Cosmic Dust: origin, applications & implications

Monday, 11 June 2018 - Friday, 15 June 2018

Geological Museum, University of Copenhagen

Book of Abstracts

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Laboratory Experiments on Cosmic Dust

Cosmic dust grains are present in nearly all astrophysical environments proving their existence by the absorption, scattering, and reemission of stellar light in a broad spectral range covering wavelengths from the UV up to millimeters. Dedicated laboratory experiments are necessary to get more insight into the formation pathways and chemical modification of refractory solids under different astrophysical conditions. Such experiments include the formation of dust at varying temperatures and densities and the processing of grains due to a bombardment with ions, atoms, and UV photons. All these studies have to be complemented by a detailed analytical characterization of the final products. The measurements of the spectral properties of dust at different evolutionary states in the laboratory provide a major link to the astronomical observations and the tool for identification of cosmic dust components. In addition, it helps to restrict the conditions in the corresponding astrophysical environments. Our insight into the structural and
spectral properties of cosmic dust in different astrophysical environments such as circumstellar shells, the diffuse and dense interstellar medium, and disks around young stars has been significantly improved by the laboratory studies in the last years. This review describes the recent progress in understanding the formation, processing, morphology, and composition of main dust components including siliceous and carbonaceous grains.

Consider for a poster?:

Laboratory studies of cosmic dust / 9

How laboratory experiments can help in studying cosmic PAHs

Author: Christine Joblin[None]

Polycyclic aromatic hydrocarbons (PAHs) are commonly thought to play a key role in the chemical and physical evolution of star-forming regions from the small scales of protoplanetary disks to the large scales of galaxies. However attempts to identify individual species have been so far unsuccessful. Cosmic PAHs and related species such as C_{60}, are observed by their emission features in the mid-infrared, the so-called aromatic infrared bands (AIBs). Emission in the AIBs is triggered by the absorption of VUV photons but this process can also induce ionisation and unimolecular dissociation. The composition of the IR-emitting population might therefore reflect this processing. In addition the formation routes of these large carbonaceous molecules have still to be elucidated. Several scenarios including bottom-up and top-down ones have been proposed.

In my presentation, I will discuss how this subject takes benefit from laboratory astrophysics. The photophysics of isolated PAHs, including ionisation, dissociation and radiative cooling is studied with different setups (molecular jets, ion traps, storage rings) and makes use of VUV tunable synchrotron radiation [1-6]. The question of the formation by gas-phase condensation of PAHs and carbonaceous grains in circumstellar environments has been discussed following experiments that use techniques such as laser ablation, laser pyrolysis or plasma discharges [7-9]. Recently, the Stardust machine in Madrid [10] has been developed to study grain formation in conditions that approach those found in Asymptotic Giant Branch star environment. The molecular analysis of laboratory analogues of cosmic dust, combined with that of extraterrestrial samples such as meteorites, is expected to provide new insights into chemical pathways leading to the formation of cosmic PAHs. I will describe how this topic is addressed in the framework of the Nanocosmos ERC Synergy project using in particular the AROMA setup [11].

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Acknowledgement
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Consider for a poster?:

Molecules and dust / 10

From Molecules to Dust (and back)

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Throughout the Universe, there is a close interplay between the formation, evolution and destruction of dust grains and molecules, driven by the diverse conditions encountered in various astrophysical environments. When stellar gas cools down in the surroundings of evolved stars, it starts a transformation into molecular gas and dust grains. The resulting inventory depends not only on the chemical makeup of the stellar photosphere, but also on the physical conditions and available timescales. Dense tori and disks can offer long timescales for chemistry and grain growth, while photo-processing by stellar and interstellar radiation further drives molecular chemistry and dust erosion as stellar outflows are dispersed into the interstellar medium. In interstellar environments, dust grains and large molecules can offer their surfaces to facilitate the formation of molecules, and a particularly rich molecular chemistry occurs in the ice mantles on dust grains in molecular clouds. Near hot stars, intense radiation fields create harsh conditions where UV photons destroy all but the fittest of molecular species.

In this talk, I will present an overview of the environments where molecules and dust reside, and the physical and chemical processes that affect them.

Consider for a poster?:

Molecules and dust / 11

The High-Dimensional ISM As A Tool To Explore Galaxy Evolution

Author: Gail Zasowski[1]

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Because large molecules (including PAHs and other carbonaceous particles) straddle the divide between molecular gas and dust grains, their spatial and dynamical distributions carry information on both of these phases and their interface. This talk will explore the power of harnessing this information using a few case studies of molecular absorption spectroscopy combined with absorption-based dust maps. I will describe how this approach allows us to tackle such diverse galaxy evolution questions as spiral arm formation and molecular cloud dissolution, and discuss the prospects for expanding high-dimensional ISM studies in the next several years.

Consider for a poster?:

Dust production by supernovae and massive stars / 12

Dust production by supernovae and massive stars

Author: Mike Barlow[1]

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In this review I will cover the theoretical expectations and the observational evidence as to whether massive stars and their supernovae can form sufficiently large quantities of dust to provide a significant contribution to the dust budgets of galaxies.

A series of papers addressing dust condensation in the ejecta of core-collapse supernovae (CCSNe) have predicted that up to one solar mass of dust could form, with one of the principal uncertainties being the dust's survivability against destruction by reverse shocks. Observations out to mid-infrared wavelengths of dust formed by extragalactic CCSNe, including those made with the Spitzer Space Telescope, have measured relatively small dust masses, typically less than $10^{-3}\,M_\odot$. The advent of the Herschel Space Observatory, covering wavelengths out to 500 µm, has enabled much cooler dust to be detected from young CCSN ejecta and CCSNRs than possible at mid-IR wavelengths. Since cooler dust emits less efficiently than warm dust, larger dust mass detections have resulted. The Herschel mission ended in 2013, which has stimulated the development of alternative methods to measure CCSN dust masses, for example by modelling red-blue emission line profile asymmetries, and their time evolution, in the optical spectra of CCSNe. I will summarise the currently available results from these various methods and their implications.

Consider for a poster?:

Dust production by supernovae and massive stars / 13

Resolved dust analysis of two iconic Galactic supernova remnants: Cassiopeia A and the Crab Nebula

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The large reservoirs of dust observed in some high redshift galaxies have been hypothesised to originate from dust produced by supernovae (SN). Theoretical models predict that core-collapse SN can be efficient dust producers (0.1-1 $M_{\odot}$) potentially responsible for most of the dust production in the early Universe. Observational evidence for this dust production efficiency is however currently limited to only a few remnants (e.g., SN 1987A, Crab Nebula) that confirm this scenario.

We revisit the dust mass produced in Cassiopeia A (Cas A), a $\sim$ 330-year old O-rich Galactic supernova remnant (SNR) embedded in a dense interstellar foreground and background. We present the first spatially resolved analysis based on Spitzer and Herschel infrared and submillimetre data at a common resolution of $\sim 0.6'$ for this $5'$ diameter remnant following a careful removal of contaminating line emission and synchrotron radiation. We find a concentration of cold dust in the unshocked ejecta of Cas A and derive a mass of 0.3-0.6$M_{\odot}$ of silicate grains (+a minor contribution from carbon grains) freshly produced in the SNR. The cold SN dust component is mainly distributed interior to the reverse shock of Cas A, suggesting that part of the newly formed dust has already been destroyed by the reverse shock. We derive an interstellar+SN dust extinction map which towards Cas A gives average values of $A_V = 6 - 8$ mag, up to a maximum of $A_V = 15$ mag. We have modelled the mid-infrared to radio emission from the Crab Nebula with a broken power law synchrotron spectrum, and a warm+cold SN dust component. Dust grains in the Crab Nebula are distributed predominantly along dense filaments, mostly in the southern half of the remnant, and account for 0.02 to 0.17 $M_{\odot}$ of 40K carbon dust with the somewhat lower dust mass compared to previous Herschel-based estimates being due to a re-analysis of the synchrotron component contribution and SN dust temperatures using the latest Herschel SPIRE calibrations. In addition, we require an extra model component in the millimetre wavelength domain, which accounts for 25 to 35% of the emission at 1 to 3 mm. We discuss possible origins for this excess emission in the centre of the Crab Nebula; including spinning dust grains, a secondary synchrotron component, magnetic Fe-bearing dust particles and free-free emission from a hot plasma.

In conclusion, these updated dust mass estimates for Cas A and the Crab Nebula support the scenario of supernova dominated dust production at high redshifts.

Consider for a poster?:

Dust production in low mass stars / 14

Dust production in low- and intermediate-mass stars

Corresponding Author: susanne.hoefner@physics.uu.se

Stars in their late stages of evolution are generally considered to be major sources of interstellar dust. However, there is a long standing debate over the relative contributions by massive stars (both before and after they explode as supernovae), compared to low- and intermediate-mass stars, which expel a significant fraction of their total mass in stellar winds during the cool giant phase. In this talk I will focus on the latter process, discussing state-of-the-art models of dust-driven winds and, in particular, results regarding dust production.

Consider for a poster?:

Dust production in low mass stars / 15

Dust production in low mass stars

Corresponding Author: sundar@asiaa.sinica.edu.tw

Outflows from asymptotic giant branch (AGB) and red supergiant (RSG) stars regulate the lifecycle of dust in the interstellar medium (ISM) in nearby galaxies. Metals produced in AGB nucleosynthesis are transported to the surface where they cool to form molecules and, further out, dust. The chemistry of this material depends on the surface atomic ratio of carbon to oxygen, resulting in either silicate-rich or carbonaceous dust.

Detailed radiative transfer is required to accurately model each AGB star; however, for a large sample such as the entire population in a galaxy, this becomes time-consuming. Astronomers thus either use proxies for the dust-production rate (DPR) such as the mid-infrared colour or the infrared excess. Along with my collaborators, I developed the Grid of RSG and AGB ModelS (GRAMS; Sargent et al. 2011 ApJ 728 93, Srinivasan et al. 2011 A\&A 532A 54), which can be used for quick estimates of the DPRs of a large sample via χ^2 fits to their spectral energy distributions (SEDs).

We have used this model grid to compute the dust budget in the Large (Riebel et al. 2012 ApJ 753 71) and Small (Srinivasan et al. 2016 MNRAS 457 2814) Magellanic Clouds, and are also in the process of estimating the dust budget in M33 and NGC 6822 (Srinivasan et al., in prep). As part of the Nearby Evolved Stars Survey (NESS), we are also determining the dust budget within 2 kpc of the Solar Neighbourhood (Trejo et al., in prep; see poster by Dr. Ciska Kemper).

When combined with results for Local Group dwarfs (DUSTINGs; Boyer et al. 2015 ApJS 216 10), we now have dust budget information over six decades in total stellar mass and seven decades in integrated DPR. I will describe our methods and findings in this talk.

Consider for a poster?:

Non-stellar dust production and the dust cycle in the ISM / 16

The Condensation of Gas-Phase Elements onto Interstellar Dust Grains

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Over the past 45 years, investigations of ultraviolet absorption features in stellar spectra have revealed that most of the heavy elements in the interstellar medium are depleted from the gas phase to values well below solar or B star reference abundances. The strengths of such depletions reveal the composition of dust grains in space, and they can be characterized by a limited set of parameters that are closely linked to the average gas densities and the condensation temperatures of the elements. Two outstanding mysteries remain: one is the fact that the depletion of oxygen exceeds that needed for forming silicates or metallic oxides, and the other is that the chemically inert element krypton shows some depletion. When we observe absorption features to derive the element abundances in distant galaxies, we must understand how to correct for depletions by using the patterns found in our Galaxy or the Small Magellanic Cloud as examples.

Consider for a poster?:

Non-stellar dust production and the dust cycle in the ISM / 17

Growth, destruction, and expulsion of dust in galaxies

Corresponding Author: kenji.bekki@uwa.edu.au

Physical properties of interstellar dust (e.g., dust-to-gas ratios) are observed to be quite diverse in galaxies with different masses and types. I will discuss the origin of these diverse dust properties based on the latest results of galaxy-scale hydrodynamical simulations of galaxies with dust physics. I will particularly discuss how dust growth processes in interstellar medium (ISM) depends on the physical properties of ISM, dust-related physical processes (e.g., photo-electric heating and radiation pressure of stars on dust grains), global galaxy-scale dynamics. I will demonstrate that the formation of molecular hydrogen and dust growth in cold molecular clouds is strongly coupled. I will also show the masses of galaxies and galaxy interaction/merging can significantly influence the dust growth processes in ISM. I will briefly discuss how radiation pressure of young stars on dust grains can influence the evolution of dust in galaxies.

Consider for a poster?:

Dust in the early universe / 18

Dust in the early universe

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Early dust enrichment is believed to occur on very short timescales following the first supernova explosions. The efficiency of this process and the nature of the first dust have a large impact on early star formation. Molecule formation on the surface of dust grains promotes gas cooling, increasing the star formation efficiency. In the densest part of collapsing pre-stellar clouds dust-driven fragmentation is believed to enable the formation of low-mass and long lived stars. The properties of these fossil remnants may provide us with important clues on the nature of the first supernovae and their dust production efficiencies. Finally, deep ALMA observations are probing the dust content of normal star forming galaxies at z > 6, pointing to a rapid dust enrichment of the interstellar medium for some of these sources. In this talk, I will review the status of our understanding of early dust enrichment and the many open questions that need to be addressed in the future.

Consider for a poster?:

Dust in the early universe / 19

Dust and elements in the epoch of reionization

Author: Akio Inoue[1]

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First, I will present our recent results from ALMA observations of galaxies in the epoch of reionization, redshifts $z > 6$. Second, I will present a method for estimating the dust temperature from far-infrared flux densities, taking the radiative equilibrium and transfer effect into account. Then, I will present a demographics study of dust mass in $z > 6$ galaxies and compare the observations with a simple theoretical model. I will pay attention to "dust-free" objects as well as dust-rich ones. Finally, I will discuss the dust mass growth in the interstellar medium and future perspective.

Consider for a poster?:

Dust as a galaxy probe / 20

Dust as a galaxy probe

Author: Susanne Aalto[1]

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In this talk I will discuss our current view of dust as a tracer of galaxy properties – from dust in extended, star forming disks and winds – to properties of dusty nuclei and compact, collimated nuclear outflows . I will show optical studies of dust in absorption - and dust in emission at long wavelengths (from infrared to mm/submm). Finally, I will present new results on very optically thick dust in the inner regions of galaxies that hide extreme, hitherto unknown, nuclear activity. I will discuss the nature of the buried activity and how we can study the properties of the dust in these deeply veiled regions.

Consider for a poster?:

Dust as a galaxy probe / 21

Insights into the Life Cycle of Dust at Low Metallicity from the Local Group and Nearby Galaxies

Dust plays critical roles in many of the processes occurring in the interstellar medium and dust's infrared emission serves as a probe of the ISM and star formation in galaxies out to high redshift. The role of dust in ISM physics and its use as a probe of distant galaxies both depend on the characteristics of the grain population: the dust-to-gas ratio and the grain composition, charge, and size distributions. These properties are set by the life cycle of dust in the ISM, which may be dramatically different in the low metallicity conditions prevalent at high redshifts or in nearby dwarf galaxies. I will present results from several efforts to constrain aspects of the dust life cycle in nearby, low metallicity environments.

Consider for a poster?:

Dust in AGN / 22

Dust in Active Galactic Nuclei: A close look at the torus and its surroundings

Author: Almudena Alonso-Herrero[1]

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In this talk I will review our current knowledge of the torus of dust and molecular gas in AGN and its close surroundings. I will summarize recent results on the geometry of the torus in nearby AGN, the connection to inflows and outflows, and the properties of AGN dust. In the last part of the talk I will touch upon the properties of the torus in distant AGN and in particular the dust covering factors and the torus evolution.

Consider for a poster?:

Dust in AGN / 23

Hot, cool, dark and bright: the various shades of dust around AGN

Author: Sebastian Hönig[1]

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Dust accreting onto supermassive black holes has been a cornerstone of AGN unification as it provides the angle dependent obscuration required to explain the various AGN types by a pure view angle effect. However, advancements in angular resolution over the last decade have allowed us to resolve the dust-emitting region for the first time. It is now clear that dust plays a fundamental role in dynamically shaping the immediate environment of the black holes. At the same time, the hard AGN radiation significantly processes the dust, altering its size distribution and chemical composition. In this talk, I will present recent results from high angular resolution observation, including infrared (IR) interferometry. A particular emphasis will be the physical constraints of the composition and distribution of dust, specifically the predominance of large graphite grains in shaping the IR emission. I will also show new results on PAH emission from within 100 pc of an AGN, provoking thoughts on its common use as a star-formation tracer.

Consider for a poster?:

Dust as a tracer in the Milky Way and local galaxies / 24

The properties of interstellar dust in the Milky Way and in nearby galaxies

Author: Maud Galametz[1]

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In this review, I will give an overview of the properties of dust (spatial distribution, composition, heating sources) in the ISM of nearby galaxies and in the Milky Way. I will discuss the main spectral energy distributions fitting techniques to model the ISM dust and their caveats. I will also discuss the need for dust models including an evolution of dust grains in the ISM to explain the current observables in emission or extinction.

Consider for a poster?:

Dust as a tracer in the Milky Way and local galaxies / 25

Dust as a tracer in the Milky Way and local galaxies

Abstract here

Grain growth, planet formation and debris disks / 26

Planet Formation, grain growth and debris disks: Theory

Author: Carsten Dominik[1]

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The evolution of the solid particle component of protoplanetary disks from the formation of the disk into the debris disk phase holds important keys about the planet formation process. I will cover the some aspects of the basic physics and recent developments in the theory of dust growth, dust dynamics, planet formation and debris disks.

Consider for a poster?:

Grain growth, planet formation and debris disks / 27

Grain growth, planet formation and debris disks

Abstract here

Dust in the solar system / 28

Analytical laboratory studies of solar system dust

Author: John Bradley[1]

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Contemporary solar system dust is collected as interplanetary dust particles (IDPs) and micrometeorites (MMs) in the stratosphere using aircraft, and at polar and mid-latitude ground locations using several sampling methods. The collections are fundamentally important to cosmochemistry, planetary science and early solar system accretional processes in particular because some IDPs and MMs are from parent bodies, including comets and other small, icy bodies, that are not well represented among known meteorite groups [1]. Small bodies are more likely to contain well-preserved solids from the outer solar nebula and presolar environments. The miniscule masses of individual IDPs and MMs have severely limited analytical measurements but advances in instrumentation are expanding the scope of measurements and providing fundamental insight. It is well established that IDPs and MMs contain the highest abundances of presolar refractory constituents (e.g. crystalline oxides and silicates) and recent studies have identified a population of non-refractory "soft" constituents [2]. All IDPs and MMs are pulse heated, many to incandescence, for several seconds during atmospheric entry followed by exposure to terrestrial contamination. A key finding and challenge arising from the study of "soft" constituents are that well-preserved IDPs and MMs appear to be much rarer than has previously been assumed.

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Consider for a poster?:

Observational constraints on dust properties / 31

Observational constraints on dust properties

Corresponding Author: draine@astro.princeton.edu

Abstract here

Consider for a poster?:

Poster Presentations - Board: 32 / **32**

Large Interstellar Polarisation Survey

Author: Ralf Siebenmorgen[1]

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We study the variability of the dust characteristics from cloud-to-cloud in the diffuse ISM (arXiv:1711.08672). We took low-resolution spectro-polarimetric data obtained in the context of the Large Interstellar Polarisation Survey (LIPS, arXiv:1710.02439) towards 59 sight-lines in the southern hemisphere, and we fitted these data using a dust model composed of silicate and carbon. Particles sizes range from the molecular to the sub-micrometre domain. Large (>6 nm) spheroidal dust that are of prolate shape and made of silicate account for the observed polarisation curve (arXiv:1705.07828). For 32 sight-lines we complemented our data set with UVES archive high-resolution spectra, which enable us to establish the presence of single-cloud or multiple-clouds towards individual sight-lines. We find that the majority of these 32 sight-lines intersect two or more dust clouds, while eight of them are dominated by a single absorbing cloud. We confirm several correlations between extinction and polarisation characteristics and the dust parameters, but we find also several previously undetected correlations between these parameters that are valid only in single-cloud sight-lines (arXiv:1711.08672). We observe that interstellar polarisation from multiple-clouds is smaller than from single-cloud sight-lines, showing that the presence of a second or more clouds depolarises the incoming radiation. We find large variations of the dust characteristics from cloud-to-cloud. However, when we average a number of clouds we always retrieve similar mean dust parameters. Typical dust abundances of the single-cloud cases are [C]/[H] = 92 ppm and [Si]/[H] = 20 ppm. Further we present the status of our search of single-cloud sight-lines and discuss the impact of grain porosity on the extinction and to the optical-to-submmillimter polarisation.

Consider for a poster?:

Dust production in low mass stars / 33

The submm properties of dust around carbon AGB stars

Author: Matthias Maercker[1]

Co-authors: Magdalena Brunner [2]; Theo Khouri [3]

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The origin and properties of dust in the universe, and the contribution from AGB stars, is a fundamental question in galaxy evolution. We constrain the properties of the dust grains in the thin detached shells around the carbon AGB stars R Scl, U Ant, V644 Sco, and DR Ser. The shells were created during recent thermal pulses, and the dust properties play a crucial role in understanding the wind-driving mechanism, the evolution of the star throughout the thermal pulse cycle, and the type and amount of dust returned to the ISM from AGB stars. We use new observations from LABOCA and ALMA to model the entire SED including submm wavelengths. For all objects, we find an excess emission in the submm. Spatially resolved observations confine this excess to the detached shells. However, a straightforward explanation for this excess is still lacking. While very large, cold grains can explain the submm flux, they do not reproduce the overall shape of the SED in the FIR and submm. Other obvious grain properties (e.g., composition or geometry) also do not reproduce the observed SEDs. The results imply that the submm observations probe properties of the dust grains that are not typically considered, but may be critical for a complete understanding of dust around evolved stars. A similar SED shape and submm excess has been seen in observations of the small and large magellanic clouds, and has been attributed to unknown dust properties. If the origin of this excess is the same as for the detached shell sources, this would have important implications on the contribution to the total dust budget from AGB stars to galaxies.

Consider for a poster?:

Yes

Poster Presentations - Board: 35 / **35**

The ESO Diffuse Interstellar Band Large Exploration Survey: First Results.

