



# Report from the event supported by RadioNet

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**TITLE** Cosmic dust: origin, applications and implications

**DATE:** 11–15 June 2018

**LOCATION:** *COPENHAGEN, DENMARK*

**MEETING WEBPAGE:** <http://cphdust2018.nbi.ku.dk>

**HOST INSTITUTE:** *UNIVERSITY OF COPENHAGEN*

**RADIONET** *TO BE FILLED BY MANAGEMENT*

**BENEFICIARY / NO:**

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# Report:

## 1 SCIENTIFIC SUMMARY

The conference 'Cosmic dust: origin, applications and implications' was held on 11-15 June 2018 in Copenhagen. There were 45 talks and over 100 posters, most of which were presented briefly in 1 minute summaries. It was extremely successful in its aims of bringing together dust experts from all over the world in an atmosphere of intense discussion. (<https://indico.nbi.ku.dk/event/1040/>)

- This conference was the fourth in a series held every five years on cosmic dust, following successful meetings in Colorado, USA (2003), in Heidelberg, Germany (2008), and in Taipei, Taiwan (2013).
- Despite its fundamental importance to so much of the cosmos, we still do not know where most dust originates, what its mineralogy is, what its properties in different environments are, or its physics and chemistry in the interstellar medium. These questions are under active study, and significant progress has been made over the past decade with new instrumentation, laboratory results, and theoretical modeling.
- This conference brought together experts on dust and dust practitioners from all different backgrounds: meteoritics, interplanetary dust, protoplanets, star-formation, AGB stars and Planetary Nebulae, dust in galaxies, supernovae, and AGN.

The conference was timed to lay out the remarkable progress on dust since the Herschel and Planck missions ended and their legacies have begun to be exploited, since ALMA began real science operations over the previous five years, and to prepare for the launch of JWST.

The conference addressed issues related to

- the Sources of dust, in particular its formation pathways, from molecules to dust, including PAHs, DIB carriers, fullerenes, and silicate nanoparticles, as well as its formation in stars and in supernovae, including destruction by the reverse shock.
- The dust budget with reference to gas, metallicity, dust to metals ratios, opacities and observed fluxes.
- Dust Composition & properties including such questions as: Where is the iron? Where is the oxygen? The carbonaceous/silicate ratio and the crystalline fraction of silicates. Whether oxides are an important dust component, and forms of carbon.
- Comparison with laboratory and computational data
- The wild diversity of dust in galaxies, with reference to trends with metallicity, differences from galaxy to galaxy, and variations within galaxies.
- The role of dust in planet formation, specific questions addressed were: How does planet formation depend on the dust properties? Dust as a tracer to study planet formation. Is there enough dust to explain exoplanets? How does the interstellar grain model connect to samples collected in the Solar System?
- Future pathways:
  - Mid- and far-infrared spectroscopy; mid-IR polarimetry ◦ JWST, SPICA, 30-m class, ...
  - X-ray observations, viz. ATHENA, ...
  - Optical
    - i. SDSS-VI; GAIA; LSST;
    - ii. UV
  - Submm
    - iii. ALMA, NOEMA, APEX, and other single-dish, ...
    - iv. Dust masses; high-z; AME; high spatial resolution observations
  - Laboratory dust astrophysics
  - Computational dust astrophysics
  - A white paper on the future of dust

The next international cosmic dust conference was decided to be held in the US in 2023, with Karl Gordon from STScI leading the organisation.

## 1.1 RADIONET RELEVANCE

Cosmic dust, the smoke-like, sub-micron particles that dominate the condensed matter mass of the universe, is essential to nearly all aspects of modern astrophysics, astrochemistry and cosmology. Its study crosses the divide between laboratory, astronomical observation, and theory. The realisation of the central role of dust in the physics and chemistry of planet formation, star formation, galaxy evolution, and supermassive black hole growth, means that the study of cosmic dust has moved to the heart of all of these subjects. This conference broadly surveyed all aspects of cosmic dust, its origin and its properties, and its growing role as a unique tool for studying the physical processes that shape our Universe. The meeting allowed the whole community to come together to survey and organize the rapidly changing landscape of dust studies since the end of Herschel, Planck, and Spitzer, and the beginning of full science operations with ALMA, and synthesise a coherent picture of our understanding of dust prior to the launch of JWST.

The main rationale and relevance for RadioNet support is that the conference directly concerns and involves those working with the scientific output from ALMA, APEX, NOEMA, and other telescopes operating at long wavelengths – including the SKA in the long-term. The conference's programme covered ISM, observations of star-formation and late stage stellar evolution, as well as solar system science and galaxy evolution, early universe science, cosmology, and AGN. The conference crossed over traditional subject divisions, bringing together laboratory, theory and observations, including observations from X-ray (dust scattering and fine structure spectroscopy), UV/optical, and infrared, through to radio wavelengths.

## 1.2 IMPACT

The conference touched upon one of the key science cases for telescopes operating from submillimetre through centimetre wavelengths – namely on the properties and evolution of dust from the interstellar medium onto protoplanetary disks. In this sense, the conference managed to (i) educate astronomers working at different wavelengths about the progress made with the longer wavelength facilities and vice versa (ii) would have provided information and understanding to help radio astronomers in strengthening the science cases for, e.g., future programs at ALMA, NOEMA, and the SKA.

