Monday 6 January - Interiors

Jon Wade
University of Oxford

The role of core formation in planetary habitability and the development of complex life

Earth and Mars both possessed ample surface water very soon after formation, yet while oceans still cover around 70% of the Earth's surface, Mars has lost the majority of its surface water, leaving it inhospitable for the development of complex life. What happened to surface water on Mars? While the Martian water inventory was undoubtedly depleted by loss to space following the collapse of the planet's magnetic field, the presence of hydrated clays and the widespread serpentinisation of surface basalts attests to water-rock reactions playing a critical role in its sequestion. This, then, leads to an obvious question - why has Earth remained habitable for life, and Mars became barren? This is problematic, especially given the secular evolution of the Earth, and the presence of active water transport mechanisms, such as plate tectonics, to the Earth's essentially dry lower mantle.

One possible explanation concerns iron, the one major rock forming element whose mantle concentration varies significantly across the terrestrial bodies. We show how this subtle chemical variation, set by the differing conditions of planetary accretion and core formation, plays a disproportionate role in subsequent planetary development and habitability. The ability of a planet's surface to retain water over geological timescales is therefore a result of the stochastic processes that resulted in planetary core formation. Furthermore, we suggest that the Earth's mantle iron content provides a key evolutionary driver for the development of complex, multicellular life.

In summary, it is likely that planetary habitability may not simply be a case of "right ingredients and distance from star" but rather the correct "recipe" of planet accretion.

Tim Lichtenberg
University of Oxford

Rocky (exo-)planet diversity from protoplanet solidification

The census of currently known rocky exoplanets has proven vastly more diverse than anticipated and we do not understand which are the main physical mechanisms to form 'Earth-like' planets. In this talk I will describe current efforts to establish a general modeling framework for the transition of rocky planets from the disk-stage accretion phase to their long-term evolution, bridging the gap between theories of planet formation and the reality of exoplanet data. The model framework spatially resolves the cooling and volatile partitioning of a rocky planet from the core-mantle boundary to the top of the atmosphere using a non-grey radiative transfer scheme for non-ideal atmospheres. I will outline how the stochasticity of accretion, such as drastically varying volatile mixing ratios, planet-star distance, late-stage giant impact rate, or planet mass, can play a crucial role in setting the stage for the long-term evolution of a rocky planet, and how future observations from ground and space-based telescopes may make use of such models to distinguish between rocky planets like and unlike Earth.

Fergus Horrobin
University of Toronto

Modelling Tidal Dissipation in Super-Earths with a Partially Molten Mantle

Astronomers have typically treated tidal dissipation using a simple constant dissipation value and have used tidal dissipation to explore the orbital evolution of super-Earths under tides. This approach is fundamentally flawed when regions of the planet begin to melt, as has been shown in recent geophysical research. In this work, we present a self-consistent numerical model to determine how dissipation proceeds in the presence of melt on tidally-heated rocky exoplanets. We model the feedback effects between tidal heating and melt to discuss where tidal heating happens, how much dissipation can occur and how much melt is generated and transported. To do this, we combine models for rocky planet rheology, tidal dissipation, and melt transport. We evaluate the effectiveness of our model using Io and show that modelling melt is important to reproduce the correct surface heat flux. We then apply the model to rocky planets to determine where and how much dissipation occurs and answer a fundamental question: is tidal heating a runaway process, or is it confined to a region of the interior due to a regulating mechanism.

John Harrison
IoA

Polluted White Dwarfs: Constraints on the Origin and Geology of Exoplanetary Material

White dwarfs that have accreted rocky exoplanetary debris offer a unique insight into the bulk composition of exoplanetary material. Understanding the range of bulk compositions possible for rocky bodies in exoplanetary systems will significantly aid our understanding of the interiors of extrasolar terrestrial planets, in an analogous way to how the solar system meteorite suites provide insights into the interior compositions of the terrestrial planets. We have created a Bayesian framework which can take observed polluted white dwarf atmospheric abundances and output constraints on the temperature experienced by the polluting material and the geological and collisional history of the polluting material. Our analysis suggests that all the polluted white dwarf atmospheric abundances observed to date can be explained using a solar system-like differentiation model, hinting that exoplanetary geologies may not be dissimilar from the geologies of rocky bodies in the solar system. The atmospheric abundances present in many polluted white dwarfs can only be explained if solar system-like differentiation and collisional processing is commonplace exoplanetary systems. We also find evidence that the material that pollutes white dwarfs can have a wide range in formation temperatures, ranging from icy volatile-rich material (analogous to Kuiper belt objects) to refractory enhanced volatile-poor material (analogous to objects primarily composed of calcium aluminium inclusions).

