ARIEL: Science, Mission & Community 2020 Conference

14 - 16 January 2020

https://www.cosmos.esa.int/web/ariel/conference-2020

Welcome

ESA welcomes you to the ARIEL: Science, Mission & Community 2020 Conference.

ARIEL, the Atmospheric Remote-sensing Infrared Exoplanet Large-survey, will study what planets are made of and how planetary systems form and evolve by surveying a large and diverse sample of many hundred extrasolar planets. Observations will be carried out simultaneously in visible and infrared wavelengths, covering the range 0.5-7.8 micron with high precision.

ARIEL is the first space mission dedicated to measuring the chemical composition and thermal structures of a large diverse sample of transiting and eclipsing exoplanets, enabling planetary science far beyond the boundaries of the Solar System.

In March 2018, ARIEL was selected as M4, the fourth medium-sized (M class) mission in ESA's Cosmic Vision Plan. ARIEL is now in phase B. This conference aims to:

- Involve the planetary and astrophysical community at large in the mission;
- Present how the mission and its science has progressed during phase B;
- Put it into context of other missions and observatories; and
- Discuss and plan the best ways to promote long term community involvement

The ARIEL mission payload is developed by a consortium from 17 ESA countries and NASA. These are:

- Austria
- Belgium
- Czech Republic
- Denmark
- Estonia
- France
- Germany
- Hungary
- Italy
- Ireland
- Norway
- Poland
- Portugal
- Sweden
- Spain
- The Netherlands
- UK
- US

ESA ARIEL Science Advisory Team:

- Pilbratt, Göran - ESA/ESTEC
- Haswell, Carole - Open University
- Lagage, Pierre-Olivier - CEA, Saclay
- Leconte, Jérémy - Bordeaux University
- Micela, Giusi - INAF
- Min, Michiel - SRON
- Osorio, María Rosa Zapatero - CAB, CSIC/INTA
- Testi, Leonardo - ESO
- Tinetti, Giovanna - UCL
- Turrini, Diego - INAF
- Vandenbussche, Bart - KUL

Day 1: Tuesday 14th January - Agenda

08:00: Arrival and Registration

Welcome, ARIEL Introduction & Overview

09:30: **Welcome - ARIEL In Context Of ESA Science Program**
By: Günther Hasinger - ESA

09:50: **ARIEL: Mission Overview And Community Participation**
By: Göran Pilbratt - ESA

10:15: **The ARIEL Science Case Outline**
By: Giovanna Tinetti - UCL

10:45: **ARIEL Mission Status**
By: Ludovic Puig - ESA

11:05: Coffee Break

11:35: **ARIEL Payload Design Overview**
By: Paul Eccleston - RAL Space

12:05: **ARIEL Performance Modelling And Predictions Of Performance**
By: Enzo Pascale - Sapienza

12:35: **The NASA CASE Contribution To ARIEL**
By: Mark Swain - JPL

12:55: Lunch

The ARIEL Target Sample

13:55: **The ARIEL Mission Reference Sample Target List**
By: Billy Edwards - UCL

14:10: **Results From ALFNOOR Population Study**
By: Lorenzo Mugnai - Sapienza

14:25: **Characterisation Of ARIEL Host Stars**
By: Camilla Danielski - CEA

14:40: **Exoplanet Phase-Curves With ARIEL**
By: Benjamin Charnay - LESIA

14:55: **Colour-Magnitude Diagrams Of Transiting Exoplanets 3: A New Tool For The Community**
By: Georgina Dransfield - University of Birmingham

15:10: **Exploiting The Transit Timing Capability Of ARIEL High-Precision Photometry**
By: Luca Borsato - University of Padova

15:25: Coffee break

Missions & Surveys Delivering ARIEL Targets

15:55: **PLATO Summary**
By: Heike Rauer - DLR

16:15: **Summary Of Ground Based Surveys**
By: Don Pollacco - University of Warwick

16:35: **Synergies Between Radial Velocities And The ARIEL Mission**
By: Alexandre Santerne - LAM

16:55: **Which Planets Have Atmospheres: The Role Of Photo-Evaporation**
By: Vincent Van Eylen - MSSL

17:10: **Synergies Between ARIEL And ESPRESSO**
By: Maria Rosa Zapatero Osorio - CAB

17:25: **MuSCAT1/2/3: Global Multi-Color Photometric Monitoring Network For Exoplanetary Transits**
By: Norio Narita - University of Tokyo

17:40: Poster Previews & Lightning Talks

18:30: Drinks & Poster Reception

19:30: Buses to Noordwijk

Day 2: Wednesday 15th January - Agenda

ARIEL Instrumental Capabilities & Data

09:00: **ARIEL Telescope Assembly Design Overview**
By: Emanuele Pace - INAF

09:20: **AIRS: The ARIEL InfraRed Spectrometer**
By: Jérôme Amiaux - CEA

09:40: **The ARIEL Fine Guidance System (FGS), Photometer & NIRSpec**
By: Mirosław Rataj - CBK

10:00: **The ARIEL Science Ground Segment And The Instrument Operations And Science Data Centre: Data Flow And Science Products**
By: Pino Malaguti - INAF and Chris Pearson - RAL

10:20: **ARIEL Target Scheduling**
By: Juan-Carlos Morales - ICE-SIC/CNES

10:40: Coffee Break

Discs & Planet Formation

11:10: **Diagnosing Planet Formation With Elemental Ratios**
By: Mihkel Kama - University of Cambridge

11:25: **Linking Exoplanet Statistics With Giant Planet Formation**
By: Olja Panic - University of Leeds

11:40: **ARIEL: Decoding The Secrets Of Planetary Formation**
By: Diego Turrini - INAF-IAPS

12:00: **State Of The Art Of Planet Formation Models**
By: Shigeru Ida - ELSI, Tokyo

12:20: **Inside-Out Planet Formation And ARIEL**
By: Jonathan Tan - University of Chalmers/University of Virginia

12:35: **Planetary Systems In Stellar Clusters - A Lesson From Planet Nine?**
By: Hans Rickman - CBK

12:50: **Streaming Instability In Two-Dimensional Protoplanetary Disks**
By: Cong Yu - SYSU

13:05: **Planet Formation And Composition Around Low-Mass Stars**
By: Yamila Miguel - University of Leiden

13:20: Lunch

Interiors & Connection To Atmospheres

14:20: **Interiors & The Connection To Atmospheres**
By: Jérémy Leconte - University of Bordeaux

14:40: **On The Evolution And Internal Structure Of Giant Planets**
By: Simon Muller - University of Zurich

14:55: **Atmospheres of Hot Rocky Exoplanets**
By: Yuichi Ito - UCL

15:10: **Exploring Super-Earth Surfaces Albedo Of Near-Airless Magma Ocean Planets And Topography**
By: Darius Modirrousta-Galian - INAF

15:25: Coffee Break

Atmospheric Models & Observations

15:55: **State Of The Art – Observations Of Exoplanet Atmospheres**
By: Laura Kreidberg - CfA

16:15: **Spectroscopic Phase Curves Of Exoplanets In The ARIEL Era**
By: Jean-Michel Desert - University of Amsterdam

16:30: **Understanding The Chemical Composition Of Exoplanet Atmosphere**
By: Olivia Venot - LISA

16:45: **Atmospheric Dynamical Models: From Solar System Planets To Exoplanets Observed By ARIEL**
By: Aymeric Spiga - LMD

17:00: **Atmospheres In 3D With Ariel**
By: Vivien Parmentier - Oxford

17:15: **Lessons Learned From IR Solar System Observations**
By: Thierry Fouchet - Paris Observatory

17:35: **Classification Of Super-Earths And Sub-Neptunes With ARIEL Based On The Main Ions In The Thermosphere**
By: Jérémy Bourgalais - LATMOS

17:50: **How Known Planets From The Solar System Would Be Seen If They Were Exoplanets**
By: Gabriella Gilli and Pedro Machado - IA Lisboa

18:05: **Exploring Disequilibrium Chemistry In The Atmospheres Of Hot Jupiters**
By: Yui Kawashima - SRON

18:20: **Geometric Albedos Of Exoplanet Day Sides At Optical Wavelengths**
By: Matthias Mallonn - Leibniz Institute Potsdam

18:35: Buses To Noordwijk

19:30: Conference Dinner

Day 3: Thursday 16th January - Agenda

Synergies With Other Missions & Observatories

09:00: **TESS Discoveries**
By: David Ciardi - Caltech/IPAC

09:15: **Complementarities And Synergies Between ARIEL And JWST**
By: Pierre Olivier Lagage - CEA

09:30: **Exoplanet Science With The James Webb Space Telescope**
By: Knicole Colon - NASA Goddard

09:45: **Synergies Between ARIEL And The ELTs**
By: Enric Palle - IAC

10:00: **ARIEL Targets And High-Precision Photometric Support From NGTS**
By: Peter Wheatley - University of Warwick

10:15: **On The Synergy Between ARIEL And Ground-Based High-Resolution Spectroscopy**
By: Alessandro Sozzetti - INAF

10:30: Coffee Break

11:00: **CHEOPS**
By: Willi Benz - University of Bern

11:15: **Synergies Between ARIEL And Direct Imaging And WFIRST**
By: Anthony Boccaletti - LESIA

Spectral Retrievals & Spectroscopic Data

11:30: **Atmospheric Retrieval For The ARIEL Spectral Database**
By: Michiel Min - SRON

11:50: **Machine Learning In Exoplanet Atmospheric Characterisation**
By: Ingo Waldmann - UCL

12:05: **Using Model Comparisons To Understand And Overcome Challenges In Atmospheric Retrieval**
By: Joanna Barstow - UCL

12:20: **Exploring The ARIEL Capabilities To Constrain Exoplanet Atmospheres**
By: Patricio Cubillos - Space Research Institute, Graz

12:35: **Self-Consistent Phase Curve Retrieval In The ARIEL Era**
By: Jasmina Blecic - NYUAD

12:50: **The Status Of Spectroscopic Data For The ARIEL Mission**
By: Sergey Yurchenko - UCL

13:05: **Infrared Spectroscopy Of Ions, Radicals And Rydberg Atoms For Ariel Astronomy**
By: Svatopluk Civiš - Heyrovský Institute

13:20: Lunch

Properties Of Exoplanet Host Stars & Interactions

14:20: **Stellar Activity And Ariel Observations**
By: Giusi Micela - INAF

14:40: **What Can The Dispersed Matter Planet Project Do For ARIEL?**
By: Carole Haswell - Open University

15:00: **Stars Shaping The Atmospheres Of Their Planets**
By: Theresa Lueftinger - University of Vienna

15:15: **Stellar Flares With ARIEL**
By: Krisztián Vida - Konkoly Observatory

15:30: **Which Planets Have Atmospheres: The Role Of Photo-Evaporation**
By: Vincent Van Eylen - MSSL

15:45: **Direct Recovery Of Planet Masses For ARIEL With Radial Velocities**
By: John Barnes - Open University

16:00: Coffee Break

Data Challenges & Community Tools

16:30: **Overview Of ARIEL Machine Learning Data Challenge Results**
By: Nikolaos Nikolaou - UCL

16:45: **Details Of MLDC Winning Team Results 1**
By: James Dawson (remote)

16:50: **Details Of MLDC Winning Team Results 2**
By: Vadim Borisov (remote)

16:55: **Details f MLDC Winning Team Results 3**
By: Artash Nath (remote)

17:00: **ARES, The Ariel Retrieval Of Exolanet Spectra School**
By: Jean-Philippe Beaulieu - IAP

17:15: **ARIEL Data Reduction Challenge**
By: Angelos Tsiaras - UCL

17:30: **The Horizon-2020 ExoplANETS-A Project: Advancing Transit Spectroscopy**
By: Jeroen Bouwman - MPIA

17:45: **The ExoClock Project: Pro-Am Collaboration For Ground-Based Observations In Support Of The ARIEL Space Mission**
By: Anastasia Kokori - Royal Observatory, Greenwich

Summary & Conference Conclusions

18:00: **Summary Of Community Feedback And Questions**
By: SAT Round Table

18:30: End Of Conference

Invited & SOC Talks

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Giusi Micela - INAF

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Carole Haswell - Open University

For possible last minute updates to the programme, please consult the online programme at: https://www.cosmos.esa.int/web/ariel/programme

Contributed Presentations

Exploring The Clearness/Cloudiness Of The Atmospheres Of Gas Giant Exoplanets:
by Lorena Acuña - LAM (Poster)

Puffy hot Jupiters with a clear atmosphere are the most favorable targets for atmospheric characterisation. Theory predicts that cloud-free atmospheres would show a Rayleigh scattering slope from molecular hydrogen in the visible part of the transmission spectrum. However, clouds and hazes are ubiquitous across the day-night terminator of exoplanets. To first order, hazes would introduce a linear slope in the transmission spectrum while optically thick clouds would act as gray absorbers and mute the transmission spectrum which becomes flat and featureless. We conducted low resolution spectroscopy of seven transiting gas giant exoplanets with the Nordic Optical Telescope (La Palma, Spain) at blue and visible wavelengths to probe the presence of Rayleigh scattering and constrain the clearness or cloudiness of their atmospheres. These observations will help understand the atmospheric properties of close-in gas giant exoplanets and inform expectations from transmission spectroscopy with ARIEL. They may also be used to complement transmission spectra obtained with ARIEL. In this poster, we present preliminary results from this survey.