## 2 AGENDA OF THE EVENT

For a detailed view <https://indico.nbi.ku.dk/event/1040/timetable/#all.detailed>

### Mon 11/6

08:15 Check-in and registration

09:00 Welcome and introduction Darach Watson

09:15 The Condensation of Gas-Phase Elements onto Interstellar Dust Grains Edward Jenkins

10:00 Growth, destruction, and expulsion of dust in galaxies Prof. Kenji Bekki

10:35 Poster Presentations: Poster Presentations

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10:50 Break

11:15 Probing dust properties in the LMC from UV to FIR Julia Roman-Duval

11:40 Low-temperature surface reactions of carbon atoms Serge Krasnokutski

12:05 Iron and silicate dust growth in the Galactic interstellar medium: clues from element depletions Svitlana Zhukovska

12:30 Lunch

14:00 Dust production in low- and intermediate-mass stars Prof. Susanne Höfner

14:45 Dust production in low mass stars Dr Sundar Srinivasan

15:20 Break

15:45 Infrared light curves of dusty & metal-poor AGB stars Steve Goldman

16:10 The metallicity-dependence of mass loss in carbon stars Dr Sara Bladh

16:35 The submm properties of dust around carbon AGB stars Matthias Maercker

17:00 Poster Presentations: Poster Presentations

### Tue 12/6

09:00 Dust production by supernovae and massive stars Prof. Mike Barlow

09:45 Resolved dust analysis of two iconic Galactic supernova remnants: Cassiopeia A and the Crab Nebula Ilse De Looze  
10:20 Break  
10:50 Survey of dust emission in Galactic supernova remnants Hannah Chawner  
11:15 Shock-induced formation and survival of dust in the dense CSM surrounding Type II<sub>n</sub> supernovae Dr Arkaprabha Sarangi  
11:40 - 12:05 Dust in supernova 1987A Mikako Matsuura  
12:05 Old and new dust associated with Supernova 1995N Roger Wesson  
12:30 Lunch  
14:00 Poster Presentations  
14:15 Main Auditorium Observational constraints on dust properties Prof. Bruce Draine  
15:00 A new window on Interstellar Silicates Sascha Zeegers  
15:35 Break  
16:05 Constraining dust mineralogy from mid-IR spectra Dr Peter Scicluna  
16:30 Investigating Silicate Dust in Galaxies Using Quasar Absorption Systems Prof. Monique Aller  
16:55 The photochemical evolution of the interstellar PAH family in photodissociation regions Els Peeters

### Wed 13/6

09:00 From Molecules to Dust (and back) Prof. Jan Cami  
09:45 The High-Dimensional ISM As A Tool To Explore Galaxy Evolution Dr Gail Zasowski  
10:20 Break  
10:50 Laboratory Experiments on Cosmic Dust Dr Cornelia Jäger  
11:35 How laboratory experiments can help in studying cosmic PAHs Christine Joblin  
12:10 Formation of molecules on cosmic dust grains: a laboratory view Alexey Potapov  
12:35 Lunch  
14:00 Determining the systematic errors in fits of dust thermal emission: the role of laboratory data in upcoming models Dr Lapo Fanciullo  
14:25 Poster Presentations  
14:45 Analytical laboratory studies of solar system dust Dr John Bradley  
15:30 Christine Floss. In memoriam Dr John Bradley  
15:35 Break  
16:00 Panel Discussion Anja C. Andersen  
18:30 Conference Dinner

### Thu 14/6

09:00 Planet Formation, grain growth and debris disks: Theory Prof. Carsten Dominik  
09:45 Grain growth, planet formation and debris disks Dr Zahed Wahhaj  
10:20 Poster Presentations: Poster Presentations  
10:40 Break  
11:10 A multi-wavelength view of planet forming discs: unleashing the full power of ALMA for grain growth studies Marco Tazzari  
11:35 The properties of interstellar dust in the Milky Way and in nearby galaxies Dr Maud Galametz  
12:20 Poster Presentations: Poster Presentations  
12:30 Lunch  
14:00 Dust as a tracer in the Milky Way and local galaxies Dr Matt Smith  
14:35 An Empirical Determination of the Dust Mass Absorption Coefficient,  $\kappa_d$ , and its Variation Within Nearby Galaxies Christopher Clark  
15:00 Break  
15:30 Dust as a galaxy probe Prof. Susanne Aalto  
16:15 Insights into the Life Cycle of Dust at Low Metallicity from the Local Group and Nearby Galaxies Dr Karin Sandstrom  
16:50 Radiative transfer model of dust attenuation curves in clumpy, galactic environments Kwang-il Seon

**Fri 15/6**

09:00 Dust in Active Galactic Nuclei: A close look at the torus and its surroundings Prof. Almudena Alonso-Herrero

09:45 Hot, cool, dark and bright: the various shades of dust around AGN Dr Sebastian Hönig

10:20 Growth of massive black holes in dusty clouds: impacts of relative velocity between dust and gas Mr Shohei Ishiki

10:45 Break

11:15 Optical and infrared radiation pressure on dust and gas around AGN as drivers of dusty winds Marta Venanzi

11:40 Dust in the early universe Prof. Raffaella Schneider

12:25 Lunch

14:00 Dust and elements in the epoch of reionization Akio Inoue

14:35 The dust-to-stellar mass ratio, a key-tool for probing galaxy evolution from  $z=0$  up to  $z=6$  Dr Francesca Pozzi

15:00 Conference Summary and Review Dr Ciska Kemper

### 3 PARTICIPANTS



We had 132 participants from over 20 countries, with 33% women and a large fraction of people under 40 years of age. 43% of our invited speakers were women.

#### 3.1 RADIONET NEWSLETTER

Subscribers list submitted to RadioNet MGT

#### **4 RADIO NET FINANCIAL CONTRIBUTION**

RadioNet financial support of 2700€ has been used for reimbursement of accommodation costs for three invited speakers.

#### **5 PUBLICATIONS**

*The presentations of the supported persons include an acknowledgment:*

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#### **6 CONFIRMATION:**

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