Elbereth conference 2021

lundi 8 février 2021 - vendredi 12 février 2021

Gather

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Welcome speech

Talk / **2**

WISDOM/ExoMars 2022: Fantastic Martian subsurface reflectors and where to find them

Auteurs: Nicolas Oudart[1]; Valérie Ciarletti[1]; Alice Le Gall[1]; Yann Hervé[1]

[1] *LATMOS*

Auteur correspondant nicolas.oudart@latmos.ipsl.fr

The mission of the ExoMars 2022 Martian rover, Rosalind Franklin, will be to find traces of past or present life in the shallow subsurface of Oxia Planum. To assure such traces were shielded from radiations and oxydation, the rover will be equiped with an instrumented drill, able to collect samples down to 2 m in the Martian subsurface. Samples will be analyzed in-situ, by instruments located in the rover body.
Only a limited amount of drilling operations are planned for the nominal mission, and the integrity of the drill must be preserved at all cost. For these reasons, the drilling sites must be selected carefully. The WISDOM Ground Penetrating Radar, one of the 9 instruments onboard Rosalind Franklin, is designed to give insights on the structure and dielectric properties of the subsurface prior to any drilling operation, with radar images known as radargrams.
An underground subsurface reflector, such as a buried boulder which could harm the rover drill, would appear as a hyperbolic shape in a classic GPR radargram. An the shape of this hyperbola gives an estimation of the dielectric constant of the surrounding subsurface (allowing the estimation of the reflector depth).
However, due to engineering constraints, the WISDOM radar antennas are 38 cm above the Martian surface, and the signals sent and received by WISDOM are therefore refracted. Thus the shape corresponding to a reflector in WISDOM radargrams is no longer a hyperbola.
In order to correctly detect these signatures of underground reflectors, and to accurately estimate the dielectric constant of the subsurface, an automated detector software has been developed, and tested on both synthetic and experimental WISDOM radargrams.

Day constaints:

Field:

Instrumentation

Talk / **29**

Modeling the atmospheric circulation of Uranus and Neptune

Auteur: Gwenael Milcareck[1]

[1] *LATMOS*

Auteur correspondant gwenael.milcareck@latmos.ipsl.fr

Since the end of the 1980s, observations collected by Voyager 2, large ground-based telescopes and space telescopes (notably Hubble Space Telescope) have revealed that Uranus and Neptune are cold

but very active worlds. Indeed, the observations revealed intense jet streams and strong meteorological activity (dark spots or bright cloud features). It's on Neptune where we find the fastest zonal tropospheric winds of the solar system (~400 m/s).

In addition, their atmospheres are home to numerous hydrocarbons that form aerosol mists in the lower stratosphere. Methane also condenses in these very cold environments, forming a cloud layer at the tropopause and a hydrogen sulfide cloud layer is suspected at the upper troposphere. Many observations document the properties of these mists and clouds, as well as their spatial distribution, but few microphysical models have been developed, and none couple microphysics to dynamics. The impact of these aerosols on the climate of Uranus and Neptune thus remains uncertain.

Today, the physical and microphysical processes that govern the atmosphere of Uranus and Neptune are still unknown.

The objective of this thesis is to reproduce and understand the atmospheric circulation of these atmospheres and the microphysics of aerosols using a GCM (Global Climate Model). This will include studying the role of waves and instabilities in the establishment of jet streams and the vertical structure and size distribution of aerosols with the observations.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

I will not able to make my presentation the 9th of February (between 9h30 am and 12h30 pm) and the 12th of February (between 9h30 am and 12h30 pm).

Talk / **27**

Dynamics of the transition corona and solar wind generation

Auteur: Théo PELLEGRIN[None]

Auteur correspondant theo.pellegrin@obspm.fr

Understanding the physical mechanism responsible for the solar wind generation is one of the key objectives of the two new solar missions, Parker Solar Probe and Solar Orbiter. The Sun produces two kinds of solar winds. The first one, the fast wind, has a velocity larger than 600 km.s-1. The second one is the slow wind which velocity is slower than 400 km.s-1. Its generation mechanism is still widely debated. The corona, source region of the wind, is structured by its magnetic field. This field can be closed, i.e., magnetic loops connecting positive and negative polarities at the solar surface or open when only one footpoint of the field lines is rooted at the solar surface and the other one extends in the heliosphere. One of the existing theories to explain the observed properties of the slow wind is that the plasma, confined low in the solar atmosphere in closed magnetic field, is dynamically released into the open field thanks to magnetic reconnections between open and closed magnetic field.. Although the local magnetic field properties has been frequently studied using static models, the dynamic of the open-closed magnetic boundary remains ill-understood.
The objective of my thesis is to study the dynamics of specific magnetic geometries that can generate the slow solar wind. We perform 3D magnetohydrodynamics (MHD) numerical simulations of the solar corona and inner heliosphere using a MHD code with adaptive mesh refinement. We study the dynamics of several initial magnetic configurations, in order to provide constraints over the slow wind generation process.
In this presentation, I will present a quick overview of the slow wind generation problematics and introduce our current work and its preliminary results.

Field:

Solar & Stellar Physics

Day constaints:

Talk / 9

Use of unified equations of state in the modelisation of neutron star macroscopic parameters

Auteur: Lami Suleiman[1]

Co-auteur: Morgane Fortin

[1] *Laboratoire Univers et Théories*

Auteur correspondant lami.suleiman@obspm.fr

The core of neutron stars involve such high densities that its matter cannot be reproduced in laboratories. There is however a chance to probe the interior of those compact stars via observation of macroscopic parameters such as the mass, the radius, the moment of inertia or the tidal deformability. We propose to give insight in the consequences of using nuclear models calculated non consistently for the core and and the crust. Constructions of matched equations of states found in the litterature are evaluated with regards to the modelisation of neutron star parameters and compared to promised precision of measurements from present and future generation of telescopes.

Field:

Compact objects (supernovae, black holes, neutron stars)

Day constaints:

Invited talk / 53

Invited talk - L'atmosphère de Mars scrutée par le satellite ExoMars Trace Gas Orbiter

Auteur: Sandrine Guerlet[1]

[1] *LMD*

Lancé en mars 2016, et en phase opérationnelle depuis mars 2018, le satellite ExoMars Trace Gas Orbiter (TGO) embarque plusieurs spectromètres ultra performants à la recherche de gaz traces dans l'atmosphère martienne – dont le plus emblématique est probablement le méthane. La détection passée du méthane par d'autres instruments fait l'objet de nombreuses controverses, qui ne sont toujours pas résolues à ce jour, comme nous le verrons. Un autre volet de cette mission concerne l'acquisition de nombreuses données de climatologie pour mieux comprendre l'évolution diurne de la température atmosphérique. Nous ferons le point sur les résultats principaux de ces spectromètres et les questions qui restent en suspens.

Talk / 5

Global Climate Modeling of Saturn's stratosphere to determine the nature of its equatorial oscillation

Auteur: Deborah Bardet[1]

[1] *Laboratoire de Météorologie Dynamique*

Auteur correspondant deborah.bardet@lmd.jussieu.fr

Introduction: The Saturn's Semi-Annual Oscillation (SSAO) observed by Cassini is a source of debate within the community, because of its similarities (sometimes conflicting) with both the terrestrial Quasi-Biennial Oscillation (QBO) and the terrestrial Semi-Annual Oscillation (SAO). As the QBO, the downward propagation of the SSAO occurs almost to the tropopause (Schinder et al. 2011). In contrast, the half a Saturn year period of the SSAO is advocated for a seasonal forcing and hints the SAO mechanism driving. Moreover, observation of anomalies in warm temperature and high hydrocarbon concentration at winter tropics is interpreted as the downwelling branch of a meridional stratospheric circulation.
Using DYNAMICO-Saturn Global Climate Model (GCM) – with an higher vertical discretization (96 σ-levels from 3×10^5 to 10^{-1}~Pa) than previous works (Spiga et al. 2020, Bardet et al. 2021) – we performed simulations lasting at 13 simulated Saturn years, to study Saturn's stratospheric equatorial oscillation, its inter-hemispheric circulation and the driving mechanism connecting them.

Results: Firstly, DYNAMICO-Saturn depicts a stratospheric equatorial oscillation of temperature and zonal wind. The new vertical resolution permits to stabilize more the oscillation periodicity and its eastward phase compared to previous study. The period varies between 0.5 and 1 simulated Saturn years. Indeed, because of irregularity in the waves and eddy-to-mean forcings, the downward propagation is carried out by episodes of descent followed by episodes of stagnation at a given level of pressure. The amplitude of the associated temperature oscillation is under-estimated by 10 K compared to the Cassini observations.

Secondly, DYNAMICO-Saturn also models an inter-hemispheric circulation taking place from the summer tropical latitudes to the winter ones, with a strong subsidence between 20 and 40° in the winter hemisphere. The main subsidence branch is located in the same latitude region as temperature and hydrocarbons anomalies observed by Cassini (Guerlet et al. 2009, 2010, Sinclair et al. 2013, Fletcher et al. 2015, Sylvestre et al. 2015).