On The Degeneracy Of The Planetary Spectral Slope With Orbital Parameters:
by Xanthippi Alexoudi - Leibniz Institute (Poster)

Transmission spectroscopy is the widely used observational technique that exploits the planetary transit events with aim to characterize the exoplanetary atmospheres. While it already revealed atomic and molecular absorption, haze layers and thick clouds in about two dozen of objects, the literature presents some worthy mentioned discrepant results on individual targets. An example of controversial results in the literature is the case of HAT-P-12b, which I solved successfully during my studies. Intriguingly, two independent investigations from different groups, one with ground-based observations and one using the Hubble Space Telescope (HST), concluded to contradicting transmission spectra, interpreted from opaque clouds in the atmosphere to a Rayleigh scattering slope. The optical slope in this case is affected by the orbital parameters yielding to inconsistencies. I will present this degeneracy investigated for the entire parameter space with aim to ameliorate the quality of the scientific output.

TauREx III: A Fast, Dynamic And Extendable Framework For Retrievals:
by Ahmed Al-Refaie - UCL (Poster)

TauREx 3 is the next generation of the TauREx exoplanet atmospheric retrieval framework for Windows, Mac and Linux. It is a complete rewrite with a full Python stack that makes it simple to use, high performance and dynamic/flexible. The new main taurex program is extremely modular, allowing the user to augment taurex functionalities with their own code and easily perform retrievals on their own parameters. This is achieved by dynamic determination of fitting parameters where TauREx 3 can detect new parameters for retrieval from the user code though a simple interface. TauREx 3 can act as a library with a simple 'import taurex' providing a rich set of classes and functions related to atmospheric modelling. A 10x speed-up in forward model computations is achieved compared to the previous version with a six-fold reduction in retrieval times whilst maintaining robust results. TauREx 3 intends to act as a standalone, all in one package for retrievals whilst the TauREx 3 python library can be used by the user to easily build or augment their own data pipelines.

AIRS: The ARIEL InfraRed Spectrometer: by Jérôme Amiaux - CEA (Talk)

AIRS will be the infrared spectroscopic instrument of the ARIEL mission providing spectroscopic data covering the channel 0 [1.95-3.90] µm and the channel 1 [3.90-7.80] µm wavelength range with dispersive elements producing spectrum of low resolutions R>100 in channel 0 and R>30 in channel 1. This instrument overview will cover opto-mechanical design of the instrument functioning in a 60-K environment, up to the detection chain of both channels based on 2 HgCdTe detectors functioning at 42-K.

Twinkle – A Low-Earth Orbit Visible And Infrared Exoplanet Spectroscopy Observatory: by Richard Archer - BSSL (Poster)

The Twinkle Space Mission is a space-based observatory that has been conceived to measure the atmospheric composition of exoplanets, stars and solar system objects. This cost-effective spacecraft is being constructed on a short timescale in the UK with planned scientific observations starting in 2023. The satellite is based on a high-heritage platform and will carry a 0.45m telescope with a spectrograph that covers both the visible and near-infrared wavelengths. This spectrograph provides simultaneous wavelength coverage from 0.5 to 4.5 µm. The spacecraft will be launched into a Sun-synchronous low-Earth polar orbit and will have a baseline lifetime of seven years.

Twinkle will have the capability to provide high-quality visible and infrared spectroscopic characterisation of hundreds of bright exoplanets, including at least 100 currently-known exoplanets. It will also be capable of follow-up photometric observations of 1000 or more exoplanets. Photometric measurements, taken simultaneously in the visible and the infrared bands, will allow orbital parameters of systems to be well-constrained and enable precise measurements of transit timing variations present in multi-planet systems. The exoplanet targets observed by Twinkle will be composed of known exoplanets discovered by existing and upcoming ground- and space-based surveys, including TESS, GAIA, K2, CHEOPS, WASP and HATSouth.

Direct Recovery Of Planet Masses For ARIEL With Radial Velocities: by John Barnes - Open University (Talk)

ARIEL's ambitious goal to survey a quarter of known exoplanets will transform our knowledge of planetary atmospheres. Masses measured directly with the radial velocity (RV) technique are essential for well determined planetary bulk properties. RV masses will provide important checks of masses derived from atmospheric fits; or alternatively can be treated as a fixed input parameter to reduce possible degeneracies in atmospheric retrievals. We will quantify the impact of stellar activity on planet mass recovery for the ARIEL mission sample, using Sun-like spot models scaled for active stars, and starspot distributions informed by indirect imaging techniques such as Doppler tomography. We simulate the derived planet mass precision as a function of host star spectral type, planet mass, activity and number of observations using ground-based facilities currently achieving individual RV measurements with velocity precisions ranging from 10s of cm/s to ~10 m/s. Our simulations can be used to determine the optimal strategies for observing campaigns to determine the masses of planets from the ARIEL target list.

Using Model Comparisons To Understand And Overcome Challenges In Atmospheric Retrieval: by Joanna Barstow - UCL (Talk)

Spectral retrieval is the leading technique for interpretation of exoplanet transmission spectra. Whilst several atmospheric models and retrieval algorithms have been successfully employed, as yet the different model suites have mostly been used in isolation and so it is unknown whether results from each are comparable. As we approach the launch of the JWST in 2020, and looking further ahead to ARIEL, we are entering a new data-rich era in the field of exoplanet atmospheres and so it is important that the tools that will be used to interpret these data are properly verified. We here present a comparative study of three retrieval code suites, TauREX, NEMESIS and CHIMERA.

We compared output transmission spectra for both simple model atmospheres including only a single spectrally active gas, and more realistic planet models including simple clouds and combinations of gases. We then took each of the more realistic model planets and binned the spectra down to a resolution of R=100 over the wavelength range of 0.5--10 microns. These spectra were cross-retrieved between the three algorithms to assess whether spectra generated with one model can be accurately retrieved using the others. We tested error bars at 30, 60 and 100 ppm. Despite the fact that the forward models agreed well with each other, we found that whilst for error envelopes of 60 and 100 ppm the correct solution was generally recovered within 1 sigma, for 30 ppm small differences between the forward model spectra became important and the true atmospheric state was not recovered. This can be seen as analagous to the presence of uncorrected instrumental or astrophysical systematics, or model incompleteness, and thus serves as an important aid to understanding the challenges in retrieval of exoplanet atmospheres.

ARES, The ARIEL Retrieval Of Exoplanet Spectra School: by Jean-Philippe Beaulieu - IAP (Talk)

ARIEL is due to launch in 2028 and to start its regular survey operation in 2029. In order to prepare the community for the exploitation, we have decided to organize every year an ARIEL school. The PhD students and postdocs of today, will be on the front line for the final preparation, and the Science exploitation of ARIEL. We will choose one theme per year, and develop a program with theory and hands-on exercises with experts from the field.

We have several objectives :
A - Teaching the state of the art of the theory for the theme of the School.
B - key role of intense Hands-on sessions:

The first edition, funded by CNES, was held in Biarritz in September 2019, with 19 participants and 6 tutors. The objective was to first learn about the physics and chemistry of exoplanet atmospheres, before extracting planet spectra from HST archive and retrieving temperature-pressure profiles and molecular abundances, and then model what ARIEL will be able to observe. During the schools, 10 planets observed by HST have been analyzed, and it will lead to several publications in the coming weeks. We will present the highlights, and the plans for the years to come.

Feasibility Of Mass Determination For ARIEL Targets: Implications For Atmospheric Characterisation: by Serena Benatti - INAF (Poster)

Spectral retrievals allow us to infer the planetary masses with a high degree of accuracy in case of light atmosphere (H/He) of gas giant exoplanets. However, the degeneracy between the planet mass and the mean molecular weight of species populating the heavier secondary atmospheres of rocky planets plays a more important role in the estimation of many other atmospheric parameters, both for clear skies and dense cloudy coverage (Changeat et al 2019). In this case, a prior information of the planet mass helps in finding the main atmospheric compounds.

We used available tools in the literature to estimate the time requested to obtain independent measure of planetary masses for the ARIEL Mission Reference Sample with a coordinated high-precision RV monitoring, to be accomplished with 4m class telescopes in the upcoming years. To verify the predictions, we compare them with real data from HARPS-N dedicated campaigns to characterize K2 planets.

Self-Consistent Phase Curve Retrieval In The ARIEL Era: by Jasmina Blecic - NY University (Talk)

Planets are intrinsically 3D, yet our current data permit us to have limited insight into their atmospheres, mostly in 1D. Our ultimate goal is, however, to develop tools to comprehensively analyse longitudinal, latitudinal, and radial dimensions of planetary atmospheres. ARIEL is the first space mission fully dedicated to understand the chemical composition and thermal structures of large diversity of exoplanets. Carried out in high resolution (~ 100) and wide wavelength coverage (0.5-7.8 micron), ARIEL will allow us to get an insight into both reflective and thermal flux from these objects with high precision. Thus, it is of a crucial importance that we develop tools that will allow us to assess the variation in the thermal structure, molecular abundances, and cloud coverage with phase, as the spectroscopic phase curve observations carry the most comprehensive information about planetary envelopes, atmospheric dynamics, chemical processes, and radiative energy balance. We present a first physically motivated temperature-pressure (T-P) model for the phase curve retrieval that accounts for the energy redistribution around the planet and enables retrieval of all orbital phases simultaneously. This new parametrized T-P profile includes the advection and radiation time scales, sources and sinks in the planetary atmosphere and informs us about the amplitude and phase offset caused by the equatorial jet. The self-consistent connection of all orbital phases allows the physical insight into the planetary day-night redistribution, providing an important feedback for the general circulation models.

Understanding Stellar Activity And Winds In Sun-Like Stars: by Sudeshna Boro Saikia - University of Vienna (Poster)

Understanding stellar magnetic activity is not only of utmost importance for planet detection and characterization, it is also important for planetary habitability. We investigate magnetic activity and winds of sun-like stars using high resolution spectra and the data driven 3D MHD model BATS-R-US/AWSoM, to understand what kind of space environments are suitable to nurture an Earth-like atmosphere. Additionally, we also aim to gain key insights into the space weather experienced by close-in planets around these stars. We use chromospheric Ca II H & K and H-alpha lines to determine stellar activity, and use Zeeman Doppler imaging (ZDI) to determine the surface magnetic geometry in these stars. The ZDI magnetic maps are then used as input boundary conditions to model stellar wind properties. I will discuss our current results related to stellar winds and activity for a handful of sun-like stars including our Sun

Exploiting The Transit Timing Capability Of ARIEL High-Precision Photometry: by Luca Borsato - University of Padova (Talk)

The Transit Time Variation (TTV) technique is a powerful tool to discover and characterise exoplanetary systems by measuring the departure of the transit times from a linear ephemeris due to gravitational interaction. The fast-cadence photometry provided by the ARIEL Fine Guidance Sensors (FGS1 and FGS2) will allow us to measure the planetary transit time at second-level precision and accuracy. This will shed light on doubtful dynamical solutions extending the temporal baseline of known planets in multiple-planet systems showing TTV signals. We present the ARIEL timing performances based on simulations of real targets and some possible science cases.

Classification Of Super-Earths And Sub-Neptunes With ARIEL Based On The Main Ions In The Thermosphere: by Jérémy Bourgalais - LATMOS (Talk)

With the upcoming launch of space telescopes dedicated to the study of exoplanets, like ARIEL, a new era is opening on exoplanetary atmospheric observations. This work focuses on laboratory simulations of EUV irradiation of poor and rich-H2 environments reproducing simplified super-Earth and mini-Neptune atmospheres. In the specific case of rich-H2 environments, H3+ has been observed as one of the most abundant ions contributors to the formation of heavier species and its observation provides access to fundamental parameters of the atmospheres. Combining with simulations of transmission spectra using ARIEL resolution, these results suggest that sub-Neptunes could be good candidates for the detection of H3+. This work shows also that the same main ions, HCO+ and H3O+, can be formed in both environments. Thus, this work also suggests to couple direct observations of H3+ with the observation of two of its ionic by-products, H3O+ and HCO+. The combination of these three compounds could constitute a new parametric set to classify bodies in the transition between super-Earths and sub-Neptunes.

The Horizon-2020 ExoplANETS-A Project: Advancing Transit Spectroscopy: by Jeroen Bouwman - MPIA (Talk)

The primary objective of the Exoplanet Atmosphere New Emission Transmission Spectra Analysis (ExoplANETS-A) project is to establish new knowledge on exoplanet atmospheres by exploiting archived space data (Hubble, Spitzer, Kepler) building on the state-of the art knowledge and long term experience within our team. This will be achieved through: the development of novel data reduction techniques based on a causal pixel model; the development of novel parameter retrieval methods to e.g. simultaneously deal with transmission and emission observations; establishing new knowledge on exoplanet atmospheres; establishing new insight on the influence of the host star on the planet atmosphere; the dissemination of knowledge, using online, web-based platforms. The project, funded under the EU's Horizon-2020 program, started in January 2018 and has a duration of 3 years. Here we present an overview of the project focussing on data reduction and parameter retrieval with some early results.

Activity Levels And Cycles Of The ARIEL Stars: by Giovanni Bruno - INAF (Poster)

The ever growing catalogue of known extrasolar planets, the detailed study of the planetary bodies in the Solar System, and the new capabilities of ground-based observatories for the study of circumstellar disks are providing us with different pieces of the complex puzzle that is understanding the birth and early evolution of planetary systems in our Galaxy. For these pieces to fit together and provide us with the complete picture, however, we need the additional and still missing piece of information offered by the compositional characterization of a large and representative sample of exoplanets. ARIEL will provide this missing centrepiece of the puzzle and, in doing so, will allow for an unprecedented view of how the process of planetary formation shapes the characteristics of planetary systems, including our own Solar System. In this talk I'll highlight the science cases devised in the framework of the ARIEL mission to address some of the most outstanding open questions on planetary formation and the ongoing efforts within the ARIEL team to fully take advantage of the unique data that the mission will provide.