Authors: Jan Cami[1]; Nick L.J. Cox[None]; Amin Farhang[None]; Jonathan Smoker[None]; Meriem Elyajouri[None]; Rosine Lallement[None]; Xavier Bacalla[None]; Neil H. Bhatt[None]; Emeric Bron[None]; Martin A. Cordiner[None]; Alex de Koter[None]; Pascale Ehrenfreund[None]; Chistopher J. Evans[None]; Bernard H. Foing[None]; Atefeh Javadi[None]; Christine Joblin[None]; Lex Kaper[None]; Habib Khosroshahi[None]; Mike Laverick[None]; Franck Le Petit[None]; Harold Linnartz[None]; Charlotte C.M. Marshall[None]; Ana Monreal-Ibero[None]; Giacomo Mulas[None]; Evelyne Roueff[None]; Pierre Royer[None]; Farid Salama[None]; Peter J. Sarre[None]; Keith T. Smith[None]; Marco Spaans[None]; Jacco Th. van Loon[None]

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The ESO Diffuse Interstellar Band Large Exploration Survey (EDIBLES) is Large Programme that is collecting high-signal-to-noise (S/N) spectra of a large sample of O and B-type stars covering a large spectral range using the UVES spectrograph mounted on the Very Large Telescope (VLT). The goal of the programme is to extract a unique sample of high-quality interstellar spectra from these data that represent different physical and chemical environments, and to characterise these environments in great detail. An important component of interstellar spectra are the diffuse interstellar bands (DIBs), a set of hundreds of unidentified interstellar absorption lines that are commonly found in the spectra of reddened targets. With the detailed line-of-sight information derived from these high-quality spectra, EDIBLES will derive strong constraints on the potential DIB carrier molecules. EDIBLES will thus guide the laboratory experiments necessary to identify these interstellar "mystery molecules", and will turn the DIBs into powerful diagnostics of their environments in our Milky Way Galaxy and beyond. Here, we will present some of our first results showing the unique capabilities of the EDIBLES programme.

Consider for a poster?:

Yes

Poster Presentations - Board: 36 / **36**

Temperature-Dependent Laboratory Measurements of the Far-Infrared to Millimeter Opacity of Carbonaceous Dust-Analogues

Author: Jonas Greif[1]

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We are measuring and analysing the FIR- and THz- Spectra of pyrolysed micro-crystalline cellulose as an analogue of carbonaceous interstellar dust. We are using cellulose-powder with crystal sizes of about 20\,μm and are heating it up to 1000°C. First results of the mass normalised extinction are presented and compared to J\"ager et al. (1998). The temperature dependent measurements took place in a dry environment at room temperature (RT) down to the environmental temperature of $T_{\rm env} = 10$\,K. \\

Our aim is to assess carbonaceous dust analogues in terms of structure, nature and morphology. For theoretical and observational investigation we are going to determine their optical constants. Furthermore, we are going to calculate the emission cross section of particles with different geometries to compare them with the measured results.

Consider for a poster?:

Yes

Laboratory studies of cosmic dust / **37**

Formation of molecules on cosmic dust grains: a laboratory view

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Molecular ices covering dust grains are known to be a source of molecules, including complex organic molecules (COMs), in the interstellar medium (ISM) and circumstellar shells and disks, the molecules, which cannot be created via gas phase reactions. Studying the formation of COMs is crucially important to understand the processes that lead to stars and planets formation, and to understand a degree of molecular complexity on planetary bodies, which can shed some light on the origin of life on Earth. Many laboratory experiments have been performed on the formation of simple and complex molecules, including amino acids, in interstellar and circumstellar ice analogues by a number of triggering processes, such as UV and X-ray irradiation, bombardment by energetic particles and atom addition. But a major part of the laboratory work deals with molecular ices covering standard substrates not related to the cosmic dust. The dust grain surface can participate in ice chemistry and can alter the efficiency of the molecular formation. There is a handful of laboratory works on the formation of molecules in ice-dust systems. Only CO and CO_2 have been synthesized in laboratory cosmic ice-dust analogues up until very recently, when we performed our experiments

on the formation of formaldehyde on hydrogenated fullerene-like carbon grains by the O/H atom addition. Our results demonstrate, for the first time, that the bombardment of carbonaceous grains by O and H atoms at low temperatures causes the formation of CO molecules with their further hydrogenation leading to the formation of solid formaldehyde. The formation of H_2CO is an indication for a possible methanol formation route in such systems and CH_3OH, in turn, is well known as a starting point for the formation of more complex organic molecules in the ISM and circumstellar phases.

Consider for a poster?:

Yes

Poster Presentations - Board: 39 / **39**

(Sub-)millimeter optical constants of silicates and water ice

Authors: Harald Mutschke[1]; Pierre Mohr[None]; Denny Häßner[None]

Co-authors: Frank Lewen [2]; Jürgen Blum [3]; Alexey Potapov [4]; Bastian Gundlach [3]; Tim Dressler [5]

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We provide new temperature-dependent optical constants of silicate glasses, silicate minerals, and crystalline and amorphous water ice, in the sub-millimeter spectral range, for silicate glasses up to a wavelength of 4 mm. We compare these optical constants to literature data, such as the "astronomical silicate" and commonly used extrapolations of the water-ice opacity. We discuss physical reasons of the strong temperature dependence of the absorptivity seen in the data, and consequences for the contribution of these materials to the sub-millimeter emission of cosmic dust.

Consider for a poster?:

Yes

Poster Presentations - Board: 40 / **40**

Steep extinction curves in GRBs and quasars

Author: Kasper Heintz[1]

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One of the main tools to study dust grain properties is to measure the extinction curves in sightlines toward stars in the Local Group or extragalactic lighthouses such as quasars, gamma-ray bursts and supernovae. Typically, the extinction curves seen in the extragalactic, interstellar medium can be well-described by extinction curves similar to those observed in the Small and Large Magellanic Clouds and in the Milky Way. Toward a few sources, however, a much steeper extinction curve

have been derived most notably that of GRB 140506A which will be the focus of this talk. I will show, using a general parametrization of the extinction, how the reddening in this case compare to those observed in the Local Group and argue that the origin of this can not be reproduced assuming the local reddening laws. I will also show how the global extinction of the host galaxy follow the presciption of a typical Calzetti extinction curve, commonly found to describe star-forming galaxies. The conclusion is then that the steep extinction must be imprinted only on very local scales from the circumburst medium. It is puzzling that the evidence point towards the scenario of a local effect only, since a similar steep reddening is observed in quasars in which the emitting region is in the centre of the host galaxy, where the observed extinction would probe the global galaxy system.

Consider for a poster?:

Yes

Poster Presentations - Board: 41 / **41**

The Spatially Resolved Dust-to-Metals Ratio in M101

Authors: I-Da Chiang[1]; Karin Sandstrom[1]; Jeremy Chastenet[2]; Adam Leroy[3]; Dyas Utomo[3]

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The dust-to-metals ratio provides insights into the life cycle of dust. We measure the dust-to-metals ratio in M101, a nearby galaxy with a radial metallicity gradient spanning ~ 1 dex. We fit the dust spectral energy distribution (SED) from 100 to 500 μm with five variants of the modified blackbody (MBB) dust emission model (free β, fixed β, broken emissivity, warm dust component, and a power-law radiation field distribution). The broken emissivity method performs the best among them, showing small residuals, reasonable $\tilde{\chi}^2$ distribution, a temperature gradient decreasing with radius and no violation of the upper bounds on available metals. We show that the dust-to-metals ratio is not constant in M101, but decreases as a function of radius, leading to a lower fraction of the heavy elements being trapped in dust at low metallicity. We show that the dust-to-gas ratio (DGR) is proportional to $Z^{1.71}$. Alternatively, we could instead explain the DGR gradient as an increase in emissivity as dust grains coagulate. If we assume the Draine et al. 2014 dust-to-metals relation, the opacity constant κ_{160} would increase at most by a factor of two, which is similar to what Planck Collaboration et al. 2014 found.

Consider for a poster?:

Yes

Dust in AGN / **43**

Growth of massive black holes in dusty clouds: impacts of relative velocity between dust and gas

Author: Shohei Ishiki[1]

Co-authors: Takashi Okamoto [1]; Hidenobu Yajima [2]

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Recent observations have suggested the existence of a large amount of dust around supermassive black holes (SMBHs) in the early universe (e.g. Maiolino et al. 2004). In dusty clouds, the growth of black holes can be significantly regulated due to strong radiation force on dust grains. Yajima et al. (2017) recently showed that the accretion on to intermediate-mass black holes (IMBHs) in dusty clouds are significantly suppressed compared with dustless clouds because of the strong radiation force on dust grains. They, however, assumed that the dust and gas are completely coupled. This assumption might be invalid in the vicinity of black holes. The relative velocity between dust and gas is likely to have impacts on the accretion rate.

We here investigate the impacts of the relative motions of dust and gas on the accretion rate onto IMBHs with the mass of 10^5 $M_{\odot}$ by using one-dimensional radiation hydrodynamic simulations in clouds with initial gas densities of $n_{\rm H} = 10$ and 100 cm^{-3}. To investigate the effect of grain size on the gas accretion, we introduce two additional fluid components which describe large (0.1 micron) and small (0.01 micron) dust grains in the simulations as we did in Ishiki et al. (2018).

We show that the accretion rate is reduced due to the radiation force. We show that the dust-to-gas mass ratio significantly changes in $\rm H_{II}$ regions because of the relative motions of dust and gas. The decoupling of dust from gas alleviates the suppression of black hole growth compared with the complete coupling case. This effect may allow moderate growth of black holes even in dusty clouds.

Consider for a poster?:

Yes

Non-stellar dust production and the dust cycle in the ISM / 44

Probing dust properties in the LMC from UV to FIR

Author: Julia Roman-Duval[1]

Co-authors: Edward Jenkins [2]; Karl Gordon [1]; Margaret Meixner [1]

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Interstellar dust is a key component of galaxy evolution owing to its crucial role in the chemistry and radiative transfer in galaxies. Our interpretation of extragalactic SEDs and our understanding of galaxy evolution thus critically depend on an accurate characterization of how the dust content and properties vary within and between galaxies. Recent observations suggest that dust grains must grow in the ISM to explain dust masses over cosmic times (Rowlands et al. 2014), leading to changes in the abundance, composition, size, and optical properties of dust grains with environment (e.g., density, metallicity, dynamics). In this talk, I will present results from two recent efforts to characterize the dust properties in the Magellanic Clouds. First, an analysis of the gas-to-dust ratio variations in the LMC and SMC (with metallicities 0.5 and 0.2 solar, respectively) based on the stacking and modeling of the resolved SED from all-sky FIR surveys (IRAS and Planck at 100, 350, 550, and 850 m) suggests that the dust abundances increases by factors 3-7 between the diffuse ISM and dense molecular clouds (Roman-Duval et al. 2017). Second, the large Hubble Space Telescope (HST) program METAL (Metal Evolution, Transport, and Abundance in the LMC - GO-14675, 101 orbits, Roman-Duval et al., in prep) is delivering its first large sample of interstellar depletions at half-solar metallicity toward 33 massive stars in the LMC. The gas-phase abundances of the key components of dust grains (Si, Mg, Fe, Ni, Ti) but also other volatile elements (Zn, S) strongly support dust growth in the ISM via accretion of gas-phase metals onto dust grains. Depletion patterns however differ between the Milky Way, the LMC, and SMC, with the dust-to-metal ratio offsetting almost exactly the metallicity differences, leading to constant gas-phase metallicities in those galaxies. Additionally, parallel WFC3 imaging obtained as part of METAL allow us to derive high-resolution extinction maps, which can be directly compared to FIR emission seen in Spitzer and Herschel to characterize the FIR dust emissivity. Preliminary results suggest that the emissivity of dust could increase by a factor 3 between the diffuse ISM and denser molecular regions, likely due to coagulation. These results have important implications for the sub-grid modeling of galaxy evolution, and for the calibration of dust-based gas mass estimates used for star-formation studies, both locally and at high-redshift.

Consider for a poster?:

Yes

Poster Presentations - Board: 45 / **45**

Polycyclic aromatic hydrocarbon emission toward the Galactic bulge

Author: Matthew Shannon[1]

Co-authors: Els Peeters [2]; Jan Cami [2]; Joris Blommaert [3]

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We examine polycyclic aromatic hydrocarbon (PAH), dust and atomic/molecular emission toward the Galactic bulge using *Spitzer* Space Telescope observations of four fields: C32, C35, OGLE and NGC 6522. These fields are approximately centered on (l, b) = (0.0°, 1.0°), (0.0°, -1.0°), (0.4°, -2.1°) and (1.0°, -3.8°), respectively. Far-infrared photometric observations complement the Spitzer/IRS spectroscopic data and are used to construct spectral energy distributions. We find that the dust and PAH emission are exceptionally similar between C32 and C35 overall, in part explained due to their locations—they reside on or near boundaries of a 7 Myr-old Galactic outflow event and are partly shock-heated. Within the C32 and C35 fields, we identify a region of elevated Hα emission that is coincident with elevated fine-structure and [O ɪ⊠] line emission and weak PAH feature strengths. We are likely tracing a transition zone of the outflow into the nascent environment. PAH abundances in these fields are slightly depressed relative to typical ISM values. In the OGLE and NGC 6522 fields, we observe weak features on a continuum dominated by zodiacal dust. SED fitting indicates that thermal dust grains in C32 and C35 have comparable temperatures to those of diffuse, high-latitude cirrus clouds. Little variability is detected in the PAH properties between C32 and C35, indicating that a stable population of PAHs dominates the overall spectral appearance. In fact, their PAH features are exceptionally similar to that of the M82 superwind, emphasizing that we are probing a local Galactic wind environment.

Consider for a poster?:

Yes

Poster Presentations - Board: 47 / **47**

Spatial variations in dust extinction properties and 3D structure in the Small Magellanic Cloud with SMIDGE

Author: Petia Yanchulova Merica-Jones[1]

Co-author: Karin Sandstrom [1]

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Dust properties in the Small Magellanic Cloud (SMC) provide insight into the interstellar environment of one of the closest analogs to early-Universe and low-metallicity galaxies. We examine the spatial variations in dust extinction curve properties and the three-dimensional structure in the Southwest Bar of the SMC using resolved stellar populations observed with the \textit{Hubble Space Telescope (HST)} as a part of the Small Magellanic Cloud Investigation of Dust and Gas Evolution (SMIDGE) program. We use color-magnitude diagrams (CMDs) of reddened red clump and red giant branch stars to investigate in detail the impact of environment on dust extinction properties. Our eight-band HST photometry enables us to simultaneously constrain SMC's 3D structure allowing us to accurately measure dust extinction from the CMD. We use the Bayesian Extinction And Stellar Tool (BEAST, Gordon et al. (2016)) to model the photometric effects of extinction on the spectral energy distribution of individual stars in SMIDGE taking into account a log-normal distribution of foreground A_V and an input extinction curve. We additionally model the relative positions of the stellar and dust distributions and the galactic depth along the line of sight. We then use CMD matching techniques based on Poisson statistics to extract the best-fit dust extinction and 3D structure parameters. We find a large line-of-sight depth and a slight offset of the dust on the near side of the stars. We find an extinction curve shape which varies only modestly even towards regions with high molecular gas content. These results yield the first detailed dust extinction curve properties in a key region in the SMC and have potential implications for how dust coagulates in molecular clouds in low-metallicity galaxies.

Consider for a poster?:

Yes

Poster Presentations - Board: 48 / **48**

Infrared emission and dust dynamics in expanding HII regions

Authors: Maria Kirsanova[1]; Yaroslav Pavlyuchenkov[1]; Vitaly Akimkin[1]; Dmitry Wiebe[1]; Anastasiia Topchieva[1]

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Massive stars signpost places of their birth in molecular clouds with expanding HII regions and photodissociation regions (PDRs). The HII regions and PDRs have very specific observational manifestation on *Spitzer* images. Namely, the ring-like structures which are seen at 8 micron surround the inner regions which are bright at 24 micron. The ring-like structures are also seen on *Herschel* images at longer wavelengths. This can be related to the properties of dust particles which are not the same inside and outside of HII regions. We present new results of a long-term theoretical study of expanding HII regions in order to understand what happens with the dust particles near young massive stars and how HII regions and PDRs look during their evolution around massive stars. We consider the drift of charged dust under the influence of radiation pressure, Coulomb drag and the lug of dust by gas simultaneously during the expansion of an HII region. Dust particles are represented by the polycyclic aromatic hydrocarbons (PAHs) and an ensemble of silicate and graphite grains of larger sizes. We evaluated a grain charge evolution within the HII region for each dust type. We find that PAHs and intermediate-size silicates have the greatest impact on the gas dynamics. Dust-to-gas mass ratio within the HII region changes from initial canonical value up to 50-90% depending on a spectral type of the massive star. Big grains are effectively swept out of the HII region. Intermediate size grains have double-peaked distribution of radial density profile. Dynamics of charged grains allows us to qualitatively explain the emission in the HII region RCW 120. We show relative input of every dust grain type to the emission in the infrared wavelength range. Emission at 4–8 micron is produced by PAHs. Our simulations show that PAHs and smaller graphite grains are mostly coupled to the gas. Removal of PAHs from the HII regions is required to reproduce their ring-like appearance at 3.6–8 micron found by *Spitzer.* Photo-destruction of PAHs by strong ultraviolet emission produced by the central massive star can explain the depletion of PAHs in the HII region. Our study of a large sample of HII regions confirms that PAHs mass fraction is much lower in these objects than the average Galactic value, implying the effective destruction of aromatic particles in HII regions. We discuss how simultaneous fitting of dust emission at several *Spitzer* and *Herschel* images helps to constrain dust properties near young massive stars.

Consider for a poster?:

Yes

Poster Presentations - Board: 49 / **49**

The AGN torus as a dynamical dusty wind

Author: David Williamson[1]

Co-authors: Sebastian Hönig [1]; Marta Venanzi

[1] *University of Southampton*

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High resolution interferometric observations of infrared emission from dust in the immediate environment of AGNs reveal that the warm dust is extended in the polar directions. This suggests a scenario where warm dust is raised above the plane of the AGN through a radiation-pressure driven wind. We have produced a 3D radiation hydrodynamic model including self-gravity effects, and radiation pressure from the central source, with the goal of explaining the features of the dusty wind, as well as the observed emission and obscuration properties. We pre-calculate the heating, cooling, radiation pressure, and sublimation of dust grains for an assumed dust population, and include these effects in the dynamical model. We will present the results of these simulations, commenting on what physical processes are required to accurately model the observations, and examining how our simulations compare to other recent models.

Consider for a poster?:

Yes

Poster Presentations - Board: 51 / **51**

Dust Reverberation Mapping in AGN

Author: Bella Boulderstone[1]

Co-authors: Sebastian Hönig [1]; Triana Almeyda [1]

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The dusty obscuring structure around the active galactic nuclei (AGN), commonly referred to as the 'torus', provides the angle-dependent obscuration as postulated in the Unification Scheme of AGN.

This dust rich environment supplies the central engine with material for accretion and is known to thermally absorb optical light from the accretion disc and re-emit it in the infrared (IR). The time lag between the visible and near-IR emission serves as a measure of the physical size of the innermost, hottest dust, which is set by sublimation of large graphite grains. I present the first results of our ongoing campaign to measure those time lags in a sample of AGN. The observed time lags are consistent with the established lag-luminosity relationship. We are now in the process of turning the hot dust lags into standardisable candles, as part of the ESO public survey VEILS, and will use these new lag measurements to normalise the Hubble relation at lower redshifts.

Consider for a poster?:

Yes

Dust production in low mass stars / **52**

Infrared light curves of dusty & metal-poor AGB stars

Author: Steve Goldman[1]

[1] *Space Telescope Science Institute*

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The effects of metallicity on both the dust production and mass loss of evolved stars have consequences for stellar masses, stellar lifetimes, the progenitors of core-collapse supernovae, and the origin of dust in the ISM. With the DUST in Nearby Galaxies with Spitzer (DUSTiNGS) survey, we have discovered samples of dusty evolved AGB stars out to the edge of the Local Group, reaching metallicities down to 0.6% solar. This makes them the nearest analogs of AGB stars in high-redshift galaxies. We present new infrared light curves of the dustiest AGB stars in 10 galaxies from the DUSTiNGS survey and show how the infrared Period-Luminosity (PL) relation is affected by dust and by metallicity. These results have implications for the efficiency of AGB dust production at high-redshift and for the use of the Mira PL relation as a potential distance indicator.

Consider for a poster?:

Yes

Poster Presentations - Board: 53 / **53**

Mid-IR spectroscopic observations of the dustiest AGB stars in the Galaxy

Author: Steve Goldman[1]

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We have used the VISIR spectrograph at the Very Large Telescope to target 21 of the most luminous and heavily-obscured oxygen-rich evolved AGB stars in the galaxy. Low resolution N-band (8 - 13 um) spectroscopy was used to target the 10 µm silicate feature. The sample, with a median luminosity of ~10,000 solar luminosities and a median mass loss rate of ~10E-4 solar masses per year, has shown higher mass loss rates than previous Galactic and Large Magellanic Cloud samples, given their luminosities. These results, along with expansion velocities from previous OH maser detections, have

been used to test and refine the wind-driving and mass loss mechanisms. Our new spectra have also allowed us to study the dust composition and geometries of these sources.

Consider for a poster?:

Yes

Poster Presentations - Board: 54 / **54**

The abundance of SiC2 in Carbon Star Envelopes

Author: Sarah Massalkhi[1]

Co-authors: Marcelino Agúndez [2]; José Cernicharo [3]; Luis Velilla Prieto [1]; Javier R. Goicoechea [3]; Guillermo Quintana-Lacaci [1]; José Pablo Fonfría [1]; Javier Alcolea [4]; Valentin Bujarrabal [4]

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During the late stages of their evolution, asymptotic giant branch (AGB) stars experience significant mass loss processes, which result in extended circumstellar envelopes (CSEs). These environments are efficient factories of molecules and dust grains. The main paradigm for the dust formation process involves a first step in which condensation nuclei of nanometer size are formed from some gas-phase precursor seeds of highly refractory character and a second step in which the nuclei grow to micrometer sizes by accretion and coagulation as the material is pushed out by the stellar wind. The chemical nature of the molecules and dust grains formed depends to a large extent on the C/O elemental abundance ratio at the stellar surface. Although much has been advanced recently, there is still much to understand about how are dust grains formed and which are the main gas-phase seeds. This is the main driver of the ERC Synergy Project NANOCOSMOS.

Silicon carbide (SiC) dust grains, which are detected through a band at 11.3 micron, are exclusively found in the envelopes around C-type (C/O>1) AGB stars (Treffers & Cohen 1974). Here, we explore what the main precursor seeds of SiC dust grains are. Only three gas-phase molecules containing the Si-C bond have been observed in C-rich envelopes around AGB stars. The ring molecule SiC₂ has been observed towards a few AGB and post-AGB stars (Thaddeus et al 1984; Bachiller et al. 1997; Zhang et al. 2009a,b), while SiC and Si₂C have only been observed in the C star envelope IRC +10216 (Cernicharo et al. 1989, 2015). Much of the knowledge about the role of these three molecules as seeds of SiC dust grains comes from the study of IRC +10216, as in this source SiC₂ has been thoroughly identified across the mm and sub-mm ranges with ground based radio telescopes and with the Herschel Space Telescope (Lucas et al. 1995; Cernicharo et al. 2010; Velilla Prieto et al. 2015). The scenario emerged from these studies suggests that only SiC₂ and Si₂C are present in the inner circumstellar layers of IRC +10216, while SiC is probably a photodissociation product of these molecules, and thus it is restricted to the outer envelope. This scenario indicates that SiC₂ and Si₂C are likely the main gas-phase seeds to form SiC dust grains.