Furthermore, eddy-to-mean interaction diagnostics show that the phases of Saturn's equatorial oscillation are controlled by the inter-hemispheric circulation. During the solstices, the cross-equatorial drift of the inter-hemispheric circulation, associated to the forcing of the mid-latitude planetary-scale Rossby waves, drive the equatorial zonal wind to westward direction. In contrast, during the equinoctial overturning of the inter-hemispheric circulation, the residual mean circulation is reduced to an unique ascendance at the equator to permit the transport and eastward moment deposition of Kelvin waves from the troposphere.

Perspectives: This present modelling study of the dynamics of Saturn's stratosphere confirms the SAO-like character of the Saturn's equatorial oscillation. However, we will also explore the putative part of the QBO-like character of it.We plan to use this new vertical resolution combine to the subgrid-scale gravity wave parameterization.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / **6**

What role will binary neutron star merger afterglows play in multimessenger cosmology?

Auteur: Raphaël Duque[1]

Co-auteurs: Simone Mastrogiovanni [2]; Eric Chassande-Mottin [3]; Robert Mochkovitch [4]; Frédéric Daigne [5]

[1] *Institut d'Astrophysique de Paris*

[2] *Astroparticule et cosmologie, Paris Diderot university*

[3] *CNRS AstroParticule et Cosmologie*

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[5] *Institut d'Astrophysique de Paris - Sorbonne Université*

Auteur correspondant duque@iap.fr

Binary neutron star mergers offer a new and independent means of measuring the Hubble constant by combining the gravitational-wave-inferred source luminosity distance with its redshift obtained from electromagnetic follow-up. This method is limited by intrinsic degeneracy between the system distance and orbital inclination in the gravitational-wave signal. Observing the afterglow counterpart to a merger can further constrain the inclination angle, allowing this degeneracy to be partially lifted and improving the measurement of H_0. In the case of the binary neutron star merger GW170817, afterglow light-curve and imagery modeling thus allowed to improve the H_0 measurement by a factor of 3. However, systematic access to afterglow data is far from guaranteed. I will present models for emission and detection of gravitational-wave and electromagnetic radiation from binary neutron star mergers and realistic source population models. With these models, I will quantify whether afterglows will play a leading role in multimessenger cosmology, or whether they will be too rare to significantly contribute to the narrowing-down of the Hubble constant.

Field:

Cosmology

Day constaints:

Monday, Tuesday, Wednesday, Thursday, Friday

Talk / 50

Long-term variations in the Earth's orbit govern its insolation and climate

Auteur: Nam Hoang[1]

[1] *IMCCE*

Auteur correspondant nam.hoang-hoai@obspm.fr

These astronomical signals, which have been recovered in geological records, revolutionized the accuracy and precision of the geological timescale (Gradstein & Ogg 2020). However, the orbital variations beyond 60 Myr cannot be reliably predicted because of the chaotic dynamics of the Solar System planets (Laskar 1989). Taking into account the uncertainty of the orbital evolution beyond 60 Myr is thus necessary for astronomical calibration of geological records. Our work addresses this problem with a statistical analysis over 120 000 orbits of the secular model of the Solar System ranging from 500 Myr to 5 Gyr. We obtain the probability density function of the fundamental frequencies of the orbital motion by kernel density estimation and the corresponding confidence interval by moving block bootstrap. The results obtained with the secular model are shown to be compatible with direct integrations of a comprehensive model of the Solar System. Application of our work is illustrated on two geological data: Newark-Hartford records and Libsack core.

Field:

Not in the above

Day constaints:

Invited talk / 51

Association Français d'Astronomie

Auteur: The AFA Team[None]

Talk / **41**

The Evolution of the Dynamical Ellipticity of the Earth

Auteur: Mohammad Farhat[1]

[1] *IMCCE*

Auteur correspondant mohammad.farhat@obspm.fr

The "timescale problem" of the Lunar origin is one of the major concerns in understanding the past history of the evolution of the Earth-Moon system. Using the present rate of tidal breaking of the Earth's rotation, a backward integration of the system places the Moon at the Roche limit just 2 billion years ago, which is not compatible with modern theories of Lunar formation. A possible resolution of the problem is in varying the tidal dissipation rate during earlier times and reducing the Earth's dynamical ellipticity and rotational period. A combination of dissipative mechanisms, both astronomical and geophysical can possibly lead to such a scenario.

In this talk, we will focus on the variation of the dynamical ellipticity, or the figure change of the Earth due to the past ice ages. During these ice ages, cycles of glaciation and deglaciation exert a varying surface load on the Earth forcing it to deform to maintain its equilibrium. The modelling of this deformation requires two key elements that happen to be a spatio-temporal history of the glacial spread over the surface of the Earth and the internal rheological structure that dictates how the Earth responds to any exerted force. We will visit the history of the problem and present our prediction of the effect of these glacial cycles on the oblateness of the Earth for the past 50 million years. This ellipticity evolution will be utilised in constraining the present uncertainties of the rotational and orbital solution of the Earth-Moon system.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Tuesday 9/2
Wednesday 10/2

Talk / **13**

The Giant Radio Array for Neutrino Detection

Auteur: Simon Chiche[1]

[1] *Institut d'Astrophysique de Paris*

Auteur correspondant simon.chiche@iap.fr

The Giant Radio Array for Neutrino Detection (GRAND) is a project dedicated to the radio detection of ultra-high energy cosmic rays, gamma rays and neutrinos. It aims at deploying a radio array of 200 000 antennas over 200 000 km2 in mountainous regions with 20 subarrays of 10 000 antennas in several favorable locations around the world. The objective is to detect inclined ($\theta > 65^\circ$) particle showers with $E > 10^{17}$ eV induced by the interaction of ultra-high energy astroparticles with the atmosphere or underground via their radio-emission in the 50-200 MHz range. Its expected sensitivity of

~10^{-10} $\mathrm{GeV cm^{-2} s^{-1} sr^{-1}}$ above 5.10^{17} eV combined with its sub-degree angular resolution, should allow unveiling the unchartered territory of ultra-high energy neutrinos, secondary particles guaranteed to exist by the detection of ultra-high energy cosmic rays. In this talk, I will present the science case of GRAND and will particularly focus on GRANDProto300, a pathfinder of 300 antennas to be deployed in 2021 that will allow to test the detection principle of the GRAND experiment.

Field:

Not in the above

Day constaints:

Preferentially on tuesday or wednesday if possible.

Talk / 31

Stellar mass and Star Formation surface densities in GRB hosts compared to field galaxies: evidence of a trend with redshift

Auteur: Benjamin Schneider[1]

Co-auteur: EMERIC LE FLOC'H [2]

[1] *CEA - Saclay*

[2] *CEA*

Auteur correspondant benjamin.schneider@cea.fr

Long-duration gamma-ray bursts (GRBs) are produced after the death of very massive stars and can be used to trace the formation of stars inside the host galaxy. Thus, their rate might constraint the evolution of star formation throughout the cosmic times, especially at high-redshift where the trend is still under debate. However, previous works on GRB host galaxies at low redshift bring to light a potential bias of these tracers towards low metallicity galaxies and more recently towards dense stellar environments. At high redshift, many questions remain, especially the evolution and the relative importance of these two biases.
We proposed to study the impact of the environment density at high redshift ($1 < z < 3$) of GRB host galaxies by using a compiled sample of GRBs observed in the IR with the Wide Field Camera 3 of the Hubble Space Telescope (HST). We performed a systematic morphological characterization of each host galaxy by fitting their surface brightness profile with GALFIT. We compared the distribution of the physical and morphological properties of the host galaxies to a sample of typical star-forming galaxies at the same redshift from the 3D-HST survey. Our results suggest that GRB hosts are more compact than field galaxies and have a preference for a higher stellar mass density. The situation seems to evolve at $z > 2$ where the GRB hosts show no preference for the half-light radius and a lower preference for high stellar density over field galaxies. These results appear to confirm the bias of GRB progenitors for dense stellar environments in addition to a preference for low metallicity. A possible connection between these two factors remains to be explored.