Exoplanet Ephemeris Maintenance Using An Autonomous Telescope Network: by Hamish Caines, Giorgio Savini, and Marco Rocchetto - UCL (Poster)

ARIEL will require precise knowledge of the transit timings for all of the targets it is going to observe throughout its mission. However, the precision we have for each target will degrade significantly over the 8 years between today and the mission launch, in some cases to the point where the error exceeds the duration of the transit itself. These transits would be deemed "lost". In order to counteract this, we must observe the targets within the ARIEL target list, generating new ephemerides, in effect "resetting the clock". We aim to use the Telescope Live network of robotic telescopes to obtain this data. However, with 1000 targets, and an average orbital period on the order of days, the size and usage of the network required needs to be quantified. Here we present results from simulations of these observations for a variety of telescope networks of varying sizes, which include the number of targets that can be successfully constrained, and the amount of observing time required to do so. From these results we can conclude that a ground-based telescope network containing as few as 4 telescopes can constrain over 90% of the targets with transit depths observable from the ground.

An Atmospheric Retrieval System For The ExoMars Trace Gas Orbiter: by George Cann - UCL (Poster)

The Nadir and Occultation for MArs Discovery (NOMAD) instrument, onboard the European Space Agency's Exomars Trace Gas Orbiter (TGO) was designed to unravel the mystery of methane (CH4) on Mars. However, the TGOs arrival and sub-sequent science mission has detected no CH4, with an upper limit of 0.05 ppbv. In contrast, NASA's Curiosity Sample Analysis at Mars Tunable Laser Spectrometer (SAM-TLS) recently measured a spike of 21 ppbv at Teal Ridge in Gale Crater. The discrepancy between surface measurements by SAM-TLS and orbital measurements from NOMAD and the Planetary Fourier Spectrometer (PFS) onboard Mars Express significantly constrains the mechanisms to corroborate the measurements. Here we present a novel retrieval framework, Ares 3, the Mars branch of Tau-REx-3, designed for TGO NOMAD Solar Occultation (SO) channel solar occultation measurements, that could help unravel the mystery of CH4 on Mars.

N-Dominated Atmospheres: Organic Chemistry Driven By Ions In Super-Earth Atmospheres In The Habitable Zone: by Nathalie Carrasco - LATMOS (Poster)

The population of exoplanets with a radius between Earth and Neptune represents a significant proportion of the planets in our Galaxy and none of which exist in our solar system. Unlike hot gas giants, the atmospheres of super-Earth, which are relatively cold (200-600K) and small ($<3R_\oplus$), are difficult to observe by transit spectroscopy and their atmospheric properties are therefore largely unknown. To remedy this, it is therefore important to refer to the knowledge acquired on the planets of the SS and particularly on Saturn's largest satellite, Titan. On Titan it has been shown that ion-neutral chemistry is a major element in molecular growth to form organic haze precursors. Titan serves as a reference for hazy exoplanet and similar mechanisms need to be evaluated for thermosphere of Titan-like exoplanets. But Titan is out of the habitable zone in the solar system, whereas several super-Earths planets have been detected in the habitable zone of their host-star. The aim of this work is therefore to investigate experimentally the effect of water on the ion chemistry occurring in a exoplanetary atmosphere similar to Titan but containing some water. The impact on the habitability of such planets will be discussed.

Towards A More Complex Description Of Chemical Profiles In Exoplanet Retrievals: A 2-layer Parameterisation: by Quentin Changeat - UCL (Poster)

State of the art spectral retrieval models of exoplanet atmospheres assume constant chemical profiles with altitude. This assumption is justified by the information content of current datasets which do not allow, in most cases, for the molecular abundances as a function of pressure to be constrained.

In the context of the next generation of telescopes, a more accurate description of chemical profiles may become crucial to interpret observations and gain new insights into atmospheric physics. We explore here the possibility of retrieving pressure-dependent chemical profiles from transit spectra, without injecting any priors from theoretical chemical models in our retrievals. The ``2-layer'' parameterisation presented here allows for the independent extraction of molecular abundances above and below a certain atmospheric pressure.

We find that the 2-layer retrieval accurately captures discontinuities in the vertical chemical profiles, which could be caused by disequilibrium processes -- such as photo-chemistry -- or the presence of clouds/hazes. The 2-layer retrieval could also help to constrain the composition of clouds and hazes by exploring the correlation between the chemical changes in the gaseous phase and the pressure at which the condensed phase occurs.

Exoplanet Phase-Curves With ARIEL: by Benjamin Charnay - LESIA (Talk)

During this talk, I will present the current plan for the observations of phase curves with ARIEL. I will describe the sciences questions, the target list, the observational strategy and some simulated phase curves with ARIEL resolution and noise.

Aluminium Oxide In The Atmosphere Of Hot Jupiter WASP-43b: by Katy Chubb - SRON (Poster)

We have conducted a re-analysis of publicly available Hubble Space Telescope Wide Field Camera 3 (HST WFC3) transmission data for “Hot Jupiter'' exoplanet WASP-43b, using Bayesian retrieval packages Tau-REx and ARCiS. We report evidence for AlO in transmission to a high level of statistical significance (> 5 sigma in comparison to a flat model, and > 3.6 sigma in comparison to a model with H2O only). We find no evidence for the presence of CO, CO2 or CH4 based on either the available HST WFC3 data or Spitzer IRAC data. H2O is the only other molecule we find to be statistically significant in this region. AlO is not expected from equilibrium chemistry at the temperatures and pressures of the atmospheric layer which is being probed by the observed data. Its presence therefore implies direct evidence for some disequilibrium processes with links to atmospheric dynamics. Implications for future study using instruments such as ARIEL and the James Webb Space Telescope (JWST) are discussed, along with future opacity needs. Comparisons are made with previous studies into WASP-43b.

TESS Discoveries: by David Ciardi - Caltech/IPAC (Talk)

A summary of the exoplanet discoveries of TESS from the candidate production through the follow-up and confirmation of the planets will be presented.

Infrared Spectroscopy Of Ions, Radicals And Rydberg Atoms For Ariel Astronomy: by Svatopluk Civiš - J. Heyrovský Institute of Physical Chemistry, CAS (Talk)

The ARIEL satellite is designed as a survey mission for observing a large sample of planetary atmospheres and their subsequent analysis. The observation itself will be divided into three tiers and will differ in the depth of the analysis of the chemical composition. The payload will be sensitive enough to detect 10 – 100 ppm signals from the planets when compared to the signal from the star, which will allow the detection of clouds, the monitoring of stellar activity and the detection of a range of molecular and ionic species. The wavelength range proposed covers all the expected major atmospheric gases from e.g. H2O, CO2, CH4, NH3, HCN, H2S through to the more exotic species such as radicals CN, NH, CH, OH, CH, He2, highly vibrationaly excited molecule of CO and many atoms in Rydberg (highly excited) states, which spectra appear in the 1.25-7.8 μm spectral range. These unstable species have so far not been very often involved into chemical and spectral retrieval models. The first step in this direction is the measurement and understanding their spectra and then the creation of a spectral database, which will be directly used for the Ariel mission.

SiH$_2$: A New ExoMol Line List: by Victoria Clark - UCL (Poster)

During this talk, I will present the current plan for the observations of phase curves with ARIEL. I will describe the sciences questions, the target list, the observational strategy and some simulated phase curves with ARIEL resolution and noise.

Exoplanet Science With The James Webb Space Telescope: by Knicole Colon - NASA Goddard (Talk)

The James Webb Space Telescope (JWST) will be the next premier space-based facility for near- and mid-infrared astronomy over 0.6-28.5 microns. The 6.5-meter telescope will be placed at the Earth-Sun Lagrange 2 point and will be equipped with four state-of-the-art instruments that include capabilities for imaging, spectroscopy, and coronagraphy. JWST will offer unprecedented sensitivity enabling detailed studies of transiting exoplanets and their atmospheres. We will provide an overview and status update of the observatory, its capabilities for transiting exoplanet studies, and details about the Early Release Science (ERS) and Guaranteed Time Observations (GTO) transiting exoplanet programs (including the specific exoplanets to be targeted, the science goals of the programs, and the timeline for observations). In addition, we will provide an overview of the first call for General Observer (GO) proposals, which will be released in January 2020 with a submission deadline of 1 May 2020. JWST is scheduled for launch in Spring 2021 and is an international collaboration between the National Aeronautics and Space Administration (NASA), the European Space Agency (ESA), and the Canadian Space Agency (CSA).

Exploring The Clearness/Cloudiness Of The Atmospheres Of Gas Giant Exoplanets: by Nicolas Crouzet - ESA (Poster)

Puffy hot Jupiters with a clear atmosphere are the most favorable targets for atmospheric characterisation. Theory predicts that cloud-free atmospheres would show a Rayleigh scattering slope from molecular hydrogen in the visible part of the transmission spectrum. However, clouds and hazes are ubiquitous across the day-night terminator of exoplanets. To first order, hazes would introduce a linear slope in the transmission spectrum while optically thick clouds would act as gray absorbers and mute the transmission spectrum which becomes flat and featureless. We conducted low resolution spectroscopy of seven transiting gas giant exoplanets with the Nordic Optical Telescope (La Palma, Spain) at blue and visible wavelengths to probe the presence of Rayleigh scattering and constrain the clearness or cloudiness of their atmospheres. These observations will help understand the atmospheric properties of close-in gas giant exoplanets and inform expectations from transmission spectroscopy with ARIEL. They may also be used to complement transmission spectra obtained with ARIEL. In this poster, we present our survey and preliminary results.

The JWST Transiting Exoplanet Community Early Release Science Program: by Nicolas Crouzet - ESA (Poster)

With a 6.5-meter diameter primary mirror in space and a wavelength coverage from the visible to the mid-infrared, the James Webb Space Telescope will soon open new windows to scrutinize transiting exoplanets' atmospheres. It will provide missing clues to understand hot Jupiter's atmospheres such as the relative abundances of molecular species and the thermal structure over a wide range of altitudes and will probe the atmospheres of terrestrial exoplanets. The transiting exoplanet community joined forces to define a coherent strategy to evaluate JWST's capabilities during the Early Release Science (ERS) program. We will conduct a set of well chosen observations that will be executed in the first months of JWST science operations and will be accompanied by data analysis toolkits and guides for best practices. These observations will pave the way to future exoplanet observations with JWST and will provide new constraints on the atmospheres of close-in gas giant exoplanets that may inform the definition of the ARIEL mission reference sample. In this talk, I will review the observing modes available for transiting exoplanet spectroscopy with JWST and present the Transiting Exoplanet Community ERS program and potential synergies with ARIEL.

Exploring The ARIEL Capabilities To Constrain Exoplanet Atmospheres: by Patrico Cubillos - Space Research Institute (Talk)

The study of extra-solar planets is one of the most exciting and fastest-growing fields in Astrophysics. The hundreds of targets that ARIEL will observe will provide an unprecedented sample of high precision planetary spectra from the visible to the infrared. This large sample will allow us to better understand the diversity of their composition and thermal structures, and search for fundamental physical properties to classify them.

Here, I will present a study of spectral retrievals of ARIEL simulated data, using the Pyrat Bay modeling and retrieval package. I will present our efforts to develop open-science tools to model exoplanet atmospheres. I will review some of the challenges that atmospheric retrievals present, and explore ways to mitigate these limitations. Finally, I will explore the impact that the diversity of physical properties and our prior knowledge of these has in our capability to characterize the planets' composition and thermal structure.

Cryotesting Of A Protected Silver Coating For The ARIEL Telescope Aluminum Mirrors: by Vania Da Deppo - CNR-IFN (Poster)

The baseline material chosen for ARIEL telescope mirrors is aluminum with a protected silver coating to enhance reflectivity at the operating visible and near-IR wavelength bands. A specific coating with space heritage has been selected during phase B of the mission, and will undergo a qualification process.

Given the operating conditions of the telescope, an important step in the qualification is to assure unaltered performance and integrity of the coating layers at cryogenic temperatures. A set of material samples, in the shape of flat disks, has been prepared from the same baseline aluminum alloy as the telescope mirror substrates. The disks will be coated and then subjected to a series of cryogenic temperature cycles to assess coating stability through visual inspection, reflectivity and atomic force microscopy and adhesion tests. This study presents the results of these tests before and after the cryogenic cycles.

Testing Of A Thermal Treatment Procedure For The Opto-Mechanical Stability At Cryogenic Temperatures Of The ARIEL Mirrors: by Vania Da Deppo - CNR-IFN (Poster)

After a tradeoff study, aluminum alloy 6061 has been chosen as baseline material for the ARIEL telescope mirrors. However, the large size of the main mirror (0.6 square meters) presents specific challenges concerning opto-mechanical stability in cryogenic environment. To minimize risk, fabrication processes will first be tested on flat Al samples of 150 mm of diameter and then applied to a full-size demonstrator mirror, before finalizing the design and producing the flight mirror. In particular, a dedicated thermal treatment procedure has been developed, together with a set of figuring and polishing techniques. Purpose of the procedure is to release residual stresses present in the substrate material or induced by the machining and figuring/polishing steps. This work describes testing and evaluation of the stress release procedure that has been proposed for the mirrors and presents preliminary results.