To explore the role of gas-phase SiC₂ molecules on the formation of silicon carbide dust, we have used the IRAM 30m telescope to observe SiC₂ in a wide sample of C-rich AGB stars. The observations have been interpreted carrying out non-LTE excitation and radiative transfer calculations to estimate the fractional abundance of SiC₂ in the CSEs. The behavior of the abundance of SiC₂ as a function of the envelope density indicates that this gas-phase molecule does indeed play an important role as seed of silicon carbide dust.

Consider for a poster?:

Yes

Poster Presentations - Board: 55 / **55**

Resolved spectral attenuation curves in dusty ETGs

Author: Sébastien Viaene[1]

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The properties of a particular dust mix are encoded in the extinction curve, which is notoriously hard to measure. In all but a few external galaxies, it is not possible to resolve individual stars and match them to local, unreddened stars of the same spectral type. Most measurements for external galaxies are thus global attenuation curves, which hold a convolution with the line-of-sight geometry, and are usually sampled only in a few bands, relative to the V band.
Using high-quality MUSE integral-field observations, we developed a technique to directly measure the attenuation curve in dust-lane early-type galaxies (ETGs). I will present, for the first time, these spectrally resolved optical attenuation curves, and how their strength and slope changes within the dust lane of two ETGs. Finally, using 3D radiative transfer simulations, I will show how we start break the degeneracy between geometry and dust mix to obtain detailed information about the extinction curve and the distribution of dust in external galaxies.

Consider for a poster?:

Yes

Poster Presentations / **56**

A Unified Model of the Emission, Extinction, and Polarization of Interstellar Dust

Authors: Bruce Draine[1]; Brandon Hensley[2]

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We present a new model of interstellar dust composed of silicates, graphitic carbonaceous grains, and polycyclic aromatic hydrocarbons that reproduces the wavelength dependence of dust extinction (total and polarized) and emission (total and polarized) in the diffuse interstellar medium from UV to microwave wavelengths. In this talk, I will focus on the use of new observational data, particularly from the Planck satellite, to place constraints on the optical properties and shapes of interstellar grains. I will also discuss the key differences between this model and the Draine and Li 2007 model.

Consider for a poster?:

Yes

Poster Presentations - Board: 58 / **58**

DustKING: revealing the dust attenuation in NGC628

Author: Marjorie Decleir[1]

Co-authors: Ilse De Looze [2]; Médéric Boquien [3]; Maarten Baes [1]

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The shape of the dust attenuation law is not expected to be uniform between galaxies, nor within a galaxy. The DustKING project sets to study these variations in nearby galaxies of the KINGFISH sample. To this aim, we used the CIGALE SED fitting code to fit models with varying dust extinction properties to a set of multi-wavelength data. Particularly important for our goal are UV images taken with the SWIFT space telescope, whose filters uniquely cover the curious bump feature in the attenuation curve at 2175 Å. This enables us to characterise the strength of this bump and the UV slope of the attenuation curve.

In this talk, I present the results for the spiral galaxy NGC628 which clearly illustrate the potential of the SWIFT data in obtaining the characteristics of the attenuation curve on spatially resolved scales. From UV colours and from SED modelling, we found that the attenuation law of this galaxy is characterised by a relatively small bump and a shallower UV slope compared to the Milky Way. Also, we noticed variations of the dust attenuation properties on different scales within the galaxy. I will walk you through some intriguing trends between dust attenuation law shapes and other galaxy properties, and discuss the impact of our results.

Consider for a poster?:

Yes

Poster Presentations - Board: 60 / **60**

Constraining dust parameters through observations of eccentric debris disks

Authors: Minjae Kim[1]; Sebastian Wolf[2]; Torsten Löhne[3]; Florian Kirchschlager[4]; Alexander Krivov[3]

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Debris disks contain very fine dust but the lifetime of these dust grains is much shorter than the stellar age. It implies that these dust grains are not primordial and must be replenished continuously through mutual collisions of dust-producing planetesimals.

We investigated the impact of mutual collisions on the observational appearance of eccentric debris disks. For this purpose we simulated the collisional evolution of selected debris disks configurations and derived observable quantities. The impact of the eccentricity, the level of the dynamical excitation of the eccentricities, and the material strength are discussed with respect to the grain

size distribution, the spectral energy distribution, and spatially resolved images of debris disks systems.

The most recognizable features in different collisional evolutions are as follows: First, both the increase of the dynamical excitation in the eccentric belt of the debris disk system and the decrease of the material strength of dust particles result in a higher production rate of smaller particles. This reduces the surface brightness differences between the periastron and the apastron sides of the disks. For very low material strengths, the "pericenter glow" phenomenon is reduced and eventually even replaced by the opposite effect, the "apocenter glow". In contrast, higher material strengths and a decrease of the dynamical excitation level result in an increase of asymmetries in the surface brightness distribution. Second, it is possible to constrain the level of collisional activity from the appearance of the disk, e.g., the wavelength-dependent apocenter-to-pericenter flux ratio. Within the considered parameter space, the impact of the material strength on the appearance of the disk is stronger than that of the dynamical excitation level in the belt eccentricity.

Consider for a poster?:

Yes

Poster Presentations - Board: 61 / **61**

Constraining dust grain porosity via debris disk observations

Authors: Robert Brunngräber[1]; Sebastian Wolf[2]; Florian Kirchschlager[3]; Steve Ertel[4]

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Debris disks are often modelled assuming compact dust grains, but more and more evidence for the presence of porous grains is found. We quantify the systematic errors introduced when modelling debris disks – composed of porous dust grains – assuming the presence of spherical, compact particles (Brunngräber et al. 2017).

We use the effective medium theory to calculate the optical properties of the dust. Furthermore, we simulate observations of debris disks with different porosities and feed them into a fitting procedure assuming compact grains only. Finally, we analyse the deviations of the results for compact grains from the original, porous model.

We find that with increasing grain porosity the blowout size increases up to a factor of two. An analytical approximation function for the blowout size as a function of porosity and stellar luminosity is derived. The analysis of the geometrical disk set-up, when constrained by radial profiles, is barely affected by the porosity. However, the estimated minimum grain size and the slope of the grain size distribution derived using compact grains are significantly overestimated. Thus, the discrepancy between the minimum grain size and the predicted blowout size found in various previous studies assuming compact grains can be partially explained by the presence of porous dust grains.

Consider for a poster?:

Poster Presentations - Board: 62 / **62**

Dust formation and survival in Quasars

Authors: Arkaprabha Sarangi[1]; Eli Dwek[2]; Demos Kazanas[2]

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Infrared observations of AGN reveal the emission from a dusty circumnuclear "torus" that is heated up by radiation from the central accreting black hole (BH). The strong 9.7 and 18 micron silicate features observed in the AGN spectra both in emission and absorption, further indicate the presence of such dusty environment. The origin of this dust is presently unclear. It could be pre-existing dust that streamed from the surrounding medium into the accretion disk or, it could be dust that has newly- formed in the environment surrounding the active BH.
The environment of a quasar is often assumed to be too hostile to support the necessary chemical processes leading to the formation of cosmic dust. In this talk, I will present the results of our study based on the formation and survival mechanism of newly formed, as well as pre-existing dust, in the winds blown off the accretion disks, which has been proposed to constitute the AGN ''tori". The study takes into account the series of physical and chemical processes relevant to the environment, such as: a) the radiation transport from the central source through the surrounding medium, b) the formation of dust seed-nuclei from gas phase metals, c) the growth of dust grains through accretion and coagulation, and d) the radiative and collisional heating of the dust grains. We compare the timescales associated to these mechanisms to the flow time of the winds, identifying the "bottle-necks" to the formation of dust in the AGN environment.
The model enables us to estimate the dust production rate in quasars and to quantify their relative contribution as dust producers in the galaxies and in the intergalactic medium. Further, we study the interaction of the X-ray and UV-optical from the accretion disk with the ambient dusty winds and calculate the emerging X-ray, UVO and IR spectra from the AGNs as a function of the quasar viewing angle.

Consider for a poster?:

Yes

Dust production by supernovae and massive stars / 63

Shock-induced formation and survival of dust in the dense CSM surrounding Type IIn supernovae

Authors: Arkaprabha Sarangi[1]; Eli Dwek[2]; Richard Arendt[3]

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The light curve of Type IIn supernovae are dominated by the radiative energy release through the interaction of the supernova blastwave with their dense circumstellar medium (CSM). Specifically, in case of ultraluminous Type IIn supernova SN 2010jl, the spectra show an excess in the IR component as early as a few weeks after the explosion. The IR emission has been attributed by some as evidence for early dust formation in the circumstellar gas. We investigate in detail the physical processes that may inhibit or facilitate the formation of dust in the CSM. The post-explosion environment of Type IIn supernovae are characterized by high velocity shocks and strong ionizing radiations. We show that dust formation is inhibited by the effect of the downstream radiation from the supernova forward shock. In spite of the high densities in shocked gas that ensue rapid cooling, we find that the formation of dust grains in the post-shock circumstellar shell of SN 2010jl does not commence until day 380 post- explosion. On the other hand, observations on day 460 and later show that the IR luminosity exceeds the UV-optical luminosity. The IR emission is therefore powered by the

UVO emission from the reverse shock which is totally absorbed by the optically-thick shell of newly-formed CSM dust. The early IR emission is attributed to an IR echo from preexisting CSM dust, which has survived the SN flash associated with the outburst. In this talk, I shall present the first model of Type IIn supernovae that addresses the role of the radiation from the SN forward and reverse shock in the formation and survival of dust in the dense circumstellar environments.

Consider for a poster?:

Yes

Dust as a tracer in the Milky Way and local galaxies / 67

An Empirical Determination of the Dust Mass Absorption Coefficient, κd, and its Variation Within Nearby Galaxies

Authors: Christopher Clark[1]; Pieter De Vis[2]

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With the advent of large far-infrared and submillimetre facilities such as Herschel, Planck, JCMT, and especially ALMA, dust now provides an indispensable way to study the evolution of galaxies. In particular, our ability to observe large areas of the submillimetre sky quickly (along with the advantageous effects of negative-k-correction and lensing) mean that dust observations are increasingly used as a proxy to study star-formation rates, gas masses, and chemical evolution - which are impractical to observe directly for such substantial numbers of galaxies.

However, our ability to exploit dust observations in this way is predicated on a simple assumption - that we can actually use observations of dust emission to infer dust masses. But the dust mass absorption coefficient, κd, is uncertain to (at best!) an order of magnitude. Worse still, this forces us to treat κd as being constant both between galaxies, and within them - which of course cannot be true in reality. Pinning down κd, and how it varies, is therefore vital.

I will present a simple empirical method for determining the value of κd in galaxies, which exploits the fact that the dust-to-metals ratio in galaxies exhibits minimal variation in high- and intermediate-metallicity systems. This method puts new empirical constraints on global values of κd, providing an important counterpoint to theoretical and laboratory models.

I will also present the first ever resolved maps of κd, obtained by applying the method in a pixel-by-pixel manner to well-resolved nearby galaxies. These maps provide strong observational evidence for variation of κd within galaxies.

Consider for a poster?:

Yes

Poster Presentations - Board: 69 / **69**

Dust charge distribution in the Interstellar Medium

Author: Juan C. Ibañez Mejia[1]

Co-authors: Stefanie Walch [1]; Paola Caselli ; Alexei Ivlev ; Seamus Clark ; Prabesh Joshi

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The dynamics of dust grains vary depending on the forces that act on them at different environments in the multi-phase interstellar medium (ISM). Grains interact with the gas through collisions, gravitational attraction and long-range coulomb forces, and also experience varying coupling strengths to magnetic field lines depending on their charge. The charge distribution of dust grains in the ISM depends on the flux of charged particles from the grain surface, which is strongly dependent on the local properties of the ISM temperature, density, local radiation field and, within dense molecular clouds and protostellar disks, cosmic ray flux. We examine the charge distribution, f(Z), of a dust grain population in a radiative, turbulent, multi-phase, interstellar medium, accounting for collisional charging of grains by electrons and ions, photoelectric charging due to a background ultraviolet interstellar radiation field (ISRF) and cosmic rays. We use three-dimensional, adaptive-mesh-refinement, hydrodynamic colliding flows simulations, including gas self-gravity, gas and dust (self-)shielding, on the fly non-equilibrium chemistry, diffuse heating and radiative cooling, to model the complex structure of the multi-phase interstellar medium.
We find that mean charge is strongly dependent to the phase of the ISM where dust is present. Grains in molecular gas have predominantly neutral charge, while grains in the cold-dense and warm-diffuse ISM have predominantly positive charges, varying from charges of order unity, $\langle Z \rangle \sim 1$, for small (5 Angstrom) grains, to $\langle Z \rangle \sim 200$, for large (0.1 μm) grains. We found a combination of parameters that can be used to immediately find an approximate value of the charge centroid depending on the grain composition, size and ambient conditions. We then compare the timescale required for dust grains to reach equilibrium charge, to local dynamical timescales of the turbulent flow and find that in the diffuse ISM and within dense clouds dust charge equilibrium is a good approximation.

Consider for a poster?:

Yes

Poster Presentations / 70

From grain growth to astromineralogy: Studying dust with X-ray imaging and spectroscopy

Author: Lia Corrales[1]

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X-ray imaging and spectroscopy can provide a powerful tool for measuring the large end of the dust grain size distribution — important for interpretting infrared extinction as well as understanding grain growth in the diffuse interstellar medium (ISM). In addition, X-ray photoelectric absorption edges observed in high resolution spectra of Galactic X-ray binaries directly reveal the mineral composition of interstellar dust. I will review open problems in the field of astromineralogy, as probed by X-ray extinction. I will describe how observations from the next two X-ray missions — XARM and ARCUS — will answer some of those questions. Finally, I will discuss synergistic opportunities for X-ray telescopes and JWST to provide a more complete picture of dust grain evolution in the diffuse ISM.

Consider for a poster?:

Yes

Observational constraints on dust properties / 71

A new window on Interstellar Silicates

Author: Sascha Zeegers[1]

Co-authors: Elisa Costantini [1]; Alexander Tielens [2]; Cor de Vries [1]; Harald Mutschke [3]

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X-rays provide a powerful tool to study interstellar dust. Using X-ray binaries as background sources, we can investigate the intervening dust along the line of sight. This is done by observing the edges present in the spectra of these sources, that serve as a unique fingerprint of the dust (Costantini 2012).
In particular, the extinction features in the Si K-edge offer a range of possibilities to study silicon bearing dust, such as investigating the grain size distribution, crystallinity, abundance and the chemical composition along a given line of sight (Zeegers et al. 2017). The edge is modelled with unprecedented accuracy, as we include a total of 15 laboratory measurements of interstellar dust analogues. Here we also present our results of 9 different lines of sight toward the Galactic
plane and give a detailed mapping of the properties of the dust, unveiling the dust nature toward the central region of the Galaxy (Zeegers et al. 2018 in prep.).

Consider for a poster?:

Yes

Laboratory studies of cosmic dust / 72

Determining the systematic errors in fits of dust thermal emission: the role of laboratory data in upcoming models

Authors: Lapo Fanciullo[1]; Ciska Kemper[1]; Peter Scicluna[1]

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Interstellar dust plays an important role the study of interstellar medium, especially since the development of far-infrared and submillimeter instruments in the last decades (e.g. IRAS, Herschel, Planck, ALMA) has allowed wide surveys of dust thermal emission. Using a dust emission model these observations can be converted to maps of quantities such as the dust column density and temperature, or to constrain dust masses in molecular clouds and galaxies.

Dust emission is commonly modeled as a blackbody with temperature T multiplied by an opacity κ that varies with wavelength as a power law: $\kappa \propto \lambda^{-\beta}$, usually with $\beta \sim 2$. However, we are learning from both astronomical observations and laboratory tests on dust analogues that T–β models are too simplistic. Two facts in particular emerge:
1. For most candidate dust materials the opacity $\kappa(\lambda)$ does not follow a power law: its slope decreases beyond a certain wavelength (typically around 400–700 μm);
2. The optical properties of materials often depend on temperature as well; for instance opacity often increases with T.

Our group is working on optical data on several candidate dust materials, collected by multiple laboratories, to parametrize the materials' opacities as functions of λ and T. This parametrization will

be the first step in building a more physically realistic and flexible dust model. By fitting observations of molecular clouds and nearby galaxies, and by constructing synthetic observations to fit with conventional methods, the new model will allow to find potential systematics in T–β fit results. The model could also be applied to galaxies at high redshift, where recent dust mass estimates are posing a challenge to dust formation models, and understanding systematics on such measurements is essential.

Consider for a poster?:

Yes

Dust production by supernovae and massive stars / 73

Dust in supernova 1987A

Authors: Mikako Matsuura[1]; James M. De Buizer[2]; Richard G. Arendt[3]; Eli Dwek[3]; M.J. Barlow[4]; Antonia Bevan[None]; Phil Cigan[None]; Haley Gomez[None]; JH Rho[2]; Roger Wesson[None]; Patrice Bouchet[None]; John Danziger[None]; Margaret Meixner[None]

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Core-collapse supernovae (SNe) are considered to play a dual role in the production and destruction of dust in the interstellar media of galaxies. Currently, the subjects of intense investigations are the questions of how much dust SNe form, and how much dust survives SN shocks.

Supernova 1987A is the nearest supernova explosion detected in the last 400 years, and provides a unique opportunity for detailed studies of dust in a supernova. Both dust formation and destruction can be observed in a single object: it has freshly formed dust in the ejecta, while the fast expanding blast waves collide with circumstellar dust, which was expelled from the progenitor when this star was in the red-supergiant phase 40,000 years ago. We report recent SOFIA and VLT observations of dust in the ring of Supernova 1987A.

Mid-infrared VLT and SOFIA observations has captured the time development of ring dust in Supernova 1987A. Our VLT image shows that the 10-micron emission is now emitted from the west part of the ring, where the shock interaction is on-going. On the east side of the ring, the flux is declining, as the shock waves have passed the ring. Furthermore, our recent SOFIA observations detected that the 35-micron flux has increased since the last Spitzer observations 10 years ago. It might be possible that dust grains have been re-formed in the post shocked region.

Consider for a poster?:

Non-stellar dust production and the dust cycle in the ISM / 74

Low-temperature surface reactions of carbon atoms

Author: Serge Krasnokutski[1]

Co-authors: Paul Scheier [2]; Dmitriy Semenov [3]; Matjaz Simoncic [4]; Cornelia Jäger [5]; Thomas Henning [6]

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The method to study surface chemical reactions at ultra-low-temperatures and to measure the amount of energy release has been developed. The method was used to investigate surface reactions of carbon atoms leading to the formation of complex organic molecules (COMs). We found that that the key surface reaction $C+H_2 \rightarrow HCH$ is barrierless in contrast with the previously considered energy barrier of 2500 K. The corresponding modification of the value of the energy barrier of this reaction in the chemical network simulations provides a huge impact on the abundancies of many molecules inside dark molecular clouds.
This is also in line with our experiments, where the carbon atoms together with the most abundant interstellar molecules (H_2, H_2O, and CO) were used to dope superfluid helium nanodroplets. These experiments suggest that in the denser regions of the ISM, the condensation of carbon atoms leads to the formation of complex organic molecules (COMs) and their polymers. Water molecules were found not to be involved directly in the reaction network leading to the formation of COMs. It was proposed that COMs are formed via addition of carbon atoms to H_2 and CO molecules ($C + H_2 \rightarrow HCH, HCH + CO \rightarrow OCCH_2$, ...). Due to the involvement of molecular hydrogen, the formation of COMs by carbon addition reactions is expected to be more efficient at high extinctions compared with the previously proposed reaction scheme with atomic hydrogen.

Consider for a poster?:

Dust production by supernovae and massive stars / 75

Survey of dust emission in Galactic supernova remnants

Author: Hannah Chawner[1]

Co-authors: Ken Marsh [1]; Mikako Matsuura [1]; Haley Gomez [2]; Phil Cigan ; Ilse De Looze [3]; Mike Barlow [3]; Loretta Dunne [1]; Alberto Noriega-Crespo [4]; Jeonghee Rho [5]

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There is still on-going debate as to how much dust has been formed and destroyed by supernovae and supernova remnants. A systematic search for dust in supernova remnants is an effective way to resolve this issue. We search for far-infrared counterparts of 62 known supernova remnants in the Galactic plane (| l |<60○) at 70, 160, 250, 350, and 500μm using the Herschel Infrared Galactic Plane Survey (Hi-GAL). We detect FIR dust emission from 24 of our sample, with some evidence of ejecta dust heated by pulsar wind nebulae. Detailed analysis of near-infrared to radio emission from three pulsar wind nebulae suggests that there is a significant mass of ejecta dust within the supernova remnants. We use point process mapping to further analyse the dust mass distribution across the three sources at various temperatures and values of dust emissivity. This indicates the presence of between 0.29 and 0.64 solar masses of dust within each supernova remnant which is warmer than that of the ISM, at temperatures of 20 - 45 K. We expect that pulsar wind nebulae can heat SNR dust, increasing the temperature above that of the surrounding interstellar medium. We also find marginal evidence for one SNR that there may be a variation in the dust emissivity between the SNR material compared to that of the ISM, suggesting that there is a different dust composition within the SNR.

Consider for a poster?:

Yes

Poster Presentations - Board: 77 / **77**

Dust models compatible with Planck and starlight polarization data

Author: Vincent Guillet[1]

Co-authors: François Boulanger [2]; Lapo Fanciullo [3]; Anthony Jones [2]; François Levrier [4]; Marc-Antoine Miville-Deschênes [2]; Laurent Verstraete [2]

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The HFI instrument onboard the Planck satellite has allowed us to characterize the statistical and spectral properties of dust polarized emission over the whole sky in the submillimeter wavelength range.
Dust polarization is not only useful to trace the magnetic field orientation or to test alignment theories. It is also a way to characterize the spectral properties of the dust population that is aligned with the magnetic field.
I will summarize the main results of the analysis of Planck polarization data, and show how they challenge existing dust models.
I will also describe how we updated the DUSTEM model (Guillet et al 2018) to integrate polarization and account for these new constraints on dust emission in both total intensity and polarization.