Field:

Compact objects (supernovae, black holes, neutron stars)

Day constaints:

I have constraints (teaching) on Thursday and Friday

Talk / 28

The climate of Early Mars

Auteur: Antony DELAVOIS[1]

[1] *{CNRS}UMR8539*

Auteur correspondant antony.delavois@lmd.ipsl.fr

How Mars was during its first billion years is one of the most intriguing question in our understanding of the Solar System. The planet was host of a tremendous amount of liquid water flowing on the surface throughout the Noachian era, approximatively 4Gya. Geomorphological observations is the main evidence for liquid water since valley networks and lakes are still visible on the surface, although dry nowadays. With current and future missions to Mars, we are also now able to study mineralogy and to perform in-situ analysis of the martian soil, providing new pieces for the Early Mars puzzle.
In the context of a faint young sun, radiating 75% of the actual solar energy around 3.8Gya, maintaining a global temperature above 0℃ is challenging. In order to deciphering this paradox, the scientific community has been using a variety of models including 3-D GCMs (Global Climate Models). These models try to closely reproduce the physics of the atmosphere, providing a powerful tool for the comprehension of planetary climates. We present here a quick overview of the Martian climate during this period called Noachian. We also describe the previous studies performed during the last decades of Early Mars climate modeling and finally focus on the main objectives of my PhD research. Future work includes the exploration of different scenarios with a new ambitious high-resolution model: the Mars Evolution Model.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / 12

Physical properties of cosmic filaments

Auteur: Daniela Galárraga-Espinosa[1]

Co-auteurs: Nabila Aghanim ; Mathieu Langer

[1] *Universite Paris-Saclay*

Auteur correspondant daniela.galarraga@universite-paris-saclay.fr

Under the action of gravity, matter in the largest scales is assembled to form a gigantic network composed of nodes, filaments, walls and voids, that is called the cosmic web. According to numerical simulations, around 50% of the total mass of the Universe might reside in the cosmic filaments, thus tying our understanding of matter to that of filaments. However, since these large-scale structures are very challenging to observe, a large fraction of baryons in the late Universe are still 'missing'.
In this talk, will present a study of galaxies and gas around cosmic filaments, detected in the IllustrisTNG300-1 hydro-dynamical simulation at redshift z=0. I will show that filaments can be separated into two different populations: the short and puffy filaments (L<9 Mpc) that might act as bridges of matter in the over-dense regions of the cosmic web, and the long filaments (L>20 Mpc) that are thinner and live in less-dense environments.
I will show that filaments are essentially dominated by gas in the warm-hot intergalactic medium (WHIM), which accounts for more than 86% of the baryon budget at 1 Mpc from the spine. Apart from WHIM gas, cores of filaments also host large contributions of other hotter and denser gas phases, whose fractions depend on the filament population. By building temperature and pressure profiles, I will show that gas in filaments is isothermal up to distances of ~ 1.5 Mpc, with average temperatures of T_core = 4 − 13 × 10^5 K, depending on the large scale environment. Pressure at cores of filaments is on average P_core = 4 − 12 × 10^−7 keV.cm−3 , which is ~ 1000 times lower than pressure measured in observed clusters. Finally, I will present an estimation of the observed

Sunyaev-Zel'dovich signal from cores of filaments, and these results will be compared with recent observations.

Field:

Cosmology

Day constaints:

Invited talk / **49**

Invited talk - Black hole magnetospheres under the PICoscope

Auteur: Benoît Cerutti[1]

[1] *Institut de Planétologie et d'Astrophysique de Grenoble / Université Grenoble Alpes*

Auteur correspondant benoit.cerutti@univ-grenoble-alpes.fr

Black hole astrophysics has taken a dramatic leap forward in recent years thanks to the detection of gravitational waves from merging stellar-mass black holes and the first image of the shadow of the supermassive black hole M87*, opening up the exciting opportunity to probe physics in curved spacetime. To this end, it is of prime importance to have an accurate description of how matter and light behave under extreme physical conditions. My work aims at understanding how particle acceleration and the emission of non-thermal radiation proceed in relativistic magnetized plasmas such as those forming around rotating black holes. In this talk, I will summarize our current efforts to reproduce a black hole magnetosphere from scratch on National supercomputers using ab-initio particle-in-cell simulations, with the ultimate goal to bridge the gap between theoretical models and observations.

Field:

Compact objects (supernovae, black holes, neutron stars)

Day constaints:

Talk / **20**

INTEGRATED AND ULTRA-SENSITIVE THZ MIXER MODULE

Auteur: Huy Duy Do[1]

[1] *Do*

Auteur correspondant duy.do-huy@obspm.fr

For the development of future telescopes, or more generally for all heterodyne instruments, high resolution spectroscopic imaging in the THz domain is an important issue that is attracting increasing interest in many scientific fields. This canbe achieved only through the development of a mixer technology in multi-pixel configuration. Of all the existing THz mixers, the Superconducting Hot Electron Bolometer (HEB) mixer achieved the best performance for frequencies well
beyond THz with noise temperatures approaching the quantum limit. It becomes the unavoidable candidate for observation projects applying heterodyne technology and requiring high sensitivities in the THz domain. Several space projects in preparation are using HEB mixers. Thus LERMA is a partner of the Millimetron (Russian satellite) and OST (NASA proposal) projects. Our laboratory

has a very good experience of HEB mixers operating in the THz range.
Heterodyne sensitivities in the state of the art were obtained at 2.5 and 1.3 THz on single-pixel mixer. In the perspective of making multi-pixel mixers with the HEB developed in the laboratory, we plan to study a new configuration of the mixer to allow its integration into a multi-pixel structure. This project aims to find a solution, through theoretical and experimental studies, to integrate all the currently distinct modules of a heterodyne receiver inside a single compact and built-in block in order to build a heterodyne camera in the THz domain without restriction on the number or arrangement of the pixels. The work consists of conducting studies on the intermediate frequency (IF) characteristics of HEB, the design of low-noise cryogenic amplifiers, and the miniaturization and integration of polarization and filter circuits. In parallel, a general review of the current mixer block will be performed in order to provide a concept for 2D integration of a large number of single-pixel mixers. The realization of a prototype is envisaged. This work step will be carried out in conjunction with ongoing research projects at the laboratory whose objective is to study the distribution and coupling of THz signals at the input of the multi-pixel mixer . This study is a continuation of our current developments on compact and ultra-sensitive THz detection systems to better meet the needs of future space observatories.
During my presentation, I will show my work I have done so far during half of my thesis.

Field:

Instrumentation

Day constaints:

All the days are possible for me

Talk / **42**

Constraining the Origin of Stellar Masses and of the Chemical Complexity in Hierarchical Infalling Clouds

Auteur: Mélanie Armante[1]

[1] *doctorate*

Auteur correspondant melanie.armante@phys.ens.fr

The formation of stars plays a central role in the evolution of the interstellar medium of galaxies, characterized by complex multi-scale mechanisms. In large hyperdense filaments generated by Galactic
collisions between molecular clouds, cloud fragments called dense cores form, then collapse, converting
their material in protostars. In order to survive this collapse and efficiently accrete gas, these protostars
eject material in the form of jets that carve protostellar outflows in the surrounding medium. With this thesis, we propose to study the formation of stars in regions observed at high angular resolution in the
frame of the ALMA-IMF large program. The scientific objectives are to characterize the cores and protostars
(multiplicity, mass, temperature, evolutionary stage, chemistry) and to understand the effects likely to play a role in the determination of the final mass of the stars (kinematics/dynamics and magnetic fields at all scales, ejection processes⋯).

Field:

InterStellar Medium

Day constaints:

Talk / 14

Europa's interaction with the jovian plasma from hybrid simulation

Auteur: Claire Baskevitch[None]

Auteur correspondant claire.baskevitch@latmos.ipsl.fr

Galilean moons are embedded in Jupiter's giant magnetosphere. The jovian plasma particles interact with the atmosphere of the moons, exchanging momentum and energy, and generate different phenoma such as aurora, electric current, etc..
The exploration of the Galilean moons, and in particular Ganymede and Europa considered as potential habitats, are listed among the main objectives of the ESA JUpiter ICy moon Explorer mission. In preparation of future observations, a simulation effort is conducted to describe the Europa/Ganymede moon-magnetosphere system.
LatHyS is a hybrid 3D, multi-species and parallel simulation model which is based on a kinetic description of ions and a fluid description of electrons. It allows to describe the interaction between the jovian plasma and the moon environments. As Ganymede's environment has already been implemented, we propose to enrich the model by completing it with Europa's –jovian plasma interaction and to optimize it in order to improve the accuracy of the results.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / 45

Young solar wind coherent structures from inertial to sub-ion range.

Auteurs: Alexander Vinogradov[1]; Olga Alexandrova[2]; Milan Maksimovic[2]; Anton Artemyev[3]; Alexey Vasiliev[4]; Anatoly Petrukovich[5]; Stuart Bale[6]; Karine Issautier[1]; Michel Moncuquet[1]

[1] *LESIA, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, Université de Paris*

[2] *LESIA, Observatoire de Paris, Université PSL, CNRS, Sorbonne Université, Université de Paris,*

[3] *University of California, Los Angeles, USA*

[4] *Space Research Institute RAS, Moscow, Russia*

[5] *Space Research Institute RAS, Moscow Russia*

[6] *Space Sciences Laboratory, University of California, Berkeley, USA*

Auteur correspondant alexander.vinogradov@obspm.fr

We study intermittency of turbulence in the young solar wind at 0.17 au with NASA/Parker Solar Probe during the first perihelion. We use a merged FIELDS/Search Coil and Fluxgate Magnetometers data for magnetic field, SWEAP/SPC instrument for ions and RFS/FIELDS quasi thermal noise data for electrons parameters to characterize the plasma environment. The merged magnetic waveforms have 3.4 ms time resolution, which allows us to resolve a wide range of scales, going from MHD inertial range to sub-ion range. We apply a wavelet transform to the magnetic waveforms and we observe localized enhancements in power density that form corresponding peaks in Local Intermittency Measure (LIM) going from MHD to kinetic scales. These LIM peaks are not present in the random-phase signal with the same Fourier amplitudes. This indicates the presence of coherent structures in the observed signal. To detect coherent structures at a given timescale, we use the maximum of the random-phase signal LIM at the same scale as a threshold.
We observe a variety of coherent events from MHD to kinetic scales. We estimate the filling factor of the structures as well as their minimum variance properties and local topology. The physical connections between intermittency and solar wind heating are discussed.