Characterisation Of ARIEL Host Stars: by Camilla Danielski - IAP (Talk)

The ARIEL Stellar Characterisation working group is responsible for the precise determination of the stellar parameters of the host stars belonging to the ARIEL target list. In this talk I will present both the group and the work that has been done so far towards the production of a homogeneous catalogue of fundamental stellar parameters. I will conclude by providing an overview of our future plans and interactions with the other WGs within the ARIEL consortium.

Spectroscopic Phase Curves Of Exoplanets In The ARIEL Era: by Jean-Michel Desert - University of Amsterdam (Talk)

Planets' longitudinal phase resolved spectra are crucial to test atmospheric climate models. This is because a spectroscopic phase curve allows for the measurements of the thermal emission and the reflected light of a planet as function of the longitude. Thus, phase curve data yield constraints on the energy budgets (albedo), heat redistributions, and dynamics of exoplanet atmospheres. Ultimately, spectroscopic phase curve observations provide much more comprehensive views of exoplanets as compared to spectra gathered only during transits or eclipses. I present state-of-the-art studies of exoplanets based on spectroscopic phase curve obtained with HST/WFC3. I emphasize the main results, but also the challenges and the limits of these studies with HST. I present how ARIEL can be transformative for studying exoplanets with spectroscopic phase curves. I discuss some of the main outcomes that we should expect from ARIEL for studies based on phase resolved spectra of exoplanets, and I propose avenues on how to prepare for such advances.

Exploiting The Potential Of Low-Resolution Spectrophotometry To Characterize Exoplanetary Atmospheres: by Daria Desidera - University of Padova (Poster)

Transmission spectroscopy is one of the most fruitful techniques exploited to characterize exoplanetary atmospheres. During a transit, the light is selectively absorbed or scattered by the planetary limb depending on the atmosphere properties. The wavelength dependence of the transit depth (transmission spectrum) probes the chemistry and physics of the atmosphere at the terminator. On typical Hot Jupiters, neutral alkali metals and aerosols dominate the signal in the optical, molecular bands in near-infrared. These components give us complementary clues on the atmospheric physical processes, that cannot be investigated through slit/fiber-based spectroscopy, since its observables are continuum-normalized. Low- to mid-resolution differential measurements with spectrophotometric slits, achievable with MOS spectrographs such as MODS@LBT and FORS2@VLT, are able to deliver accurate chromatic light curves over a wide spectral range, without losing any information on the continuum, therefore this approach is complementary with high-resolution spectroscopy. Here we present some results obtained using SCOLOPENDRA, our (soon to be) publicly-available software pipeline specifically developed to perform high-accuracy differential spectrophotometry. We show the first results of SCOLOPENDRA on both unpublished and archival data, suggesting how it could be exploited as a flexible and accurate tool to homogeneously analyze and merge data sets from different instruments and setups.

Colour-Magnitude Diagrams Of Transiting Exoplanets 3: A New Tool For The Community: by Georgina Dransfield - University of Birmingham (Talk)

ARIEL will observe a statistically significant sample of exoplanets and compile the planetary equivalent of an HR diagram. Such a diagram can already be established using Colour-Magnitude Diagrams. We present a public Python module to create colour-magnitude diagrams in near- and mid-infrared bands, as well as an up-to-date database of secondary eclipse measurements. Using our tool, we identify several planets which are clear outliers in colour and magnitude. Those tend to be special in another way: they are cooler, less massive, or more eccentric than the majority of Hot Jupiters.

We also observe that Brown Dwarfs of brightness comparable to exoplanets are systematically redder than their Hot Jupiter counterparts. We attribute this to an excess absorption by the molecule Phosphine, in the 4.5m Spitzer band. We further propose that Phosphine might provide an answer to many puzzlingly low fluxes in this band, for instance on warm Neptunes, like GJ 436b. Finally, we simulate the Ariel yield, and demonstrate how our tools can be used to constrain the C/O ratio of exoplanet sub-populations.

Solar System Transit Spectroscopic Observations: Comparison To ARIEL: by Pierre Drossart - LESIA (Poster)

Observations of stellar or solar occultations by planets with infrared spectrometers have been made by various space missions, but also from ground based observatory. A reanalysis of a Jupiter occultation of star HIP9369 in October 1999 with VLT/ISAAC (Raynaud et al, Icarus 2003) shows information obtained on methane in the upper atmosphere of Jupiter retrieved from absorption close to the homopause. A comparison with transit exoplanet spectroscopy will be made in the context of the ARIEL mission.

From Planets To Exoplanets: Lessons Learned From 70 Years Of Planetary Exploration by Pierre Drossart - LESIA (Poster)

The space exploration of the Solar System has revolutionized our understanding of the physics of the planets, and changed our perspective for Earth exploration. Exoplanets exploration is still in infancy by many aspects, in particular concerning composition, structure and dynamics, and many lessons can be transposed from Solar System planets. In particular Venus atmosphere and Jupiter atmosphere can be used as templates for deep CO_2 and H_2 atmospheres respectively. Extrapolation to a wide domain in temperature range is possible if accurate spectroscopic information is included in the models. The preparation of the characterization of exoplanets from JWST and ARIEL observations will benefit from the large corpus of observations obtained in the Solar System.

ARIEL Payload Design Overview: by Paul Eccleston - RAL Space (Talk)

This talk will provide the overview of the ARIEL payload design concept and top level performance as an introduction to the more detailed later presentations on the specific aspects of the design and performance modelling.

The ARIEL Mission Reference Sample Target List: by Billy Edwards - UCL (Talk)

Thousands of exoplanets have now been discovered with a huge range of masses, sizes and orbits. However, the essential nature of these exoplanets remains largely mysterious: there is no known, discernible pattern linking the presence, size, or orbital parameters of a planet to the nature of its parent star. We have little idea whether the chemistry of a planet is linked to its formation environment, or whether the type of host star drives the processes controlling the planet's birth and evolution.

By studying a large and diverse population of exoplanetary atmospheres, Ariel will provide insights into planetary formation and evolution within our galaxy. I will present the latest study of potential targets for Ariel in which we assessed the suitability of currently-known exoplanets and predicted TESS yields. This list of planets has been utilised to form several Mission Reference Samples (MRS) to demonstrate that Ariel's mission goals could be met from this planetary population. Much work still needs to be completed to ensure Ariel is utilised effectively and efficiently and thus I will also present an overview of the projects and studies being undertaken to guarantee this.

Hot Jupiter Atmospheres Built From Chemically Evolved Disk Midplane Material: by Christian Eistrup - University of Virginia (Poster)

Exoplanets are ubiquitous. From detecting them, and determining their sizes, masses and orbital characteristics, exoplanetary science is now also attempting to determine the atmospheric compositions of exoplanets. While detections of simple atmospheric gases have been reported in later years, it will likely require the next generation of facilities, such as the JWST and ground- based ELTs, to constrain exoplanet atmospheric gas abundances to levels that may enable chemical differentiation between exoplanets. In preparation for that, it is important to understand the chemical composition in protoplanetary disk midplanes, how it evolves, and how chemical changes in the gas and ice in the midplane may lead to differences in the compositions of the exoplanet atmospheres that form out of this material. In this talk, I will present results from thermochemical modeling of Hot Jupiter atmospheres using the TEA code (Blecic et al. 2016), where the these atmospheres are assumed to have formed from disk midplanes with different chemical histories (as described in Eistrup et al. 2016, 2018). The compositional differences between these Hot Jupiter atmospheres could therefore be used to distinguish between different chemical environments in the disk midplanes, and, in turn, different formation scenarios for the exoplanet atmospheres.

Observability Of Temperate Jupiters With ARIEL: by Therese Encrenaz - LESIA (Poster)

Several temperate Jupiters have been discovered to date, but most of them remain to be detected. In this note, we analyse the expected infrared transmission spectrum of a temperate Jupiter, with an equilibrium temperature ranging between 350 and 500 K. We estimate its expected amplitude signal through a primary transit, and we analyse the best conditions for the host star to be filled in order to optimize the S/N ratio of its transmission spectrum. Calculations show that temperate Jupiters around M stars could have an amplitude signal higher than 10−4 in primary transits, with revolution periods of a few tens of days and transit durations of a few hours. In this note, we analyse the detectability of such objects with ARIEL (presently focused on objects warmer than 500 K), in view of enlarging the sampling of exoplanets to be observed with this mission.

Astrobiology, Prebiotic Chemistry And ARIEL Mission: by Martin Ferus - J. Heyrovsky Institute of Physical Chemistry (Poster)

Chemical evolution of the Earth and subsequent origin of the first living structures are one of the most fascinating and the most controversial questions of contemporary science. Direct geological records revealing chemical conditions and their evolution during Hadean eon (>4 Gya) of the early Earth are very sporadic. Information on the Hadean is very sparse, and the evidences are indirect. For instance, we can assume that the impact-degassed or transformed atmosphere led to a reduced chemical composition. However, the degree to which the atmosphere was reducing is still uncertain and the exact composition of the reducing mixture remains unknown. It is very complicated to unify a series of diverse results into one picture that would show in detail conditions on early Earth, nor do they answer the fundamental question: which chemical environment was behind the initial prebiotic synthesis and the subsequent origin of life. Upcoming observations of exoplanets afford a unique opportunity to solve this fundamental problem by studying other planetary systems with similar initial conditions. ARIEL will systematically observe over 500 exoplanets ranging from Jupiter- and Neptune-size down to super-Earths in a wide variety of environments. And such observations will certainly open window to the past of our own world.

On The Radiation Power, Burst Rate And Frequency Shift Of Exoplanetary Synchrotron Radio Bursts: by Yang Gao - Sun Yat-Sen University (Poster)

Magnetic fields of exoplanets are important in shielding the planets from cosmic rays and interplanetary plasmas. Considering the interaction with the plasma from their host stars, the exoplanet magnetic spheres are predicted to have both cyclotron and synchrotron radio emissions, but neither has been definitely detected yet. Leaving the better studied coherent cyclotron emission aside, in this talk we focus on the planetary synchrotron radiation with bursty behaviors (i.e., radio flares) caused by the bursts of plasma ejections from the host star. The burst flux (modulated by the star-planet interaction), and two key features namely the burst light curve and frequency shift, are predicted for star-Hot Jupiter systems. Previous X-ray and radio observations of two well studies candidates, HD 189733 b and V830 \tau b are adopted to predict their specific parameters of bursty synchrotron emissions for further observations. Consequently the detectability of such emissions by current and upcoming radio telescopes are studied, showing that we are at the dawn of the discovery.

Middle-Upper Atmospheres Of Exoplanets And Star-Planet Interactions With ARIEL: by Antonio García Muñoz - Technische Universität Berlin (Poster)

The middle-upper atmosphere plays a key role at protecting the lower altitudes from the effects of energetic stellar photons and precipitating particles. Through a variety of transport processes, the middle-upper atmosphere also participates in the net loss of a planet's bulk composition into space. As such, the physics and chemistry occurring in the middle-upper atmosphere influence the evolution of a planet over its lifetime. Understanding these processes is critical to form a complete picture of planet evolution and their response to the stellar environment. In this presentation, we will explore the possibilities of ARIEL to explore such phenomena. We will also discuss the possibilities to investigate the debris that is seen orbiting some main sequence and white dwarf stars, and the connection with their parent rocky bodies.

How Known Planets From The Solar System Would Be Seen If They Were Exoplanets: by Gabriella Gilli and Pedro Machado - Institute of Astrophysics and Space Sciences, Portugal (Talk)

We propose here to use of Solar System'planet atmospheres as a natural laboratory for the understanding of extra-solar planet atmospheres, taking advantage of both spectroscopic observatons and state-of-the art modeling, in order to test tools and provide science cases for ARIEL. We will provide spectra templates of Solar System planets reflected light and IR emission spectra using existing spectra in order to build an average spectra (point source) of Venus, Saturn, Jupiter and Titan (visible and infrared).

Although optimal ARIEL targets are hot and warm giant planets, a long term scientific objective of ARIEL is to characterize the whole range of exoplanets, including potentially habitable ones. In the perspective of characterizing more and more close-in-orbit hot terrestrial exoplanets transiting nearby small stars (e.g best targets for transmission spectroscopy studies), the atmosphere of Venus is one of the most relevant cases. We will focus here on theoretical transmission spectra of Venus-analogue exoplanet atmosphere as observed by ARIEL using Venus atmosphere templates (0-150 km altitude) based on a 3D model (Gilli et al. 2017), together with observational dataset of extinction profiles by Venus Express (Luginin et al. 2016), with the goals of studying how the large variability of aerosols and upper haze modify the observable parameters.

Sounding The Jupiter Systen With The Submillimetre Wave Instrument (SWI): by Paul Hartogh - MPS (Poster)

The Submillietre Wave Instrument (SWI) is part of the JUICE (JUpiter ICy moons Explorer) payload. JUICE is the first large class mission of ESA's Cosmic Vision 2015-2015 programme. JUICE intends to investigate Jupiter as an archetype of gas giants. SWI investigates the general circulation of Jupiters stratosphere and how it couples the troposphere to the thermosphere by simultaneous temperature and Doppler wind measurements. It determines the stratospheric elemental composition, ratios of important isotopologues and the ortho-to-para ratio in water. Moreover SWI sounds the elemenal and isotopic composition, hydrodynamics and kinetics of the Galilean moons' atmospheres, addresses questions about sources, sinks and origin and how they interact with the surfaces and the space environment. Presently the flight model of the instrument starts to be built and is planned to be delivered to ESA in fall 2020.

