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Editorial

Cosmic Dust VII

For dust you are and to dust you will return.
Genesis 3:19

1. Interdisciplinary research on cosmic dust

Cosmic dust has long been recognized to play a key role in astronomy, especially in planetary science, space science, astrophysics, astrochemistry, astrobiology, and astromineralogy. The reason for its crucial importance is that it has been found essentially in all the environments where the temperature is low enough for gases to condense into solids. Dust carries critical information on the medium where it is observed and acts as a fantastic probe into the physical properties and chemical conditions of various astronomical objects. Over the years, each astronomical community has naturally developed its own observing strategies, laboratory equipment, models, numerical codes, etc. As a consequence, it has become a real challenge of the present day to get a consistent and global picture of such considerably diverse approaches using cosmic dust as a tool, despite the broadly shared interest in it.

A series of Cosmic Dust meetings[1] provides a unique opportunity to overcome this difficulty. These meetings cover the widest range of cosmic dust research in the world by gathering experts from different fields in astronomy with the goal to share their best knowledge of dust. Since 2006, we have been organizing the Cosmic Dust meetings in Asia, every time with a small number of invited experts from various fields of dust, together with a limited number of contributed experts. The basic format of the meeting is made up of 50–60 selected attendees and ample time for both scientific discussion and the development of interpersonal relationships during long coffee breaks and enjoyable evening events. A banquet and a half-day excursion also contribute to making these meetings a pleasant moment, and providing a very specific place to trigger new projects and come up with emerging new ideas. Therefore, the overall atmosphere of the meetings is conducive to establishing long-term relationships and possible collaborations across scientific disciplines.

The 7th meeting on Cosmic Dust (hereafter "Cosmic Dust VII") was held at the Umeda Satellite Campus of Osaka Sangyo University, Japan, from August 4 to 8, 2014. It was fortunate for us that we could have a great list of invited speakers year after year from a broad range of research fields. The invited speakers of Cosmic Dust VII were Michael F. A'Hearn (University of Maryland, USA), Til D. Birnstiel (CfA, USA), Erika L. Gibb (University of Missouri-St. Louis, USA), Mika J. Juvela (University of Helsinki, Finland), Michael S.P. Kelley (University of Maryland, USA), Antonio Mario Magalhães (University of São Paulo, Brazil), Rachel Mason (Gemini Obs., USA), Takaya Nozawa (NAOJ, Japan), Johan Olofsson (MPIA, Germany), Takashi Onaka (University of Tokyo, Japan), Aurélie Rémy-Ruyer (CEA Saclay, France), and Toru Yada (ISAS/JAXA, Japan). They gave outstanding 40-min talks covering various themes as described in the next section, and served as excellent chairpersons and members of the panel for the best poster contest. The Best Poster Award of Cosmic Dust VII was received by Shoji Mori for his paper entitled "Interplay between dust and MHD turbulence in protoplanetary disks: Electric-field heating of plasmas and its effect on the ionization balance of dusty disks" (Mori and Okuzumi, 2014). Successful contributed speakers presented their recent work through either a 20-min talk or a poster with a 1-min introductory talk prior to the first poster session. The posters were displayed throughout the meeting for intensive discussion along with extended coffee breaks that lasted for 1 h every time following each 1-h oral session. The abstracts of the talks and the posters presented at the meeting are available for download at the Cosmic Dust website (https://www.cps-jp.org/~dust/Program_VII.html). Fig. 1 is a group shot of the participants taken immediately after the banquet, held on the Dojima waterfront of the Aqua Metropolis Osaka.

This special issue in Planetary and Space Science (PSS) is aimed at collecting the new results and original ideas that were presented at Cosmic Dust VII in 2014. We are pleased that this issue also includes relevant papers from scientists outside the meeting attendees, so that it warrants total coverage of the most recent findings (Krełowski, 2015; Moores et al., 2015). In Section 2, we shall overview the papers presented at Cosmic Dust VII, since the reader is not necessarily familiar with the subject of this volume. The papers are classified into subsections according to their dusty environments in the same way as the program of the meeting, although we admit that the classification is not unique. Section 3 briefly describes our perspectives for the development of cosmic dust research and ends with our concluding remarks.