Field:

Solar & Stellar Physics

Day constaints:

8,9,11,12

Talk / **11**

The interpretation and optimization of the SAM GCMS runs aboard the Martian rover, Curiosity. .

Auteur: Ophélie MCINTOSH[1]

[1] *{UNIV VERSAILLES ST-QUENTIN}UMR8190*

Auteur correspondant ophelie.mcintosh@latmos.ipsl.fr

Mars has long been considered a planet with high astrobiological interests. Scientific research has shown that the Martian surface, due to its resemblance with Earth environments in its early history, could have seen the emergence of life. Exploratory missions, such as the one conducted by the rover Curiosity since 2012, have deployed scientific tools to find chemical and mineral evidence of past and present habitable environments on its surface.The Sample Analysis at Mars (SAM) instrumental suite aboard Curiosity was designed to detect elements potentially associated with life on Mars by exploring molecular and elemental chemistry. More specifically, the Gas Chromatograph Mass Spectrometer (GCMS) component of SAM has helped identify a wide range of organic compounds indigenous to the red planet. However, the complexity of the data collected requires experimental work and instrumental optimizations to be fully understood and explained. To follow this effort, laboratory analyses were conducted on different SAM GCMS spare columns to help the interpretation of the flight model in situ results and prepare future runs. This specific study focuses on four of the six SAM GCMS columns: GC1 and GC2 used for the first TMAH run on Mars; as well as GC4 and GC6 which were studied to help the MSL science team to gain perspective on the capabilities of these columns to identify highly volatile compounds (Phosphine, Methane, H2S, etc.). The configurations and conditions of the GCMS runs are key factors to maximize our chances of identifying organic molecules on the Martian surface.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Ideally in order of preference: 1. Wednesday 10th; 2. Monday 8th; Friday 12th; Thursday 11th, 4. Tuesday 9th.

Talk / **8**

Calibration and preparation of MIRS instrument observations for the JAXA MMX space mission

Auteur: Fériel Tache[None]

Co-auteur: Antonella Barucci

Auteur correspondant feriel.tache@obspm.fr

MMX (Martian Moons eXploration) is the first sample return mission from the Phobos satellite (2024) with detailed exploration of the Martian system.
The objective is to determine the origins of the Mars's moons in order to address the roles of small bodies in the formation of planetary systems in the habitable zone.
MMX will carry several scientific instruments, including a rover and a sampling system, which will be returned to Earth at the end of the mission (2029).
MIRS (MMX InfraRed Spectrometer) is an imaging spectrometer working from 0.9 to 3.6 μm with wavelength resolution of 20 nm. Its developed by LESIA (Laboratoire d'Etudes Spatiales et d'Instrumentation en Astrophysique) and other French laboratories (LAB, LAM,LATMOS, OMP), and the CNES.
MIRS will provide global spectral maps of Phobos and Deimos to detect the surface composition and to support the sampling site selection. MIRS will study Mars atmosphere with particular attention to spatial and temporal changes as clouds, dust storm and water vapor.
The objective of my thesis is to carry out the performance and the calibration of the MIRS detector and instrument.

Field:

Instrumentation

Day constaints:

Talk / 32

Physical properties of Brightest Cluster Galaxies up to redshift 1.80 based on HST data

Auteurs: Aline Chu[1]; Florence Durret[2]; Isabel Márquez Pérez[3]

[1] *Institut d'Astrophysique de Paris*

[2] *IAP*

[3] *Instituto de Astrofísica de Andalucía*

Auteur correspondant chu@iap.fr

Galaxy clusters are the largest gravitationally bound structures in the Universe, and are believed to form by accretion of galaxies and mergers with smaller groups of galaxies. Clusters have generally in their center a very massive galaxy (BCG, the Brightest Cluster Galaxy), which is located at the bottom of the cluster gravitational potential well, and has grown by accreting gas as well as many smaller galaxies. Those extremely massive and bright galaxies, usually described as supermassive elliptical galaxies or cD galaxies, constitute a distinct class of galaxies on their own. BCGs can be up to 2 magnitudes brighter than the second ranked galaxy in their cluster, which makes them easily recognisable. A few studies (West et al. 2017, Durret et al. 2016) also show that BCGs tend to be aligned along a preferential axis, which is the major axis of the cluster in which they reside, hinting at the close link between BCGs and their host clusters. BCGs can give us important clues on the way clusters have formed and evolved, and enable to impose strong contraints on cosmological models by comparing them with the results obtained with numerical simulations.

We present a study of the physical properties of a large sample of BCGs between redshift 0.1 and 1.8, using high resolution photometry with images taken with the Hubble Space Telescope, as well as a new tool to detect automatically the BCGs on optical images (Chu et al. 2021).

Field:

Cosmology

Day constaints:

Talk / **7**

Investigation of the energy conversion associated with a series of dipolarization fronts observed by MMS

Auteurs: Soboh AlQeeq[1]; Olivier Lecontel[2]; Patrick Canu[2]; Retino Alessandro[2]; Thomas Chust[2]; Laurent Mirioni[2]; Yuri Khotyaintsev[3]; Rumi Nakamura[4]; Frederick Wilder[5]; Ahmadi Narges[5]; H. Y. Wei[6]; Argall Matthew[7]; David Fischer[4]; Daniel J. Gershman[8]; Jim Burch[9]; Roy Torbert[7]; Barbara Giles[8]; Steven Fuselier[9]; Robert Ergun[5]; Per-Arne Lindqvist[10]; Drew L Turner[11]; Cohen Ian[12]

[1] *LPP*

[2] *Laboratoire de Physique des Plasmas, Paris, France*

[3] *Swedish Institute of Space Physics, Uppsala, Sweden*

[4] *Space Research Institute, Austrian Academy of Sciences, Graz, Austria*

[5] *Laboratory of Atmospheric and Space Physics, Colorado, USA*

[6] *Institute of Geophysics and Planetary Physics, Los Angeles, USA*

[7] *Space Science Center and Department of Physics, University of New Hampshire, Durham*

[8] *NASA Goddard Space Flight Center, Greenbelt, MD, USA*

[9] *Southwest Research Institute, San Antonio, Texas, USA*

[10] *Space and Plasma Group, Royal Institute of Technology, Stockholm, Sweden*

[11] *Aerospace Corporation, El Segundo, California, USA*

[12] *The Johns Hopkins University Applied Physics Laboratory, Laurel, Maryland, USA*

Auteur correspondant soboh.al-qeeq@lpp.polytechnique.fr

In July 2017, the MMS constellation was in the magnetotail with an apogee of 25 Earth radii and an average inter-satellite distance of 10 km (i.e. at electron scales). On 23 July around 16:19 UT, MMS was located at the edge of the current sheet which was in a quasi-static state. Then, MMS suddenly entered in the central plasma sheet and detected the local onset of a small substorm as indicated by the AE index (~400 nT). Fast earthward plasma flows were measured for about 1 hour starting with a period of quasi-steady flow and followed by a saw-tooth like series of fast flows associated with dipolarization fronts. This plasma transport sequence finished with a flow reversal still occurring close to the magnetic equator. In the present study, we investigate the energy conversion processes at ion and electron scales for these different phases with particular attention on the processes in the vicinity of the dipolarization fronts.

Field:

Not in the above

Day constaints:

Talk / **16**

Earth imaging using optical interferometry

Auteurs: Hiyam Debary[1]; Vincent Michau[1]; Laurent Mugnier[1]

[1] *ONERA*

Auteur correspondant hiyam.debary@onera.fr

A new concept of imaging device has emerged during the past decade: the Segmented Planar Imaging Detector for Electro-optical Reconnaissance (SPIDER).

While with a conventional telescope the image is directly detected in the focal plane, with SPIDER, the incident wave is sampled in the pupil by a lenslet array. The wave fractions collected by each lens

are then recombined in a photonic integrated circuit. The interferences obtained allow the retrieval of the image.

Technologically complex, this concept allows a drastic reduction in the size, weight and power (SWaP) of an imaging system. It also may enable the reduction of acquired data by prioritizing useful information.

The noise is one of the major limitations in imaging devices. The first part of my PhD was dedicated to noise propagation in interferometric measurements. I will present an original analytical approach to investigate the noise propagation with respect to the measurement process.

Field:

Instrumentation

Day constaints:

Invited talk / 54

Invited talk - Solar Orbiter: un aperçu des premières données

Auteur: Frédéric Auchère[1]

[1] *IAS*

La mission Solar Orbiter a été lancée avec succès en février 2020. Elle emporte une charge utile de 10 instruments dédiée à l'étude du Soleil et de son influence sur l'héliosphère. La phase de recette en vol s'est achevée en juin 2020. Après une première manœuvre d'assistance gravitationnelle avec Vénus en décembre, la sonde est maintenant sur une trajectoire qui l'amènera au plus près du Soleil début 2022. Bien qu'encore en phase de croisière, les instruments acquièrent déjà des données remarquables et produisent leurs premiers résultats scientifiques. Nous passerons en revue les caractéristiques principales de la mission et détaillerons certaines des premières observations, en particulier l'imagerie EUV de la couronne solaire à très haute résolution et leurs implications pour son bilan énergétique.