Light Curve Analysis Of PTFO8-8695: by Marzieh Hosseini - Leibniz Institute (Poster)

The star PTFO8-8695, a very young (PMS) M dwarf with stellar rotation period of 0.5 days, shows periodic fading events with a slightly shorter period of 0.448 days that are attributed to a close-in hot Jupiter. However, the nature of this object is still debated. We have collected light curves of the dimming events of PTFO8-8695 with ground-based telescopes in 2017 and 2018, and have analyzed space-based light curves of the star from TESS. We find that the period of the dimming events is changing in comparison to older ground-based observations. If the dimming events are indeed caused by a young planet, our observations can constrain whether the planet is spiralling closer to the star or not.

NASA's Exoplanet Exploration Program: Update And Prospects For The 2020's And Beyond: by Douglas Hudgins - NASA Headquarters (Poster)

The NASA Exoplanet Exploration Program (ExEP) is responsible for implementing NASA's plans for discovering and characterizing exoplanets, and Identifying candidates that could harbor life. ExEP manages mission concept studies, technology development programs, and precursor and follow-up ground based science programs that aim towards achieving the science goals of current and future NASA missions (and that enable the design of next generation exoplanet missions). The program also interfaces with the exoplanet research community through the NASA Exoplanet Science Institute (NExScI) and communicates the excitement of exoplanet research to the public. Here we provide an overview of the many facets of the NASA's ExEP and look forward to the possibilities for the coming decade and beyond.

Atmospheres Of Hot Rocky Exoplanets: by Yuichi Ito - UCL (Talk)

About 500 exoplanets whose radii are less than 2 Earth radii have substellar equilibrium temperatures high enough to melt and vaporize rock. Thus, if rocky and volatile-free, they likely have atmospheres composed of rocky materials (Schaefer & Fegley 2009, Ito et al. 2015). Also, if rocky but volatile-rich, they likely have atmospheres composed also of volatile molecules. If the atmospheric composition could be detected with future space missions such as ARIEL, it would potentially inform the magma composition and volatile abundance of hot rocky exoplanets.

Community Access To CHEOPS: by Kate Isaak - ESA/ESTEC (Poster)

Launched 18 December 2019, CHEOPS (CHaracterising ExOPlanet Satellite) is the first exoplanet mission dedicated to the search for transits of exoplanets by means of ultrahigh precision photometry of bright stars already known to host planets. It is the first S-(small) class mission in ESA's Cosmic Vision 2015-2025, and a partnership between Switzerland and ESA, with important contributions from 10 other member states.

CHEOPS will provide the unique capability of determining accurate radii for a subset of planets in the super-Earth to Neptune mass range, for which masses have already been estimated from ground- based spectroscopic surveys. It will also provide precision radii for new planets discovered by ground- and space-based transit surveys, including TESS. By combining known masses with CHEOPS sizes, it will be possible to determine accurate densities for these smaller planets, providing key insight into their composition and internal structure. By identifying transiting exoplanets with high potential for in-depth characterisation – e.g. those that are potentially rocky and have thin atmospheres - CHEOPS will also provide prime targets for future instruments suited to the spectroscopic characterisation of exoplanetary atmospheres.

Investigating Catastrophically Disintegrating Exoplanets Through Their Vapour Trails: by Mark Jones - Open University (Poster)

In exoplanetary systems similar to KIC 12557548b (Rappaport et al., 2012) it appears that dust is actively being formed as a result of the destruction of a close-in rocky planet due to stellar irradiation. The transits seen in these catastrophically destructing exoplanet (CDE) systems imply that this dust is distributed in a cometary-like tail that can cover up to ~1% of the stellar disc. It has already been noted (e.g. Bochinski et al., 2015, Tinetti et al., 2017) that combined optical and infrared photometry (such as will be possible with ARIEL) will provide better constraints on grain sizes in CDEs. Less attention has been paid to the gas phase associated with this tail, but it provides a direct way to study the composition of the planet that is being destroyed. Viewed spectroscopically with AIRS, transits of CDE systems could potentially show variable absorption due to SiO (4.02 – 4.13 µm) and CO (4.2 – 6 µm), both of which are species that may be expected to be formed on sublimation of the planetary dust. We discuss the conditions under which these spectral signatures of CDE dust sublimation may be detectable with ARIEL.

Diagnosing Planet Formation With Elemental Ratios: by Mihkel Kama - University of Cambridge (Talk)

The carbon-to-oxygen ratio (C/O) is touted as a tracer of the formation location of the planet. This hinges on a radial sequence of snowlines for volatile molecules containing C or O atoms. But do we really know and understand how elemental ratios in gas and solids behave in protoplanetary disks? Building on recent observational and modelling results in disks, we will review what the C/O ratio of a planet may mean, and which other elements ARIEL studies can employ to characterise planets and their formation histories.

Exploring Disequilibrium Chemistry In The Atmospheres Of Hot Jupiters: by Yui Kawashima - SRON (Talk)

The quality of transmission and emission spectra of exoplanets as observed by both space- and ground-based telescopes is rapidly increasing. Currently, most of the spectral retrieval models assume for simplicity that the abundance profiles of chemical species in the atmospheres are constant or follow from thermochemical-equilibrium. Recently, a few studies introduced a quenching altitude as a parameter to take the effect of disequilibrium into account. However, these studies assume the same quenching altitudes for all species without any physical basis. In the study we present here, we develop a model to compute the quenching altitude for each species as a function of the eddy diffusion coefficient using the chemical timescales as derived by Tsai et al. (2018). We implement this module to the spectral retrieval code ARCiS (Min et al. in prep.). We apply our model to 10 hot Jupiters with high-quality transmission spectra. As a result, we find evidence for disequilibrium chemistry for some planets. We will also discuss prospects for further constraints on atmospheric properties with ARIEL.

A Framework To Constrain Planet Formation Scenarios From Atmospheric Properties Of Exoplanets Measured By ARIEL: by Niloofar Khorshid - University of Amsterdam/SRON (Poster)

Knowing elemental abundances of a planet is key to understanding its formation. This is because the composition of a planet atmosphere is heavily influenced by the planet formation process and subsequent evolution. In this work we develop a framework that uses models for protoplanetary disks and for planet formation to parameterize the inputs in simple manners and form giant planets. We simulate a large population of planets with various initial conditions which allows us to study the trends that explain the synergy between a planet composition and its formation.

Today, we are comparing our models to observations from close-in giant planets to constrain planet formation scenarios from their atmospheric composition. ARIEL will provide a much larger population of planet atmospheres that is currently inaccessible with a diverse properties such as masses, orbital distances, and atmospheric properties. We will use ARIEL data to retrieve the composition and structure of the protoplanetary disks in which planets were formed. In particular, observing the atmospheres of planets from a wide range of orbital distance will establish the importance of migration in comparison to in-situ formation. Additionally, studying smaller planets will help constrain the importance of the core on the atmospheric composition.

Auxiliary Science With ARIEL: by Csaba Kiss - Konkoly Observatory (Poster)

Due to the fixed times of the ARIEL explanet transit observations waiting periods remain between the actual active periods. Scheduling simulations estimate that a significant fraction of the total mission duration (19%-27%) will be waiting time. The simulations also predict that these gaps are short, typically 0.5-2.0h, much shorter than the typical ~7h target measurements. With efficient scheduling and target selection these waiting times could be filled with valuable observations of ancillary targets and could maximize ARIEL's scientific impact. Our proposed ancillary targets include a selected sample of young stars, specifically newborn Sun-like stars, relatively young normal main-sequence stars, and brown dwarfs. In the youngest subsample ARIEL can study the composition of the circumstellar discs and envelopes and characterize the impact of stellar variability on disc properties. In the main-sequence stellar sample and in brown dwarfs the focus of research is debris discs, stellar activity and magnetism. For all these target groups mid-infrared spectroscopy is an extremely valuable tool, but currently observations are available for a very limited sample only.

Photochemical Reduction Of CO2 On Terrestrial Planets: by Antonín Knížek - CAS (Poster)

Planetary atmospheric composition which will be observed by Ariel strongly depends on the chemical processes that take place on the planet. Here, a new scenario of the origin of methane on Mars and terrestrial planets will be shown as an example scenario, which crucially alters the composition of the planetary atmosphere. In this scenario, carbon dioxide, which is the main component of the Martian atmosphere, is photochemically converted to CH4 and CO using a catalytic surface, HCl (an acidic proton) as the source of hydrogen and also an acidic catalyst and UV radiation. This process of 'methanogenesis' can take place on any terrestrial planet where the desired conditions are met. Such processes, and there still may be many undiscovered ones, must be taken into account if we want to correctly understand the chemical composition and dynamics of planetary atmospheres that will be observed by Ariel.

The ExoClock Project: Pro-Am Collaboration For Ground-Based Observations In Support Of The ARIEL Space Mission: by Anastasia Kokori - UCL (Talk)

ExoCLock (exoclock.space) is a project that started in September 2019, aiming to monitor transiting exoplanets through long-term regular observations using small and medium scale telescopes. We are part of the ARIEL ephemeris working group, aiming to define the ephemerides of ARIEL targets as precisely as possible. In this effort, we are supported by amateur and professional astronomers around the globe. We strongly believe that research is an effort that everyone can contribute and thus, in our project we have an active collaboration with amateur astronomers from different locations. To facilitate this, we have developed user-friendly data analysis tools and two dedicated websites, in order to disseminate the material to as many people as possible. The website includes audiovisual material, information on the project, data analysis tools, instructions, observational data and graphics. All sources are online, free, and available for everyone both in English and Greek. So far, we have 30 participants with 35 telescopes, and approximately 40 transit observations. In this presentation, we will present the network of our observing partners, the future observing plans, and the most exceptional cases of exoplanets observed until today as part of our project.

Follow Up Of Transiting Hot Jupiters With The OpenScience Observatories: by Ulrich Kolb - Open University (Poster)

We have been using the Open University OpenScience Observatories (OSO) to undertake follow up observations of known transiting hot Jupiters for the past three years. Here we present recent system characterisation and transit timing results for WASP-52b and HAT-P-23b and report on the performance of the observatory.

The OSO consists of two 0.4 meter class telescopes used for undergraduate distance learning and research. The telescopes, located at the Teide Observatory on Tenerife at an altitude of 2390 meters, can be operated remotely for teaching or fully autonomously via an automated scheduler. Teide Observatory provides an excellent location with typical seeing of 0.6" and an average 280 clear nights per year.

Our new observations, supplemented with additional data from a telescope located in the UK and previously published results, show that HAT-P-23b is neither inflated nor eccentric. We find that a linear ephemeris is the best fit to the available timing data. For WASP-52b we slightly prefer a quadratic ephemeris indicative of period change. Further observations through the 2020-21 observing season should discriminate between the linear and quadratic ephemerides.

The Effect Of M Star Flares On The Chemistry And Spectra Of Exoplanet Atmospheres: by Amy Louca - Leiden University (Poster)

This contribution uses an actual observed flare from GJ674, retrieved from the MUSCLES collaboration, to have a closer look on the impact of such stellar activity on the atmosphere of exoplanet GJ674b. Using the photochemical kinetics code VULCAN, various simulations are done on this particular system to see how the single flare impacts the composition in the atmosphere. It is shown that a single flare has most impact on the abundant and easy to observe species H_2O, CO_2, and HCN during the event. The newly found equilibrium substantially resembles the initial equilibrium. Other simulations included multiple flares where the observed flare of GJ 674 was repeated 15 times. Two different scenarios have been set up where one of them included the frequency of this particular flare. By taking the flare frequency into account, the results obtained from the simulation were extremely similar to the single flare-case. When the flare frequency is not included, and all the flares are continuously activated one after another, the results show greater changes in abundance of the species in the atmosphere during the flare events. However, when letting the system go to equilibrium after all flares have passed the same initial equilibrium has been found.

Stars Shaping The Atmospheres Of Their Planets: by Theresa Lueftinger - University of Vienna (Talk)

Planets orbiting young, solar-type stars are embedded in an environment that is far from being as calm as the present solar neighbourhood. They experience the extreme environments of their host stars, which cannot have been without consequences for young stellar systems and the evolution of planets and their atmospheres. Stellar magnetism and the related stellar activity are crucial drivers of ionization, photodissociation, and chemistry. Stellar winds can compress planetary magnetospheres and even strip away the outer layers of their atmospheres, thus having an enormous impact on the atmospheres and the magnetospheres of surrounding exoplanets. Modelling of stellar magnetic fields and their winds is extremely challenging, both from the observational and the theoretical points of view, and only ground breaking advances in observational instrumentation, both from ground and in space, and a deeper theoretical understanding of magnetohydrodynamic processes in stars enable us to model stellar magnetic fields and their winds – and the resulting influence on the atmospheres of surrounding exoplanets – in more and more detail. In this presentation we will discuss how stellar evolutionary aspects in relation to activity, magnetic fields and winds influence the erosion of planetary atmospheres and magnetospheres. We will present recent results of our theoretical and observational studies based on Zeeman Doppler Imaging (ZDI), field extrapolation methods, wind simulations, and the modeling of planetary upper atmospheres with a particular focus on the characterisation of ARIEL target stars and planets.

Star And Planet's Characterisation Through High Spectral Resolution:
by Maria Chiara Maimone - CNRS (Poster)

With thousands of confirmed exoplanets and an increasing number of dedicated instruments, we are finally moving into an era where we can address fundamental questions concerning the diversity of their compositions, their atmospheric and interior processes, and their formation histories. How? Via their observable spectroscopic signatures.