Consider for a poster?:

Yes

Poster Presentations - Board: 78 / **78**

Systematics in dust emission modeling in nearby galaxies

Author: Jeremy Chastenet[1]

Co-authors: Karl Gordon [2]; Caroline Bot [3]; Karin Sandstrom [4]

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The dust properties of nearby galaxies are often inferred by modeling their infrared (IR) spectral energy distributions (SEDs), using dust grain models. These are created with a simplified radiation model, with assumptions on the intensity and hardness of the radiation field.
Using the Draine & Li (2007; DL07) dust model, we create a set of synthetic dust emission SEDs with a 3D radiative transfer (RT) model (DIRTY; Gordon et al. 2001), taking into account absorption, scattering and stellar and dust emission, in various galactic environments (varying the dust and stars distribution, star formation history, metallicity and dust mass). We use the DL07 models to fit these synthetic SEDs, and estimate the systematic biases due to the difference in the dust heating treatment.
We find that the empirical description (a power-law) of the radiation field heating the dust may lead to over- (when a dust layer surrounds stars) and underestimation (when dust is embedded in a cluster of stars) of dust properties such as total mass, or PAH fraction. We quantify these errors by comparing the RT-calculated radiation field and the empirical approach, showing that the power-law description is not suited for all cases.

Consider for a poster?:

Yes

Poster Presentations - Board: 79 / **79**

Dust and gas properties in nearby galaxies

Author: Monica Relano Pastor[1]

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The amount of dust in the interstellar medium (ISM) is directly linked to physical quantities that trace the evolution of galaxies. The emission from dust has been proposed as a probe of the amount of star formation within a galaxy and the physical properties of the dust are related to those of the ISM where it is located. Therefore, understanding better how the dust physical properties change under different conditions of the ISM will help us to get a better picture on how the dust traces the star formation rate and how galaxies evolve with time.

The infrared/submillimetre spectral energy distribution (SED) of galaxies provides a unique set of data to study how the dust is processed in galaxies and in the ISM in general. In this talk we present an analysis of the dust properties across the disc of M 33 performed by fitting the observed infrared SED at small galactic scales of $\sim$170 pc with the classical dust model from Desert et al. (1990). Our new analysis provides relative dust grain abundance of the different species and shows how they change with the ISM physical conditions in the disc of M 33. The dust grains are modified inside the star-forming regions, in agreement with a theoretical framework of dust evolution under different physical conditions. At each spatial location in the disc, we investigate how the gas-to-dust mass ratio is correlated with other physical properties of the galaxy: metallicity, dust and gas mass surface density and strength of the interstellar radiation field heating the dust.

The submillimetre excess, defined as the fraction of emission in the submillimetre range that is above a dust model having an emissivity coefficient β=2, is analysed at each spatial location. We produce a map of submillimetre excess in the 500μm SPIRE band for the disc of M 33. The excess can be as high as 50% and increases at large galactocentric distances. We further study the relation of the excess with other physical properties of the galaxy and find that the excess is prominent in zones of diffuse ISM outside the main star-forming regions, where the molecular gas and dust surface density are low.

We have applied the same methodology for M 33 to a set of nearby star-forming galaxies and we will present the first results of this analysis.

Consider for a poster?:

Poster Presentations - Board: 80 / **80**

DustPedia: Multiwavelength Photometry & Imagery of 875 Nearby Galaxies in 42 Ultraviolet-Microwave Bands

Authors: Christopher Clark[1]; Sam Verstockoen[2]; Simone Bianchi[3]

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The DustPedia project is capitalising on the legacy of the Herschel Space Observatory, using cutting-edge modelling techniques to study dust in the 875 DustPedia galaxies - representing the vast majority of extended galaxies within 3000 km/s (~40 Mpc) that were observed by Herschel. This work requires a database of multiwavelength imagery and photometry that greatly exceeds the scope (in terms of wavelength coverage and number of galaxies) of any previous local-Universe survey.

We therefore present multiwavelength imagery and photometry across 42 UV-microwave bands for the 875 DustPedia. This database contains custom Herschel reductions, plus standardised GALEX, SDSS, DSS, 2MASS, WISE, Spitzer, and Planck data. We also present CAAPR, the pipeline we use to conduct aperture-matched photometry of our data; CAAPR is designed to produce consistent photometry for the enormous range of galaxy and observation types we employ. In particular, CAAPR is able to determine robust cross-compatible uncertainties, thanks to a novel method for reliably extrapolating the aperture noise for observations that cover a very limited amount of background. The 27-band aperture-matched photometry, in combination with ancillary catalogue data from IRAS and Planck, represents 21857 photometric measurements. A typical DustPedia galaxy has photometry spanning 25 bands. This database of imagery and photometry is being made publicly available at: dustpedia.astro.noa.gr.

Consider for a poster?:

Yes

Dust in the early universe / **81**

The dust-to-stellar mass ratio, a key-tool for probing galaxy evolution from z~0 up to z~6

Authors: Francesca Pozzi[1]; Francesco Calura[2]; Carlotta Gruppioni[3]

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Over the last decade, the IR Herschel satellite has allowed to trace the
dust budget up to z ~4, and the recent ALMA facility
is extending the measurement of the dust production to even early times.
This has rendered particularly urgent the issue of explaining how

the dust mass in galaxies is related to other key galaxy-integrated quantities, i.e. stellar mass andstar-formation rate.
In the present work, I will focus, in detail, on the dust-to-stellar mass (DTS) ratio, as this quantity represents a true measure of how much dust per unit stellar mass survives the various destruction processes, i.e. astration and interstellar shocks.
The observed values of the DTS from z~0 up to z~6 will be compared to theoretical estimates computed by means of state-of-the art chemical evolution models for galaxies of different morphological type, showing the strong dependence of this quantity on two key ingredients, i.e. the underlying star formation history and the stellar initial mass function.

Consider for a poster?:

Poster Presentations - Board: 82 / **82**

Cosmological simulation with dust evolution

Author: kuan-chou Hou[1]

Co-authors: Hiroyuki Hirashita [1]; Ikkoh Shimizu [2]; Kentaro Nagamine [2]; Shohei Aoyama [1]

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Dust enrichment is one of the most important aspects in galaxy evolution. The evolution of dust is tightly coupled with the nonlinear evolution of the ISM including star formation and stellar feedback, which drive the chemical enrichment in a galaxy. Hydrodynamical simulation provides a powerful approach to studies of such nonlinear processes.

In this work, we perform a smoothed particle hydrodynamic simulation with a dust enrichment model in a cosmological volume. We adopt the dust evolution model that represents the grain size distribution by two sizes and takes into account stellar dust production and interstellar dust processing. We show that our cosmological simulation allows us to examine the dust mass function and to analyze the dust abundance and dust properties in galaxies statistically. The simulation broadly reproduces the observed dust mass functions at redshifts $z \sim 0$ and 2.5 and the relation between dust-to-gas ratio and metallicity shows a good agreement with the observed one at $z = 0$, which indicate a successful implementation of dust evolution in our cosmological simulation. Besides, we also examine the redshift evolution up to $z \sim 5$, and find that the galaxies have the highest dust abundance at $z =$ 1-2. For the grain size distribution, we find that galaxies with metallicity $\sim 0.3\ Z_\odot$ have the highest small-to-large grain abundance ratio at $z < 5$; consequently, the extinction curves in those galaxies have the steepest ultra-violet slopes.

Consider for a poster?:

Yes

Poster Presentations - Board: 83 / **83**

UV Dust Extinction and Attenuation Curves in the Local Volume

Author: Lea Hagen[1]

Co-authors: Julia Roman-Duval [2]; Karl Gordon [2]; Ben Williams [3]; Caryl Gronwall [4]; Steven Sebzda [4]; Michael Siegel [4]

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Our knowledge of the shape of the ultraviolet (UV) extinction curve informs our understanding of topics from the composition of dust grains in the ISM to how we interpret the shape of galaxy SEDs. I will discuss two complementary approaches to measuring the extinction curve.

First, we use resolved stellar populations in the Large Magellanic Cloud to determine the extinction curve shape along lines of sight to over 600,000 stars. The METAL (Metal Evolution, Transport, and Abundance in the LMC) program has obtained 33 fields of HST WFC3 imaging in seven NUV to NIR filters. For each of the stars in these fields, we use the BEAST (Bayesian Extinction And Stellar Tool) to model their SEDs and infer their stellar (age, mass, metallicity) and dust (A_V, R_V, 2175A bump) parameters. We derive high-resolution extinction maps by combining the measurements of many stars in each pixel on the sky, which we can then relate to the properties of the local ISM.

Second, we measure the shape of the attenuation curve for unresolved stellar populations in entire galaxies. The Ultraviolet/Optical Telescope (UVOT) on the Swift satellite has nearly completed a survey of 450 galaxies in the Local Volume. The three broadband NUV filters on UVOT are situated such that they can constrain both R_V and the 2175A bump. We use this unique capability in combination with archival optical and NIR imaging to model the SEDs of each galaxy and derive representative attenuation curves. For three galaxies (M31, M33, SMC), we have additionally created the first maps of the attenuation curve. We then examine variations of the attenuation curve with local (e.g., star formation rate, PAHs, dust temperature) and global (e.g., metallicity) galactic environment.

Together, these two methods will provide comprehensive constraints on the nature and properties of dust and how they vary within and between galaxies.

Consider for a poster?:

Yes

Poster Presentations - Board: 85 / **85**

A systematic study of dust and star formation in early-type galaxies with AKARI

Author: Takuma Kokusho[1]

Co-authors: Hidehiro Kaneda [1]; Martin Bureau [2]; Suzuki Toyoaki [1]; Mitsuyoshi Yamagishi [3]; Takashi Onaka [4]

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With the AKARI all-sky maps, we conduct a systematic study of dust and star formation for the 260 local early-type galaxies (ETGs) from the ATLAS3D survey, for which cold (HI and CO) and hot (X-ray) gas measurements are available. We detected far-infrared dust emission in 30% of the ETGs, where the dust emission is not correlated with the stellar emission, indicating that dust in those galaxies is of interstellar origin. In addition, polycyclic aromatic hydrocarbons (PAHs) are detected in many ETGs, suggesting that ETGs still form stars. We modeled the spectral energy distributions of the sample ETGs to derive the dust and PAH luminosities, from which we estimated the dust masses and star formation rates (SFRs), respectively. The dust-to-stellar mass ratios and current SFRs of the ETGs are lower than those of late-type galaxies (LTGs), showing that ETGs are quiescent galaxies, while their current star formation efficiencies are similar to those of LTGs. Our results indicate that the low SFRs of ETGs are likely due to their smaller cold gas fractions rather than a suppression of star formation. We also find that the dust masses and X-ray luminosities are correlated in fast-rotating ETGs, which appears to be caused by their higher current star formation activity than slow-rotating ETGs.

Consider for a poster?:

Yes

Poster Presentations - Board: 87 / **87**

Transfer of ionizing radiation through gas and dust

Author: Martin Glatzle[1]

Co-author: Luca Graziani [2]

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Cosmic dust provides a significant contribution to the absorption of electromagnetic radiation at all galactic scales. Hydrogen ionizing radiation ($h\nu \geq 13.6$ eV) emitted from star forming regions has to survive the large columns of gas and dust present in the galactic ISM of normal high-z galaxies before contributing to the IGM reionization process. Nevertheless, dust absorption is rarely self-consistently coupled with gas ionization in cosmological radiative transfer simulations and its impact on the timing of cosmic reionization poorly investigated. In this talk, I will first introduce a novel implementation of the cosmological radiative transfer code CRASH which supports the inclusion of an arbitrary number of dust species and accounts for the absorption of radiation by dust and the charging of grains associated with it. The results of several simulations adopting a Milky Way-like dust model both in idealized HII regions and realistic dusty galaxies will be critically discussed to show how the presence of dust grains sharpens the ionization fronts of expanding bubbles and reduces the ionization fractions of gas species at cosmic scales. We show how, depending on the total amount of dust in the high-redshift universe, the inclusion of dust in galaxy formation models can significantly change the ionization of the galactic ISM and impact the global reionization process.

Consider for a poster?:

Yes

Poster Presentations - Board: 88 / **88**

Hydrodynamic Simulations of Dust Destruction in Supernova Remnants

Author: Franziska Schmidt[1]

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Sub-millimetre observations of galaxies at redshift z>6 have revealed dust masses of up to 10^8 solar masses (e.g. Bertoldi and Cox, 2002). As such systems are thought too young for significant dust enrichment by asymptotic giant branch (AGB) stars to have occurred, core-collapse supernovae (CCSNe) have been suggested as possible alternative dust producers (Nozawa et al. 2003, Dwek et al. 2007). This is supported by recent Herschel far-IR and sub-millimetre observations of young CCSN remnants that are estimated to show between 0.25-0.8 solar masses of cool dust in SN 1987A, Cassiopeia A and the Crab Nebula (Barlow et al. 2010, Matsuura et al., 2011, De Looze et al. 2017).

Once formed, the dust particles can be subjected to various erosion processes such as sputtering and grain-grain collisions (the latter subject to a separate contribution by F. Kirchschlager) due to the reverse shock generated by interactions between ejecta and circumstellar material. This can result either in the complete destruction of the grains or in a size reduction. Whether significant quantities of dust can survive these conditions long enough to be incorporated into the interstellar medium (ISM) has been the subject of multiple recent studies (Nozawa et al. 2006, 2007, Silvia et al. 2010, 2012, Bocchio et al. 2016). The predicted dust survival rates vary greatly and models tend to adopt ISM-like grain size distributions dominated by small particles. However, recent determinations of ejecta dust size distributions (e.g. Wesson et al. 2015, Bevan et al. 2017) have indicated that larger (~1 micrometer radius) particles may dominate.

In this study, I investigate the survival rates of dust produced in CCSNRs through (magneto)hydrodynamic (MHD) shock simulations carried out with the publicly available AMR codes ENZO (Bryan et al. 2014) and AstroBEAR (Cunningham et al. 2009). The MHD models feature a cloud of dense gas (clump) embedded in a less dense ambient medium through which a shock propagates. As the shock travels through the computational domain, it collides with the clump and accelerates, compresses and heats the gas contained within. Following Silvia et al., 2010, we introduce parcels of dust in post-processing using a code developed at UCL. Each dust parcel contains a realistic dust grain size distribution and is advected alongside the gas flow. Sputtering effects (based on Tielens et al., 1994) then lead to a redistribution of grain sizes in the dust parcels.
I present preliminary results featuring purely hydrodynamic simulations in 2D with realistic dust grain radii distributions and sputtering rates.

This work was supported by ERC Grant 694520 SNDUST.

Consider for a poster?:

Yes

Poster Presentations - Board: 90 / **90**

Constraints on the structure of hot exozodiacal dust belts and their observability in the MIR

Authors: Florian Kirchschlager[1]; Sebastian Wolf[2]; Alexander Krivov[3]; Robert Brunngräber[4]; Harald Mutschke[5]

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Hot exozodiacal dust emission was detected around several main sequence stars at distances of less than 1 au using NIR and MIR interferometry. Studies of exozodis offer a way to better understand the inner regions of extrasolar planetary systems, and the possible presence of small grains in exozodiacal clouds is a potential problem for the detection of terrestrial planets in the habitable zone of these systems.

We modelled the observed excess of nine of these systems and found that grains have to be sufficiently absorbing to be consistent with the observed excess, while dielectric grains with pure silicate compositions fail to reproduce the observations. The dust should be located within ~0.01-1 au from the star depending on its luminosity. Furthermore, we found a significant trend for the disc radius to increase with the stellar luminosity. The dust grains are determined to be below 0.2-0.5 µm, but above 0.02-0.15 µm in radius. The dust masses amount to 0.2-3.5 × 10^{−9} M_{earth}. The near-infrared excess is probably dominated by thermal reemission.

In addition, we assessed the feasibility of observation and characterization of exozodis with the upcoming MIR instrument MATISSE at the Very Large Telescope Interferometer (VLTI). We find that MATISSE is potentially able to detect dust emission in five of the nine systems and will allow one to constrain the dust location in three of these systems, in particular to determine whether the dust piles up at the sublimation radius or is located at radii up to 1 au.

Consider for a poster?:

Yes

Poster Presentations - Board: 91 / **91**

Dust emission from the Cassiopeia A supernova remnant

Authors: Felix Priestley[1]; M.J. Barlow[1]

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We model the thermal emission from a distribution of dust grains heated by particle collisions and the ambient supernova remnant radiation field, under conditions representative of the knots observed in Cassiopeia A (Cas A). In order to reproduce the observed Cas A dust spectral energy distribution reported by de Looze et al. (2017), we require dust emission from both the pre- and post-shock regions. We find that the shocked dust is heated mainly by collisions with electrons, while the unshocked dust is heated by the synchrotron radiation field. The grain size distribution is required to extend to smaller radii in the shocked region, indicative of the destuction of dust grains by the reverse shock. The model SEDs are only weakly dependent on the maximum grain radii, leading to a range of possible dust masses between 0.4 and 1.2 solar masses (assuming $MgSiO_3$ grains), the majority of which is located in the preshock region.

This work was supported by ERC Grant 694520 SNDUST.

Consider for a poster?:

Poster Presentations - Board: 92 / **92**

A Closer Look at Some Gas-Phase Depletions in the ISM: Trends for O, Ge and Kr vs. F*, f(H_2) and Starlight Intensity

Author: Edward Jenkins[1]

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An analysis of interstellar absorption features in UV stellar spectra in the HST and FUSE archives reveals column densities of O I, Ge II, Kr I, Mn II, Mg II, H I and H_2 in many different directions. Expanding on an earlier study by Jenkins (2009), this effort probes the partial correlations of the element abundances of O, Ge, and Kr relative to hydrogen for three fundamental parameters: (1) a generalized parameter F*for the strength of depletions of elements by dust, (2) the fraction of hydrogen in molecular form f(H_2), and (3) a measure of the local intensity of starlight. Abundances of Mg II and Mn II relative to atomic and molecular hydrogen establish values of F.* Previous claims that the chemically inert element Kr is sometimes depleted are substantiated in this study, but correlations with any of the three parameters are very weak, especially after one accounts for error covariances arising from uncertainties in the total hydrogen column densities. The ratio of gas-phase O to H in the ISM exhibits positive correlations with both f(H_2) and starlight intensity, and as expected, a negative correlation with F. *Photodesorption of oxygen atoms from solid constituents probably accounts for the relationship between concentrations of gas-phase O and starlight intensity, but the reason for the correspondence with f(H2) is more difficult to explain and may arise from some indirect effect. Ge/H has a negative correlation with F* and no significant dependence on the other two parameters.

Consider for a poster?:

Yes

Poster Presentations - Board: 96 / **96**

Probing the interstellar dust with X-rays: The Fe L and O K edges

Authors: Ioanna Psaradaki[1]; Ioanna Psaradaki[2]

Co-authors: Mehdipour Missagh [2]; de Vries Cor ; Daniele Rogantini [2]; Sascha Zeegers ; Elisa Costantini [3]

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The content of the interstellar medium (ISM) is very important for the evolution of the Galaxy and for star formation processes. Today it is known that the structure of the ISM mainly consists of gas, dust and molecules. However, the composition of dust in the ISM is not yet fully understood. Insights can be gained from the X-ray band. High-resolution X-ray spectroscopy is a powerful method to investigate the interstellar dust composition. With X-ray spectra of bright background sources, it is possible to determine the silicate content and the physical properties of the diffuse regions in the ISM. We can probe the different phases of the interstellar medium and the chemical composition of gas along different lines of sight. In this work we analyse XMM-Newton and Chandra observations of the Low Mass X-ray Binary GX 9+9. This source is an ideal candidate to study the ISM because of known absorption by dust, cold and warm gas along the line of sight. For our modelling we use new laboratory measurements of different chemical composition of dust gained with the Electron Microscope Spectrometer in Cadiz, Spain. In particular, we focus here on the Fe L and O K edges, two abundant elements to study the chemical composition of dust grains along this line of sight.

Consider for a poster?:

Yes

Poster Presentations - Board: 98 / **98**

Mapping the extinction parameters of dust in the IC63 photodissociation region

Author: Dries Van De Putte[1]

Co-authors: Karl Gordon [2]; Julia Roman-Duval [2]; Brandon Lawton [2]; Maarten Baes [3]; Heddy Arab [2]

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Photodissociation regions (PDRs) are parts of the ISM consisting of predominantly neutral gas, located at the interface between HII regions and molecular clouds. The physical conditions within these regions show variations on very short length scales, and therefore PDRs form ideal laboratories for investigating the properties and evolution of dust grains. Recently, observations of the IC63 PDR were carried out with HST, producing high-resolution images with WFC3 in seven broadband filters from the UV to the NIR. With these observations, we investigate for the first time how the extinction varies across a PDR.

IC63 is an excellent target for this analysis, thanks to its many background stars. In this talk, I will explain how we simultaneously fit the stellar parameters (spectral type, effective temperature and luminosity), and extinction parameters (Av, Rv) for each of the observed background stars, based on an approach that was originally developed for the Panchromatic Hubble Andromeda Treasury (PHAT). These fits then allow us to make a map of the optical properties and the grain size distribution across the PDR, which indicates how these properties vary under the effect of the steep gradients in the physical conditions so typical for a PDR. I will discuss the impact of these results, as they may provide new constraints on the modeling of the formation and processing of dust in the ISM.

Consider for a poster?:

Yes

Dust production in low mass stars / **100**

The metallicity-depence of mass loss in carbon stars

Author: Sara Bladh[1]

Co-authors: Paola Marigo [2]; Bernhard Aringer [2]; Kjell Eriksson [1]; Sofie Liljegren [1]

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AGB stars are major contributors of dust in the universe, feeding newly produced elements into the surrounding interstellar medium in the form of gas and dust through their stellar winds.

The detailed modelling of these dense winds or outflows is therefore crucial for understanding both the chemical evolution of galaxies, and the dust production in the interstellar medium. The mass loss observed in AGB stars is believed to be caused by a combination of atmospheric levitation by pulsation-induced shock waves, creating favourable conditions for dust formation, and radiative acceleration of these newly formed dust grains. This mass-loss scenario has been successfully implemented in the 1D radiation-hydrodynamic code DARWIN for AGB stars at solar metallicity.

But what about the dust production from AGB stars in low metallicity environments such as found in the LCM or SMC? In this talk I will present wind properties, such as mass-loss rates, wind velocities and dust-to-gas ratios, from a set of DARWIN models at metallicities compatible with the LMC and SMC. These results show that as long as stars dredge up sufficient amounts of carbon during the AGB phase, they will contribute significantly to the dust production, also at LMC and SMC metallicities.

Consider for a poster?:

Poster Presentations - Board: 101 / **101**

Constraint on properties of dust grains created by Population III supernovae

Authors: Gen Chiaki[None]; Nozomu Tominaga[1]; Takaya Nozawa[2]

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Dust grains play an important role in star formation also in the early Universe. The stellar initial mass function is considered to transfer from top-heavy to the normal Salpeter one in the course of metal/dust enrichment of interstellar medium because thermal emission cooling by dust grains induce the fragmentation of their parent gas clouds. However, dust properties such as size distribution and metal condensation efficiency are largely unknown. We here focus on the lower limits of elemental abundances of metal-poor stars. Recently, by survey campaigns, we obtain large statistical samples of metal-poor stars. They are classified into C-enhanced metal-poor (CEMP) stars and C-normal metal-poor (CNMP) stars, and their carbon and iron abundances show the lower limits of $A_{\rm cr}({\rm C}) \sim 6$ and $[{\rm Fe/H}]_{\rm cr} \sim -5$, respectively. This suggests the critical elemental abundances above which cooling of carbon and silicate grains is dominant, respectively. Since the dust cooling rate depends on the condensation efficiency of metal and grain size distribution with a given metallicity, we estimate them from the observed lower-limits of carbon and iron abundances. As a result, we find that the ratio of characteristic grain size to condensation efficiency (effective grain radius) is 10 μm and 0.1 μm for carbon and silicate grains, respectively.