Talk / 26

Derivatization of amines in preparation for Dragonfly mission

Auteur: Valentin Moulay[None]

Auteur correspondant valentin.moulay@latmos.ipsl.fr

Titan is one of the most promising worlds for astrobiology in our solar system. Its thick atmosphere is the site of a complex and rich chemistry that leads to the formation of a photochemical haze. This haze precipitates at the surface [1] where a wide range of reactions can occur. Titan's surface is composed of water ice [2] which can melt under certain conditions (meteoritic impact, cryovolcanism) leading to the presence of liquid water. The interaction between liquid water and photochemical aerosols could give rise to complex molecules that could be the buildings blocks of life (as we know them). Among this molecules, there could be some that carry an amine function [3] such as amino acids [4] (or even peptides) and nucleic acids [5]. These molecules are the elementary units of our proteins and our DNA. Therefore, if theses molecules are really present on the surface of Titan, the Dragonfly probe will have to be able to detect and identify them by gaz-chromatography-mass-spectrometry (GCMS). In order to do this, Dragonfly will carry on board different sample preparation

processes such as pyrolysis or derivatization. These techniques aim to improve the analytical efficiency of the GCMS. This work will be focus on derivatization and more precisely on derivatization of amines. Here, we will show that the derivatization process allow to improve the detection as well as the quantification of amines. Besides, we will investigate on the optimisation of the derivatization procedure according different kind of molecules such as peptides and nucleotides. This aspect of the work allow us to show that the DraMS instrument could analyse such molecules at the surface of Titan. Finally, we will present an analysis of tholins (lab analogs of Titan) which has undergone the derivatisation process. This last point will show the complexity of the molecules that we expect to find on Titan.

REFERENCES
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[3] Loison et al., (2015). "The neutral photochemistry of nitriles, amines and imines in the atmosphere of Titan."
[4] Neish et al., (2010). "Titan's Primordial Soup Formation of Amino Acids via Low Temperature Hydrolysis Tholins." Astrobiology 10.
[5] Pilling et al., (2009). " DNA Nucleobase Synthesis at Titan Atmosphere Analog by soft X-rays." Journal of Physical Chemistry.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

I am not available to make my presentation monday afternoon and friday afternoon. Thanks !

Talk / **46**

Learning the principal graph of the galaxy distribution

Auteur: Tony Bonnaire[1]

[1] *Institut d'Astrophysique Spatiale*

Auteur correspondant tony.bonnaire@ias.u-psud.fr

In the context of recent and upcoming large-sky galaxy surveys, it is essential to automatically identify features of the Cosmic Web and, in particular, its filamentary pattern. In this presentation, we introduce T-ReX, a framework allowing the extraction of a principal graph from the observed set of galaxies, even in case noisy and heteroscedastic sampling. Based on a regularised mixture model, the method approximates the data manifold by a graph structure acting like a topological prior on the Gaussian clusters paving the galaxy distribution. The procedure is made robust to outliers of the pattern by introducing an additional uniform background component modelling galaxies that should not be represented by the graph structure, like those standing in walls and voids. The overall computation is guaranteed to converge toward a local maximum of the regularised log-likelihood of the probabilistic model using the Expectation-Maximisation algorithm. The proposed method uses a graph prior given by the minimum spanning tree that we extend using random sub-samplings of the dataset to make the topology more general and able to take into account cycles that are observed in the spatial arrangement of matter.

Field:

Cosmology

Day constaints:

Available on Wednesday, Thursday and Friday.

Talk / **24**

Study of the origins of ultra-high-energy cosmic rays

Auteur: Sullivan Marafico[None]

Co-auteurs: Olivier Deligny [1]; Jonathan Biteau [2]

[1] *IJCLAB - CNRS*

[2] *IJCLAB- Université Paris Saclay*

Auteur correspondant sullivan.marafico@universite-paris-saclay.fr

The Pierre Auger Observatory is the largest cosmic-ray observatory to date. It has been built in order to study the most energetic particles in the universe, commonly known as Ultra High Energy Cosmic Rays (UHECR). With a surface of $3,000\,\mathrm{km}^2$(30 times Paris), the observatory detects cosmic rays from $10^{17.5}$ to $10^{20.5}\,\mathrm{eV}$. The energy, the shower depth $\mathrm{X}_{\mathrm{max}}$ (which is linked to the mass), and the arrival direction are reconstructed. In 2017, the observatory observed a large-scale anisotropy at $\mathrm{E} \geq 8 \times 10^{18}\,\mathrm{eV}$, described as a dipole with 5.2σ confidence level, pointing to right ascension $\alpha_{\mathrm{d}} = 100 \pm 10^{\circ}$ and declination $\delta_{\mathrm{d}} = -24^{+12}_{-13}{}^{\circ}$. This direction gives strong evidence for an extra galactic origin of UHECRs. Moreover, in 2018, the collaboration published an indication of intermediate-scale anisotropy at $\mathrm{E} \geq 39 \times 10^{18}\,\mathrm{eV}$ with a 4.0σ significance level. The intermediate-scale anisotropy is found comparing the UHECR sky map with the flux pattern of extragalactic gamma-ray sources (especially Starburst galaxies & Active Galactic Nuclei). To interpret the data, an astrophysical model has been compared to UHECR spectrum and shower depth data, through a method called the Combined Fit. Nuclei are injected according to a production rate and following a distribution of sources. The nuclei propagate through space interacting with the cosmic microwave and infrared backgrounds. The Combined Fit then enables to determine the relative importance of propagation and acceleration in shaping the UHECR composition and spectrum. Starting from the Combined Fit and from arrival directions, I will present how we can include the anisotropies in the Combined Fit to have a model that describes the three main observables: Xmax, spectrum, arrival directions. Such an astrophysical model could constrain the sources in an unprecedented way and could be a key in understanding them.

Field:

Not in the above

Day constaints:

Disponible le lundi, mardi, mercredi.

Talk / **44**

Statistical estimation of the stellar binarity rate using Gaia, in the scope of a microlensing search.

Auteur: Tristan Blaineau[1]

[1] *LAL*

Auteur correspondant blaineau@lal.in2p3.fr

Gravitational microlensing imposes constraints on the massive compact object abundance within the Galactic halo. To estimate the effectiveness of microlensing search analysis, it is necessary to

know the number of stars surveyed. However an identified source in the catalogue can be composed of several stars that could not be separated by the instrument (blending). These stars may be accidentally close along the line of sight or they may be physically bounded, as in the case of binaries. I analyzed the *Gaia* EDR3 data in a purely statistical way using stars between 50 and 500pc to estimate the stellar binarity rate and evaluate its impact on a microlensing search.

Field:

Solar & Stellar Physics

Day constaints:

Talk / **55**

Encoding large scale cosmological structure with Generative Adversarial Networks

Auteur: Marion Ullmo[1]

[1] *IAS*

Auteur correspondant marion.ullmo@universite-paris-saclay.fr

Recently a type of neural networks called Generative Adversarial Networks (GANs) has been proposed as a solution for fast generation of simulation-like datasets, in an attempt to bypass heavy computations and expensive cosmological simulations to run in terms of time and computing power. In the present work, we build and train a GAN to look further into the strengths and limitations of such an approach. We then propose a novel method in which we make use of a trained GAN to construct a simple autoencoder (AE) as a first step towards building a predictive model. Both the GAN and AE are trained on images issued from two types of N-body simulations, namely 2D and 3D simulations. We find that the GAN successfully generates new images that are statistically consistent with the images it was trained on. We then show that the AE manages to efficiently extract information from simulation images, satisfyingly inferring the latent encoding of the GAN to generate an image with similar large scale structures. Finally we show preliminary results for a predictive model.

Field:

Cosmology

Day constaints:

Talk / **18**

Characterizing the atmosphere of two warm Neptune-like planets HD 106315 c and HD 3167 c with the HST/WFC3 Camera

Auteur: Amélie Gressier[1]

[1] *LATMOS/IAP*

Auteur correspondant amelie.gressier@latmos.ipsl.fr

We present an atmospheric characterisation of two intermediate-sized planets: HD 106315 c (R_P=4.98±0.23 R⊕) and HD 3167 c (R_P=2.74±0.11 R⊕) whose results have been published in the ARES IV article, i.e Guilluy et al 2020. We analysed spatially scanned spectroscopic observations obtained with the G141 grism (1.125 - 1.650 μm) of the Wide Field Camera 3 (WFC3) onboard the Hubble Space Telescope. We use the publicly available Iraclis pipeline and TauREx3 atmospheric retrieval code and we found

a strong water spectroscopic signature in HD 106315 c transmission spectrum corresponding to an abundance of log (H_2O)=2.1±0.7 (5.7σ). We also found evidences of water and carbon dioxide in HD 3167 c's atmosphere with log (H_2O)=4.1±0.9 (3.2σ) and log (CO_2)=2.4±0.7 (3.3σ). Different scenarios including additional contribution of clouds, ammonia and carbon bearing species are discussed. HD 106315 c and HD 3167 c will be interesting targets for upcoming telescopes such as the James Webb Space Telescope (JWST) and the Atmospheric Remote-Sensing Infrared Exoplanet Large- Survey (ARIEL).