In the last decade, tremendous progress has been made in detecting and characterising atmospheric signatures of exoplanets through spectroscopic methods, allowing to unveil the atmospheric composition for a dozen of them (Birkby, 2018). Nevertheless extraordinary results, we are only at the beginning: stellar and planetary models are still computed separately, and 1D models, largely used for the stars until now, do not reproduce the complexity of convection mechanism (Chiavassa & Brogi, 2019). With our work, we propose to combine 3D Radiative Hydrodynamical (RHD) simulations of stellar and planetary atmospheres in an unique powerful code to build synthetic spectra and carry out detailed analysis of the atmospheric signatures of transiting and non-transiting planets.

Know Your Star, Know Your Planet: The K2-18 Planetary System As An Example:
by Jesus Maldonado - INAF - Osservatorio Astronomico di Palermo (Poster)

In this contribution we show how small changes in the stellar parameters of the host stars might have a significant impact in the determination of the planetary bulk composition using the star K2-18 as a test case. K2-18 is an early-M dwarf, known to harbour a transiting super-Earth as well as a second non transiting planet. We compiled several datasets of stellar parameters for the host star and computed the masses of the planets using the available radial velocity data. For planet b, the planetary radius and density were also computed. We find that smaller stellar mass and radius translates into a higher overall density leading to a significantly different planetary composition. We analyse the origin of the differences in the published values of mass and radius for K2-18 finding that different mass-luminosity relationships can provide significantly different stellar and planetary properties.

Geometric Albedos Of Exoplanet Day Sides At Optical Wavelengths:
by Matthias Mallonn - Leibniz Institute Potsdam (Talk)

In the last decade, clouds were found to be ubiquitous at the terminator regions of close-in gas giant exoplanets. In contrast, we still know very little about their occurrence at the planet day sides despite their crucial influence on the energy budget of the planetary atmospheres. A cloud layer can be revealed by its reflection properties. In this talk, I will present our ground-based observing campaign to measure the wavelength-resolved optical reflection, i.e. the wavelength-resolved geometric albedo, of a selected sample of close-in gas giants. With the same observing technique, ARIEL will be able to greatly enhance the sample of investigated planets, providing reflection spectroscopy as an important complementary tool to emission and transmission spectroscopy to fully characterize the atmospheres of exoplanets.

Inferring Interior Geoactivity Of The TRAPPIST-1 System Exoplanets:
by Nicola Mari - University of Glasgow (Poster)

A plate tectonics geodynamics regime it is more likely to support life in a terrestrial planet, rather than a stagnant lid regime. The boundary between the two regimes can be located at the point in which viscosity of the upper mantle of a planet is at ~10^21 Pa s as deduced by comparison with known values for Earth and Mars mantles. We here aim to calculate whether any of the TRAPPIST-1 system terrestrial exoplanets could have a plate tectonics regime by using an Arrhenius-type temperature-dependent viscosity law. In doing this we assume normal stratified volatile-rich rocky exoplanets characterized by crust, mantle, and core that are tidally locked and without atmospheres, due to extreme stellar wind erosion. In light of this, we also consider the equilibrium temperature to be equal to the surface temperature, while using the temperature-dependent viscosity law for the night sides of these exoplanets. Results show how planets TRAPPIST-1 b, c, and d have upper mantle viscosity that could support a plate tectonics regime (4.7 x 10^22, 2.4 x 10^22, 1.3 x 10^22 Pa s, respectively), while planets TRAPPIST-1 e, f, g, h suggest a stagnant lid regime (8.5 x 10^21, 6 x 10^21, 4.8 x 10^21, and 3.3 x 10^21 Pa s, respectively), both on their day and night sides.

Exploring The Connection Between Habitability And Exoplanets Observables: by Michele Maris - INAF (Poster)

A wide literature have been produced in the past in order to quantify Planetary Habitability resulting in a number of Habitability Indexes. By using climate models of different complexity, those indexes have been successfully parameterized by quantities such as the amount of isolation, the dry atmospheric pressure at ground, the chemical composition of atmosphere and so on. However, often such parameters can not be readily derived from astronomical observations, leaving the question whether a better linked to observations can be found. Here we focused on the number of molecules in the atmosphere of a planet which can be observed during a transit or in a phase curve and we attempted a link with habitability indexes, extending the analysis of Silva et al. (2017) based on a large set of simulations in the public ARTECS archive (Murante et al. 2019), which have been produced by using the Earth-like Surface Temperature Model (ESTM, Vladilo et al. 2013, 2015), a 1D EBM model tuned for rocky planets.

Planet Formation And Composition Around Low-Mass Stars: by Yamila Miguel - Leiden University (Talk)

The detection of Earth-size exoplanets around M stars -such as Proxima Centauri band TRAPPIST-1 system- provide an exceptional chance to improve our understanding of the formation of planets around M stars and brown dwarfs. We explore the formation of such planets with a population synthesis code based on a planetesimal-driven model previously used to study the formation of the Jovian satellites. In this talk we will present the resulting population of planets, their potential compositions and architecture of the systems, as well as the differences between these systems and the ones formed around bigger stars and a comparison with observations.

Atmospheric Retrieval For The ARIEL Spectral Database: by Michiel Min - SRON (Talk)

One of the main goals of the ARIEL mission is to obtain a large database of exoplanet atmosphere characteristics. To obtain these characteristics from the observed infrared spectra is not a trivial task. Here we describe the atmospheric retrieval framework capable of analysing this large dataset. The sensitivities for detecting certain crucial molecules and elemental abundance ratios will be presented. Also, the sensitivity of ARIEL for certain atmospheric processes and the dependencies on things like the presence of clouds and hazes will be discussed. In the end we compare these expected sensitivities to those required for putting the exoplanet population in the context of formation and evolution scenarios.

Exploring Super-Earth Surfaces Albedo Of Near-Airless Magma Ocean Planets And Topography: by Darius Modirrousta-Galian - INAF (Talk)

In our paper we propose an analytic relationship between the albedo of a near-airless magma ocean planet and its surface waviness for the cases when the magma ocean has a refractive index from 1 to 10. We generated multiple 100 m wide 1D fractal surfaces unto which we bombard 10,000 light rays. Using an approximate form of the Fresnel equations we measured how much of the incident light was reflected. Having repeated this algorithm on varying surface roughnesses and compositions we find a relationship between the albedo and the Hurst exponent. As a proof of concept, we used our model on Kepler-10 b to demonstrate the applicability of our equations. We show that the high albedo of this body could be caused by a moderately wavy ocean with earth-like magmas although a different composition containing highly reflective minerals and a flatter relief is also possible. Finally, we show that in principle the ARIEL spacecraft could give information on exoplanet surface compositions by measuring the albedo at different wavelengths and comparing the observed variations with our theoretical analytic results.

The Bimodal Distribution In Exoplanet Radii: Considering Varying Core Compositions And H2 Envelop Sizes: by Darius Modirrousta-Galian - INAF (Poster)

Several models have been introduced in order to explain the radius distribution in exoplanet radii observed by Fulton et al. (2017) with one peak at ~1.3R the other at ~2.4R and the minimum at ~1.75R. In this work we focus on the hypothesis that the exoplanet size distribution is caused by stellar XUV-induced atmospheric loss. We evolve 10^6 synthetic exoplanets by exposing them to XUV irradiation from synthetic ZAMS stars. For each planet we set a different interior composition which ranged from 100 wt% Fe (very dense) through 100 wt% MgSiO3 (average density) and to 100 wt% H2O ice (low density) with varying hydrogen envelop sizes which varied from 0 wt% (a negligible envelop) to 100 wt% (a negligible core). Our simulations were able to replicate the bimodal distribution in exoplanet radii. We argue that in order to reproduce the distribution by Fulton et al. (2017) it is mandatory for there to be a paucity of exoplanets with masses above ~8M. Furthermore, our best-fit result predicts an initial flat distribution in exoplanet occurrence for MP<~8M with a strong deficiency for planets with <~3M. Our results are consistent with the ~1.3R radius peak mostly encompassing denuded exoplanets whilst the ~2.4R radius peak mainly comprising exoplanets with large hydrogen envelops.

ARIEL Target Scheduling: by Juan-Carlos Morales - ICE-SIC and CNES Team (Talk)

ARIEL will be the first dedicated mission to investigate the physics and chemistry of exoplanetary atmospheres, by obtaining high-precision spectrophotometric observations of transits and occultations (and probably phase curves) of exoplanets. These events are time constrained according to planet orbital ephemerides; therefore, when planning observations the visibility and overlap between different target events and satellite operations must be taken into account. This complicates the planning of observations during the mission lifetime, especially for the ARIEL case that is expected to survey around 1000 targets, some of them for several events. Therefore, automatic tools are designed to tackle this problem. We will show in this talk different approaches and algorithms we have developed for the ARIEL mission planning, in order to fulfill the survey goals and to optimize the time spent on science observations.

ExoTETHyS: Tools For Exoplanetary Transits Around Host Stars:
by Giuseppe Morello - CEA (Poster)

ExoTETHyS is a python package that aims to collect the functions needed to model the high-precision spectrophotometric observations obtained with ARIEL (not only). It includes: 1) stellar limb-darkening calculator that outperforms existing codes by one order of magnitude in terms of light-curve model accuracy with precision down to <10 parts per million (ppm);
2) "exact" light-curve modelling tool for exoplanetary transits and eclipsing binaries;
New tools are under development to correct for the effect of stellar activity in transit spectra and other contaminating effects.

The Thermal Architecture Of The ESA ARIEL Payload: by Gianluca Morgante - INAF (Poster)

The ARIEL mission is designed as a transit and eclipse spectroscopy survey, operated by a 1-m class telescope feeding two instruments, the Fine Guidance system (FGS) and the ARIEL InfraRed Spectrometer (AIRS), that accommodate photometric and spectroscopic channels covering the band from 0.5 to 7.8 µm in the visible to near-IR range. The payload high sensitivity requirements ask for an extremely stable thermo-mechanical platform. The PLM thermal control is based on a passive and active cooling approach. Passive cooling is achieved by a V-Groove shields system that exploits the L2 orbit favourable thermal conditions to cool the telescope and the optical bench to stable temperatures below 60 K. The FGS focal planes are maintained at the operating temperature by a dedicated radiator coupled to deep space. The AIRS channel detectors require a temperature reference in the 30 K range, that is provided by an active cooling system based on a Neon Joule-Thomson cold end fed by a mechanical compressor.

In this paper we describe the baseline thermal architecture of the payload towards the end of phase B1 and present the requirements that drive the design together with the analyses results and the expected performances in steady-state and transient conditions.

Potential Of Recurrent Neural Networks For Transit Light Curves Detrending:
by Mario Morvan - UCL (Poster)

The precise derivation of physical parameters from transit light curves is a key component for measuring exoplanet transit spectra, and henceforth for the study of exoplanet atmospheres. However, various kinds of systematic errors and noise make the physical fitting particularly challenging. Considering the complexity of light curves data and the shift towards bigger and bigger datasets – not only with planets search surveys but now also with ARIEL –, we consider here the potential usefulness of time-series modelling and recurrent neural networks for automating and improving the detrending and modelling of transit light curves. As an example of possible application, we present how a Long Short-Term Memory-based network can be used to predict the in-transit flux by modelling temporal dependencies and correlations with centroid displacements. Furthermore, we also aim at discussing open questions concerning cross-series and cross-instruments information, pixel level versus aperture photometry, the interest of instrument simulators, and the need for a hybrid detrending/physical model.

Near-Infrared Spectropolarimetry And Velocimetry: Preparation And Support For ARIEL:
by Claire Moutou - IRAP (Poster)

SPIRou is a near-infrared spectropolarimeter and high-precision velocimeter. It is covering in one shot the domain from 0.98 to 2.45 microns at 70,000 spectral resolution. In operations at CFHT since February 2019, it is used for planet searches around M stars and young stars, atmospheric characterization of exoplanets during transit, and follow-up of TESS candidates. Its spectropolarimetric capability opens a new way to look at stellar activity in combination to radial-velocity planet searches, by characterizing the stellar magnetic field. Presenting SPIRou capacities I'll show how it can be preparatory, and complementary to ARIEL.

Results From ALFNOOR Population Study: by Lorenzo Mugnai - Sapienza (Talk)

The study of ARIEL performance is conducted using different tools, and each provide estimates that can be used to support the scientific community.

ArielRad, the ARIEL radiometric model, can predict the observation SNR and put constraints on the observing time for each target. This tool is used to select the mission candidate targets, but also to estimate uncertainties vs wavelengths: these error bars can support scientists in further developing the science of ARIEL.

ExoSim is a time domain simulator that predicts ARIEL science products accurately. It is used to develop the data reduction pipeline, and to optimise systematics removal techniques.
Alfnoor, a wrapper of ArielRad and the atmospheric spectral retrieval code TauREx, allows end-to-end simulations on planetary populations and is used to investigate the ARIEL three tiers strategy.

On The Evolution And Internal Structure Of Giant Planets: by Simon Muller - University of Zurich (Talk)

Giant Planets have historically been assumed to have a simple structure of a fully-mixed H-He envelope, with possibly a compact heavy-element core. However, planet formation models suggest that a more complicated layered-structure with composition gradients is a natural outcome of the formation process. Additionally, recent interior models for Jupiter that match observational constraints indicate the presence of such layers.

