BREAKOUT SESSIONS

Monday 6 January – Interiors

Daniel Spencer
University of Oxford

Planetary Volcanism, linking interiors to atmospheres

Volcanism is the surface manifestation of dynamic processes in planetary interiors. In our solar systems observations of volcanism on bodies like Io and Enceladus has aided understanding of interior processes, and in exoplanet systems predictions of interior processes like tidal dissipation has led to predictions of volcanic activity. Beyond interiors, volcanism exerts a heavy control of the formation, evolution, and composition of planetary atmospheres. Any attempts to understand the interiors and atmospheres of planetary bodies must therefore consider the influence of volcanism.This proposed breakout session would focus on small groups planning a theoretical planetary mission. The target of the mission would be a real or imagined volcanically active planetary body. The aim would be to decide what possible planetary observations would best lead to understanding in the three themes of the meeting: formation, interiors and, atmospheres. After groups had planned their mission these would be presented to the other groups with discussion. The purpose of this would be to bring together people with a range of expertise to consider (a) what observations are possible for either solar system bodies or exoplanets, (b) what observations would help answer the widest range of planetary questions, (c) uncover overlaps between fields (e.g. someone with expertise in interiors realising links to planetary atmospheres that they hadn't previously considered).

Laura Rogers, John Harrison, Alexander Mustill
IoA

Insights into exoplanet compositions from the Solar System, exoplanet atmospheres, and host star abundances

The composition of a planet is determined at least in part by the composition of its parent star and the surrounding disc. In turn, a star's observed photospheric abundances can be enriched by its accretion of planets or asteroids, or depleted by material being locked up by planet formation. I propose a discussion session that may cover some of the following relationships between stellar and planetary compositions: - Inferring the compositions of destroyed planets through the detection of planetary/asteroidal debris in white dwarf atmospheres. - Inferring the compositions of planets engulfed by main-sequence or turn-off stars by precise differential abundance studies of stars in the same cluster, different components of multiple star systems, or the Sun versus Solar twins. - How planetary composition might vary between Galactic stellar populations with different elemental abundances such as [alpha/Fe], set by age, formation location, and membership of the Galactic thin disc, thick disc or halo. - Breaking the degeneracy when trying to determine a transiting planet's composition with only a mass and a radius measurement, by using the stellar composition as a constraint on the planetary composition.

Francis Nimmo
UC Santa Cruz

Tidal heating in the solar system and elsewhere

Bodies in eccentric or inclined orbits close to a massive primary experience tidal heating. The most famous example in this solar system is the supervolcanic moon Io, but bodies elsewhere (e.g. the TRAPPIST planets) almost certainly experience tidal heating too. This breakout session would consider the mechanisms of tidal heating, examples in this solar system, and how tidal heating elsewhere could conceivably be detected and characterized.

Tuesday 7 January – Formation

Tim Lichtenberg
University of Oxford

Bridging the gap from planet formation to rocky exoplanet evolution

Extrasolar planets and their host systems are far more diverse than anticipated, and new discoveries at breathtaking rates, such as TRAPPIST-1 or LHS 3844b, challenge our perceived understanding of how rocky worlds come to be and evolve on Gyr timescales. Our knowledge surrounding planetary accretion and evolution is (still) inherited from trying to explain the assembly of the Solar System planets, and so we must expand into unknown, sometimes uncomfortable, realms. This session is planned to foster interactions between researchers aiming to understand (and observe) terrestrial planet accretion, and their subsequent atmospheric, structural, and compositional evolution in order to generalise our conception of the rocky (exo-)planet population, and how our Solar System is placed in this context.