Teresa Wong
University of Munster

Plate Tectonics Initiation on Earth-Like Planets - Insights from Numerical Analysis of Convection-Induced Lithospheric Failure

Plate tectonics is central to many aspects of the geology and evolution of terrestrial planets, yet it is only observed on the Earth while all other known planets are covered with a stagnant lithosphere. Plate motions on the Earth are mostly driven by the pull of subducting slabs, therefore understanding the initiation of subduction is crucial to understanding plate tectonics initiation. On a one-plate planet which lacks the forces due to plate motions, some other mechanisms will have to cause the first episode of subduction to mobilize the surface. Sublithospheric convection has been proposed as a possible mechanism that induce stresses in the lithosphere. The question is whether these stresses can initiate subduction. We develop scaling laws for the criterion of lithospheric failure from single-cell steady-state convection, which has more controlled flow and thus easier to analyze. We show that these scaling laws are applicable to time-dependent convection. We extrapolate the scaling laws to planetary conditions to assess the feasibility of plate tectonics for terrestrial planets.

Mr Daniel Spencer
University of Oxford

Coupling volcanism and interior dynamics on Io

Previous models of Io have assumed the presence of a magma ocean or high melt fractions [1][2][3]. Here we demonstrate that observations can be satisfied by a two-phase fluid dynamical model which does not invoke a magma ocean, a feature that would be unlikely to form due to the resultant strong density inversion. We also demonstrate the importance of magmatic emplacement in Io’s lower lithosphere. High eruption rates with no volcanic emplacement lead to unrealistically thick lithospheres. This also means that the heat profile of Io's lithosphere could deviate significantly from a high-Peclet number problem such as those previously expected [4]. We argue most of Io's mantle is partially molten to a low melt fraction (2-5%) and that a thin, high melt fraction layer inferred from magnetometer data [3] can be understood as a decompacting boundary layer, but importantly this does not have an important effect on Io's eruption system.

[1] Bierson & Nimmo, 2016 Icarus [2] Tyler, Henning, & Hamilton, 2015[3] Khurana et al, 2011, Science[4] Kirchoff & McKinnon, 2009

Sarah McIntyre
Australian National University

Planetary magnetism as a parameter in exoplanet habitability

Evidence from the Solar system suggests that, unlike Venus and Mars, the presence of a strong magnetic dipole moment on Earth has helped maintain liquid water on its surface. Therefore, planetary magnetism could have a significant effect on the long-term maintenance of atmosphere and liquid water on rocky exoplanets. We use Olson & Christensen's (2006) model to estimate magnetic dipole moments of rocky exoplanets with radii $R_p \leq 1.23\ R_\oplus$. Even when modelling maximum magnetic dipole moments, only Kepler-186 f has a magnetic dipole moment larger than the Earth's, while approximately half of rocky exoplanets detected in the circumstellar habitable zone have a negligible magnetic dipole moment. This suggests that planetary magnetism is an important factor when prioritizing observations of potentially habitable planets.

Tuesday 7 January – Formation

Zoe Leinhardt
University of Bristol

The Birth and Death of Extrasolar Planets

To be provided

Lewis Watt
University of Bristol

Planetary Embryo Collisions in Extreme Debris Disks

Planetary collisions are an expected process in the formation of terrestrial planets, but observations of such events are lacking. Recent observations of extreme debris disks ID8 and P1121 suggest a massive amount of millimetre and micron sized dust are added and then removed in a short time period. We use numerical simulations to test the hypothesis that these events were caused by large planetary scale collisions. For the collisions we use Mars to Earth-mass impactors with varied velocities and impact parameters.

From the simulations we find that the escaping dust after a collision has a velocity dispersion which is independent of the specific impact energy but does depend on whether the impact parameter is greater than the critical value, therefore, a population of velocity dispersions can be modelled by two normal distributions. The velocity dispersion when normalised by the Keplerian velocity of the progenitor only varies with the semi-major axis. As a result, flux variations due to the collision point and anti-collision line are restricted to small semi-major axes.

Marc Brouwers
University of Cambridge

How planets grow by pebble accretion

Proto-planets embedded in their natal disks acquire hot envelopes as they grow and accrete solids. This ensures that the material they accrete - pebbles as well as (small) planetesimals - will vaporize to enrich their atmospheres. Enrichment modifies an envelope's structure and significantly alters its further evolution.