We present a theoretical framework to follow the formation and evolution of giant planets in which the heavy-elements are included self-consistently. The energy transport mechanisms within the planet are affected by such composition gradients, and determine the planetary cooling history. We investigate the evolution of giant planets with various masses and compositions, and explore under what conditions planets become homogeneously mixed. Our study is relevant for the interpretation of exoplanetary data, as it determines under what conditions (and masses) the planetary atmospheric composition can be assumed to represent the bulk composition. In the future, these theoretical predictions can be compared against atmospheric measurements. In addition, we will provide a range of planetary luminosities for different masses, and explore how they change with different formation histories. The luminosity determination is important for the interpretation of direct imaging measurements of young giant planets.

The Instrument Control Unit Of ARIEL: by Luca Naponiello - University of Florence (Poster)

ARIEL (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) is a medium-class mission (M4) selected by ESA to be launched in 2028, aiming at the study of the atmospheres of a selected sample of warm and hot exoplanets, mainly by means of primary and secondary transit (IR) spectroscopy and (VIS) photometry, in order to address the fundamental questions on how planetary systems form and evolve. During its four-years mission, ARIEL will observe several hundreds of exoplanets ranging from Jupiter- and Neptune-size down to super-Earth and Earth-size with its 1 meter-class telescope. The analysis of spectra and photometric data will allow to extract the chemical fingerprints of gases and condensates in the planets atmospheres, including the elemental composition for the most favorable targets. It will also enable the study of thermal and scattering properties of the atmosphere as the planet orbits around its parent star.

The ARIEL Payload (P/L) is based on a 1-m class telescope ahead of a suite of instruments: three spectrometric channels covering the band from 1.95 to 7.80 µm without spectral gaps and three photometric channels working in the range 0.5 to 1.1 µm. It is composed of many subsystems on both its cold and warm sides. The warm Units, maintained at ambient temperature (~270-300 K), host analog and digital electronics whose aim is to manage the overall P/L and control the data acquisition chain (scientific data and instrument housekeeping - HK), monitor the telescope and the P/L subsystems temperatures, command and provide the Service Module (SVM) with the scientific telemetries and the Instrument health status.

InMuSCAT1/2/3: Global Multi-Color Photometric Monitoring Network For Exoplanetary Transits: by Norio Narita - University of Tokyo (Talk)

We introduce a planned global network of multi-color simultaneous cameras named MuSCAT1/2/3 on 1.5-2 m class telescopes especially intended for high-precision multi-color transit photometry. The network will enable a capability of continuous multi-color monitoring, which will be powerful for transit follow-up observations in the future, especially unique for long-period planets and/or large TTV planets. MuSCAT1/2/3 would be useful to observe transits for selected ARIEL targets to improve their transit ephemerides to determine optimal times of ARIEL observations.

ARIEL Machine Learning Data Challenge: by Nikolaos Nikolaou - UCL (Talk)

ARIEL has launched a global competition series to find innovative solutions for the interpretation and analysis of exoplanet data. The first ARIEL Data Challenge has invited professional and amateur data scientists around the world to use Machine Learning to remove noise from exoplanet observations caused by starspots and by instrumentation. Each team competing in MLSAC has been given 1000 simulated ARIEL observations of exoplanet transits, 700 of which were provided with ‘clean’ solutions to train ML algorithms. Participants have submitted their predicted solutions for the remaining 300 examples. The effectiveness of the teams’ models have been ranked on the ARIEL Data Challenge leader-board. The ARIEL ML contest has been selected as a Discovery Challenge by the European Conference on Machine Learning and Principles and Practice of Knowledge Discovery in Databases (ECMLPKDD). The top-ranked teams will briefly present their results at the ARIEL Open conference in ESTEC.

Thermal Evolution Of Magma Oceans And Concurrent H2O/CO2 Atmosphere Formation: by Athanasia Nikolaou - Sapienza University of Rome (Poster)

The magma ocean (MO) is a crucial stage in the build-up of terrestrial planets. Its solidification and the accompanying outgassing of volatiles set the conditions for important processes occurring later or even simultaneously, such as solid-state mantle convection and atmospheric escape. This work provides the initial conditions for studying those processes (Nikolaou et al. 2019) .

We discuss the duration of a global scale MO on Earth and the degassing of oxidized volatiles H2O and CO2 from the interior. We find that the MO stage can last from a few thousand to several million years, for Earth. Swings in the atmospheric composition, are expected to occur during the MO stage itself, due to different solubility of the volatiles in the silicate melt. Extending its relevance to the evolution of exoplanets we also introduce 3 types of magma ocean: transient, conditionally continuous and permanent. By coupling an interior model with a line-by-line absorption for a H2O-atmosphere model (Katyal et al. 2019), we identify the conditions that determine whether the planet experiences a transient MO or it ceases to cool and maintains a conditionally continuous MO. We find a simultaneous dependence of this distinction on the mass of the outgassed H2O atmosphere and on the MO surface melting temperature. We discuss their combined impact on the MO’s lifetime in addition to the known dependence on albedo, orbital distance, and stellar luminosity, and we note observational degeneracies that arise thereby for target exoplanets.

Ground-Based High-Resolution Transit Spectroscopy With CARMENES: by Lisa Nortmann - Instituto de Astrofisica de Canarias (Poster)

In recent years a new generation of highly-stabilized high-resolution spectrographs with a broad wavelength coverage have started regular operations. One of them is CARMENES (Calar Alto high-Resolution search for M dwarfs with Exoearths with Near-infrared and optical Échelle Spectrographs), mounted at the Calar-Alto Observatory 3.5m telescope.

CARMENES was initially designed to detect exoplanets via the radial velocity method but has proven itself as an excellent tool for the study of atmospheres of warm and hot giant planets in the wavelength range between 520 - 1710 nm. In this poster we show results of several hot Jupiters observed during transit at a resolution of ~80000. At this resolution the change in the Doppler shift of the exoplanet along its orbit can be used to disentangle its spectral signature from that of its host star. As the cores of individual exoplanet spectral lines can be resolved, their depth, shape, and position can be studied. This allows us to not only draw conclusions about the planet's composition but also about atmospheric wind speeds and rotation.

In particular the coverage of the helium triplet lines at 1083 nm, recently shown to be suitable tracer for atmospheric escape, allows us to study the dynamics of the gas in the extended atmosphere of a growing sample of planets. Our detections in this sample hint at a correlation between the strength of the absorption with stellar extreme UV flux received by the planet, unveiling formation processes of this line in the atmospheres of exoplanets. These results highlight what can already be done with medium-size telescopes and give an outlook to what could be achieved with large and extremely large facilities in the future to complement ARIEL's low- to medium-resolution studies for a selected sample of targets.

Large Cryogenic Aluminum Mirrors With High IR Reflectivity For The ARIEL Telescope: by Emanuele Pace - Università di Firenze (Poster)

Current IR telescopes for space applications are generally based on SiC mirrors because of their favorable features for cryogenic use. However, aluminum optics has more recently gained momentum as competitive alternative for their simpler and lower-cost manufacturing process. This work will describe the design, development, testing of fully aluminum prototype mirrors up to 1-m diameter for infrared telescopes in space. This activity has been developed in the framework of the ARIEL (Atmospheric Remote-sensing Infrared Exoplanet Large-survey) mission, the next ESA medium-class science mission (M4) to be launched in 2028. The ARIEL telescope will be operated at about 50 K to make spectrometry in the 1.95-7.80 µm band as well as photometry in the range 0.5 to 1.9 µm. Its layout is conceived as an eccentric pupil two-mirror classic Cassegrain configuration coupled to a tertiary off-axis paraboloidal mirror. A trade-off on the mirror substrate materials for the 1-m diameter primary mirror (M1) has been carried out, with three different aluminum alloys selected for qualification testing, and a protected silver coating has been selected for high IR reflectivity. The qualification activity included substrate thermal stabilization, aluminum polishing process, protected silver coating on representative aluminum substrates, and cryogenic testing down to 50 K.

Synergies Between ARIEL And The ELTs: by Enric Palle - Instituto de Astrofisica de Canarias (Talk)

ARIEL will operate in the era of ground-based extremely large telescopes (ELTs), capable of high-spatial and spectral resolution observations of planetary atmospheres. These observations will be highly complementary to the lower spectral resolution, but broader wavelength coverage, observations taken with ARIEL. Here we will review the synergies between these complimentary sets of observations.

Atmospheres In 3D With ARIEL: by Vivien Parmentier - Oxford (Talk)

Exoplanets atmospheres are 3D in nature, however the observations that ARIEL will perform will measure atmospheric properties averaged over the limb, the dayside or in latitude. Using both 3D atmospheric models and 1D retrievals I will show the numerous biases that are to be expected when interpreting Ariel data in transmission, emission or phase curve spectroscopy. I will highlight the range of parameter space where these biases will be the largest and the potential mitigation strategies that can be used to extract more robustly atmospheric properties from the data.

Activity Model And Chromatic Effects On Transit Depths From Ground-Based Multiband Photometry: by Manuel Perger - ICE-CSIC, IEEC (Talk)

Activity phenomena significantly influence the observables of transiting exoplanets. We have to account for this since the chromatic effect of spots can represent up to 5% of the planetary radii and can induce significant signatures in the transmission spectrum of transit events. For late-type stars this could be larger than the effect expected from planetary atmospheres which can complicate its characterization in future missions such as ARIEL.

In order to study different influences, a sophisticated approach in surface modeling is necessary. We want to fit simultaneous time-series data in order to derive an adequate activity model, with which we then can investigate the chromatic effects of different surface configurations on the observables of transiting planets.

We present an updated version of the StarSim code (Herrero et al. 2016), and fit stellar and spot parameters by modelling 600 days of multiband ground-based photometry from TJO and STELLA observatories of the active star WASP-52.

We reconstruct a probability distribution of the active regions and estimate the properties of the starspots. We further quantify the chromatic contribution of activity on transmission spectroscopy observables and correct its effect with an improved accuracy of one order of magnitude.

The ARIEL Fine Guidance System (FGS), Photometer & NIRSpec: by Mirosław Rataj - Centrum Badan Kosmicznych (Talk)

The FGS is one of the two instruments of this mission. The Fine Guidance System (FGS) main task is to ensure the centering, focusing and guiding of the satellite, but it will also provide high precision astrometry and photometry of the target for complementary science. In particular, the data from the FGS will be used for de-trending and data analysis on ground. The photometer is designed for the 0.50-0.55 µm range (VIS-Phot), two FGS channels covering the 0,6 -0,8 µm and 0,8 – 1,05 µm ranges, as well as NIR-Spec low-resolution channel (1.05-1.95µm) R≥ 15.

The FGS is composed of the optics box and the electronics box. The optics box is situated at the instrument optical bench (IOB) containing cryogenic optics with two detector modules at 50 K and the cold front-end electronics (CFEE). The electronics part – FGS Control electronics Unit (FCU) is accommodated in the spacecraft service module at a temperature of 270-300 K. The FCU modules control and read the detectors and carry out the data processing for centroid calculation and image processing. The FGS application software will control and read the FGS detector electronics, establish a control loop with the spacecraft and deliver scientific data products.

Planetary Systems In Stellar Clusters - A Lesson From Planet Nine?: by Hans Rickman - PAS (Talk)

Searches for the purported Planet Nine (P9) have not yet resulted in discovery, but if its existence is confirmed, an explanation for its origin is needed. The most likely option seems to be ejection upon encounter with Saturn before the settling of the giant planets into a multi-resonant configuration, followed by perihelion extraction along with the sednoids during the embedded stage of the Sun's birth cluster. However, I will show that this meets serious problems. The remaining option is that P9 arose as a failed giant planet core in the trans-planetary disk and was scattered by Neptune after an early Nice Model instability. Its perihelion would then be extracted by a stellar encounter in a surviving solar birth cluster. I will demonstrate a method to assess the likelihood of this scenario and present a research project to realise such an assessment.

Synergies Between Radial Velocities And The ARIEL Mission: by Alexandre Santerne - LAM (Talk)

Exoplanets atmospheres are 3D in nature, however the observations that ARIEL will perform will measure atmospheric properties averaged over the limb, the dayside or in latitude. Using both 3D atmospheric models and 1D retrievals I will show the numerous biases that are to be expected when interpreting Ariel data in transmission, emission or phase curve spectroscopy. I will highlight the range of parameter space where these biases will be the largest and the potential mitigation strategies that can be used to extract more robustly atmospheric properties from the data.

ARES I : Characterising Hot Jupiters WASP-127\,b, WASP-79\,b And WASP-62\,b With Hubble WFC3 Transmission Spectra: by Nour Skaf - LESIA / UCL (Poster)

This paper presents the atmospheric characterisation of three large, gaseous planets: WASP-127b, WASP-79b andWASP-62b. We analysed spectroscopic data obtained with the G141 grism (1.125 - 1.650µm) of the Wide FieldCamera 3 (WFC3) on board the Hubble Space Telescope using theIraclispipeline and the TauREx retrieval code,both of which are publicly available. For WASP-127b, which is the least dense planet discovered so far and is locatedin the short-period Neptune desert, we find strong water absorption corresponding to an abundance of log(H2O) = -2.9+0.71−1.07and an extended cloudy atmosphere. Water vapour was also detected in WASP-79b and WASP-62b, with clearand cloudy atmospheres respectively. We used the Atmospheric Detectability Index (ADI) to quantify the strengthof the detection and compared our results to the hot Jupiter population study by Tsiaras et al. (2018). While all theplanets studied here are suitable targets for characterisation with upcoming facilities such as the James Webb SpaceTelescope (JWST) and Ariel, WASP-127b is of particular interest due to its low density and a thorough atmosphericstudy would develop our understanding of planet formation and migration.