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

I will not be available February 10th

Talk / **43**

Analysis of two multiple cluster systems detected with SZ effect and observed with VLT/VIMOS

Auteur: Raphaël Wicker[None]

Auteur correspondant raphael.wicker@ias.u-psud.fr

I will present the first analysis of VLT/VIMOS optical data of the two *Planck* detected multiple-cluster systems, PLCKG214.6+37.0 and PLCKG334.8-38.0.
These systems were discovered in 2011 in *Planck* data via their Sunyaev-Zel'dovich (SZ) signal, and their nature of triple-cluster systems was revealed by XMM-*Newton* short observations as part of a follow-up X-ray program for validation of cluster candidates.
The two systems have been the target of dedicated observations in X-rays by XMM-*Newton*, and in optical by the VIsible Multi-Object Spectrograph (VIMOS), mounted on the VLT, in 2012 and 2013.
The analysis of the optical data allowed us to put strong constraints on the redshifts of the galaxies inside the three clusters, showing that the multiple-cluster system was rather a cluster pair in the foreground, and of an isolated cluster in the background.

I will show preliminary results on the galaxy properties as well as gas content of PLCKG214.6+37.0. These multiple-cluster systems are ideal laboratories for the study the fraction of baryonic (or ordinary) matter inside the largest structures of the universe that will be the focus of my research.

Field:

Cosmology

Day constaints:

Talk / **25**

Development of a very high-contrast wavefront control method for the detection of exoplanets with the Nancy-Grace-Roman space mission

Auteurs: Mehdi KOURDOURLI[None]; Laurent Mugnier[1]; Raphaël Galicher[2]

[1] *ONERA*

[2] *LESIA*

Auteur correspondant mehdi.kourdourli@etu.u-paris.fr

The observation of rocky planets and older giant planets requires an attenuation of the star flux by a factor of 10^10 to 10^9. At this level of performance, active wavefront correction is critical to compensate the effects introduced by polishing quality, alignment errors, coronagraphic defects, thermal expansion, etc...

The correction requires, on the one hand, an unbiased measurement of the aberrations before the coronograph and, on the other hand, an algorithm to minimise the intensity of the star in an area of the image called Dark Hole.

Different techniques have been suggested for the measurements and the algorithms, including three techniques that have been tested in the laboratory at spatially representative contrast levels (10^8-10^9): Self-Coherent Camera (Mazoyer et al. 2014), Pair-Wise+Electric Field Conjugation (Give'on et al. 2011) and Speckle Nulling (Trauger & Traub 2007). Two of these techniques have been implemented on the LESIA's THD bench (Potier et al. 2019) but numerical and instrumental simulations are still needed to determine an algorithm optimised for Nancy-Grace-Roman Space Telescope (NGRST). One of the techniques that has not been intensively tested yet is the non-linear Dark Hole algorithm proposed by ONERA. This algorithm theoretically allows to converge to a stable and optimal solution in a very small number of iterations, which would save precious time on instrument calibration.

The PhD project is focused on the optimization of this algorithm, its instrumental validation on the LESIA THD bench and the demonstration of the scientific added value it will provide to the NGRST mission. It is part of a collaboration between ONERA and LESIA supported by CNES. Part of the work will also be dedicated to estimates of the added value provided by such an algorithm on the astrophysical performance of the mission.

Field:

Instrumentation

Day constaints:

Monday afternoon after 2pm
Thuesday all the day
Wednesday before 12:00 pm
Thursday afternoon after 2pm
Not available Friday

Talk / **35**

Martian dust dynamics constrained by OMEGA/Mars Express orbital data.

Auteur: Yann Leseigneur[1]

Co-auteurs: Mathieu Vincendon [1]; Aurélien Stcherbinine [2]

[1] *Institut d'Astrophysique Spatiale*

[2] *Institut d'Astrophysique Spatiale & LATMOS*

Auteur correspondant yann.leseigneur@universite-paris-saclay.fr

Dust is omnipresent within Mars's atmosphere and at its surface. These small (micrometer-sized) particles are one of the major features of Mars modern climate and may also represent a key factor controlling some current surface properties such as composition and activity. Some dust characteristics are still imperfectly unknown, such as the link between dust storms and the seasonal dark flows on Martian surface slopes.

In the first part of the Martian dust dynamics study, we use the observations of the imaging spectrometer OMEGA onboard Mars-Express (orbiter). This instrument has observed the Martian surface during three Martian years (2004-2010) in the 0.3-5.1 μm spectral range. We have developed a new method to detect the presence of dust in the atmosphere in this dataset, which is based on the decrease of the 2 μm CO_2 gas absorption caused by dust scattering. A preliminary version of the detection algorithm (automatized version of the detection method), apply to 10% of the dataset, allow to recover some temporal and spatial characteristics of the dust, such as the typical seasonal atmospheric dust variations. This data also illustrates potential time and spatial correlations between seasonal dark flows and the dust activity.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / 23

Studying the very high energy gamma ray emission at the center of the galaxy.

Auteur: Samuel Zouari[1]

Co-auteurs: Régis Terrier [2]; Anne Lemiere [3]

[1] *APC - Université de Paris*

[2] *APC*

[3] *CNRS*

Auteur correspondant samuel.zouari@etu.u-paris.fr

The galactic center (GC) is one of the most actively surveyed region for very high energy photons (noted VHE, over 100 GeV), by the High Energy Stereoscopic System (H.E.S.S) in our case. In addition to a diffuse emission in the central few 100 pc, one the strongest sources in the gamma ray sky, HESS J1745-290, is located at the GC, and is compatible with Sgr A, *the supermassive black hole at the center of the galaxy, which is highly suspected to contribute to the VHE emission in this region in some form. Though the exact origin of this particular source is still unknown due to the uncertainty on its position and size (both Sgr A* and a pulsar wind nebula are compatible and plausible origins), and although C.T.A (Cherenkov Telescope Array), the next major project for VHE astronomy, is hoped to be able to better identify sources in general, the improvement of data analysis for H.E.S.S and the amount of data collected might allow us to uncover some intrisinc properties of HESS J1745-290 already. For instance, a "short" time scale variability (a few years to a few hours as well) would strongly suggest a black hole origin for this source, since Sgr A* is also known to be subject to regular few-hour flares in X rays and infrared.

Our aim is to exploit the 15 years of H.E.S.S data at our disposal on the GC, as well as new numerical tools, in particular those brought by the gammapy library, to assert both the spectrum of the central source without contamination from the diffuse emission, and whether it has been variable on the year scale during that time. The spectral analysis relies on both spectral and spatial modelisation, which is especially relevant considering the extended diffuse emission covering this region.

We report preliminary results of this analysis about the intrinsic spectrum of HESS J1745-29 and its year to year variability.

Field:

Not in the above

Day constaints:

Lundi, Mardi, Jeudi ou Vendredi

Invited talk / **37**

Invited talk - Cosmology with galaxy clusters

Auteur: Laura Salvati[1]

[1] *OATs-INAF / IAS*

In this talk I will discuss how we can infer cosmological information from the analysis of galaxy clusters. I will consider currently available data, in particular galaxy clusters detected in the mm wavelengths, and propose a forecasts analysis for future missions.

Field:

Cosmology

Day constaints:

Talk / **4**

A graveyard of stars in the core of a bright and dense globular star cluster

Auteurs: Eduardo Vitral[1]; Gary Mamon[1]

[1] *Institut d'Astrophysique de Paris (UMR 7095: CNRS & Sorbonne Université), 98 bis Bd Arago, F-75014 Paris, France*

Auteur correspondant vitral@iap.fr

We analyze proper motions from the Hubble Space Telescope (HST) and the second Gaia data release along with line-of-sight velocities from the MUSE spectrograph to detect imprints of an intermediate-mass black hole (IMBH) in the center of the nearby globular cluster NGC 6397. For this, we use the new MAMPOSSt-PM Bayesian mass-modeling code, along with updated estimates of the surface density profile of NGC 6397. We consider different priors on velocity anisotropy and on the size of the central mass, and we also separate the stars into components of different mean mass to allow for mass segregation.
The velocity ellipsoid is very isotropic throughout the cluster and there is strong evidence for a central dark component of 0.8 to 2% of the total mass of the cluster. However, we find robust evidence disfavoring a central IMBH in NGC 6397, preferring instead a diffuse dark inner subcluster of unresolved objects with a total mass of 1000 to 2000 solar masses, half of which is concentrated within 2% of the stellar effective radius. These results require the combination of HST and Gaia data: HST for the inner diagnostics and Gaia for the outer surface density and velocity anisotropy profiles.
The small effective radius of the diffuse dark component suggests that it is composed of compact stars (white dwarfs and neutron stars) and stellar-mass black holes, whose inner locations are caused by dynamical friction given their high progenitor masses. We show that stellar-mass black holes should dominate the mass of this diffuse dark component, unless more than 80 per cent escape from the cluster. Their mergers in the cores of core-collapsed globular clusters could be an important source of the gravitational wave events detected by LIGO.