We have developed a model for the evolution of planets with polluted planets, and find that it follows four distinct phases. Initially, the central core grows directly through impacts and rainout. The inner envelope absorbs increasing amounts of solids as vapor and eventually halts the growth of the core. A planet reaches runaway accretion when the sum of its core and vapor mass exceeds a value that we refer to as the critical Z mass. We derive an expression for this criterion that supersedes the traditional critical core mass. We then identify the decline of the mean molecular weight - dilution - as a mechanism that limits gas accretion during a polluted planet's embedded cooling phase. When the disk ultimately dissipates, the vapor rains out, augmenting the mass of the core. This is a process that takes several Gyr to complete. The energy release that accompanies it does not result in significant mass-loss, as it only occurs after the planet has greatly contracted.

Our model provides a natural explanation for the relative abundance of Super-Earths and Sub-Neptunes at short orbital distances. In our model, the small core masses of the giant planets are a result of their accretion history, rather than later core erosion.

The presented results draw from our self-consistently coupled impacts and planetary structure models from (Brouwers et al. 2018), as well as from our analytical calculations (Brouwers & Ormel, submitted), and from new numerical simulations (Ormel et al in prep).

Mor Rozner
Technion

The Ablation Barrier of Meter-Size Objects in Protoplanetary Disks" to "The Ablation Barrier for the growth of Meter-Size Objects in Protoplanetary-Disks

Ablation is a destructive process which can erode small-size planetary objects. Ablation operates in a wide range of environments and under various conditions, from atmospheric entry of meteoroids to ablation in planetary envelopes. Here we point out that ablation of pebbles and small planetesimals in protoplanetary disks,that can constitute a significant barrier for the early stages of planet formation. We use analytic calculations to show that the typical gas densities and the relative velocities between planetesimals and gas make small bodies ranging in size between cm up to even tens of meters highly susceptible to gas-drag ablation. At these size ranges ablation can efficiently erode the planetesimals down to cm-size. In particular, the ablation timescale is sufficiently short as to quench any further growth of such few-cm up to tens of meters planetesimals. On the other hand, this grinding-down ablation mechanism could populate protoplanetary disks with pebble-size planetesimals, thereby boosting pebble-accretion growth at later stages of planet formation, once large planetesimals and planetary embryos exist in the disk.

Dr Thomas Haworth
QMUL

Gravitationally stable massive discs around low mass stars

A large mass in planets is being discovered around low mass stars (e.g. Trappist-1) requiring a high planet formation efficiency. This is made even more challenging because some fraction of the (potentially planet-forming) mass is accreted and stripped through processes like photoevaporation. The oft-assumed upper limit on the disc mass is around a tenth of the stellar mass, since above this gravitational instability is expected to onset. However self-gravitating discs around low mass stars have not been formally studied.

I will present new models addressing this, which demonstrate that low mass stars can actually support axisymmetric discs with higher disc-to-star mass ratios than naively anticipated. This could help to alleviate the mass budget problem for planet formation around low mass stars.

Kathryn Dodds
Department of Earth Sciences, University of Cambridge

The early thermal evolution of planetesimals during accretion and differentiation

Over the past decade, there has been an increase in the number of paleomagnetic studies of meteorites in which their primary remanence has been linked to dynamo activity on their parent bodies. This signal has been found in differentiated meteorites as well as in some chondrites, potentially providing evidence for partially differentiated parent bodies. The earliest period of dynamo activity from 5 – 20 Myr after Solar System formation has been attributed to dynamos driven by thermal convection in a molten core, instead of compositional convection during core solidification. However, generating a dynamo from thermal convection alone is difficult as the density differences induced by cooling are small. In planetesimals, this requires fast (>5 KMyr^1) core cooling rates which are only likely generated during early periods in which the body loses heat to the surface via convection in a semi-molten magma ocean.