Consider for a poster?:

Yes

Poster Presentations - Board: 102 / **102**

Dust Attenuation of Star-Forming Galaxies in the first 2 Gyr of the Universe

Authors: Yoshinobu Fudamoto[1]; Pascal Oesch[1]

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The development of extremely sensitive mm/submm telescopes (e.g. ALMA, NOEMA) opened a new window to the far infrared (FIR) continuum emitted by dust, which enables us to investigate the obscured star-formation history of the Universe. Using these new facilities, recent studies of the dust properties of early galaxies revealed unexpected results, as high redshift galaxies show much lower FIR emission than expected. However, these early results were based on small samples selected from small fields in the sky. Here, we take the next steps based on the ALMA archive in the COSMOS field (a.k.a A3COSMOS project) and present new results on the dust attenuation of a large sample of high-redshift galaxies at z~3-5. In particular, we study the relationship between the stellar mass (M_{*}), the UV spectral slope (β_{UV}), and the infrared excess (IRX). In total, our study is based on a sample of ~1000 galaxies (~10% of which are individually detected) at z=3-5 in a stellar mass range 10^{9} - 10^{11} $\mathrm{M}_{\odot}$ observed by ALMA during cycle1 - cycle4. Stacks show that the dust extinction corrections of local starburst galaxies are, on average, applicable to main-sequence z~3-5 galaxies. However, the IRX-beta_UV relation exhibits a very large scatter, up to ± 1 dex at a given UV slope. Similar results hold for the IRX-M_{*} relation. We discuss several physical explanations for the large scatter in the IRX-beta_UV relation and the IRX-Mass relation, and their implications for estimating the total cosmic star-formation rate density at $z > 3$.

Consider for a poster?:

Yes

Poster Presentations - Board: 103 / **103**

Relative sputtering rates of FeS, MgS, and Mg silicates: implications for ISM gas phase depletions of rock-forming elements

Author: Lindsay Keller[1]

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Astronomical measurements of S abundances in the diffuse interstellar medium (ISM) indicate ionized S is a dominant species with little (< 5%) S residing in grains (e.g. Jenkins 2009). This is an enigmatic result, given that abundant Fe-sulfide grains are observed in dust around pre- and post-main sequence stars (Keller et al. 2002; Hony et al. 2002) and are also observed as major components of primitive meteoritic and cometary samples. These disparate observations suggest that the lifetime of sulfide grains in the ISM is short because of destruction processes. Our previous work has shown that FeS and MgS retain their crystallinity and do not amorphize during radiation processing, whereas enstatite and forsterite are readily amorphized (Keller et al. 2013; Christoffersen and Keller, 2011). We have extended this study to measure the relative sputtering rates of FeS and MgS compared to enstatite and forsterite.

Irradiation of FeS with 4 keV He+ results in preferential sputtering of S and the formation of a thin 2-3 nm, compact Fe metal layer that armors the surface. The zone of S loss extends to a depth of ~8-10 nm below the exposed surface (Keller et al. 2013). Despite this S loss, the FeS retains its crystallinity and shows no sign of incipient amorphization. Irradiation of FeS with 5kV Ga+ in a focused ion beam (FIB) instrument resulted in preferential sputtering of S and the formation of a 5-8-nm thick surface layer of nanophase Fe metal. X-ray mapping shows that the zone of S sputtering extends to a depth of nearly 20 nm, but there is no evidence for FeS amorphization, consistent with our previous work.

The irradiation experiments show that the relative sputtering rate of FeS and MgS are much higher than olivine or enstatite. Sputtering experiments utilizing 30 kV and 5 kV Ga ions in the FIB pro-

duced volume loss in troilite that was ~4X greater than in enstatite or forsterite. The sputter yield under these conditions is such that for every Si atom sputtered from enstatite, ~14 S atoms are sputtered from FeS. We have performed similar sputtering experiments on Fe-bearing niningerite (MgS) and co-existing enstatite from the ALH 84170 EH3 chondrite. MgS also sputters much more rapidly than enstatite with a relative Si:S sputter yield of 1:8. For MgS, sulfur is highly depleted at the surface and the S-depletion zone extends to a depth of ~15 nm (using 5 kV Ga+). There is a corresponding zone of Mg and especially Fe enrichment that extends from 5 to ~10 nm below the surface, respectively.

The dominant grain destruction mechanism in the ISM is sputtering from passage of supernova-generated shock waves (Jones and Nuth 2011). This process also results in the amorphization of crystalline silicates in the ISM. Our results indicate that FeS and MgS grains produced in evolved stars and injected into the ISM will be destroyed more rapidly than crystalline silicates. This process may account for the lack of significant depletion of S from the gas phase in the ISM. However, rare nanophase FeS grains occur as inclusions in circumstellar amorphous silicate grains found in comet dust particles analyzed in the laboratory (Keller and Messenger 2011). These results show that a finite amount of S in the ISM is sequestered in solid grains.

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Consider for a poster?:

Yes

Poster Presentations - Board: 104 / **104**

VUV photoprocessing of large PAH cations: an experimental study

Author: Gabi Wenzel[1]

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As a part of interstellar dust, polycyclic aromatic hydrocarbons (PAHs) are processed by the interaction with vacuum ultraviolet (VUV) photons that are emitted by young stars [1]. After absorption of

a VUV photon, an isolated PAH can undergo different relaxation processes: ionization, dissociation and radiative cooling, including infrared (IR) fluorescence which results in the aromatic infrared bands (AIBs) observed in many astronomical objects [2].
Following an earlier work on smaller PAHs [3], we investigate in this experimental study the two relaxation processes of photofragmentation and photoionization of large PAH cations ranging in size from 30 to 48 carbon atoms. The ions are trapped in the LTQ linear ion trap of the DESIRS beamline at the synchrotron SOLEIL and energized by VUV photons in the range of 8 - 20 eV. All resulting photoproducts are mass-analyzed and recorded as a function of photon energy. The photoionization process is found to strongly dominate the competition, with the photoionization yield increasing with number of carbon atoms. From the relative intensities of the photoproducts, action spectra are obtained and compared to the photoabsorption cross sections. The latter have been computed using the real time, real space implementation of time dependent density functional theory (TD-DFT) from the Octopus code [4]. This study gives insights into the photostability of interstellar PAHs in astrophysical environments.

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Consider for a poster?:

Yes

Poster Presentations - Board: 105 / **105**

Investigating the Properties of Nearby Galaxies

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We have updated the SED fitting code "CIGALE" so that it includes dust properties based on the "THEMIS" model (Jones et al. 2017, A&A, 602, 46). We use this tool to fit the SED of 875 nearby galaxies with available photometry from the FUV to the sub-millimeter wavelengths. For this sample of galaxies (the "DustPedia" galaxies – Davies et al. 2017, PASP, 129, 4102) we are able to derive global properties like stellar and dust mass, star-formation rate and dust extinction and we compare our results with widely used recipes found in the literature. Furthermore we examine how the unattenuated luminosity of the young and old stellar populations correlate with basic properties of the galaxies of different morphological types.

Consider for a poster?:

Yes

Poster Presentations - Board: 106 / **106**

PAHs and star formation in the HII regions of M83 and M33

Authors: Alexandros Maragkoudakis[1]; Alexandros Maragkoudakis[None]

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IR emission features at 3.3, 6.2, 7.7, 8.6 and 11.3 μm are usually attributed to IR fluorescence from FUV pumped polycyclic aromatic hydrocarbons (PAHs). These features thus trace the FUV stellar flux and are a measure of star formation in the Universe. Here, we present results from a detailed study on the mid-IR emission features of HII regions in M83 and M33, with the aim to investigate the IR spatial characteristics in star-forming regions from Milky Way (MW) HII regions, to star-forming complexes in nearby galaxies, and star-forming galaxies as a whole. As such, we build a control sample to compare our results, including star-forming regions in the MW, LMC, M101, starburst nuclei, and nearby galaxies. We find that the PAH intensity ratios in M83 and M33 HII regions have similar correlations as those in individual HII regions within galaxies, starburst nuclei, and AGN host galaxies. We find that the strength of the 17.0 μm PAH band is enhanced relative to the other PAH bands compared to galactic star-forming regions, similar as in other galaxies. In comparison with other emission components we find that: **1)** the PAH/VSG intensity ratio presents a decrease with galactocentric radius for both M83 and M33 as well as the Milky Way, and **2)** the $L_{TIR}/L_{6.2\mu m}$ luminosity ratio in M83 and M33 HII regions ranges in between the values measured in Galactic and LMC HII regions, and those in normal star-forming galaxies and starburst nuclei. The extragalactic HII regions appear as a linking component between the spectral properties of local HII regions and star-forming galaxies, and can be used as better templates than Galactic HII regions when interpreting the properties of star-forming galaxies.

Consider for a poster?:

Yes

Observational constraints on dust properties / **107**

Investigating Silicate Dust in Galaxies Using Quasar Absorption Systems

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The properties of silicate and carbonaceous dust grains in galaxies, as well as those of neutral and ionized gasses and of molecules, can be studied in galaxies ranging from the local Universe to moderate redshifts using absorption lines detected in the spectra of background quasars. By exploiting serendipitous lines of sight to distant quasars that pass through foreground galaxies, we can study the absorption signatures superposed in the quasar spectra by the dust and gas in these galaxies. Since quasars are luminous across a broad spectral range, this technique allows the simultaneous investigation of carbonaceous dust grains in the rest-frame ultraviolet (e.g., the 2175 Angstrom bump), metal ion lines at rest-frame ultraviolet and optical wavelengths, and silicate dust grains in the mid-infrared. We present results from our ongoing multi-wavelength research program exploring the connections between interstellar gas and dust in both distant and local galaxies using archival data for quasars with at least moderately gas-rich, foreground quasar absorption systems. In this presentation we will predominately focus on our studies of the silicate dust grains in several of these systems, characterized using the shapes of their 10 and 18 micron absorption features in Spitzer IRS spectra. Our measurements include the peak optical depth of the 10 micron feature, the ratio of the 10-to-18 micron features, and constraints on the silicate grain compositions, morphologies, and crystallinities derived from the shape and breadth of the absorption features. As part of our analysis, we will discuss the impact of variations in the underlying quasar continuum shape on our derived properties. We will also discuss correlations and trends between the silicate dust grain properties in these systems, and properties such as the absorber redshift, gas metallicity, velocity spread, carbonaceous dust abundance, and extinction curve shape. In combination, these data may yield important constraints on models of the evolution of metals and dust in galaxies. This work was supported by NASA grants NNX14AG74G and NNX17AJ26G.

Consider for a poster?:

Yes

Poster Presentations - Board: 108 / **108**

Probing the Size Distribution of PAHs in Reflection Nebulae

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Co-authors: Dave Stock [1]; Els Peeters [2]; Alexander Tielens [3]; Olivier Berné [4]

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The mid-infrared (MIR) spectrum of many astronomical sources show prominent emission features at 3.3, 6.2, 7.7, 8.6, 11.2, and 12.7 μm attributed to the IR fluorescence of polycyclic aromatic hydrocarbons (PAHs). We use spatial maps of the 3.3 and 11.2 μm PAH emission features to measure the distribution of PAH size within two reflection nebulae with strong MIR emission present, namely NGC 2023 and NGC 7023. Variations in the size of these molecules with distance from a source of ultraviolet (UV) radiation is indicative of the photochemical evolution of these species and yields information on how they interact with their environment.

We make use of the First Light Infrared TEst CAMera (FLITECAM) on board the Stratospheric Observatory for Infrared Astronomy (SOFIA) to observe the 3.3 μm emission in each source. The 11.2 μm emission band is measured using spectral maps obtained from the Infrared Spectrograph (IRS) SH mode on board the Spitzer Space Telescope. Additionally, we use broadband photometry at 8 μm from the Infrared Array Camera (IRAC) on board Spitzer. These IRAC 8 μm images are compared with the IRS SH data to map the 8 μm over 11.2 μm ratio, as an approximate measure of the PAH ionization state.

We use the map of the 11.2 μm over 3.3 μm emission feature to probe the size distribution in each of our sources. We find that this ratio is at a minimum on the surface of the photodissociation region (PDR) and increases by a factor of 2-3 moving inwards towards the illuminating source in both reflection nebulae, suggesting these species undergo significant photoprocessing within their environment. We also note that the ionization level of these species is found to increase with decreasing

distance to the illuminating source in both of these cases. Hence, we can infer there is evidence of a rich carbon-based chemistry driven by the photochemical evolution of the omnipresent PAH molecules within the interstellar medium.

Consider for a poster?:

Yes

Poster Presentations - Board: 109 / **109**

Crystalline silicates in external galaxies

Author: Ciska Kemper[1]

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Observational evidence has long supported that most of the interstellar silicates in galaxies are amorphous. While crystalline silicates may form around evolved stars at temperatures sufficiently high to allow for annealing, it is thought that the harsh interstellar environment quickly amorphitizes any crystalline silicates, most likely through bombardment by the heavy ions in cosmic rays (Demyk et al. 2001; Jäger et al. 2003; Brucato et al. 2004; Bringa et al. 2007; Szenes et al. 2010), and a firm upper limit of 2% on the crystalline fraction of silicates was derived based on the absence of substructure in the 9.7 µm feature (Kemper et al. 2004; Kemper et al. 2005).

The first detection of crystalline silicates in external galaxies was reported by Spoon et al. (2006) in 12 out of a sample of 77 starbursting Ultraluminous Infrared Galaxies (ULIRGs), with later detections of further galaxies reported by Roussel et al. (2006), Willett et al. (2011), Stierwalt et al. (2014), and Aller et al. (2012). The only one of these studies quantifying the crystalline fraction is the work by Spoon et al. (2006), who report a crystalline fraction of 6-13% in the interstellar silicate reservoirs. A very simple model of the production of crystalline silicate dust by evolved stars, at a level of 10-20% of the total silicate dust production by these stars, is able to explain the observed crystallinities at about 30 Myr after the start of a starburst (Kemper et al. 2011). In general, the model can be used to estimate the transition time and interstellar conditions, such as cosmic ray fluence, based on observational constraints on the crystalline fraction.

However, the small number of known interstellar crystalline silicate fractions in star-forming galaxies limits the usefulness of such a model. We have devised a method to measure the crystalline fraction of silicates in a large number of galaxies quickly and easily. For this purpose, we are performing radiative transfer models of starburst galaxies, with varying crystalline fractions of their interstellar silicates using the SKIRT radiative transfer code (Camps & Baes 2015), and identified a method to determine the crystallinity of silicates in starburst galaxies directly from (archival) infrared spectroscopy.

Consider for a poster?:

Yes

Poster Presentations - Board: 110 / **110**

Dust production in the Solar Neighborhood

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Asymptotic Giant Branch (AGB) stars dominate the total dust injection into the interstellar medium (ISM) of galaxies. Studies providing total dust injection rates in the Milky Way (Jura & Kleinmann 1989) and nearby galaxies (Riebel et al. 2012; Srinivasan et al, 2016) show the importance of accurately estimating this contribution. In this work we revisit the total dust mass-loss rate from AGB stars in the Solar neighborhood. Such an update is necessary, especially for an all-sky sample, as contrary to recent and old studies. One of the challenges for Galactic and dusty AGB sources is the distance determination, which we are primarily interested in, as they are the highest mass-loss rate objects. Using present-day all-sky infrared facilities (WISE, 2MASS, AKARI). We constructed spectral energy distributions for all the AGB candidates within within 2 kpc from the Sun, which we fit with models from the GRAMS grid (Sargent, Srinivasan & Meixner 2011; Srinivasan, Sargent & Meixner 2011) to estimate their dust-production rates. We find an integrated dust production rate of ~ 4 X 10^-5 Msun/year or an average of ~ 2 X 10^-8 Msun/year per object is obtained. We compare our results to those of the Magellanic Clouds and other Local Group galaxies, for which the distance determination problems do not exist. Separating the contribution into C- and O-rich AGB is also presented and is compared with estimates from the LMC and SMC as well. This work presents new insights into the contribution of low- and intermediate-mass stars to the ISM, and the discrepancy between the dust produced by AGB stars and the estimated reservoir in the ISM.

Consider for a poster?:

Yes

Molecules and dust / **111**

The photochemical evolution of the interstellar PAH family in photodissociation regions

Author: Els Peeters[1]

Co-authors: Dave Stock [2]; Matthew Shannon [3]; Charles Bauschlicher [4]; Louis Allamandola [4]; Alexander Tielens [5]; Alessandra Ricca [6]; Mark Wolfire [7]

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As is unequivocally evident from observations, Polycyclic Aromatic Hydrocarbons (PAHs) pervade the Universe. PAHs are easily detected through their vibrational IR emission bands at 3.3, 6.2, 7.7, 8.6 and 11.2 micron. They are found in a wide variety of environments, including post-AGB stars, planetary nebulae, young stellar objects, HII regions, reflection nebulae, the interstellar medium, and

galaxies out to redshifts of z ~3. To date, PAHs are among the largest and most complex molecules known in space. They emit up to 10% of the total power output of star-forming galaxies and harbor a significant fraction of the cosmic carbon. Being so abundant and widespread, PAHs play a crucial role in several astrophysical and astrochemical processes such as the heating of the diffuse ISM and surfaces of molecular clouds and proto-planetary disks, gas-phase abundances and surface chemistry.

The Infrared Space Observatory (ISO) and the Spitzer Space Telescope showcased the richness and complexity of the astronomical PAH spectra. The PAH features exhibit significant variability and depend on several parameters such as radiation field, object type and metallicity. These variations thus reflect both the physical conditions in the emission zones and the composition of the PAH population. Thus, one of the best ways to investigate the detailed characteristics of the PAH population is by analyzing IR spectral maps. Here we present the results of such hyperspectral imaging studies done with Spitzer/IRS in the 5-20 micron range for a sample of Reflection Nebulae and HII regions. These studies reveal subtle, but significant spatial variations in individual PAH emission bands revealing a spatial sequence with distance from the illuminating star. The overall dominant charge state of the PAH population is certainly a key factor in driving these variations. However, hyperspectral imaging studies allow to probe PAH parameters beyond charge, such as molecular structure and size. Combined with the NASA Ames PAH database to fine-tune band assignments, the observed spatial sequence reveals the photochemical evolution of the interstellar PAH family as they are more and more exposed to the radiation field of the central star in the evaporative flows associated with the Photodissociation Regions.

Consider for a poster?:

Yes

Poster Presentations - Board: 112 / **112**

Modelling dust in the Nearby Evolved Star Survey (NESS) targets

Authors: Sundar Srinivasan[1]; Thavisha Dharmawardena[1]; Peter Scicluna[1]; Franciska Kemper[2]

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The Nearby Evolved Stars Survey (NESS) is a multi-telescope project targeting a volume-limited ($d < 2$ kpc) sample of $\sim$400 evolved stars, including 104 oxygen-rich stars (including $\sim$20 red supergiants), 8 S-type stars, and 19 carbon-rich AGB stars, as well as many post-AGB stars and planetary nebulae. NESS includes a 500-h ongoing JCMT survey of dust continuum as well as CO (2-1) and (3-2) line emission. The NESS JCMT data facilitate the determination of the circumstellar dust distribution and estimation of the mass-loss history in the circumstellar shells, including any deviations from spherical symmetry (Dharmawardena et al., in prep). Radiative transfer models of this dust must update fits to mid-infrared spectral energy distributions (SEDs) to fit the far-IR and sub-mm information, and should reproduce the results from JCMT observations.

In this poster, we present preliminary results of modelling dust in W Hya and U Ant, whose shells show complex structures that can not be fully explained by a uniform mass-loss rate model. NESS data has revealed U Ant's detached shell for the first time in the sub-mm continuum (Dharmawardena et al. in prep). We first fit the mid-IR SEDs with models from the GRAMS grid (Sargent et al., 2011; Srinivasan et al., 2011), tacitly assuming spherical symmetry. Using these models as a starting point, we use the radiative transfer code 2Dust to explore ranges of parameters that will reproduce the radial profiles as determined by Dharmawardena et al. (in prep), including any evidence of detached shells and/or variable mass-loss rates.

These models are the first step towards detailed modelling that incorporates data from optical through sub-mm SEDs and spectra, as well as other data such as interferometric visibilities. Modelling the large number of AGB stars targeted by NESS will lead to robust estimates of dust-production rates across the entire range of evolutionary stages along the AGB. Combined with modelling of the NESS CO line data, these can also be used to determine the gas-to-dust ratio throughout the circumstellar shell for the entire sample.

Consider for a poster?:

Yes

Grain growth, planet formation and debris disks / 114

A multi-wavelength view of planet forming discs: unleashing the full power of ALMA for grain growth studies

Author: Marco Tazzari[1]

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Observations at sub-mm/mm wavelengths allow us to probe the solids in the interior of protoplanetary discs, where the bulk of the dust is located and planet formation is expected to occur. However, the actual size of dust grains and the physical properties of the disc interior are still largely unknown due to the observational limits of past sub-mm/mm studies. ALMA, thanks to its exquisite resolution and sensitivity, is an unprecedented tool to study grain growth in large samples of discs.

In my contribution I will present a novel analysis method that constrains the radial profile of the maximum grain size in protoplanetary discs by means of a simultaneous fit of spatially resolved observations at several sub-mm/mm wavelengths (Tazzari et al. 2016, A&A 588, A53). By breaking the degeneracy between the opacity, temperature and density contributions to the sub-mm emission, this method enabled us to find observational evidence of a radial sorting of grain sizes in a few discs, an effect that is expected from dust evolution models including grain growth and radial drift.

I will also present new ALMA 3 mm observations of 35 discs in the Lupus star forming region (Tazzari et al., in prep) and the results of the coupled analysis with our previous 890 μm ALMA survey of the same discs (Ansdell et al. 2016, ApJ 828 46; Tazzari et al. 2017, A&A 606 A88). I will discuss the grain sizes inferred for such homogeneous sample of discs in comparison with the level of grain growth in other regions with different mean ages.
Finally, after characterising how the contamination from optically thick emission would affect grain size estimates, I will show that a minimum level of grain growth is always needed to account for the distribution of spectral indices and sub-mm fluxes that we currently observe.