Field:

Compact objects (supernovae, black holes, neutron stars)

Day constaints:

Talk / **22**

Direct detection of exoplanets with molecular mapping. Application to MIRI on JWST

Auteur: Mathilde Mâlin[1]

Co-auteur: Anthony Boccaletti [1]

[1] *LESIA*

Auteur correspondant mathilde.malin@obspm.fr

Direct observation is the only way to constrain the physical properties of exoplanet atmospheres. In the case of long period planets, direct imaging is challenging as it requires to achieve very high contrasts. The current generation of instruments are reaching contrast performance that allows us to observe young giant planets (still warm hence bright) that are distant from their host star (to be less contaminated with the star's luminosity). In this context, the Mid-IR Instrument (MIRI) of the James Webb Space Telescope (JWST) due to launch in October 2021 is equipped with a Medium Resolution Spectrograph covering a large spectral range from 5 to 28 microns. At such wavelengths, the star to planet flux contrast is more favorable than in the near IR and provides access to molecular signatures that are relevant to characterize exoplanet atmospheres at a spectral resolution as large as 3500. We are investigating the feasibility to retrieve those molecules with a method called "molecular mapping"which is designed to disentangle spectrally and spatially the light from the star and that of the planet. We will present preliminary results of performance estimation based on simulations of JWST observations.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / 15

Seismic analysis of red giants on the Asymptotic Giant Branch

Auteur: Guillaume Dréau[None]

Co-auteurs: Benoît Mosser [1]; Yveline Lebreton [2]

[1] *LESIA*

[2] *LESIA/Univ. de Rennes*

Auteur correspondant guillaume.dreau@obspm.fr

The success of the CoRoT and Kepler space-borne missions has opened a new era for stellar phys-ics. Indeed, thanks to the long four-year time series of Kepler, it is now possible to decipher in detail the oscillation spectrum of evolved giants. The information contained in these oscillation spectra, which has never been precisely studied so far for evolved red-giant branch (RGB) and asymptotic-giant branch (AGB) stars, is of major importance to probe the inner stellar structure, which is poorly probed only with spectroscopy. Here we show that seismology can be used to disentangle AGB from RGB stars, opening new prospects for precise stellar physics.

In this context, we considered the acoustic modes that develop in stellar interiors and we performed a thorough analysis of the oscillation spectra of ~ 2.000 evolved giants, including RGB and AGB stars. We could extract their oscillation mode properties (i.e. frequencies, amplitudes, widths) and infer the asteroseismic constraints by using a model based on the asymptotic pressure-mode pattern of red giants. My presentation will be focused on the physical differences between RGB and AGB stars involving the second helium ionisation zone (HeII), which is a region that exhibits a strong gradient in the first adiabatic exponent profile. First, I will highlight the significant differences we find in the typical signature of HeII in mode frequencies. Then, I will illustrate the prospects of

constraining stellar models of evolved RGB and AGB stars with seismic observations using the stellar evolution code MESA and the oscillation code ADIPLS. This will allow us to address the physical conditions inside those stars and to distinguish them, hence enhance our understanding of stellar evolution.

Field:

Solar & Stellar Physics

Day constaints:

Invited talk / **52**

SpaceBus France

Auteur: The SpaceBus team[None]

Talk / **30**

Turbulence and Heating in space plasma

Auteur: Pauline Simon[1]

[1] *LPP*

Auteur correspondant pauline.simon@obspm.fr

Voyager 2 revealed that the solar wind ion temperature decreases (up to 40 AU) slower than what is expected from the adiabatic radial expansion model of the wind. A possible answer to this discrepancy is a local heating allowed by turbulence. Indeed, in turbulence theories energy contained at large scales cascades to smaller scales (because of the nonlinearities in the system) until it is eventually dissipated at the smallest scales (by some kinetic effects) into particle heating. Understanding turbulence is therefore the way to better understand the solar wind heating problem.
We tackle this problem using fluid models and the formalism of the exact law introduced by Kolmogorov in 1941. We derive the most general laws to date that govern compressible Hall-MHD turbulence, test them in numerical simulations before we apply them to in-situ observations provided by Paker Solar Probe (PSP) or the Magnetospheric Multiscale Mission (MMS). PSP is a single satellite orbiting since 2018 closer and closer to the Sun, whose main objective is the study of the solar corona and the inner solar wind. MMS is a cluster of four satellites orbiting in the Earth's magnetosphere since 2015.
In this talk, I will introduce the interest of leading such studies then discuss briefly my main results.

Field:

Solar & Stellar Physics

Day constaints:

Talk / **3**

Evidence of a new component in the Martian 3 µm water band under North polar latitudes

Auteur: Aurélien Stcherbinine[1]

Co-auteurs: Mathieu Vincendon [2]; Franck Montmessin [3]; Pierre Beck [4]

[1] *IAS / LATMOS*

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[3] *LATMOS*

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Auteur correspondant aurelien.stcherbinine@u-psud.fr

Mars is known to present a widespread absorption band in the 3 µm spectral range. Related to water or aqueous hydration of a mixture, it has been used in previous studies to retrieve the surface hydration of the Red Planet, using observations of the OMEGA instrument onboard Mars-Express, that has been providing a global mapping of the Martian surface in the $0.3 - 5.1$ µm spectral range from 2004 to 2010. These studies have revealed an overall increase of the water hydration in the polar regions. Several hypotheses currently exist to explain this phenomenon, but the exact nature of this water enhancement is not yet fully understood.
Here, we present the first results of our study showing evidence of an additional component in this 3 µm band that only appears under Northern latitudes. As this signature has been observed to be stable across the years, we currently favor the hypothesis of a specific stable component. However, no clear association with other IR signatures has been firmly identified so far. Further investigations are required to fully understand this signature, but it may be of importance in the search for the origin of the strong increase of surface aqueous alteration in the Martian polar regions.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / 21

Can we prove the quantum origin of cosmic inhomogeneities ?

Auteur: Thomas Colas[1]

[1] *IAS/APC*

Auteur correspondant thomas.colas@universite-paris-saclay.fr

One of the most striking predictions of the standard model of cosmology is to trace back the origin of cosmic inhomogeneities that seed the Cosmic Microwave Background anisotropies and the Large-Scale Structures of the universe to quantum fluctuations of the primordial vacuum. Yet, the quantum nature of the inhomogeneities has not been experimentally proven so far. Before thinking of an experiment that would reveal this quantum origin, one needs to know if any quantum signature has survived the travel from the early universe to our detectors. In this talk, I will present one of the obstacles we may face in order to achieve such an experiment. When a quantum device is embedded in a wider environment, quantum decoherence takes place and information is lost in the environmental degrees of freedom. This loss of coherence makes it difficult to maintain quantum signals on macroscopic scales. I will show why this phenomenon is also likely to happen in the early universe and discuss its consequences on the generation of cosmic inhomogeneities.

Field:

Cosmology

Day constaints:

I can make a presentation on :
- Monday afternoon from 2pm
- Tuesday morning before 12:30pm
- Wednesday all day
- Thursday morning before 12:30pm
- Friday all day

Talk / **40**

Simulating interferometric signals and testing TDI for the LISA space mission

Auteur: Leon Vidal[None]

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Gravitational waves are very small variations of space-time metric which can be detected with high precision laser interferometry. The LISA method consist of measuring distance fluctuations between free-falling test masses.
As with any detector, signal to noise ratio has to be optimised. In actual ground-based interferometers like LIGO/VIRGO experiment, sensitivity is limited by seismic and quantum noises. In the LISA case, the raw measurements are burried within the laser frequency noise. Actually, due to the LISA constellation geometry, the phase fluctuations due to the laser instabilities dominate by 8 orders of magnitude the gravitational wave signal.
A noise reduction method named Time Delay Interferometry (TDI) was developped in the 90's. Recombining in post-processing the interferometric signals, it will remove the laser frequency noise of future LISA data. This algorithm is crucial for the success of the LISA mission and needs to be tested with simulated data before launch.
For several years and with the support of CNES, an electro-optical bench for metrological demonstration named LOT (for "LISA On Table") has been set up at APC. The objective of this bench is to demonstrate experimentally several aspects of TDI, characterize its frequency response and assess the noise residuals. According to the last results, TDI works properly with a reduction factor of the laser frequency noise around 10 7 for the optical interferometer and 10 8 for the electronical interferometer, using TDI 1.0 for a simplified static LISA constellation. These results and future improvement of the LOT allowing to simulate Doppler and Sagnac effects in order to test TDI 2.0 will be presented.

Field:

Instrumentation

Day constaints:

Talk / **19**

Analysis of organic matter and mineral phases in bulk chondrites by MIR Reflectance Hyperspectral Imaging

Auteur: Yann Arribard[1]

[1] *IAS*

Auteur correspondant yann.arribard@universite-paris-saclay.fr

The study of chondrites gives a lot of information about the formation and the evolution of the early solar system. The organic matter contained in those chondrites is particularly interesting. Usually, the organic matter is extracted from the meteorite matrix, what could possibly alter or modify it and inevitably make loose the information of mineral phases. To preserve this precious information and better understand the history of the organic matter, it is necessary to carry out analysis in situ, i.e. directly on the mineral context.
I will present the infrared (IR) reflectance and Raman analysis of slice of different chondrites: two carbonaceous chondrites (Paris: CM2.8 and Cold Bokkeveld: CM2.2) and one ordinary chondrite (Tuxtuac: LL5). The IR imaging spectroscopy allow to characterize and localize the mineral phases and the organic matter without altering them. In addition, I will expose the new hyperspectral data processing I used in order to localize the C-H band of the organic matter inside the mineral matrix in relatively extended surface areas (> 500x500 μm^2). Indeed, the C-H stretching modes give very weak signature in IR reflectance which make the detection of these bands very difficult.