On The Synergy Between ARIEL And Ground-Based High-Resolution Spectroscopy: by Alessandro Sozzetti - INAF (Talk)

We will explore aspects of the synergy between the ARIEL space observatory and ground-based high-resolution observations of exoplanetary atmospheres. Exploiting recent developments, we will setup a framework to effectively combine (at near-infrared wavelengths) high-res datasets analyzed via the cross-correlation technique with spectral retrieval analyses based on ARIEL low-res spectroscopy. We will show preliminary results, using benchmark objects, addressing the possibility of providing improved constraints on the temperature structure and molecular/atomic abundances.

Atmospheric Dynamical Models: From Solar System Planets To Exoplanets Observed by ARIEL: by Aymeric Spiga - LMD (Talk)

In a thousand of transiting warm/hot exoplanets' atmospheres, ARIEL will enable the detection of chemical species, the assessment of their abundances, the evaluation of cloud signatures, the retrieval of the vertical and horizontal thermal structure, and the monitoring of atmospheric activity caused by atmospheric dynamics and clouds. As the first mission to adopt such a focus on the characterization of exoplanets' atmospheres, this is an unprecedented opportunity to apply the methods developed for Solar System's planetary atmospheres to a wider diversity of planetary environments and possibly to redefine the existing tools and theoretical framework to make them more universal. I will review the existing modeling tools used to study Solar System's planetary atmospheres: energy balance models, analytical models, global climate models, meso-scale models, cloud-resolving models, and large-eddy simulations. I will then discuss how those tools could be adapted to exoplanets and how they could be used to interpret the ARIEL data set to address key questions such as the exoplanets' large-scale atmospheric dynamics and small-scale waves and turbulence, and the impact this multi scale dynamics has on the thermal structure, the variability of clouds and the transport of chemical species.

CASE - Contribution To ARIEL Spectroscopy Of Exoplanets:
by Mark Swain - Jet Propulsion Laboratory (Poster)

CASE is the NASA contribution to the ESA M4 ARIEL mission. The CASE project includes both a hardware contribution to the ARIEL Fine Guidance System and participation in the ARIEL science program. The CASE team has simulated some aspects of the ARIEL mission performance that highlight the mission's significant science capability.

Inside-Out Planet Formation And ARIEL:
by Jonathan Tan - University of Chalmers/University of Virginia (Talk)

I overview in situ planet formation theories that attempt to explain the population of close-in super-Earths that have been well-characterised by the Kepler telescope, with a particular focus on Inside-Out Planet Formation (Chatterjee & Tan 2014). I then discuss how ARIEL will make an impact by testing predictions of different planet formation models.

Molecular Line List For Exoplanet Studies: by Jonathan Tennyson - UCL (Poster)

Molecular line lists are essential for interpretting the spectra of exoplanets. The ExoMol project (www.exomol.com) aims to provide all the molecular data required to model exoplanet atmospheres and model their spectra. The contribution will report on progess in the project and discuss the provision of data for ARIEL.

ARIEL Data Analysis Challenge: by Angelos Tsiaras - UCL (Talk)

As with every space-based instrument, the data that will be obtained by ARIEL will be analysed by a dedicated pipeline to produce the higher level data products. The efficiency of this pipeline is very important for the mission, as it will have a direct impact on the quality of the data products delivered and on the delivery timeline. With the ARIEL Data Analysis Challenge, we invite participants to take part in the optimisation of the ARIEL data analysis processes.

For this exercise, we used data produced by ExoSim, considering the most up-to-date design of ARIEL. The data provided are equivalent to ARIEL DATA LEVEL 1 (equivalent to the RAW data available for HST observations – i.e. spectral images that have not been processed). Participants need to produce final data products - i.e. to estimate the transit depth as a function of wavelength, the mid-transit time, the orbital inclination and the orbital semimajor axis relatively to the stellar radius.

ARIEL: Decoding The Secrets Of Planetary Formation: by Diego Turrini - INAF-IAPS (Talk)

The ever growing catalogue of known extrasolar planets, the detailed study of the planetary bodies in the Solar System, and the new capabilities of ground-based observatories for the study of circumstellar disks are providing us with different pieces of the complex puzzle that is understanding the birth and early evolution of planetary systems in our Galaxy. For these pieces to fit together and provide us with the complete picture, however, we need the additional and still missing piece of information offered by the compositional characterization of a large and representative sample of exoplanets. ARIEL will provide this missing centrepiece of the puzzle and, in doing so, will allow for an unprecedented view of how the process of planetary formation shapes the characteristics of planetary systems, including our own Solar System. In this talk I'll highlight the science cases devised in the framework of the ARIEL mission to address some of the most outstanding open questions on planetary formation and the ongoing efforts within the ARIEL team to fully take advantage of the unique data that the mission will provide.

Which Planets Have Atmospheres: The Role Of Photo-Evaporation:
by Vincent Van Eylen - MSSL/UCL (Talk)

Almost everything we know about exoplanets to date has been inferred indirectly through their host stars, making it crucial to understand stellar properties if one hopes to learn about planetary systems. Asteroseismology, the study of stellar oscillations, provides the current gold standard of stellar characterization. In this talk, I explain how we can use asteroseismology and other techniques to make major leaps forward in our understanding of small close-in planets, the type that will be prime targets for ARIEL. I show what we have learned about the basic properties of these systems from previous surveys like Kepler and K2, and what can be expected from TESS and PLATO. In particular, I discuss the so-called "radius valley", which separates super-Earths and sub-Neptunes, and show which planets are likely to have extended H/He envelopes and which ones are likely to be a stripped core with no such atmosphere. Finally, I discuss the composition of the core of these planets, by showing some results of radial velocity observations of newly discovered TESS planets from ongoing programs on e.g. HARPS and ESPRESSO. I conclude with a forward look to what can be expected over the next years.

Understanding The Chemical Composition Of Exoplanet Atmosphere:
by Olivia Venot - LISA (Talk)

ARIEL will measure spectra of hundreds of exoplanets, showing different chemical species in their atmospheres and revealing statistics that can help to understand the exoplanet diversity. In this talk, Olivia Venot and Yamila Miguel will give an overview of the work done within the Chemistry Working Group, showing results on different model techniques (1D to 3D), different chemical schemes and planet regimes. Our oral presentation will be separated in 2 parts : the giant planets (O. Venot) and the rocky planets (Y. Miguel), showing the main challenges and discoveries that we expect.

Stellar Flares With ARIEL: by Krisztián Vida - Konkoly Observatory (Talk)

Stellar flares are fast, energetic transient events that occur due to the reconnection of surface magnetic fields on the time scale of hours. They can have serious effects on the surroundings of the host star - frequent large energy events could destroy the atmospheres of the orbiting planets over time, therefore, learning about flares can be important to understand planetary evolution, too. As flares occur on a relatively short time scale, poor sampling of the observations can yield misleading results on their physical properties. ARIEL can obtain photometric observations of unprecedented frequency and precision, that will allow us to obtain much more precise energy estimations. Besides, we might be able to detect small-energy events: although these are of less importance for planetary evolution, but in the case of the Sun, the smallest events - so called nanoflares - are thought to have a prime role in coronal heating. Photometric data from the ARIEL missions could give us insights into this phenomena on other stars.

Machine Learning In Exoplanet Atmospheric Characterisation: by Ingo Waldmann - UCL (Talk)

Analysing currently available observations of exoplanetary atmospheres often invoke large and correlated parameter spaces that can be difficult to map or constrain. This is true for both: the data analysis of observations as well as the theoretical modelling of their atmospheres. High quality data obtained by future missions such as ARIEL and JWST, will allow us to increase the complexity of our atmospheric models but at the cost of even higher dimensionality and non-linearities in the models.

In many aspects, data mining and non-linearity challenges encountered in other data intensive fields are directly transferable to the field of extrasolar planets as well as planetary sciences. In this talk, I will discuss the use of information entropy and deep learning to increase the efficiency of atmospheric retrieval algorithms and to exploit the sparsity of a low to mid-resolution exoplanet spectrum using information content informed optimal binning.

ARIEL Targets And High-Precision Photometric Support From NGTS:
by Peter Wheatley - University of Warwick (Talk)

NGTS is an array of 12 telescopes at the ESO Paranal observatory that have been designed to provide the highest-precision photometric observations possible from the ground. We now routinely achieve photometric precision of 150ppm. NGTS is discovering new transiting exoplanets and contributing to the confirmation and follow up of planets from TESS. Our high precision is also valuable for Ariel in monitoring unocculted starspot coverage and maintaining transit ephemerides of key targets.

Exploring Non-LTE Effects In Exoplanet Atmospheres: by Samuel Wright - UCL (Poster)

Great advances have been made over the last few decades in probing the atmospheres of extra-solar planets, enabling us to further constrain the conditions that exist on these worlds. When modelling these atmospheres however, the work done to date has assumed that the species present are in local thermodynamic equilibrium (LTE). It is known, for instance on Earth, that non-LTE effects are present in the atmosphere and give rise to varying spectra; work already conducted by the community has expanded the remote sensing of non-LTE to other planets within our solar system. This poster presents a preliminary exploration into non-LTE effects in exoplanet atmospheres, showing the differences that arise in some notable molecular spectra due to these effects. An initial evaluation of the detectability of these differences by next generation space telescopes is presented, along with some indicative forward models. Further work will involve the inclusion of non-LTE corrected population ratios in the atmospheric modelling and running atmospheric retrievals on instrument simulated spectra.

Integrating Light-Curve And Atmospheric Modelling Of Transiting Exoplanets:
by Kai Hou Yip - UCL (Poster)

Spectral retrieval techniques are currently our best tool to interpret the observed exoplanet atmospheric data. Said techniques retrieve the optimal atmospheric components and parameters by identifying the best fit to an observed transmission/emission spectrum. Over the past decade, our understanding of remote worlds in our galaxy has flourished thanks to the use of increasingly sophisticated spectral retrieval techniques and the collective effort of the community working on exoplanet atmospheric models. A new generation of instruments in space and from the ground is expected to deliver higher quality data in the next decade, it is therefore paramount to upgrade current models and improve their reliability, completeness and numerical speed with which they can be run. In this paper, we address the issue of reliability of the results provided by retrieval models in the presence of systematics of unknown origin. More specifically, we demonstrate that if we fit directly individual light-curves at different wavelengths (L-retrieval), instead of fitting transit or eclipse depths, as it is currently done (S-retrieval), the results obtained are more robust against astrophysical and instrumental noise. This new approach is tested, in particular, when discrepant simulated observations from HST/WFC3 and Spitzer/IRAC are combined. We find that while S-retrievals converge to an incorrect solution without any warning, L-retrievals are able to identify potential discrepancies between the data-sets.

Streaming Instability In Two-Dimensional Protoplanetary Disks:
by Cong Yu - Sun Yat-Sen University (Poster)

How planetesimals form in a protoplanetary disk is a long standing problem and remains a mystery today. The classic theory of planetesimal formation based on the gravitational instability of a dense, thin dust layer suffers from vertical spreading of dust particles due to self-generated turbulence via the Kelvin-Helmholtz instability. On the other hand, the growth of dust grains by coagulation is unlikely to directly form kilometer-size bodies due to the so-called meter-size barrier. Youdin and Goodman (2005) discovered an instability, known as the streaming instability, in the gas-dust system in a proptoplanetary disks, and the densest dust clumps generated by the streaming instability can undergo gravitational collapse, leading to rapid formation of planetesimals. It has been a general understanding that the streaming instability occurs only in 3D. However, the numerical simulations of Klarh using a local shearing box found that the streaming instability also exists in a 2D disk. We explore the streaming instability in 2-D protoplanetary disks and find interesting properties of streaming instability. We further point out the 2-D streaming instability can be understood in terms of the resonant drag instability.

The Status Of Spectroscopic Data For The ARIEL Mission: by Sergey Yurchenko - UCL (Talk)

ARIEL will deliver incredible data that can only be successfully interpreted with a high quality spectral data for a large number of molecules. This presentation will give a detailed update on the status of the data for each species considered to be important for the spectroscopy of the ARIEL targets, focusing on the main spectral features and their readiness for the atmospheric retrievals as part of the ARIEL science. This information will be used to construct the ARIEL specific spectroscopic database of opacities and spectroscopic parameters. For many molecules (eg AlO, AlH, H3+, PO, PN, H2, CO, CO2, H2O, CH4, NH3, PH3, SiO, SO2, HCN, H2S) the data are already available through the collaboration within the opacity working group. Other line lists are in progress (e.g. SiO2, CaOH, KOH, NOH, C2H4, C2H2, C3H6). Many more molecules still have absent or incomplete spectral data, and we will continue to simulate, measure and aggregate these as the mission develops.

Atmospheric Compositions And Observability Of Nitrogen Dominated Super-Earths:
by Mantas Zilinskas - Leiden Observatory (Poster)

Thermal emission phase curve observations and GCM modelling of 55 Cancri e present a case for a high-mean-molecular mass atmosphere. We explore a wide range of nitrogen dominated scenarios using chemical kinetics and present synthetically generated spectra in both, transmission and thermal emission. We also assess the potential observability of 55 Cancri e by simulating NIRISSS, NIRSpec and MIRI instruments on JWST. Shrouded in mystery, 55 Cancri e shows great potential for observability with future instrumentation.

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