To better constrain this process, we model the 1D thermal evolution of planetesimals from accretion through to the shut-down of convection in the magma ocean for a range of proposed accretionary scenarios. The heat source of these bodies is the decay of the short-lived radiogenic isotope, ^{26}Al. We model accretion timescales from 500 years (i.e., instantaneous) to 4.5 Myr and over radii from 50 km to 600 km. We use scaling laws from magnetohydrodynamic simulations to determine if these bodies generate a thermal dynamo, and the characteristics of the magnetic field. During differentiation, ^{26}Al partitions into the silicate mantle that heats up the magma ocean, causing a stable stratification to be introduced at the top of the core. This stratification inhibits dynamo generation. In the ‘instantaneously’ accreting bodies, this introduces a delay (>5Myr) to convection in the core whilst this stratification is removed. However, gradual differentiation in bodies that accrete over >0.7 Myr can destroy this stratification by adding cold material to the top of the core. Our model also produces partially differentiated planetesimals with a core and mantle overlain by a chondritic crust for accretion timescales >2 Myr. By comparing the results of the model to the paleomagnetic record of meteorite groups, we can constrain the physical properties (such as size) and the accretional history of their parent bodies.

Evgeni Grishin
Technion, Israel Institute of Technology

Seeding interstellar planetesimals in circumstellar discs

The formation of planetesimals is thought to be rapid, while they are still embedded in a gaseous protoplanetary disc. However, small planetesimals experience collisions and gas drag that lead to their destruction on short time-scales, not allowing, or requiring fine-tuned conditions for the efficient growth of ~metre-sized objects. Here we show that ~10^4 interstellar objects such as the recently detected 1I/2017-U1 (‘Oumuamua) could have been captured. The capture rates are robust even for conservative assumptions on the protoplanetary disc structure, local stellar environment, and planetesimal interstellar medium density. ‘Seeding’ of such planetesimals then catalyses further planetary growth into planetary embryos, and potentially alleviates the main challenges with the metre-sized growth barrier. In addition, interstellar and loosely bound exo-Kuiper belt and exo-Oort cloud objects can be captured onto the scaled-down gaseous disc around a white dwarf star, providing additional channel for the influx of solids. For a gaseous disc which extends much beyond its Roche limit, capture is more probable than disruption at the Roche limit and linearly increases with the radial extent of the disc. Even in systems without minor planets, capture of smaller bodies will change the disc size distribution and potentially its temporal variability. The discovery of the intact minor planet embedded in the debris disc orbiting SDSSJ1228+1040 could also potentially be explained by the capture mechanism.

Sean Raymond
Laboratoire d'Astrophysique de Bordeaux

Formation pathways of rocky planets

It is seductive to imagine super-Earths as scaled-up versions of our Solar System's rocky planets. However, the central processes involved in the growth of different populations of planets are likely very different. For example, simple scaling arguments show that migration played a dominant role in the final assembly of super-Earth systems whereas it was likely of little importance in the growth of our terrestrial planets. In this talk I will review models for the growth of rocky planets in different astrophysical settings, including mechanisms for water delivery.

Wednesday 8 January – Atmospheres

Robin Wordsworth
Harvard University

Tracing the coupled evolution of water and oxygen on temperate rocky exoplanets

Water (H2O) and oxygen (O2) are two compounds of particularly special relevance to habitability and the search for life on exoplanets. Surface liquid water is essential for all known forms of life, but its remote detection using current or future observational techniques is incredibly challenging. Oxygen is important to the habitability of complex life and is also regarded as a potential atmospheric biosignature, but abiotic ways of generating O2-dominated atmospheres are also theorized to exist. Here I describe our recent efforts to understand the evolution and observabiity of the water and oxygen inventories on rocky exoplanets. I discuss recent coupled atmosphere-interior modeling of abiotic oxygen buildup via water photolysis that we have used to assess the viability of O2 as a biosignature. I also discuss recent work that we have performed to investigate whether sulfate aerosol hazes can be used as a remote diagnostic of surface liquid water. Finally, I will briefly discuss some of the key theoretical advances that need to occur to improve terrestrial exoplanet characterization prospects over the next decade.

Nisha Katyal
TU Berlin

Effect of Secondary Outgassing on Atmospheric Evolution of Terrestrial Planets

The evolution of Earth's early atmosphere and the emergence of habitable conditions on our planet are intricately coupled with the development and duration of the magma ocean phase. In this work, we study the evolution and spectral response of steam based atmospheres which are outgassed from the mantle in the interior of the planet. The thermal emission also known as the outgoing longwave radiation from the planet is calculated using a line-by-line radiative transfer code "GARLIC". Our study suggests that for an atmosphere consisting of pure H2O, built as a result of outgassing, the solidification of the magma ocean takes place in about 1 Myr. We show the variation of surface temperature and emission spectra as a function of magma ocean solidification time. We observe that as the magma oceans cools down, the atmospheric transmission height or the depth of the water bands gets lower from a few thousand km to a few hundred km. In this talk, I will also show the effect of varying redox state of the mantle (fugacity) on the atmospheric evolution which has implications for formation of water oceans. Using atmospheric loss processes, I will present an interesting interplay between the outgassing and escape of water.