Field:

Not in the above

Day constaints:

Disponible : Lundi, Mardi, Jeudi matin, Vendredi

Invited talk / **39**

Invited talk - The search for exoplanets in radio

Auteur: Philippe Zarka[1]

[1] *LESIA, CNRS - Observatoire de Paris - PSL*

Auteur correspondant philippe.zarka@obspm.fr

Even before the discovery of the first exoplanet in 1995, radio observations inspired by the intensity of Jupiter's radio emissions had begun. They proved to be extremely difficult, but also motivated the development of ever larger antenna arrays. The theory rather predicts emissions at low radio frequencies and of very low intensity. But the predictions are subject to large uncertainties on both intensity and emitted frequencies, and there was no guarantee that these radio emissions could be detected before the advent of SKA. In recent months, several papers have suggested that the tip of the radio detection iceberg is now emerging above the galactic background. If these detections are confirmed, they will open up a new and promising field of study: comparative exo-magnetospheric physics, i.e. the physics of star-planet plasma interactions. In this field, we know only 6 planetary magnetospheres in the solar system, all quite different from each other. The detection of tens or hundreds of analogs will be a revolution comparable to the one that the discovery of exoplanets' orbital parameters has brought to solar system formation models. I will make a brief review of the theoretical bases of this research, an inventory of the observations with emphasis on recent detections, and I will give some perspectives.

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Talk / **36**

Electromagnetic electron hole generation : theory and PIC simulations

Auteurs: Gaetan GAUTHIER[1]; Olivier LE CONTEL[2]; Thomas CHUST[3]; Philippe SAVOINI[4]

[1] *LPP*

[2] *LPP CNRS*

[3] *LPP- CNRS*

[4] *LPP-SU*

Auteur correspondant gaetan.gauthier@lpp.polytechnique.fr

Recent MMS observations exploring various regions of the magnetosphere have found solitary potential structures call Electron phase-space Hole (EH). These structures have kinetic scale (dozens of Debye lengths) and persist during long time (dozens of plasma frequency periods). EH are characterized by a bipolar electric field parallel to ambient magnetic field and fastly propagate along this latter (a few tenths of speed light).

We have created a 3D Bernstein-Greene-Kruskal (BGK) model adapted to various magnetospheric ambient magnetic fields. BGK model results depend on choice of potential shape and passing distribution function at infinity (before EH potential interaction).

2D-3V Particle-In-Cell simulations have been developed with the fully kinetic code Smilei using real magnetosphere plasma parameters. Solitary waves in the magnetotail are three-dimensional potentials which can be generated through nonlinear evolution of an electron beam instability. We have also investigated the EH formation with density inhomogeneities using a BGK stability model we have developed. Indeed, density inhomogeneities exist notably in interplanetary plasmas.

Field:

Solar & Stellar Physics

Day constaints:

Talk / **10**

NAROO-AST : PRECOVERY OBSERVATIONS AND IMPACT PREDICTIONS OF NEAR EARTH ASTEROIDS

Auteur: Anne-Charlotte Perlbarg[1]

Co-auteurs: Vincent Robert [1]; Josselin Desmars [1]; Daniel Hestroffer [2]

[1] *IMCCE/IPSA*

[2] *IMCCE*

Auteur correspondant anne-charlotte.perlbarg@obspm.fr

Near Earth Asteroids represent a real danger for the Earth. An impact of a Potentially Hazardous Asteroid could have catastrophic consequences. The knowledge of the actual dynamic of Potential Hazardous Asteroids is essential for the purpose of an international program of planetary defense. In this respect, accurate astrometric measurements acquired over a large time span are crucial to provide reliable orbits and impact predictions and to detect small accelerations such as Yarkovsky effect. This in particular includes precovery observations. The NAROO digitization centre (1)(2) is dedicated to the digitization and the analysis of old astronomical observations on astrophotographic plates. Digitizations are made with a high precision digitizer composed of high-resolution camera and a plate holder mounted on an air cushion table moving on granite based out of vibrations. Glass plates up to 35 cm wide can be digitized. The resulting digitization has an accuracy better than 65 nm for the measurements. Astrophotographic plates constitute a source of old observations of solar system objects including Potential Hazardous Asteroids. Some of these old observations are precovery observations of these objects. The existing databases gather all the metadata of the past observations such as date, hour, right ascension, declination and exposure which are essential to

retrieve all the objects present in the observation. New orbit solutions of a selection of Potential Hazardous Asteroids were done from their positions on astrophotographic plates, thanks to the identification of their old and/or precovery observations among databases and to their new reduction with Gaia catalog. It shows an improvement of the accuracy of their new ephemeris 2 to 10 times better depending on the asteroid hence the interest of using these old observations. Next step will be not only to detect and to quantify small perturbations affecting asteroids such as Yarkovsky effect but also to refine accurate impact predictions thanks to these new orbital solutions.

(1) The NAROO digitization centre, V. Robert et al., upcoming paper
(2) NAROO webpage : https://omekas.obspm.fr/s/naroo-project/page/home

Field:

Planetology (including small bodies and exoplanets)

Day constaints:

Not available on the 2021/02/10 and on the 2021/02/11.

Talk / **38**

Impact of metal-enrichment on the fraction of ionizing photons leaking from the interstellar medium

Auteur: Lise RAMAMBASON[1]

Co-auteur: Vianney LEBOUTEILLER [1]

[1] *CEA/AIM*

Auteur correspondant lise.ramambason@cea.fr

Part of the ionizing continuum (Lyman continuum, LyC) produced by young stars can leak out of its host galaxy and ionize its surroundings. At high redshift, constraining the contribution of such LyC-leaking galaxies to the total ionizing budget is crucial as several studies consider primordial, low mass galaxies as the best candidates to explain the origin of reionization. Indeed, simulations (e.g. Robertson et al. 2013, Rosdahl et al. 2018) show that leaking galaxies with average escape fraction between 10 and 20% could fully account for the reionization without invoking any contribution from other sources (e.g. luminous active galactic nuclei, AGN). However, direct measurements of the escape fractions are extremely difficult as the leaking photons are easily absorbed by the intergalactic medium (IGM); they are only possible in a very narrow redshift range and suffer from large measurement uncertainties (e.g. measured along a single line of sight).

Instead, indirect tracers such as the Lyman alpha line (Verhamme et al. 2015, Kakiichi et al. 2019) or absorption lines (Gazagnes et al. 2018, Chisholm et al. 2020) have been used to probe the structure of the ISM but such methods are also sensitive to line of sight variations and absorption effects from the IGM. Using emission lines in the optical and infrared range allows to get rid of viewing angle dependencies but a complex modelling step is needed to disentangle the emission arising from different phases (ionized gas, photo-dissociated region, molecular phase and diffuse ionized gas) merged in a single beam. This method is promising as current ground-based facilities (e.g. ALMA) and up-coming missions (e.g. JWST) will grant access to spectroscopic tracers up to redshift above 7. Meanwhile, local, metal-poor, galaxies are ideal environments to study the mechanisms at play in primitive conditions.

I will hence present a grid of Cloudy (Ferland et al. 2017) models to investigate low-metallicity galaxies using a combination of different sectors, some of them being density-bounded and including the potential contribution of X-ray sources. To successfully constrain the parameters of this predictive representative galaxy model, I co-developped MULTIGRIS (Lebouteiller et al. in prep) a new Bayesian code using Monte Carlo sampling, including additional constraints through priors

and upper limits. Among the various applications, MULTIGRIS can produce probability density functions of any physical parameters directly or indirectly available in Cloudy (ionizing photon escape fraction, dust mass, H2 mass etc...).

I will present here a first application on the local, low metallicity Dwarf Galaxy Survey (Madden et al. 2013), examining the complex dependencies of the escape fractions with various parameters and especially how metallicity impacts the inferred escape fraction.

Field:

InterStellar Medium

Day constaints:

Talk / **17**

Development of a Closed Cycle Dilution Refrigerator for future astronomical missions

Auteur: Valentin SAUVAGE[None]

Auteur correspondant valentin.sauvage@ias.u-psud.fr

The use of stable sub-Kelvin coolers is a key technology in order to reach the highest sensitivity that astrophysical space missions can offer. Historically, few instruments (e.g. Planck HFI or Hitomi SXS) required temperature down to 100 mK. Currently, two technologies can provide such temperatures in a space environment: ADR (Adiabatic Demagnetization Refrigerator) and OCDR (Open Cycled Dilution Refrigerator). For CMB observations, the next generation of satellites (e.g. LiteBIRD) will require the highest stability and continuous temperature operation. For now, only the OCDR can reach such requirements but with a limited lifetime as this cooler is making use of a limited quantity of He3 and He4 isotopes which mixture is then wasted in space. Planck-HFI observations were then limited to 2.5 years.
I am working on the design and development of a new dilution system (CCDR - Closed Cycle Dilution refrigerator) for which the He3-He4 mixture will be recycled and separated in order to avoid large quantities of helium to be embarked and to extend the sub-K cooler lifetime.

Field:

Instrumentation

Day constaints:

Except 9th and 10th