2. The contents of Cosmic Dust VII

2.1. Solar system

Comets are the oldest fossils of primitive ices and dust at the early stages of the Solar System formation, while their surfaces are processed by solar radiation (Whipple, 1950). In a classical picture of comets, the sublimation of water ice near the surface of a nucleus in the inner Solar System is a driving force for water molecules to drag dust from the surface and accelerate it until it decouples in the outer coma. Michael F. A'Hearn reported that the

[1] URL: http://www.cps-jp.org/~dust

http://dx.doi.org/10.1016/j.pss.2015.03.002

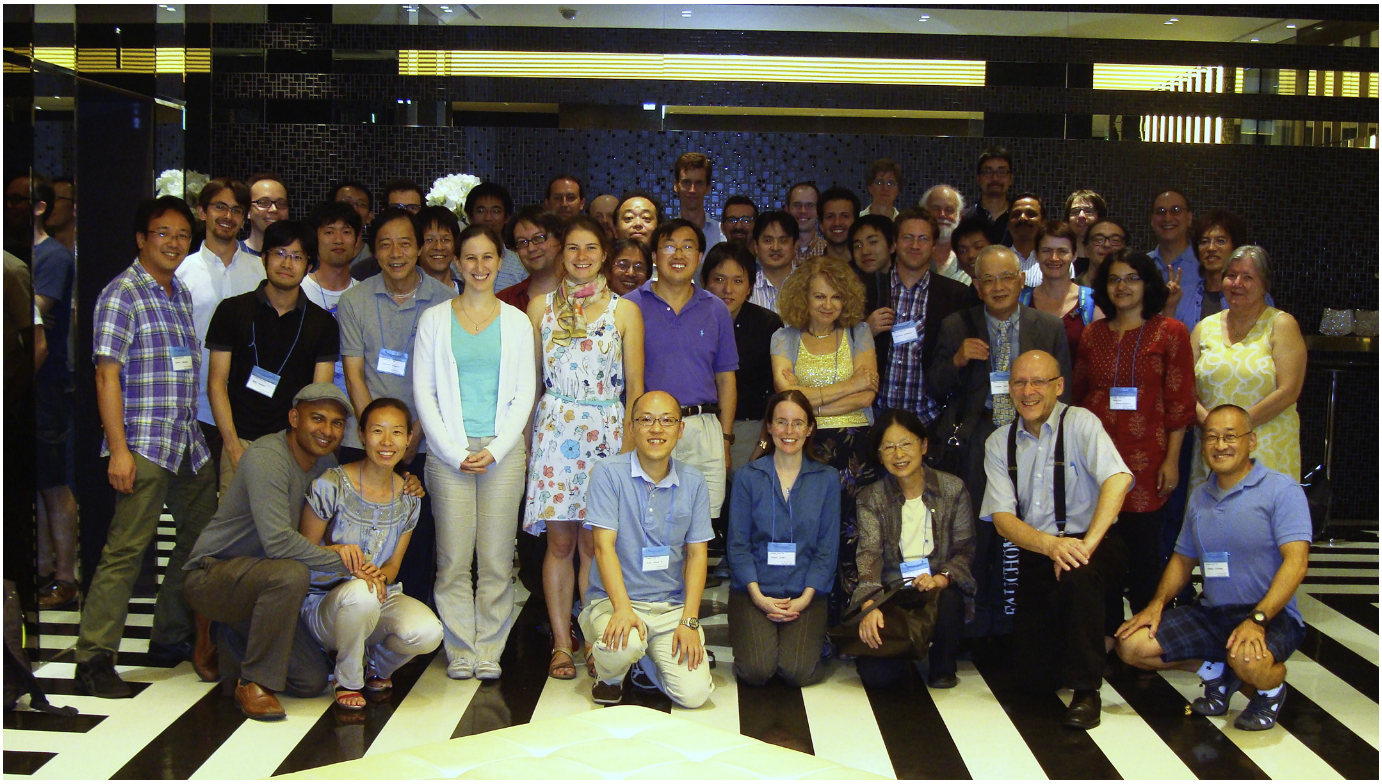

Fig. 1. A group picture of participants to Cosmic Dust VII: (in no particular order) Z. Wahhaj, B. Yang, A.K. Inoue, E. Gibb, C. Koike, A.M. Magalhães, H. Chihara, H. Senshu, R. Tazaki, T. Onaka, A. Rémy-Ruyer, M. Khramtsova, A. Li, L. Kolokolova, C. Kaito, P. Shalima, J.-F. Gonzalez, G. Chiaki, S. Mori, M. Hammonds, T. Yada, T. Shimonishi, S. Bromley, R. Mason, H. Kimura, T. Birnstiel, T. Nozawa, T. Hendrix, M. Yamagishi, F. Galliano, M. Juvela, K. Murakawa, J. Olofsson, E. Bron, K. Bekki, M.S.P. Kelley, G. Aniano, T. Kokusho, V. Sterken, M.F. A'Hearn, Y. Hattori, H. Kobayashi, H.S. Das, A.C. Bell, and A. Brieva.

picture has drastically changed within the last ten years, owing to the advent of infrared space telescopes, space missions to comets, and advances in the theory of Solar System formation (A'Hearn, 2014). It turns out that water molecules are released primarily in the coma from large chunks of nearly pure ice and do not drag dust from the surface (A'Hearn et al., 2011). In addition, the chunks, which are most likely fluffy porous aggregates of 1 μm water ice grains, are found to exist separately from dark material (Protopapa et al., 2014). This is totally dissimilar from a model of icy grains proposed by Greenberg (1998), in which water ice covers dark refractory grains. The separation of icy grains and non-icy, refractory grains has also been observed in a protoplanetary disk as a temporal variation in the 3 μm water ice absorption against a constant dust continuum (Terada et al., 2007). Therefore, recent observations suggest that icy grains and refractory grains are separately present in protoplanetary and debris disks, as well as comets. *It is clear that these findings shed new light on the formation of icy grains, if the majority of water ice in comets does not form on the surfaces of refractory grains.*