Zahra Essack
MIT

Low Albedo Surfaces of Lava Worlds

Hot super Earths are exoplanets with short orbital periods (< 10 days) whose rocky surfaces can reach temperatures high enough to become molten. There are a few hot super Earths that exhibit high geometric albedo values (> 0.4) in the Kepler band (420-900 nm). Sources of reflected light that may contribute to the high albedos include: Rayleigh scattering in an atmosphere that may contain visible wavelength absorbers, reflective clouds, and/or the planetary surface. In this study, we focus on reflection from planetary surfaces. We aim to determine whether specular reflection from molten lava and quenched glass (a product of rapidly cooled lava) on the surfaces of hot super Earths may be sources of reflected light that contribute to the high geometric albedos. We experimentally measure the specular reflection from rough and smooth textured quenched glass, and survey non-crystalline solids literature for specular reflectance values from molten silicates as a proxy for specular reflectance values for lava. Integrating the empirical glass reflectance function and non-crystalline solids reflectance values over the dayside surface of the planet at secondary eclipse yields an upper limit for the albedo of a lava-quenched glass planet surface of ~ 0.1. We conclude that lava planets with solid (quenched glass) or liquid (lava) surfaces have low albedos, and the high albedos of some hot super Earths are most likely explained by atmospheres with reflective clouds, or even possibly a calcium/aluminum oxide melt surface. Our future work includes measuring the albedo of molten lava to determine if our current low albedo surface result holds, and identifying potential lava worlds in TESS data for follow-up observations and future characterization.

Catriona Sinclair
IoA

Terrestrial Planet Bombardment and Atmosphere Evolution

We investigate how the bombardment of terrestrial planets by populations of planetesimals left over from the planet formation process affects the evolution of their atmospheres, through both impact induced atmospheric mass loss and volatile delivery. This work builds on previous studies of this topic by combining prescriptions for the atmosphere loss and mass delivery derived from hydrodynamic simulations with results from dynamical modelling of a realistic population of impactors. The effect on the atmosphere predicted by the hydrodynamical simulations performed by Shuvalov (2009) as a function of the impactor and system properties are incorporated into a numerical model for the atmospheric evolution. The effects of stochastic giant impacts, that can cause non-local atmosphere loss, are also included using the prescription from Schlichting et al. (2015), and aerial bursts and fragmentation of smaller impactors in hot and dense atmospheres is included using the prescription derived from further simulations performed by Shuvalov et al. (2014). We compare the impact induced atmosphere evolution of Earth, Venus and Mars using impact velocities and probabilities inferred from the results of dynamical models of the population of left over planetesimals in the early solar system from Morbidelli et al. (2018). The effect of the variation in the distribution of the impactor material properties is investigated, and the results discussed in light of observational constraints regarding the composition of the material delivered to Earth as the late veneer.