Consider for a poster?:

Observational constraints on dust properties / 116

Constraining dust mineralogy from mid-IR spectra

Authors: Peter Scicluna[1]; Francisca Kemper[1]; Sundar Sriviasan[1]; Lapo Fanciullo[1]; Alfonso Trejo[1]; Thavisha Dharmawardena[1]

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The first ISO spectra of evolved stars revealed a wealth of features in AGB stars, YSOs, comets and other environments, which have been linked to a variety of crystalline silicate and oxide species. The presence and strength of these features carries information about the formation and processing history of the dust in AGB envelopes. However, unlocking this information has proven difficult; our understanding is anecdotal at best, being based on small, likely biased, samples. While ISO and Spitzer have observed the mid-IR spectra of hundreds of sources, these datasets have not been properly exploited yet. Statistical problems have been a significant factor, primarily the difficulty in simultaneously fitting the overall SED and the details of spectral features using radiative-transfer models. I will explore these and related problems before presenting an attempt to alleviate them. I will present a new code we are developing, AMPERE, which includes the correct statistical treatment for simultaneous fitting of different kinds of data (photometry, spectra, imaging, interferometry). I will conclude with first results of an experiment in self-consistently fitting SEDs and mid-IR spectra to obtain detailed constraints on dust properties, including mineralogy, in selected oxygen-rich AGB envelopes.

Consider for a poster?:

Yes

Poster Presentations - Board: 117 / **117**

Effect of dust porosity on scattered light images of protoplanetary disks

Author: Ryo Tazaki[1]

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The dust porosity is a key quantity that characterizes how dust particles grow to form planetesimals in protoplanetary disks. We study how the dust porosity affects scattered light images of protoplanetary disks in near-infrared wavelengths. It is known from near-infrared observations that some protoplanetary disks are faint and show red color in the scattered light. Large fluffy dust aggregates have been considered as a potential candidate to explain these observed properties (Mulders et al. 2013).

We perform radiative transfer calculations of protoplanetary disks taking the dust porosity into account, where optical properties of fluffy dust aggregates are obtained by using a rigorous method, T-Matrix Method (TMM) and approximate methods, a modified mean field theory (MMF, Tazaki & Tanaka, submitted) and the effective medium theory (EMT). It is found that when a commonly used method, EMT, is used to obtain optical properties of fluffy dust aggregates, the disk becomes faint and shows reddish color in the scattered light. However, when a rigorous method, TMM, is used to obtain the optical properties, the disk becomes relatively bright and shows gray or slightly blue color. By using the MMF method, we show that even if the aggregate radius is increased up to mm-size, the disk tends to show relatively bright and gray color. As a result, our results suggest that red and faint protoplanetary disks in the scattered light indicate the presence of large compact aggregates at the surface layer of the disks rather than large fluffy dust aggregates.

Consider for a poster?:

Yes

Poster Presentations - Board: 123 / **123**

Constraining the presence of large dust grains in post-AGB disc systems using FIR and sub-mm photometry

Authors: Peter Scicluna[1]; Franciska Kemper[2]; Steve Ertel[3]; Alfonso Trejo[1]; Jonathan Marshall[1]

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The final stages of the evolution of intermediate mass stars ($M \sim 1 - 8M_{\odot}$) are characterised by the ejection of their envelope as they evolve off the Asymptotic Giant Branch (AGB), producing a spectacular planetary nebula (PN). In particular, this phase is characterised by the development of strong asymmetries in the circumstellar medium, with a large fraction of PNe and pre-PNe hosting jets, tori, rings or bipolar structures, while many AGB envelopes are broadly spherical in shape. These asymmetries are, therefore, believed to develop either in the final phase of AGB evolution or in the initial post-AGB phase. In a small fraction of cases, post-AGB stars are found to be orbited by a massive, dusty circumstellar disc. Other types of circumstellar discs, such as protoplanetary and debris discs, are typically populated by dust grains at least up to mm sizes, as probed by the spectral index in the FIR and (sub-)mm wavelength ranges. In protoplanetary discs (PPDs), the existence of these large dust grains is believed to be linked to grain-growth processes which can take place in such dense, long-lived discs. There is also evidence for the presence of grains of such sizes in the discs in post-AGBs in spite of the large difference in lifetime compared to PPDs. However, to date such studies have either been relatively small, or the samples used have combined both post-AGBs with discs with pre-PNe and other objects, making it difficult to evaluate the prevalence of grain growth. I will present the largest study to date of the FIR and sub-mm emission of post-AGB stars with discs. By exploiting archival Herschel/SPIRE photometery along with new SMA observations and literature fluxes of a sample of 45 post-AGBs with discs we show that grain-growth to at least several hundred micron is ubiquitous in these enigmatic systems. The similarity of the distribution of spectral indices to those of protoplanetary discs indicates that this is a result of in-situ grain growth, rather than the grinding of parent bodies. The relatively short lifetimes of these discs show that grain growth to these sizes is a rapid process, occurring on timescales of only a few kyr.

Consider for a poster?:

Yes

Poster Presentations - Board: 124 / **124**

The evolution of dust formation in SN2005ip from optical line profile models

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The source of the large masses of dust observed in some very early Universe galaxies at redshifts z > 6 has been much debated. Core-collapse supernovae (CCSNe) have been predicted to be efficient producers of dust but the majority have only had small masses of warm dust ($< 10^{-3}$ $M_{\odot}$) detected in their ejecta during their early phases (t < 3 years), based on fits to their near-IR and mid-IR SEDs. However, observations in the far-IR by Herschel and ALMA of a few CCSNe have yielded far higher cold dust masses (0.1 - 1.0 $M_{\odot}$), which, if representative of the wider CCSN population, could

potentially account for the dust masses seen in the early Universe. Unfortunately, there are now few instruments capable of detecting CCSN dust emission outside the local group at far-IR and sub-mm wavelengths, so other techniques must be exploited.

The late-time optical and near-IR line profiles of many CCSNe exhibit a red-blue asymmetry caused by red-shifted emission from the receding parts of the ejecta, which must traverse the dusty interior of the ejecta, experiencing greater extinction than the blue-shifted emission. I present Monte Carlo line transfer models of asymmetric optical line profiles of the interesting Type IIn interacting supernova SN2005ip from $\sim$40 d post-discovery to $\sim$4000 d. Dust has been predicted to form in two phases in this object, first in the ejecta and also in the post-shock region that develops following interaction of the ejecta with a dense circumstellar medium (Smith et al. 2009). I present models of the progressively blueshifted, broad Hα line that arises in the ejecta at early times ($<$ 200 d) along with models of the evolving intermediate width Hα and HeI λ7065A lines that arise in a post-shock region at later times ($\sim$400 d - $\sim$4000 d). I determine the dust masses that have formed and discuss the location of the dust and the clumpy structure of the post-shock region. I compare my SN2005ip dust mass estimates to dust mass estimates for other CCSNe that have been derived from both optical line profile modelling and SED fitting, and consider the evolution of dust formation in these objects.

Consider for a poster?:

Yes

Poster Presentations - Board: 125 / **125**

Carbon, sulfur and rare elements in the interstellar dust: an X-ray view

Author: Elisa Costantini[1]

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Here we present the prospects of observing dust features of important constitutents of the ISM (C, Al, S, Ca) using future X-ray facilities (Arcus, XARM and Athena).
Present instruments already probed the diffuse interstellar medium (e.g. Costantini et al. 2012) and the moderately dense environments (Zeegers et al. 2017).
However, carbon, one of the main constituents of the ISM, is currently outside the reach of X-ray instruments. This element is visible in an X-ray spectrum when the extinction is relatively low, probing the diffuse ISM either in the local Galactic arm or in particularly diffuse regions. We will show that in a near future we will be able to distinguish among graphite, amorphous and hydrogenated carbon, helping settling the debate on which form the carbon should take in the ISM.
Alongside heavy depleted elements (e.g. Al, Ca), we will also show how possible depletion and inclusion in dust can be measured in dense environments, like molecular clouds, for sulfur, which presence in the solid phase is still debated.

Consider for a poster?:

Yes

Poster Presentations - Board: 127 / **127**

Studying the Amorphous Material Physics of the Cosmic Dust Grains by Fitting the Observed Intensity and Polarization SEDs

in Millimeter, Submillimeter and Far-infrared Wavebands

Author: Masashi Nashimoto[None]

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The Galactic dust emission is a main obstacle to detect the cosmic microwave background (CMB) B-mode polarization signals originated from primordial gravitational waves. Accurate removal of the Galactic dust emission from the data is crucial for the success. Although a single power law frequency dependence has been usually assumed both for the dust emissivity and polarization SEDs, they might have complex frequency dependences. The deviation of the observed spectrum indexes of the Galactic dust emission in mm and submm wavebands from the spectrum index of the crystal is one of the strong evidences which support that main constituent of the Galactic dust grains is amorphous material. Therefore, we have been working on construction of the physically motivated Galactic dust SED models both for intensity and polarization from mm to FIR wavebands based on the physical properties of the amorphous material. Anomalous temperature dependences of heat capacity and heat conductivity of amorphous solids appeared in very low temperature environment support that the low temperature material physics of the amorphous is well described by the two-level systems (TLS). The complex dielectric constants and heat capacities of the amorphous dust grains are modeled by the combination of the TLS model and the crystal dust grain. Dust SEDs are calculated with our own Monte Carlo simulation code to follow thermal history of dust grain in which the physical characteristics of amorphous material is taken into account. We have constructed the scheme how to constrain the physical parameters of the amorphous dust grains by fitting both intensity and polarization observational SEDs in mm and submm wavebands. Our method is applied to intensity and polarization data of M31 obtained by Planck as for testing our scheme. We report these results.

Consider for a poster?:

Yes

Poster Presentations - Board: 128 / **128**

Co-accretion of carbon molecules and silicate precursors at cryogenic temperatures

Author: Gaël Rouillé[None]

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Dust grains are subjected to various destruction mechanisms in the interstellar medium (ISM). Together these mechanisms operate at a rate faster than the injection of grains condensed in stellar outflows and supernova ejecta. Nevertheless, comparatively long-lived dust populations are observed in the ISM. The local re-formation or growth of grains has been proposed as a process that contributes to counterbalancing their destruction.
The growth is proposed to proceed through the accretion of atoms and/or molecules present in the interstellar gas phase, and subsequent chemical reactions that incorporate the accreted species to the grain. The reactions would take place in the cold neutral medium and in molecular clouds, i.e., at temperatures in the range 10 to 100 K. The bulk of interstellar dust, however, is constituted of silicate and carbonaceous grains. The formation of these refractory materials at cold interstellar temperatures has yet to be described in detail. Especially, the mechanisms that lead to the separation of silicate and carbonaceous materials observed by astronomers have to be determined.
We have already reported experiments showing the formation and growth of silicate grains at cryogenic temperatures through the accretion of cold atoms and molecules related to silicates. In the most recent experiments, carbon atoms and molecules (C_n, n = 1−10) were added to the silicate

precursors. Significant amounts of H_2O, CO, CO_2, and C_3O molecules were also present. We have observed that amorphous silicates are formed despite the presence of the carbon molecules and the other species. These experiments will be presented and their relevance to the growth of silicate grains in the ISM will be discussed.

Consider for a poster?:

Yes

Poster Presentations - Board: 129 / **129**

Observability of Dusty Debris Disks around M-stars

Author: Patricia Luppe[None]

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During the last few decades many debris disks have been found and resolved around A to K-type stars. However, only a handful of debris disks have been discovered around M-stars, and the reasons for their paucity remain unclear.
Here we check whether the sensitivity and wavelength coverage of present-day telescopes are simply unfavorable for detection of these disks or if they are truly rare. We approach this question by looking at different surveys that have searched for debris disks around M-type stars. Assuming that M-star disks are "similar" to those of earlier type stars in some sense (i.e., in terms of dust location, temperature, fractional luminosity, or mass), we check whether these surveys should have found them. Examining integration times and sensitivities of the instruments used, we create detection limit plots for each of these surveys. We will present and discuss the implications of these results for the "true" incidence rates of M-star debris disks.

Consider for a poster?:

Yes

Poster Presentations - Board: 130 / **130**

Attempt to catch the C/O transition in dust formation in cold plasma experiments

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The formation of dust in the envelopes of evolved stars is still poorly understood. It is generally admitted that the C/O ratio in the envelope is a key parameter determining the type of dust that is formed and thus leading to either carbon-rich nanograins, possibly including polycyclic aromatics hydrocarbons (PAHs), or oxygen-rich nanograins mainly silicates.

In order to get further insights into the impact of the C/O ratio on dust nucleation and properties, we are carrying experiments in an axially-asymmetric capacitively-coupled radiofrequency (RF) argon plasma with pulsed injection of hexamethyldisiloxane (HMDSO, C6H18OSi2) that contains key elements associated with the two different families of nanograins in the envelopes of evolved stars. The plasma can be enriched in oxygen by injecting molecular oxygen.

Dust formation in the RF plasma reactor is followed *in situ* by optical emission spectroscopy and the main plasma parameters, the mean electron energy and the electron density are extracted from collisional-radiative modelling. Information on the chemical networks involved in dust nucleation is proposed after *in situ* probing of the molecular content by mass spectrometry and complementary *ex situ* mass analysis following laser desorption/ionisation of the collected dust. Finally, the dust is analysed using standard analytical technics such as electron microscopy, Fourier Transformed InfraRed (FTIR) and X-ray photoelectron spectroscopy (XPS), which reveal two main components: dust particles of ~50 nm size embedded in an organosilicon matrix. In this poster we discuss how the results obtained from different diagnostics interconnect and complete the analysis in order to reveal the mechanisms involved in dust nucleation and growth in the cold plasma reactor, with potential input to our understanding of dust formation in evolved stars.

Acknowledgement
We acknowledge support from the European Research Council under the European Union's Seventh Framework Programme ERC-2013-SyG, Grant Agreement n. 610256 NANOCOSMOS and from the UMS Raymond Castaing of the University of Toulouse for the SEM and TEM observations.

Consider for a poster?:

Yes

Poster Presentations - Board: 131 / **131**

High-temperature infrared spectroscopy of large aromatic molecules

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Large aromatic molecules are ubiquitous in astrophysical environments such as star forming regions, galaxies and planetary nebulae in which they emit the Aromatic Infrared Bands (AIBs). These molecules include polycyclic aromatic hydrocarbons (PAHs) but also fullerenes, C60 being the only molecule of this class identified so far. Emission in the AIBs is triggered by the absorption of a UV photon via an electronic transition and a sequence of radiationless transitions converting most of the absorbed energy to a vibrational excitation in the electronic ground state. The hot molecule then relaxes by emitting IR photons, the resulting spectrum being dominated by a large number of hot bands, all slightly shifted with respect to the corresponding 1-0 fundamentals due to anharmonicity. The resulting bands are very broad and their interpretation complex.
In order to progress on the analysis of the IR spectra of these hot large molecules, we are developing an experimental approach to quantify the temperature dependent infrared (IR) spectrum of PAHs. We recorded the IR spectrum of solid pyrene (C16H10) in KBr pellets from 14K to 723K. With increasing temperature a gradual red shift of the band positions and increase of the bandwidth were observed. For the higher temperatures, we compared these data with the few available data recorded in gas-phase [1]. That allows us to gain confidence into the relevance of these measurements in solid

phase to derive anharmonic constants for isolated molecules. We therefore used the same experimental approach to study the temperature-dependent IR spectra of larger species such as coronene (C24H12) and fullerene C60. In this presentation we will discuss and summarize these results.

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Consider for a poster?:

Yes

Poster Presentations - Board: 132 / **132**

Investigating the interstellar dust through the Fe K-edge

Author: Daniele Rogantini[1]

Co-authors: Elisa Costantini [2]; Sascha Zeegers [3]; Cor de Vries [3]; Ioanna Psaradaki [4]; Rens Waters [3]

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The absorption fine structures, imprinted by the interaction between X-rays and solid particles, can reveal the composition, the size, and the structure of cosmic dust (Costantini et al. 2012). The iron K-edge is particularly important because it is well visible in the X-ray band providing a large extinction especially for lines of sight with $\mathrm{N_H} > 10^{23}\mathrm{cm}^{-2}$ ($\mathrm{A_V} > 45$). We model the iron edge using the newly acquired synchrotron data, performed on a set of cosmic dust analogues (Rogantini et al. 2018). Here we highlight the potential of the iron K-edge to: 1) study the chemical properties of iron bearing grains; 2) investigate the size, the crystallinity, and the composition of cosmic silicates in dense clouds of our Galaxy. The synergy between high resolution X-ray instruments and accurate synchrotron measurements provides a unique method to look through molecular clouds in the Galactic Centre and to understand the role of iron in the grain growth process in the interstellar matter.

Consider for a poster?:

Yes

Dust as a galaxy probe / **133**

Radiative transfer model of dust attenuation curves in clumpy, galactic environments

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The attenuation of starlight by dust in galactic environments is investigated through models of radiative transfer in a spherical, clumpy interstellar medium (ISM). We show that the attenuation curves are primarily determined by the wavelength dependence of absorption rather than by the underlying extinction (absorption+scattering) curve; the observationally derived attenuation curves cannot constrain a unique extinction curve unless the absorption or scattering efficiency is specified. Attenuation curves consistent with the "Calzetti curve" are found by assuming the silicate-carbonaceous dust model for the Milky Way (MW), but with the 2175 Å bump suppressed or absent. The discrepancy between our results and previous work that claimed the Small Magellanic Cloud dust to be the origin of the Calzetti curve is ascribed to the difference in adopted albedos; we use the theoretically calculated albedos, whereas the previous works adopted albedos derived empirically from observations of reflection nebulae. It is found that the attenuation curves calculated with the MW dust model are well represented by a modified Calzetti curve with a varying slope and UV bump strength. The strong correlation between the slope and UV bump strength, as found in star-forming galaxies at $0.5 < z < 2.0$, is well reproduced when the abundance of the UV bump carriers is assumed to be 30%–40% of that of the MW dust; radiative transfer effects lead to shallower attenuation curves with weaker UV bumps as the ISM is more clumpy and dustier. We also argue that some local starburst galaxies have a UV bump in their attenuation curves, albeit very weak.

Consider for a poster?:

Yes

Poster Presentations - Board: 134 / **134**

The 30 micron sources in galaxies with different metallicities

Author: Marcin Gladkowski[1]

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A broad emission dust feature peaking around 30 microns is seen in the spectra of some carbon-rich AGB stars, post AGBs, and PNe. Since the discovery by Forrest et al. (1981) this dust feature has been detected in plenty of carbon-rich objects. Magnesium sulphide (MgS) is now the most favoured candidate to be the carrier of this spectral feature, but its identification remains a matter of some debate.

Hony et. al (2002) have analysed in a uniform way a sample of 63 Galactic 30 micron sources observed by the Infrared Space Observatory (ISO). The Spitzer Space Telescope was able to detect distant sources in our Galaxy, but also in nearby galaxies such as the Small Magellanic Cloud, Large Magellanic Cloud (LMC), and the Sagittarius Dwarf Spheroidal galaxy. All of them are characterised by the different average metallicities.

We have analysed a sample of 207 Spitzer spectra from galaxies mentioned above showing the 30 micron dust feature, and we investigated if the formation of the 30 micron feature carrier may be a function of the metallicity. We obtained and compared the basic properties of the 30 micron feature in those galaxies such as a few colour indices (e.g. [6.4]-[9.3] colour), dust temperature (T), strength of the feature, central wavelength, and finally the profiles of the feature.

Our analysis has shown that the strength of the 30 micron feature is the highest among Galactic objects. Moreover, this feature show up at the highest dust temperature for the Galactic AGB stars. The first AGB objects with this feature in the LMC are visible below 900 K, whereas such objects in the SMC and Sgr dSph objects do not appear until T drops below 700 K. The strength of the feature

increases until T drops to about 400 K, and then decreases to finally show again variety of values for post-AGB objects and PNe. The AGB objects with T < 400 K, seems to experience very large mass loss rates, which may be responsible for the drop in the strength of the 30 micron feature due to self-absorption. During post-AGB and PNe phase, the strength of the 30 micron feature seems to not depend on the metallicity of galaxy, but the Galactic post-AGB objects and PNe show rather smaller values of T.

Our analysis of central wavelengths of the 30 micron feature show that it is rather independent of T for AGB and post-AGB objects. In a case of PNe, the central wavelength is clearly shifted toward longer values. Hony et al. (2002) suggested that such shift is caused by the low temperature of the feature carrier, or change in shape of dust particles. However, we noticed several post-AGB objects with similar T, but much lower central wavelength than in planetary nebulae. Therefore, we expect that dust processing (due e.g. irradiation by UV photons from central stars of planetary nebulae) may be more important in shifting central wavelength of the 30 micron feature towards larger values. Finally, it seems that the Galactic PNe have rather smaller central wavelength than their Magellanic Clouds counterparts. If our suggestions are correct, this could mean that processing of the 30 micron feature carrier is more efficient in the MCs than in the Milky Way.

We have also searched for the median profiles of the 30 micron feature in different galaxies and/or dust temperature. We have shown that shapes of the 30 micron feature does not change as a function of metallicity in different galaxies (AGB and post-AGB objects) or dust temperature (AGB stars only). On the other hand, the shape of the feature in planetary nebulae is clearly different (not only central wavelength) than shape of the feature in AGB or post-AGB objects.

Consider for a poster?:

Yes

Poster Presentations - Board: 135 / **135**

Whipping IC63/IC59

Author: Heather Andrews[1]

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The mid-IR spectra of photodissociation regions (PDRs) are dominated by the well-known emission features at 3.3, 6.2, 7.7, 11.3, and 12.7 micron, generally attributed to polycyclic aromatic hydrocarbon molecules (PAHs). PAHs drive much of the physics and the chemistry in these PDRs, e.g. by heating the gas and as a catalyst in the formation of molecular hydrogen on their surfaces. Thus, PAHs and PDRs are intimately connected, and a complete knowledge of PDRs requires a good understanding of the properties of the PAH population and vice-versa, a complete knowledge of the PAH population requires a good understanding of the local physical conditions.

Here we present a general description of two PDRs, IC63 and IC59, from an observational standpoint in order to study the physical conditions at the UV-illuminated surfaces of these objects and their PAH properties. IC63 and IC59 are a pair of cometary-shaped nebulae in the vicinity of the star gamma Cas (also known as Tsih, "the Whip"). Both nebulae have very different optical appearances, despite the fact that both objects lie at similar projected distances from the star: IC63 shows bright rims and filaments, while IC59 looks more homogeneous and faint.

We use the available data on both nebulae taken with Spitzer, Herschel and SOFIA to study the infrared emission at the tip of both clouds, and derive the intensity of the UV radiation field, the density and the gas temperature. We find that the IR emission from polycyclic aromatic hydrocarbons (PAHs) is very similar at the tip of both nebulae. Even though it varies in intensity between the two, the derived PAH band ratios are remarkably similar. These ratios are similar to those found in the more shielded regions of other nebulae such as NGC7023 and NGC2023. Regarding the physical conditions, we obtain that while in IC63 the intensity of the UV field, G0, is a factor of ~10 higher than in IC59, the density n at the tip of IC59 is lower than in IC63 by a similar factor. For both objects we derive G0 values significantly lower than what previous works have so far assumed. Comparison with other reflection nebulae PDRs and known correlations support our claim that both IC63 and IC59 are low-UV irradiated environments. We conclude that the tips of IC63 and IC59 are about 3 and 5 times farther away from the star than their respective projected distances. The similarity of the mid-infrared emission between the two nebulae is consistent not only with both objects being overdensities within the same region around gamma Cas, but it is also consistent with the similar G0/n ratio and ionization parameters, which altogether rule the evolution of the hydrogenation and ionization level of the emitting population of PAHs. Finally, regarding the kinematics of the material in IC59, we find evidence of photo-evaporation due to the incident radiation from gamma Cas.