Sarah McIntyre
Australian National University

Multi-parameter Approach to Habitability (M-PAtH)

Within the next decade, upcoming observations with near-future telescopes will provide us with an ever-increasing number of exo-Earths. To make the most of the observational resources available, target selection so far has focused on 'habitable worlds' defined as rocky bodies (with enough surface gravity to sustain an atmosphere) orbiting their host stars at a distance where stellar radiation is suitable for the presence of surface liquid water. However, numerous planetary and astronomical factors influence an exoplanet's ability to maintain liquid water. Recent research has shown that a planet’s ability to maintain liquid water and potentially host life depends on the type of star, the planet’s density, atmospheric composition, and planet-star interactions. Additionally, there are a variety of previously undefined factors such as magnetic field, albedo, tidal locking, impact events, and plate tectonics that could also affect habitability. I believe that the diverse group of scientists attending this workshop, with different views and perspectives on the topics, would offer valuable insights into how we can utilise our current knowledge of the effect that diverse parameters have on an exoplanet’s ability to sustain liquid water to further analyse the interrelatedness of these factors and how we can quantify them.

Thomas Haworth & Jeff Jennings
QUML/University of Cambridge

Strengthening collaborations across the epochs of planetary system evolution:A broad outlook and case study in star formation and planet-forming discs

Considering planets as astrophysical objects whose evolution spans distinct epochs across Gyr of evolution, from gas-rich to debris discs to exoplanetary systems to post-main sequence accretion, how can measurements and theor in each era be used to advance study in the others ? And how can these studies of distant systems be paired with the comparatively vast corpus on the inner Solar System planets as geological objects? This breakout session will motivate and challenge participants to put forward, discuss and implement plans to follow up on joint efforts that unify work across the spectrum of fields represented at the meeting. As a specific application, we will collectively consider how closer collaboration is needed between modelers and observers in the star formation and planet formation communities to progress our understanding of the early phase of disc formation and evolution, and in turn the mass distribution and total reservoir for planet formation. In an open discussion we will take the first steps to develop a strategy for future collaborative research in this regard. Using this case as motivation, we will then ask each other, based on our knowledge of challenges in our respective fields, whether other opportunities for cross-field collaboration are needed and how we can establish a discourse to achieve this.

Evgeni Grishin
Technion, Institute of Technology Israel

Formation and properties of the first planetesimals

The formation of the first planetesimals is challenging. The streaming instability is a promising conjecture, with recent evidence that it was operating efficiently in the outer parts of the Solar system, forming Kuiper Belt objects and cometary material. Nevertheless, the streaming instability requires high metallicity and local large dust-to-gas ratio. It remains unclear if streaming instability or other alternative formation challenges such as collisional growth and icy agglomeration are dominant. We'd like to discuss the different models, and their outcomes in terms of their size distribution, internal structure and radial location within the protoplanetary disc. Understanding planetesimal formation is important for the underlying internal structure an composition of fully formed planets.

Wednesday 8 January – Atmospheres

Victoria Hartwick
NASA Ames Research Center

Cloud Microphysics in Exoplanet Atmospheres

Clouds rarely form homogeneously in terrestrial atmosphere like Earth and Mars. While we believe clouds should be prevalent on terrestrial exoplanets, it is difficult to imagine how to incorporate advanced microphysics into the study of these climates. In particular, if cloud condensation nuclei are critical, how can we model their distribution and can observations of cloud fields inform our understanding of the surface environment. I would like to discuss how we can utilize initial observations as inputs for cloud parameterizations in 1D and 3D general circulation models. Further, I would like to discuss how simulations of clouds in models can assist in our understanding of observational data sets.

Quentin Changeat
University College London

Exploring degeneracies in atmospheric retrieval techniques

Discussion around the needs and issues encountered in regard to analysing the next generation telescopes observations (JWST, Ariel). Discussion around the needs and issues encountered in regard to analysing the next generation telescopes observations (JWST, Ariel). Examples include the impact of vertical profiles for chemistry and temperature, disentangling signature of chemical species.

Paul Rimmer and Sang-Min Tsai
University of Cambridge/AOPP, Oxford

Atmospheric Features as "Golden Spikes" for Exoplanetary Eons

The topic focuses on signatures of primordial atmospheres (with connections to disk chemistry), magma ocean degassed atmospheres, volcanic atmospheres, impact transformed atmospheres, biosignatures, etc. as ways to divide up geological time for exoplanets, ideally connected to exoplanets around stars of well-constrained ages. This involves disk and gas giant chemistry, for which primordial composition can be better constrained, and rocky planets, to see how the atmosphere evolves with time for different systems

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