Other papers covered the following topics: infrared spectral fittings of dust in cometary comae by Michael S.P. Kelley; the curation and characteristics of Hayabusa-returned particles from the S-type Near-Earth Asteroid 25143 Itokawa by Toru Yada; submillimeter observations of comet dust by Bin Yang; numerical simulation on the motion of electrically charged grains above the surfaces of airless bodies by Hiroki Senshu (Senshu et al., 2015); a laboratory experiment on the infrared spectra of LIME (Low Iron Manganese Enriched) olivine by Hiroki Chihara; radiative transfer modeling of impact ejecta curtains by Shalima Puthiyaveettil (Shalima et al., 2015); numerical simulation on light scattering by porous spheroidal particles with rough surfaces by Himadri Sekhar Das (Kolokolova et al., 2015).

2.2. Debris disks

Infrared space observatories such as Spitzer and Herschel have provided valuable spectral data of debris disks at different stages of evolution. Johan Olofsson addressed dust mineralogy in debris disks as well as protoplanetary disks in terms of disk evolution and planet formation (Olofsson et al., 2014). The spectral decomposition of the data relies on, to a great extent, laboratory measurements of infrared spectra with synthesized or natural terrestrial grains. Among the emission features of crystalline olivine, the 69 μm feature has been used as an indicator of the grain temperature and the iron fraction in olivine grains (e.g., Koike et al., 2006). It is, however, worth mentioning that the spectral decomposition of debris disks often does not incorporate the knowledge of dust mineralogy acquired through in situ and laboratory analyses of real dust samples from comets, despite the similarity of their infrared spectra. Laboratory measurements of the 69 μm feature were performed with pure olivine grains, but the absence of pure olivine grains is a consensus on dust mineralogy in comets. In situ measurements of element abundances for dust in Comet 1P/Halley revealed that olivine is always associated with organic refractory material without exception (Jessberger et al., 1988). Laboratory analyses of dust particles captured from Comet 81P/Wild 2 have revealed the presence of minerals as well as high-mass polycyclic aromatic hydrocarbon (PAH) associated with whole particles, despite the fact that organics suffered from destruction and loss during the capture and the analyses (Brownlee et al., 2006; Sandford et al., 2006). The chondritic porous subset of interplanetary dust particles (IDPs), which is most likely of cometary origin, shows that mineral grains are embedded in organic-rich carbonaceous material (e.g., Flynn et al., 2013). The organic coating of mineral grains is similarly found in