Consider for a poster?:

Yes

Poster Presentations - Board: 137 / **137**

Distributions of metallicity and gas-to-dust ratio in the Magellanic system

Authors: Kengo Tachihara[1]; Hiroaki Yamamoto[1]; Kisetsu Tsuge[1]; Hidetoshi Sano[1]; Yasuo Fukui[1]

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The two Magellanic clouds and our Galaxy are known to have been tidally interacting each other in the past $\sim$ billion years. It is indicated by the elongated distributions of interstellar medium (ISM), known as the Magellanic stream and the Magellanic bridge. Numerical simulations of the dynamical interactions of these galaxies successfully reproduced these features. This dynamical interaction is also suggested to play an important role for triggering the massive star formations in the Magellanic clouds. Because the Small Magellanic Cloud (SMC) has $\sim 1/5$ of metallicity compared to the Large Magellanic Cloud (LMC), one can expect weaker dust emission from the ISM originated from the SMC, which may mix with the ISM from the LMC. We have investigated the dust thermal emission obtained by the Planck satellite and the H I 21 cm data, and discovered large diversity with more than an order of magnitude of the gas-to-dust ratio among the Magellanic system. The distribution of the gas-to-dust ratio clearly indicate that the Magellanic stream is dominated by the metal-poor ISM stretched from the SMC, while the stream of the metal-poor ISM falling onto the LMC. The massive cluster forming regions including 30 Dor in the LMC tend to show mixed ISM properties of the LMC and the SMC, which support the idea of massive star formation triggered by the gas infall and the cloud-cloud collisions.

Consider for a poster?:

Yes

Poster Presentations - Board: 138 / **138**

Spatially resolved carbonaceous dust infrared emission in protoplanetary disks around Herbig Ae/Be stars

Author: Thomas Boutéraon[1]

Co-authors: Anthony Jones [2]; Emilie Habart [2]; Nathalie Ysard [2]

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In the interstellar medium (ISM), the carbon (nano-)grains are a major component of interstellar dust. This solid phase is more vulnerable to processing/destruction than their silicate counterparts. It exhibits a complex, size-dependent evolution due to photon interactions, which provides a modeling challenge. How these micro-physical processes work under the extreme conditions found in disks (different from the ISM by orders of magnitude in terms of excitation and local gas density)? Nano-grains could play an essential role in the gas heating, and thus could have a major influence on the disk structure and its evolution. Moreover, due to their large effective surface area, they could play a key role in the formation of molecules. Finally, they are the tracers of the physical conditions (excitation, extinction, geometry).
I will present an analysis of infrared ground-based data, obtained with VLT/NACO in the 3-4 micron range (which includes aromatic, olefinic and aliphatic bands), for disks around intermediate mass stars (e.g., HD100546, HD100453, HD169142, HD179218). I will discuss what band ratios and parameters tell us on: dust composition, evolution and renewal at the disk surface. At last, I will propose a first comparison between observations of disks which are dense phases and The Heterogeneous dust Evolution Model for Interstellar Solids (THEMIS) developed at the IAS (Jones A. P. et al., A&A, 602, A46 (2017))

Consider for a poster?:

Yes

Non-stellar dust production and the dust cycle in the ISM / 139

Iron and silicate dust growth in the Galactic interstellar medium: clues from element depletions

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The question "What is the dominant mechanism of dust formation?" has long been the matter of debate. We address this question by modelling the distribution of interstellar Fe and Si element abundances in the local Milky Way with dust evolution model. The model follows the time evolution of grains in inhomogeneous, multiphase interstellar medium from high-resolution hydrodynamic simulations of the lifecycle of giant molecular clouds. This allows us to include the dependence of dust destruction in SN shocks and growth by accretion of gas-phase metals on local physical conditions. We find that the growth of iron and silicate grains occurs already in the cold neutral medium, with the Coulomb focusing playing an important role to enhance the collision rates. In order to reproduce the heavier depletion of interstellar Fe compared to Si, our model requires that solid iron resides in two dust components: (i) metallic iron nanoparticles with sizes in the range of 1-10 nm and (ii) small inclusions in silicate grains.

Consider for a poster?:

Poster Presentations / 140

An extensive grid of DARWIN models for M-type AGB stars

Author: Sofie Liljegren[1]

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Asymptotic giant branch (AGB) stars are luminous, cool giants with non-spherical morphology and substantial mass loss. Dust formed in the stellar atmospheres plays a key role for the mass-loss mechanism: radial pulsations of the surface layers of the stars levitate material to distances where dust can form, which then is accelerated outward by radiation pressure. AGB stars are significant dust donors to the interstellar medium through these stellar winds.

To model these dense winds, we have constructed an extensive grid of M-type AGB stars (stars with oxygen dominated chemistry) using DARWIN models (Dynamic Atmosphere and Radiation-driven Wind models based on Implicit Numerics). The mass-loss process is modelled from first principles, with frequency-dependent radiation-hydrodynamics, and dust growth and evaporation. In the grid we cover a wide range of the relevant stellar parameters (0.75-3 M_sun, 1000 − 70 000 L_sun and 2200-2300 K). Direct outputs from the models include mass loss rates, wind velocities, dust-to-gas ratios and grain sizes.

We plan to combine this grid with stellar evolution codes, where parameterised relationships (e.g. Reimer's classical mass-loss formula) are widely used to describe the mass-loss rates of AGB stars. This can then be used to estimate the dust contribution for entire populations of AGB stars.

Consider for a poster?:

Yes

Poster Presentations - Board: 141 / **141**

PAH photodissociation and the formation of H_2

Authors: Pablo Castellanos[None]; Alessandra Candian[None]; Junfeng Zhen[None]; Harold Linnartz[None]; Alexander Tielens[1]

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Polycyclic Aromatic Hydrocarbon (PAH) molecules are ubiquitous carbonaceous molecules, responsible for the Aromatic Infrared Bands (AIB) dominating the IR spectrum of diverse astronomical environments, from planetary and reflection nebulae, to transitional disks to entire galaxies (Tielens, 2013). PAHs make up the low-mass end of the grain size distribution (Weingartner & Draine 2001) and, akin to dust grains, these molecules can act as catalytic surfaces where H_2, the most abundant molecule in the Universe (Draine & Bertoldi, 2996), can efficiently form. The invoked mechanism is addition of a H atom and subsequent abstraction of a H_2 unit by an incident H atom (Wakelam et al, 2017). Other mechanisms, like photodissociation, were considered so far less important.
Recently we studied the photodissociation of a sample of PAH cations of astronomical size with a combination of experiments, quantum chemistry and modeling (Castellanos et al, 2018a, 2018b). We found that PAHs behave differently depending on their size and shape, and that H_2 can be a likely product of the dissociation. In this talk I will show these results and discuss how they impact our understanding of H_2 formation on PAHs in photodissociation regions.

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Weingartner J.C.& Draine B.T., 2001, ApJ, 548, 296

Consider for a poster?:

Yes

Poster Presentations / 142

PDRs with JWST: Probes of dust formation and evolution

Authors: Karl Misselt[1]; Karl Gordon[2]; Alain Abergel[3]; Alberto Noriega-Crespo[2]; Tea Temim[2]; Heddy Arab[4]; Maaren Baes[5]; Henrik Beuther[6]; Patrice Bouchet[7]; Bernhard Brandle[8]; Peirre Guillard[9]; Sarah Kendrew[10]; Pamela Klaasen[11]; Dries Van de Putte[12]; Adolf Witt[13]

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Photodissociation regions (PDRs) are predominantly neutral regions of the ISM in which the heating and chemistry are mainly regulated by far ultraviolet photons emitted from one or more nearby young stars. They are extended regions at the interface between the ionizing sources and molecular clouds, and contain dense structures and clumps of dust and gas immersed in a more diffuse medium. Dust at the PDR interface experiences extreme physical conditions, with temperatures and densities varying by orders of magnitude over very small spatial scales, of order a few hundred AU. Hence the PDR interface provides a unique opportunity to study (1) dust formation as a function of environment, from the ionized region in front of the PDR to the dense regions behind the PDR
(2) the destruction and evolution of grain mantles/clusters in the transition region,
(3) the role of dust in regulating molecular chemistry (e.g. H2 formation on grain surfaces),
and (4) the potential identification of grain composition via excitation studies.
In light of the potential impact PDRs have on our understanding of dust properties and their interdependence with the gaseous and molecular phase, the JWST NIRCam and MIRI GTO teams have
proposed a joint GTO program to study two nearby PDRs, NGC 7023 and the Horsehead nebula, using a suite of instruments and modes on JWST. These emblematic PDRs have different

excitation conditions and relatively simple geometries and are ideal targets to take full advantage of the high spatial resolution and sensitivity of JWST. In this poster, we describe the observing strategy for our GTO program and briefly describe several of the science goals of the team.

Consider for a poster?:

Yes

Poster Presentations - Board: 145 / **145**

ALMA's View of Dust in SN 1987A

Authors: Phil Cigan[1]; Mikako Matsuura[1]; Haley Gomez[1]; Remy Indebetouw[2]

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SN 1987A, being relatively young as well as the brightest supernova observed in over 400 years, is a unique and exciting laboratory for studying supernova dust production. Located around 50kpc away in the Large Magellanic Cloud, SN 1987A is too far away for single-dish telescopes to resolve the structure of the sub-mm emission on the scale of the ejecta, where the dust is produced. Recent ALMA observations have allowed us to peer into the inner ejecta to the cool dust, with resolution probing down to physical scales of 4500 AU. Comparison of the dust location and morphology with other multi-wavelength emission presents an interesting picture of the role dust plays in the ejecta. The distributions of the dust continuum and molecular line emission are all notably complex, having implications for the physical properties of the system.

Consider for a poster?:

Yes

Poster Presentations - Board: 146 / **146**

Mineralogical Studies of Silicate Stardust in the Laboratory

Author: Ann Nguyen[1]

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Silicate dust is pervasive throughout the cosmos and has been observed in interstellar space, around evolved oxygen-rich stars, protoplanetary disks, and in our Solar System. The chemical and physical properties of this dust have traditionally been inferred through remote astronomical observations. Spectral observations of circumstellar dust indicate mainly amorphous, Fe-bearing grains having non-stoichiometric compositions intermediate between olivine and pyroxene compositions (Molster

and Kemper, 2005; Tielens et al., 1998; Sargent et al., 2010), and variable proportions of extremely Mg-rich crystalline pyroxene and olivine (de Vries et al., 2010; Molster et al., 2002). Spectral data for dust originating from supernovae and novae are scarce and suggest that these sources mainly produce Mg-rich amorphous silicates (Arendt et al., 2014; Evans et al., 1997). Crystalline silicates are rare in the diffuse ISM (<1%; Kemper et al., 2004), most likely due to grain amorphization and destruction in the ISM (Jones and Nuth, 2011).

The discovery of preserved silicate stardust grains in meteorites, interplanetary dust particles (IDPs), and dust returned from comet Wild 2 by NASA's Stardust mission has allowed for direct, detailed study of individual grains of silicate stardust in the laboratory. This has essentially opened new windows into the fields of astrophysics and astromineralogy. The exotic isotopic compositions of these silicate stardust grains, determined by isotopic mapping with the NanoSIMS ion microprobe, reflect origins in asymptotic giant branch stars, supernovae, and novae. We have performed coordinated isotopic, chemical and mineralogical characterization of these ~100−500 nm-sized grains by NanoSIMS and transmission electron microscopy (TEM) analyses. Microtome sections of IDPs are first analyzed by TEM and isotopically anomalous grains are subsequently identified by NanoSIMS isotopic mapping. Stardust grains in meteorites are first identified by NanoSIMS analysis, and grain cross-sections are then prepared by focused ion beam (FIB) milling for TEM analysis.

Our studies show that the majority of the silicate grains are amorphous with non-stoichiometric Fe-bearing chemical compositions, generally consistent with astronomical observations (Nguyen et al., 2016). However, approximately 1/3 of the analyzed grains were found to be crystalline pyroxene and olivine, considerably higher than the crystalline silicate fraction in the ISM. While the pyroxene grains are Mg-rich, the olivine grains have more substantial Fe-contents, also in contradiction with astronomical observations. Thus far, we do not observe any systematic mineralogical differences among grains from different stellar sources. Our studies have uncovered details of circumstellar grain properties that cannot be seen remotely. For example, "compound" grains have been identified, including an amorphous Fe-rich silicate with olivine and pyroxene inclusions and a crystalline spinel grain encased in amorphous silicate glass (Nguyen et al., 2017; Nguyen et al., 2014). Laboratory studies of interstellar silicates have yet to show evidence of organic mantles predicted by some models of interstellar dust lifecycles (Greenberg and Li, 1997). Rare evidence for amorphization in space was also observed in two silicate stardust grains (Nguyen et al. 2016). A chemically uniform grain with a composition of the mineral enstatite is mostly amorphous but retains a crystalline core. The grain likely condensed as a single, solid crystal, but the outer portions were later amorphized in the ISM. An amorphous supernova grain having the chemical composition of enstatite most likely condensed as a crystal and was later rendered amorphous. The laboratory analysis of silicate stardust grains complements astronomical observations and provides an extraordinarily detailed look into the chemical makeup, structure, and lifecycle of silicate dust in the Galaxy.

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Consider for a poster?:

Yes

Dust in AGN / 147

Optical and infrared radiation pressure on dust and gas around AGN as drivers of dusty winds

Authors: Marta Venanzi[1]; Sebastian Hoenig[2]

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Parsec-scale polar emission signatures seen in the infrared continuum of many nearby AGN suggest the presence of dust in a region generally associated with outflowing gas. This makes clear that the idea of a circum-nuclear obscurer referred as torus needs to be revised in favour of a more complex obscuring structure, yielding a polar component. We present a semi analytical model to test the hypothesis of radiatively accelerated dusty winds launched by the AGN and the heated dust itself. The main components of the model under consideration are an AGN and an infrared radiating dusty disk, the latter being the primary mass reservoir for the outflow. We derive the full components of the force field experienced by dusty clouds in this environment, accounting for both gravity and the AGN radiation as well as the re-radiation by the hot dusty gas clouds themselves. We see that dusty outflows naturally emerge, whose strength and directions will depend on the Eddington ratio and the column density of the intervening material.

Consider for a poster?:

Yes

Poster Presentations - Board: 148 / **148**

Reverberation Mapping the Hot Dust Emission in AGN from VEILS

Author: Triana Almeyda[1]

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Due to observational limitations, the size and structure of the obscuring circumnuclear dust in active galactic nuclei (AGN) is not well understood. Using reverberation mapping techniques the size of this hot dust emission can be determined by analyzing the temporal variations of the infrared (IR)

emission from the dust in response to variations in the accretion disk continuum luminosity. Over the last 30 years, the dust reverberation time lag (and, thus, radius) has been measured by monitoring the optical and near-IR emission in about 20 galaxies. And similar to the broad emission-line region, it was found that the time lags determined by dust reverberation correlate tightly with AGN luminosity, $\tau \propto L_{AGN}^{0.5}$, a relation that may be used as a cosmological standard candle. Now we are taking AGN dust reverberation mapping to the next level, targeting about 500 AGN as part of the VISTA Extragalactic Infrared Legacy Survey (VEILS) in order to firmly establish dust time lags as a standard candle. VEILS is the first wide and deep IR extragalactic time domain survey that will monitor AGN in the optical and near-IR for at least 3 years. We will map the dust time lags of AGN over a range of redshifts, $0 < z < 1.2$, allowing us to independently constrain cosmological parameters. The first season of VEILS has already been conducted. Here, I present preliminary light curves of AGN from our survey and discuss how we plan on using our light curves in order to establish AGN dust time lags as a standardizable candle.

Consider for a poster?:

Yes

Poster Presentations - Board: 150 / **150**

Near- and Mid-Infrared Interstellar Dust Extinction Observations

Author: Karl Gordon[1]

Co-authors: Karl Misselt [2]; Jeroen Bouwman [3]; Geoff Clayton [4]; Dean Hines [5]; Yvonne Pendleton [6]; George Rieke [7]; J. D. Smith [8]; Douglas Whittet [9]

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The interstellar dust extinction in the near- and mid-infrared (IR) wavelength range (1-40 microns) is characterized by decreasing continuum extinction and four main absorption features that are diagnostic of dust grain compositions. The absorption features at 10 and 18 micron are due to silicate material, at 3.4 micron due to hydrogenated carbon material, and at 3.0 micron due to water ice. Measurements based on Spitzer spectroscopic observations from 5-40 micron provide a detailed view of the continuum extinction and silicate absorption features in sightlines with A(V) values from 1.5 to 5.5 mag. As these sightlines all have existing ultraviolet extinction measurements, this sample provides consistent measurements of extinction from 0.1 to 40 microns giving strong, consistent constraints on dust grain sizes and compositions. Plans for expanding this work with JWST to include spectroscopic measurements in the near-IR region (1-5 micron) and more sightlines are presented.

Consider for a poster?:

Yes

Poster Presentations - Board: 153 / **153**

Aliphatic Features in Mid-Infrared Polycyclic Aromatic Hydrocarbon Spectra

Author: Pernille Jenssen[1]

Co-authors: Matthew Shannon [2]; Els Peeters [3]; David J. Stock [4]

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The mid-IR spectra of almost all objects are dominated by strong emission bands at 3.3, 6.2, 7.7, 8.6, and 11.3 micron due to Polycyclic Aromatic Hydrocarbon molecules (PAHs). It is now well established that these mid-IR bands show clear variations in shape and peak position from one point source to another, as well as varying spatially within extended sources. The spectral diversity of the PAH band profiles reveals the nature of the carriers and hence allows one to study their formation and evolution throughout their life cycle. Although the origin of the profile variations is still under debate, one posited explanation is the varying importance of aliphatics versus aromatics in the carrier molecules.

We present the 5-12 micron spectra of sixty-three astronomical sources exhibiting PAH emission bands observed by ISO/SWS, Spitzer/IRS, and SOFIA/FORCAST. We aim to test this hypothesis by quantifying the aliphatic emission and identifying relationships between the aliphatic and aromatic emission features. We find that the presence of aliphatic features depends on PAH class, with aliphatic features detected in all class D sources, approximately half of the class B sources, and no class C sources present in our sample. We observe spectral variation of these aliphatic features in peak position and intensity. The peak position of the 6.9 micron feature varies continuously between 6.8 and 6.95 micron, with the variation being more pronounced in class B sources than in class D sources. In addition, the 6.9 micron feature is strongest in class D sources, in some cases being stronger than the 6.2 micron feature. Finally, our investigation of possible correlations between aliphatic and aromatic emission features only reveals a correlation between i) the two aliphatic bands, and ii) the aliphatic features and the 11.2 micron PAH band. We discuss these results within the framework of the varying aliphatic to aromatic ratio as the origin of the band profile variations.

Consider for a poster?:

Yes

Poster Presentations - Board: 157 / **157**

Probing the solar accretion disk using the properties of dust filtering at gaps in the early Solar System

Author: Troels Haugbølle[1]

Co-authors: Philipp Weber [2]; Daniel Wielandt [3]; Pablo Benitez Llambay [2]; Martin Bizzarro [4]; Oliver Gressel [2]; Martin Pessah [2]

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During the formation of the Solar System, Jupiter and Saturn played an important role in modulating and controlling the dust dynamics through the formation of gaps in the protosolar accretion disk that acted as dust traps. This is reflected in the distribution of chondrules and calcium-aluminum inclusions (CAIs). CAIs are almost exclusively present in chondrites arriving from the outer Solar System, and there are clear isotopic finger prints showing that while inner Solar System chondrules where transported to the outer Solar System, no outer Solar System chondrules returned to the inner Solar System. A dust trap can only stop particles above a certain size, while small particles are well coupled and flows through the gap with the gas. To investigate the roles of Jupiter and Saturn we combine a large suite of numerical models of the protocolar accretion disk with embedded planets with a systematic cosmochemical search for CAIs in inner Solar System chondrite slabs. This allow us to put new limits on the surface density of the accretion disk where Jupiter formed, the relative sizes of the dust reservoir in the inner and outer Solar System, the probable orbital geometry of the gas giants in the early solar system, and inform us about the recycling of material in the formation region of ordinary chondrites.

Consider for a poster?:

Dust production by supernovae and massive stars / 158

Old and new dust associated with Supernova 1995N

Author: Roger Wesson[1]

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The discovery of 0.4-0.7$M_\odot$ of dust in the remnant of SN1987A 23 years after its explosion (Matsuura et al. 2011) demonstrated that supernovae can be efficient dust factories, but raised many questions. Among them, when did this dust form? Was it there at early times but previously undiagnosed by techniques for estimating dust masses, or did it form at later times? In Wesson et al. (2015) we created radiative transfer models to investigate this question, fitting the optical-far IR SED of SN1987A to calculate the dust mass at epochs from 600-9000 days after the explosion. We found that the rate of dust formation could be represented by a sigmoid curve with peak dust formation occurring many years after the explosion.

The far infrared observations necessary to constrain the emission from cold dust are lacking in most supernovae. An alternative method of estimating the dust mass exploits the blue-shifting of emission lines in the presence of dust to diagnose the dust mass (Bevan and Barlow, 2016). This has the additional advantage that only dust within the expanding remnant will affect the line profiles - pre-existing dust that is thermally echoing will not.

I will present SED and emission line profile models of SN 1995N, observed as part of a programme to determine dust masses in supernova remnants years to decades old. Van Dyk (2013) found that mid-IR observations implied the presence of 0.05-0.2Mo of pre-existing circumstellar dust which has been flash-heated by the supernova outburst. I confirm this with three-dimensional radiative transfer models to fit the SED. Additionally, emission line profile

modelling reveals that a further 0.1-0.4Mo of dust has formed in the expanding supernova ejecta. This shows that pre-existing and newly formed dust can be clearly distinguished in supernova remnants, and that both may contribute significantly to the total dust mass formed by a massive star.

