal evolution of planetesimals and dust particles by planetesimal bow shocks"

Kyoko K. Tanaka (Hokkaido University)

In protoplanetary disks, planetesimals grow to planets through their mutual collisions and accumulations. The gravitational interactions among planetesimals increase the eccentricities of their orbits. When the relative velocity between a planetesimal and the disk gas exceeds the speed of sound of the gas, a bow shock is produced. In particular, the formation of Jupiter induces resonances and strong plantesimal bow shocks are generated around the asteroid belt (~2–5 AU). Because of the shock heating, icy planetesimals suffers a significant evaporation even outside the snow line and produces a large amount of icy fine grains with the recondensation of the vapor. The planetesimal bow shocks also give short-time-scale heating of dust grains, which is appropriate for the formation of chondrules included in chondritic meteorites. We introduce our recent studies about the thermal evolution of planetesimals and dust particles by the planetesimal bow shocks (Tanaka et al. ApJ, 2013, 764, 120, Nagasawa et al. 2014, ApJL, 794:L7).

8th January, 17:00-17:40

“Adhesion of small particles”

Tetsuo Yamamoto (Kobe University)

Collisional growth of dust in protoplanetary disk is one of the key processes for formation of planetesimals. N-body simulations of collisional growth done so far revealed that silicate aggregates cannot for for expected in the disks, whereas H2O ice aggregates can. This is mainly due to the difference of their surface energies. We examine the nature of adhesion forces between two particles. We take two kinds of approaches, namely, macroscopic and microscopic ones and examine the results of the experiments of measuring adhesive force between two particles. Discussion is given on the implications to collisional growth of dust in astrophysical situations.

9th January, 9:00- 9:40

"Interstellar PAHs: Emission band profiles and structural variation"

Mark Hammonds (University of Tokyo)

Polycyclic Aromatic Hydrocarbons (PAHs) and/or related structures are widely accepted to be the cause of the extremely luminous mid-infrared emission observed ubiquitously throughout the Universe. However, to date, no one specific molecular structure has been unambiguously identified astronomically. This talk will elaborate on the background of the PAH hypothesis and discuss some current efforts to identify the type of PAHs present in astrophysical environments, using near-IR data from the AKARI IRC instrument, combined chemical data on PAH structures and their expected emission bands.

9^{th} January, 9:40-10:20

"PAH Processing in the HII region: M1-78"

Ryou Ohsawa (IoA, University of Tokyo)

Polycyclic aromatic hydrocarbons (PAHs) are thought to be carriers of the aromatic infrared bands (AIBs). Although PAHs account for only about 10% of carbons in galaxies, they efficiently convert UV into infrared and produce the strong emission bands. PAHs may have some impact on the chemistry in the Universe. The life cycle of PAHs remains to be investigated. Since PAHs are small particles, they can be destroyed in harsh environments by photo-dissociation or ion-sputtering. Observationally, PAH emission becomes weak inside HII regions, indicating the destruction of PAHs. The intensity ratio of the 3.3 to 11.3μm PAH features is suggested as a promising indicator of the PAH destruction, but no observation had confirmed the variation in the ratio within a single HII region. The spatial distribution of the PAH emission is investigated in a Galactic HII region, M1-78, with Gemini/NIRI and Subaru/COMICS. The intensity ratio of the 3.3 to 11.3μm PAH features becomes smaller around the ionizing star. The variation in the ratio may be attributed in part to the destruction or dehydrogenation of small-sized PAHs. Although the mechanism of PAH processing remains to be identified, the present result suggest that observations with a high spatial resolution in both the near- and mid-infrared are effective to investigate the processing and evolution of PAHs.

9th January, 11:00-11:40

"MIMIZUKU – the mid-infrared camera and spectrograph on the TAO telescope –"

Takafumi Kamizuka (IoA, University of Tokyo)

The University of Tokyo is constructing a ground-based observatory named TAO on the summit of Co. Chajnantor (5640-m altitude) at the Atacama Desert in Chile. A 6.5-m telescope will be installed, and a mid-infrared camera and spectrograph, MIMIZUKU, is being developed as its 1st-generation instrument. Owing to dry climate and high altitude, the site gives new atmospheric windows like near-infrared water-absorbing bands and long-wavelength mid-infrared bands. They allow us to investigate hydrous materials and cool dust in the universe. The MIMIZUKU covers a wavelength range of 2 – 38 microns, which covers the whole new atmospheric windows. Low-resolution spectroscopy modes (R = 60 – 170) are also available in the wavelength region. The MIMIZUKU has a unique mechanism called "Field Stacker". It enables us to observe two fields within 25′ simultaneously. This observation mode enables real-time atmospheric calibration, and it will improve photometric and spectroscopic accuracy, which are important for long-term monitoring observations. We aim to explore formation, destruction, and alteration of dust through monitoring time-variable phenomena utilizing this capability. Development will be completed in 2015, and early science observations are planned in 2016 at the Subaru telescope. Observations at the TAO telescope will be opened after its completion around 2017.

“Herschel and ALMA observations of dust in Supernova 1987A”

Mikako Matsuura (University College London)

The formation of dust in core-collapse supernovae (SNe) is one of the key processes in the chemical and physical evolution of supernova, with implications for the origin of dust in the interstellar media of galaxies.

I will present Herschel Space Observatory’s discovery of a large dust reservoir in SN 1987A. The estimated dust mass was 0.4-0.7 solar masses, which is more than 1000 times larger than the previously reported mass. Following ALMA high-angular resolution images have confirmed that cold dust grains were formed in the supernova ejecta. A significant fraction of the elements synthesized by the supernova have now condensed into solid phase (dust grains), showing supernovae as dust factories.

ALMA also discovered unexpectedly strong CO and SiO rotational lines in SN 1987A, showing supernova ejecta are filled with cold molecular gas. The ALMA will provide crucial constraints on supernova nucleosynthesis, with an implication of more precise modelling of chemical evolution of galaxies.

List of Participants

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