David Grinspoon
Planetary Science Institute

The Evolution of Climate and a Possible Biosphere on Venus

Of the three local terrestrial planets, two have lost their oceans either to a subsurface cryosphere or to space, and one has had liquid oceans for most of its history. It is likely that planetary desiccation in one form or another is common among extrasolar terrestrial planets near the edges of their habitable zones. As our understanding of terrestrial planet evolution has increased, the importance of water abundance as a substance controlling many evolutionary factors has become increasingly clear. This is true of biological evolution, as well as geological and climatic evolution. Water is among the most important climatically active atmospheric gasses on the terrestrial planets. It is also a controlling variable for tectonic style and geologic processes, as well as a mediator of surface-atmosphere chemical reactions. Thus, understanding the sources and sinks for surface water and characterizing the longevity of oceans and the magnitude of loss mechanisms on terrestrial planets of differing size, composition and proximity to stars of various stellar types, and the range of physical parameters which facilitates plate tectonics is key to defining stellar habitable zones.Venus almost surely experienced a transition, early in its history, from a wet, more Earth- like environment to its current hot and highly desiccated state. The timescale is disputed, but recent results using 3D GCM's suggest that, depending on ancient rotation rate and topography, an ancient ocean may have persisted for ~ 2 GY. A more recent global transition is indicated by the sparse, randomly distributed and relatively pristine crater population, which implies a decrease in volcanic resurfacing rate between 300 and 1000 Myr ago. The accompanying decline in outgassing rate may have caused large climate change. Geological evidence for dramatic changes in resurfacing rate implies large amplitude climate changes which may have left a record of synchronous global deformations and other climatically forced geological signatures. These two transitions may have been causally related if the loss of atmospheric and interior water caused the transition from plate tectonics to single plate behavior. Today ongoing volcanism most likely provides the ingredients for the global sulfuric acid cloud decks. Rapid loss of SO2 to carbonates at the surface and H2O to space strongly implies an active source for these gases on the scale of 10's of MY, a result consistent with surface data suggesting the presence of active volcanism. The stability of Venus' climate is therefore likely dependent upon active volcanism and the sulfur cycle. For much of solar system history Earth may have had a neighbouring planet with life-supporting oceans. During this time the terrestrial planets were not isolated. Rather, due to frequent impact transport, they represented a continuous environment for early microbial life. Life, once established in the early oceans of Venus, may have migrated to the clouds which, on present day Venus, may represent a habitable niche. Though highly acidic, this aqueous environment enjoys moderate temperatures, surroundings far from chemical equilibrium, and potentially useful radiation fluxes. Observations of unusual chemistry in the clouds, puzzling patterns of unidentified solar absorbers, and particle populations that are not well characterized, suggest that this environment must be explored much more fully before biology can be ruled out. A sulfur-based metabolism for cloud-based life on Venus has been proposed. While speculative, these arguments, along with the discovery of terrestrial extremophile organisms that might survive in the Venusian clouds, establish the credibility of astrobiological exploration of Venus. Given that many exoplanets are sure to be "Venus like" in many respects, the exploration of this climate history and of a possible cloud-based biosphere, has implications for terrestrial planets and habitability throughout the galaxy.

Mr Robert Graham
University of Oxford

Hydrologic Control of Silicate Weathering and Rocky Planet Climate Stability

The classical concept of the “liquid water habitable zone” relies on the silicate weathering feedback to stabilize climate across a range of instellations. However, the representation of the silicate weathering feedback that is typically used in rocky exoplanet weathering and climate stability studies does not account for the limit on the concentration of silicate weathering products in runoff that emerges due to thermodynamic equilibrium between silicate mineral dissolution and clay precipitation in weathering systems (Maher & Chamberlain 2014). The maximum solute concentration is determined by pCO_2 and the stoichiometry of dissolution/precipitation reactions in the weathering system. We constructed a coupled zero-dimensional CO_2- and energy-balance model with simple representations of hydrology and surface properties that includes this parameterization of silicate weathering. Including the thermodynamic limit on solute concentration causes modeled global weathering fluxes to be controlled by a combination of runoff, CO_2 partial pressure, and surface properties like soil age and porosity. In our simulations, the outer edge of the habitable zone (defined as the instellation where planetary temperature falls below freezing) is more sensitive to land fraction and CO_2 outgassing rate than previous exoplanet weathering studies have indicated. The habitable zone outer edge is also very sensitive to hydrology and planetary surface properties, which have not been considered in previous exoplanet weathering studies. This suggests that the climate stability of ocean- and land-bearing exoplanets is determined by a complex interplay of poorly-understood factors.

Quentin Changeat
UCL

ARIEL, a mission to unravel the atmospheric composition of a large number of super-Earths

Ariel has been selected as ESA's M4 mission for launch in 2028 and is designed for the characterization of a large and diverse population of exoplanetary atmospheres to provide insights into planetary formation and evolution within our Galaxy.

Here we explore the mission capability to perform an in-depth survey into the atmospheres of smaller planets, which may be enriched or secondary. Earth-sized planets and super-Earths with atmospheres heavier than H/He will be more challenging to observe spectroscopically. However, a recent assessment of the mission performances in Phase B has found that Ariel could have substantial capability for providing in-depth observations of smaller planets. Trade-offs between the number and type of planets observed will form a key part of the target selection process and this list of planets will continually evolve with new exoplanet discoveries replacing predicted detections.

Professor Vivien Parmentier
University of Oxford

Understanding the spectrum of far away worlds: lessons learned form hot giant planets.

Each exoplanet is a unique world to explore surrounded by a complex three-dimensional atmosphere. Yet, observations of these atmospheres are often low signal-to-noise, cover a limited range of wavelengths and are the average of different parts of the atmosphere with potentially very different properties. I will discuss the challenges and many pitfalls faced in interpreting the observations of hot, giant exoplanets in the past decade and which lessons should be kept in mind when the atmospheres of rocky worlds will become accessible.