Consider for a poster?:

Yes

161

Welcome and introduction

Corresponding Author: darach@nbi.ku.dk

Conference opening and welcome

Consider for a poster?:

162

Panel Discussion

Author: Anja C. Andersen[1]

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Panel discussion on something

Consider for a poster?:

163

Conference Summary and Review

Author: Ciska Kemper[1]

[1] *ASIAA*

A summary and a review of the conference

Consider for a poster?:

Poster Presentations - Board: 164 / **164**

The Benchmark Dust Mass Function of the Nearby Universe

Author: Rosie Beeston[1]

Co-authors: Angus Wright ; Steve Maddox ; Loretta Dunne ; Haley Gomez

[1] *Cardiff University*

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We present a fundamental measure of the dust content of nearby galaxies - the Dust Mass Function (DMF) for the largest sample of galaxies to date. Our DMF is drawn from a stellar mass selected sample of galaxies comprised of the overlap between two large area surveys - the Galaxy And Mass Assembly (GAMA), and the Herschel Astrophysical Terahertz Large Area Survey (H-ATLAS). The overlap between these surveys spans ~140 square degrees, and 21 wavebands, containing over 15,000 galaxies below redshift 0.1 that are observable in the r-band. This study is the most statistically robust measurement of the low-redshift DMF ever made, allowing us to probe at least an order of magnitude lower in dust mass than any survey before for a sample ~70 times larger than previous surveys. We compare to literature and to theoretical predictions of DMFs derived from semi-analytic dust evolution models or hydrodynamical cosmological simulations. We also calculate the dust mass function for different morphological types and find scaling relations between our DMFs and their corresponding galaxy stellar mass functions (GSMF) for the same sample.

Consider for a poster?:

Yes

Poster Presentations - Board: 165 / **165**

Temperature programed desorption of water ice mixed with amorphous carbon and silicate grains

Authors: Alexey Potapov[1]; Cornelia Jäger[2]; Thomas Henning[3]

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The desorption of molecular ices from grain surfaces is important in a number of astrophysical environments including dense molecular clouds, circumstellar regions, cometary nuclei, and surfaces and atmospheres of planets. It has been shown that for multicomponent ices within water ice matrices, the desorption of all species in the ice is controlled by the behaviour of water. A study of the desorption of H_2O ice mixed with dust is therefore crucial for our understanding of the ice-dust interaction and in turn, the physics of cold dense molecular clouds and circumstellar disks, where the relatively high dust density allows coagulation of dust grains, which can be catalysed by water. Measurements of ice-dust interactions will further aid our understanding of the structure and morphology of dust aggregates at different phases of the ISM.

In our experiments, for the first time, temperature programmed desorption (TPD) of water ice *mixed with* amorphous carbon and silicate grains has been studied in the laboratory. Grain/ice mixtures represent laboratory analogues of interstellar and circumstellar icy dust grains. We show that variations of the grain/ice mass ratio lead to a transformation of the TPD curve of H_2O ice, which can be perfectly fitted with the Polanyi-Wigner equation by using fractional desorption orders. For carbon grains the desorption order of H_2O ice increases from 0.1 for pure H_2O ice to 1 for the grain/ice ratio of 1.3. For two silicate/ice mixtures, the desorption order of H_2O ice is 1. This is a unique result, which have not been obtained in previous experiments on the thermal desorption of ices *from* carbon and silicate surfaces. It can be explained by the desorption of water molecules from a large surface of fractal clusters composed of carbon or silicate grains and provides a link between the structure and morphology of dust grains and the kinetics of desorption of water ice mixed with these grains.

Consider for a poster?:

Yes

Poster Presentations - Board: 166 / **166**

High-resolution, 3D radiative transfer modeling of barred galaxies M83 and NGC1365

Author: Angelos Nersesian[1]

Co-authors: Sam Verstocken [2]; Sebastien Viaene [2]; Maarten Baes [2]

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Within the framework of the DustPedia project we study the effect of cosmic dust on a vast sample of nearby galaxies. Dust radiative transfer (RT) simulations provide us with the unique opportunity to study the heating mechanisms of dust by the stellar radiation field. From 2D FITS images we were able to derive the 3D geometry distributions of stars, a technique, first introduced by De Looze et al. (2014) and followed afterwards by Viaene et al. (2016). This powerful method allows a more realistic description of the complex stellar geometries found in galaxies like asymmetric features or clumpy structures.

Our aim is to analyze the contribution of the different stellar populations (old, young & ionizing) to the radiative dust heating processes in the nearby face-on barred galaxies NGC1365 and M83, by using high resolution 3D radiative transfer modeling. To model the complex geometries mentioned above, we used SKIRT, a state-of-the-art, 3D Monte Carlo RT code designed to model the absorption, scattering and thermal re-emission of dust in a variety of environments.

Consider for a poster?:

Yes

Poster Presentations - Board: 168 / **168**

Comparison of the extraplanar Hα and UV emissions in the halos of nearby edge-on spiral galaxies

Authors: Young-Soo Jo[1]; Kwang-il Seon[2]; Jong-Ho Shinn[1]; Yujin Yang[1]; Dukhang Lee[1]; Kyoung-Wook Min[3]

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We compare vertical profiles of the extraplanar Hα emission to those of the UV emission for 38 nearby edge-on late-type galaxies. It is found that detection of the "diffuse" extraplanar dust (eDust), traced by the vertically extended, scattered UV starlight, always coincides with the presence of the extraplanar Hα emission. A strong correlation between the scale heights of the extraplanar Hα and

UV emissions is also found; the scale height at H⊠ is found to be ~0.74 of the scale height at FUV. Our results may indicate the multiphase nature of the diffuse ionized gas and dust in the galactic halos. The existence of eDust in galaxies where the extraplanar H⊠ emission is detected suggests that a larger portion of the extraplanar H⊠ emission than that predicted in previous studies may be caused by H⊠ photons that originate from H II regions in the galactic plane and are subsequently scattered by the eDust. This possibility raise a in studing the eDIG. We also find that the scale heights of the extraplanar emissions normalized to the galaxy size correlate well with the star formation rate surface density of the galaxies. The properties of eDust in our galaxies is on a continuation line of that found through previous observations of the extraplanar polycyclic aromatic hydrocarbons emission in more active galaxies known to have galactic winds.

Consider for a poster?:

Yes

Poster Presentations - Board: 169 / **169**

Revealing the dust grain sizes in the envelope of Per-emb-50

Author: Carolina Agurto[1]

Co-authors: Jaime Pineda [1]; Laszlo Szucs [2]; Leonardo Testi [3]; Marco Tazzari [4]; Anna Miotello [3]; Paola Caselli ; Michael Dunham [5]; Ian Stephens [6]

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Disks and envelopes around protostars play a fundamental role in the process of planet formation, since they contain the ingredients that will form planets. However, it is not yet clear at which stage of the star and planet formation process dust grains start to efficiently coagulate and evolve from small solid particles to macroscopic dimensions.
We studied the Class I protostar, Per-emb-50, at 1.3mm with SMA and 2.7mm with NOEMA in order to determine the spectral index α_{mm} in the envelope region on scales 400-3000 AU. The data analysis show a high value for $\alpha_{1.3-2.7\mathrm{mm}}$m, which implies that there is no evidence of mm-sized dust grains in the envelope. To understand the dust properties in more detail, we performed a radiative transfer modeling of the source and found a maximum grain size of a few hundred microns.
The current observations on Per-emb-50 confirm that there are no mm sized grains in the envelope, contrary to previous studies on similar sources where mm size grains have been found. This would imply that the grain growth on YSO's is highly affected by the environment and dynamica history of the source.

Consider for a poster?:

Yes

Poster Presentations - Board: 170 / **170**

Evidence of pyroxene magic nanoclusters in protoplanetary disks around Herbig Ae stars from first principles calculations

Authors: Antoni Macià[1]; Stefan Bromley[2]

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From infrared (IR) observations it is known that magnesium silicates are the major dust component in protoplanetary disks. From such observations one can discern the likely size, composition and crystallinity of such dust thus allowing one to infer the likely associated properties of the disk. Of special interest are the disks surrounding Herbig Ae/Be (HAeBe) stars corresponding to the stellar evolutionary stage where embryonic planets should be forming.

Using Spitzer IR data, Juhasz et al. [1] derived the averaged mass absorption coefficient (MAC) of the crystalline pyroxene component from a selected set of HAeBe stars and compared it with experimentally derived MACs of different bulk crystalline pyroxene samples. The star-derived MAC was found to contain signals in regions that do not appear in the experimental crystalline pyroxene MACs (e.g. a sharp feature at 8.7 microns and a broad region between 14.4 - 16.4 microns). Using accurate first principle electronic structure calculations, we provide evidence that the spectral mismatches between experimental and observationally derived MACs for crystalline pyroxene could be explained by the presence of pyroxene nanodust.

Using dedicated global optimisation search algorithms we have established the most stable atomic scale structures of a range of pyroxene nanoclusters $(MgSiO_3)_N$ for N = 1 - 10. Within this set we identified those clusters with particularly high energetic stability with respect to other clusters of a similar size. Such so-called "magic" clusters are known from cluster beam experiments to have disproportionally high abundances in cluster populations. Correspondingly, one should expect that, if nano-pyroxene dust forms a reasonable proportion of the pyroxene silicate dust budget in protoplanetary disks, then magic pyroxene clusters may be particularly abundant. We found that the pyroxene nanosilicate cluster $(MgSiO_3)_5$ was indeed a magic cluster and thus a possible abundant dust candidate. Using first principles density functional theory (DFT) based electronic structure calculations we then calculated the accurate IR spectrum of the magic $(MgSiO_3)_5$ cluster. The calculated IR spectrum of the magic pyroxene cluster exhibits a number of features at wavelengths in very good agreement with the observationally derived average MAC for crystalline pyroxene, which, at the same time, cannot be explained using experimental MACs from bulk crystalline pyroxene samples. We interpret this finding as strong evidence for the existence of this particular nanodust particle around HAeBe stars. The implications of this result with respect to the properties of the associated protoplanetary disks are discussed.

[1] A. Juhász et al., "Dust evolution in protoplanetary disks around Herbig Ae/Be stars-the Spitzer view," Astrophys. J. 721, 431 (2010).

Consider for a poster?:

Yes

Poster Presentations - Board: 171 / **171**

Realistic modelling of nano-aggregated magnesium silicate dust particles using atomistic simulations.

Authors: Antoni Macià[1]; Stefan Bromley[2]

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Dust can be found everywhere in the universe from stars in the latest stages of evolution (post-AGB stars), to the interstellar medium (ISM) and protoplanetary disks around young stars (e.g. T Tauri and Herbig Ae/Be stars). Dust can provide a wealth of information about the medium it is embedded in, since processing will affect its composition, structure and size in a characteristic and distinct manner. The properties of dust can thus also be used to track the nature of its environment. For instance, the growth of dust particles in protoplanetary disks is linked to the evolution from flared to flattered disks, while the small crystalline fraction of silicates in the ISM indicates a high degree of energetic processing.

The source of data to understand dust formation, growth, composition and shape of the dust particles is infrared (IR) spectroscopy. Nevertheless, the information provided by IR spectroscopy from laboratory synthesized particles is not well understood, due to the difficulties to control and understand the generated particles at the nanoscale level. Knowledge at the nanoscale, such as cation mobility and disorder, can be helpful in order to understand properties of silicate materials such as the crystallization below the glass transition temperature.

Bottom-up atomistic computational modelling methods allow the study of particles with atomic-scale precision, but in order to perform such simulations we require realistic models of the particles of interest. Here we present an new approach that uses well-tailored interatomic potentials to simulate the growth of silicate nanoparticles with diameters up to of tens nanometres following the detailed circumstellar nucleation conditions typical for a post-AGB star. The simulations progressively and realistically add monomers (SiO, Mg and O) to a seed particle moving away from the star with a determined initial velocity.

We solve the equation of movement for the seed particle, and thus estimate how the typical circumstellar conditions for nucleation (e.g. temperature, pressure) change with time and thus distance from the star. From the generated atomistically detailed nanodust particle models, we can probe properties that are difficult to accurately extract from experiments such as surface structure, surface to volume ratios, degree of polymerization of silicate tetrahedra, nanoporosity and nanosized phase separation. Via analysing the vibrational atomic motions within the generated nanodust silicate particles we can also directly simulate the IR emission from such species. In this way we are able show how the IR spectra of silicate nanodust relates to changes in atomic disorder/crystallinity, chemical composition (e.g. pyroxene vs olivine) and nucleation conditions (e.g. temperature).

Consider for a poster?:

Yes

Poster Presentations - Board: 172 / **172**

Interstellar Catalysis of Molecular Hydrogen through Superhydrogenation of Polycyclic Aromatic Hydrocarbons

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In the field of astrochemistry and surface science a primary objective is to identify and characterize effective catalysts which have a plausible existence in the interstellar medium (ISM). Molecular hydrogen (H_2) is the most abundant molecule in the ISM with well-established and efficient catalytic

formation routes in many regions of interstellar space. However, in certain regions of the ISM, discrepancies between formation rates and dissociations rates have been found [1]. Specifically, in Photodissociation regions (PDRs), the dissociation rate is so high that prevailing formation routes may not be efficient enough to explain the observed abundancies of H_2 and needed formation rates. Here we examine a group of planar nanosized molecules called polycyclic aromatic hydrocarbons (PAHs) as possible catalysts of H_2 formation. Significant abundancies of PAHs have been observed to spatially overlap with regions of high H_2 formation rates [2].

We have used temperature programmed desorption (TPD) and scanning tunneling microscopy (STM) to examine a template PAH, coronene ($C_{24}H_{12}$). Density functional theory (DFT) reveals that coronene and possibly other PAHs will have 0eV energy barriers for both Hydrogen (H) addition and H_2 abstraction even at low super-hydrogenation degrees (4 adatoms) [3]. The state of hydrogenation will therefore depend on these competing processes and their relative cross sections for addition, σ_{add}, and abstraction, σ_{abs}.
Monolayers of neutral PAH molecules are deposited on a highly oriented pyrolytic graphite (HOPG) surface and exposed to different fluences of D or H atoms. The atomic beam is estimated to have a temperature of approximately 1000K. Fully deuterated coronene ($C_{24}D_{36}$) is observed, indicating formation of HD via an exchange process between H and D [4].
First addition cross sections, $\sigma_{add}(0)$ for D/H addition can be found experimentally from the exponential decay in pristine coronene as a function of D/H fluence. Cross sections of $\sigma_{add,H}(0)$ = $0.25 \pm {}^{0.14}_{0.05}$Å^2 for H addition and $\sigma_{add,D}(0)$ = $0.065 \pm {}^{0.10}_{0.05}$Å^2 for D addition are best fits to data. Determination of sequential addition and abstraction cross sections, however, require further modelling and will here be determined through comparisons to Kinetic Monte-Carlo (KMC) simulations. Also observed from TPD is indications of preferred D/H-PAH configurations with high stability and increased barriers against further D/H addition. Experimental data points towards a barrier preventing addition to the center ring. These barriers are not detected when a high temperature atomic beam is used (T≈2000K) [5].

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Consider for a poster?:

Yes

Poster Presentations - Board: 173 / **173**

Superhydrogenation of PAHs through interaction with hydrogenated grain surfaces

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The formation of molecular hydrogen, H_2, in the ISM is thought to primarily occur on dust grain surfaces. This process has been investigated extensively through a variety of experimental and theoretical approaches for several different model grain surfaces. More recently it has been suggested that PAHs, representing the molecular limit of the carbonaceous grain population, can act as catalysts for H_2 formation through the generation of superhydrogenated PAH, or HPAH species (Rauls

& Hornekær 2008). In addition to interaction with gas-phase hydrogen atoms (Thrower *et al.* 2012), our laboratory measurements have shown that adsorption of PAHs on hydrogenated graphitic surfaces can also lead to the formation of HPAHs through the pick-up of adsorbed H-atoms that are bound to the graphite surface (Thrower *et al.* 2014). Whilst mass spectrometry provides evidence for the formation of HPAHs through this mechanism, the exact hydrogen adsorption sites occupied remains unclear. Scanning tunneling microscopy (STM) provides us with the ability to probe the adsorption and hydrogenation of PAHs at the micropscopic level. Using coronene $C_{24}H_{12}$ as a prototypical PAH molecule, we show that a variety of hydrogenation structures are formed following adsorption on a hydrogenated HOPG surface. We also demonstrate how the surface temperature affects the hydrogenation process, which depends on the ability of the adsorbed coronene to scan the surface in order to pick up the adsorbed hydrogen atoms.

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Consider for a poster?:

Yes

Poster Presentations - Board: 174 / **174**

Investigation of the hydrogenation of pentacene

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Carbonaceous surfaces are known to act as catalysts for the formation of molecular hydrogen in the interstellar medium [1,2]. Molecular hydrogen is the most abundant molecule in the universe and it controls the chemistry of the interstellar medium. Hence, the formation of molecular hydrogen is the first step in the evolution of the chemical complexity of the interstellar medium.

Observations correlate the abundance of polycyclic aromatic hydrocarbons (PAHs) to an increased rate of H_2 formation [3]. PAHs and HPAHs are closely linked to the carbonaceous grain population although PAH interaction with grains is still poorly understood. Experiments and theoretical calculations indicate that PAHs play a role as catalysts for H_2 formation [4] and addition of hydrogen to PAHs pushes the molecule away from a planar geometry [5]. Here,we investigate reactions between pentacene and atomic hydrogen. Our goal is to examine the carbon sites at which incoming H atoms are most likely to bind, and to study how the morphology and reactivity of the pentacene molecule changes as the degree of superhydrogenation increases.

A monolayer of pentacene was prepared under ultra-high vacuum conditions on a Au (111) surface and then exposed to a controlled fluence of hydrogen atoms. X-ray photoelectron spectroscopy was used to characterize the system by tracking chemical shifts in in the C1s and Au4f core levels.

After hydrogenation, a chemical shift was observed for the carbon core level electrons. This indicates that the sp^2 carbon sites change to a sp^3 hybridisation after hydrogen exposure. Furthermore, there is evidence for more than one type of sp^3 hybridised carbon site. Chemical shifts in the gold core levels were observed firstly after dosing of pentacene and again after hydrogen exposure. The latter could indicate Au-C bond formation simultaneous with new C-H formation on the pentacene molecule or a Au-H interaction, or both. Combining this data with STM images and DFT calculations will help us understand the dynamics of hydrogen addition to the pentacene molecule and elucidate a route towards superhydrogenation of the PAHs in the interstellar medium.

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Consider for a poster?:

Yes

Poster Presentations - Board: 175 / **175**

PAHs trace the molecular gas in star-forming galaxies

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We present new CO(1-0) line observations of 34 infrared-selected PAH emitters at intermediate redshift ($0.01 \leq z \leq 0.3$) to investigate the connection among the PAH emission, the total gas content, and the star formation rate in normal and starbursting galaxies. Combined with observations from the literature at low and high redshift, our analysis reveals a universal, tight, and linear PAH-CO relation independent of redshift and star formation efficiency, suggesting that the emission from PAHs is strongly correlated with the cold diffuse gas. We also find a strong correlation between the PAHs and the cold dust emission, which is another reliable gas tracer independent of CO. Based on our results, we propose the use of PAHs as a proxy for the molecular gas content in star-forming galaxies at all redshifts. As PAHs will be routinely detected with the upcoming launch of JWST, they will serve as a useful tool to investigate the cold gas properties of high-z galaxies up to z~3.

Consider for a poster?:

Yes

Poster Presentations - Board: 177 / **177**

The JWST-ERS program ID 1288: Radiative Feedback from Massive Stars as Traced by Multiband Imaging and Spectroscopic Mosaics

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Massive stars disrupt their natal molecular cloud material by dissociating molecules, ionizing atoms and molecules, and heating the gas and dust. These processes drive the evolution of interstellar matter in our Galaxy and throughout the Universe from the era of vigorous star formation at redshifts of 1-3, to the present day. Much of this interaction occurs in Photo-Dissociation Regions (PDRs) where far-ultraviolet photons of these stars create a largely neutral, but warm region of gas and dust. PDR emission dominates the IR spectra of star-forming galaxies and also provides a unique tool to study in detail the physical and chemical processes that are relevant for inter- and circumstellar media including diffuse clouds, molecular cloud and protoplanetary disk surfaces, globules, planetary nebulae, and starburst galaxies.

We propose to provide template datasets designed to identify key PDR characteristics in the full 1-28 µm JWST spectra in order to guide the preparation of Cycle 2 proposals on star-forming regions in our Galaxy and beyond. We plan to obtain the first spatially resolved, high spectral resolution IR observations of a PDR using NIRCam, NIRSpec and MIRI. We will observe a nearby PDR with well-defined UV illumination in a typical massive star-forming region. JWST observations will, for the first time, spatially resolve and perform a tomography of the PDR, revealing the individual IR spectral signatures from the key zones and sub-regions within the ionized gas, the PDR and the molecular cloud. These data will test widely used theoretical models and extend them into the JWST era. We will assist the community interested in JWST observations of PDRs through several science-enabling products (maps of spectral features, template spectra, calibration of narrow/broad band filters in gas lines and PAH bands, data-interpretation tools e.g. to infer gas physical conditions or PAH and dust characteristics). This project is supported by a large international team of one hundred scientists collaborators.

Consider for a poster?:

Yes

Poster Presentations - Board: 178 / **178**

Polycyclic Aromatic Hydrocarbon fraction at ~10 pc scale in the Magellanic Clouds

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The spatial variations of dust properties within a galaxy and their
correlation with local environment provide critical insights into the life cycle of dust. Low metallicity galaxies, in particular, let one study the dust life cycle in environments relevant for galaxies earlier in the history of the Universe.

In this work, we present maps of the dust properties in the Small and Large Magellanic Clouds (SMC, LMC), two nearby, highly resolved, low metallicity galaxies, fit with the Draine & Li (2007; DL07) dust grain model. We use/Spitzer/and/Herschel/infrared observations of the clouds to derive the spatial distribution of the dust properties, in particular the abundance of the small carbonaceous grain (or polycyclic aromatic hydrocarbons; PAH)
component. Overall, the average PAH fraction is smaller in the SMC than in the LMC, which is lower than that of the Milky Way. In particular, we find an anti-correlation between the DL07 q_PAH fraction and the Hα intensity. This is an indication that the smallest dust grains could be destroyed in high-ionization regions. We provide maps of the q_PAH fraction at resolved
scales.

We also compare our final maps with previous modeling (LMC: Paradis et al. 2009; SMC: Sandstrom et al. 2010, using the DL07 model). This helps us identifying the most model-dependent dust properties, and how they vary with resolution and wavelength coverage. We use these results to constrain the drivers of the PAH lifecycle in low metallicity environments.

Consider for a poster?:

Dust in the solar system / **179**

Christine Floss. In memoriam

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A brief remembrance of Prof. Christine Floss, planetary scientist at Washington University in St. Louis.

Poster Presentations - Board: 180 / **180**

Spectroscopic Characterization of Interstellar Ice Analogues

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The experimental setup was developed with the goal to characterize the optical properties of astrophysically relevant solids (ice mixtures, silicates, and carbonaceous materials). For the experiments, we use a combination of spectral techniques to obtain information regarding their chemical, physical, and optical properties. When analysed, together with astronomical observations and theoretical models we will better understand the roles of solid materials in different environments.

Consider for a poster?: