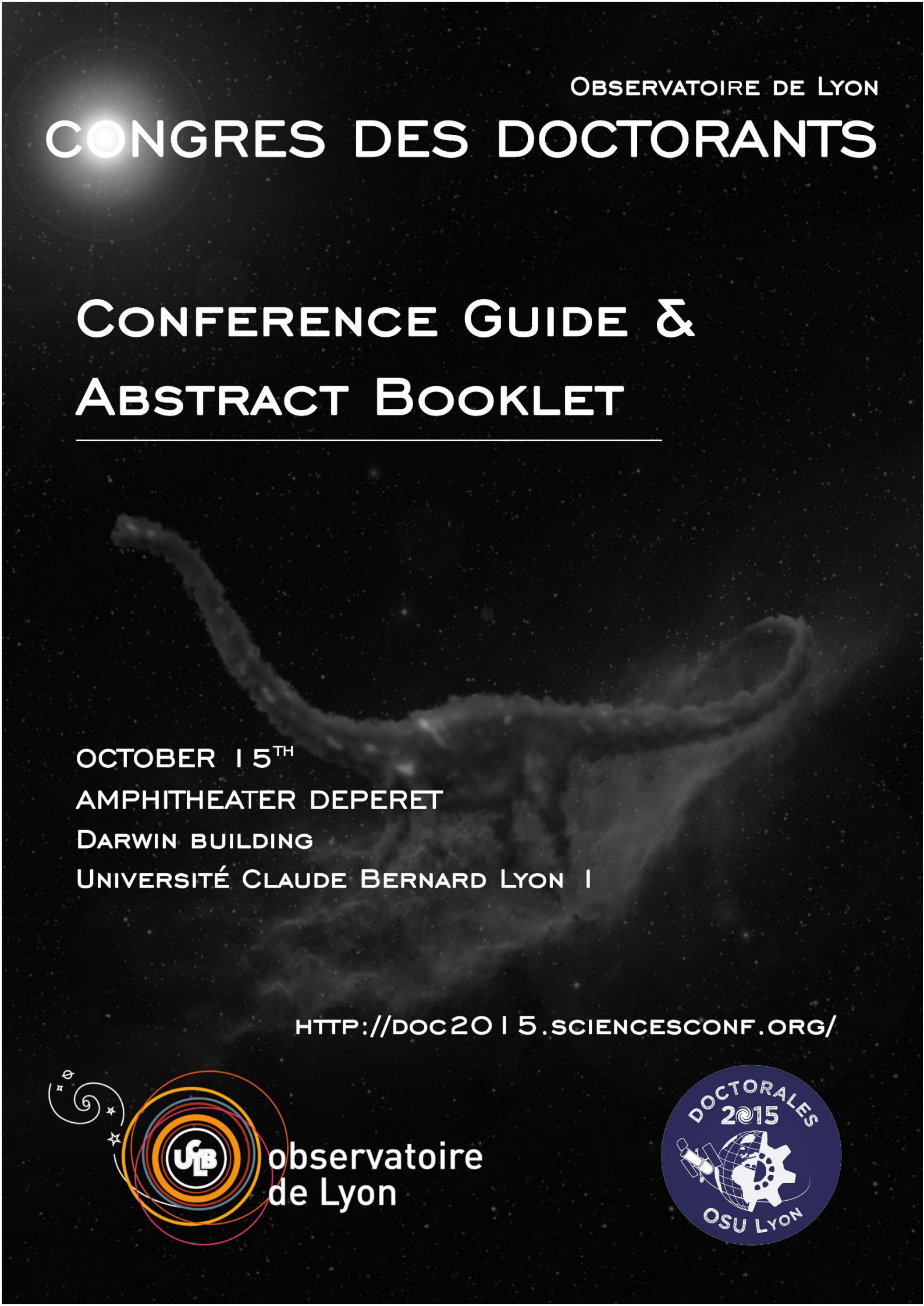
Observatoire de Lyon

Congres des doctorants

Conference Guide & Abstract Booklet



October 15th
Amphitheater Deperet
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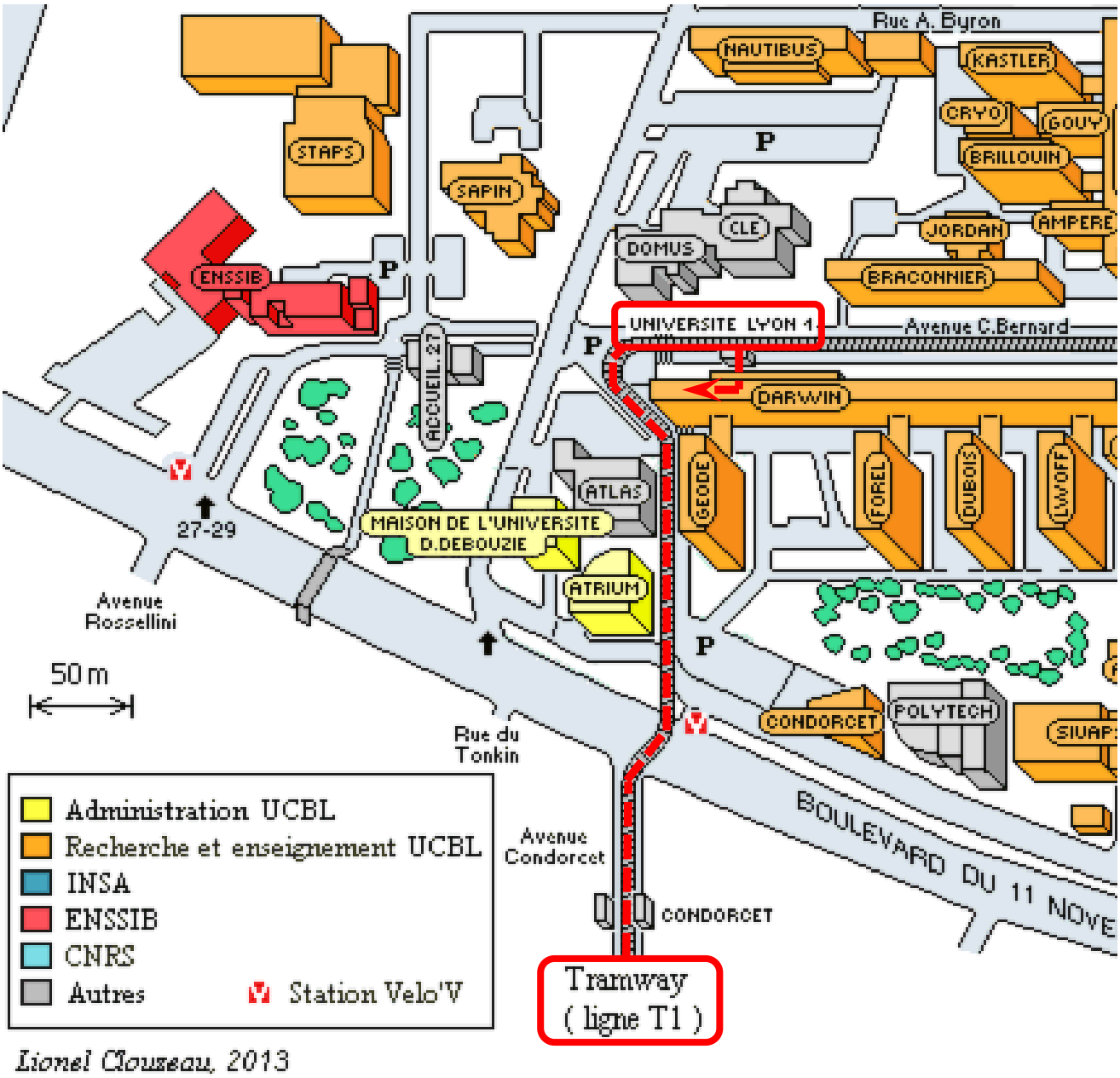
Doctorales 2015 OSU Lyon

Table of contents

Access map	**p.3**
Program	**p.4**
Abstracts Session 1: Extragalactic	**p.6**
Abstracts Session 2: Bio-geochemistry	**p.12**
Abstracts Session 3: Deep Earth	**p.16**
Abstracts Session 4: Planetary sciences	**p.24**
Abstracts Poster Session	**p.30**

Access map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Program

08:30 – 09:00	**Reception of the congress participants**
09:00 – 09:15	Welcoming speech
09:15 – 10:30	**Session 1: Extragalactic**
09:15 – 09:30	Supersymmetric Dark Matter (G. Robbins)
09:30 – 09:45	Automatic selection of multiple images in a deep galaxy cluster field of view (G. Mahler)
09:45 – 10:00	Study of distant faint galaxies in galaxy clusters (J. Martinez)
10:00 – 10:15	Resolved properties of high-redshift lensed galaxies (V. Patricio)
10:15 – 10:30	The lyman alpha dress of galaxies (F. Leclercq)
10:30 – 11:00	**Coffee break**
11:00 – 11:45	**Session 2: Bio-geochemistry**
11:00 – 11:15	The hydrothermal reactivity of glycine: a Raman study for the origin of life (U. Pedreira)
11:15 – 11:30	Calcium isotopes in dental enamel and dietary transitions in Human (T. Tacail)
11:30 – 11:45	The Out of Water of First Tetrapods: Insight from Sulphur Stable Isotope Analysis (J. Goedert)
11:45 – 12:00	**Session 3: Deep Earth (part 1)**
11:45 – 12:00	Fluid-rock interactions in subduction zones (H. Pilorgé)
12:00 – 13:30	**Buffet lunch, poster session**

13:45 – 14:00	**Presentation of the « Service de Diffusion des Savoirs de l'OSU » (C. Vilatte)**
14:00 – 15:15	**Session 3: Deep Earth (part 2)**
14:00 – 14:15	Subduction drives the size of Earth's tectonic plates (C. Mallard)
14:15 – 14:30	Geoid and true polar wander in convection models with plate tectonics (M. Arnould)
14:30 – 14:45	Global attenuation model of the upper mantle (A. Adenis)
14:45 – 15:00	The properties of silicate melts at high pressures and temperatures (A. Seclaman)
15:00 – 15:15	A tracers methods for studying double diffusive convection in the liquid layers of planetary interiors (M. Bouffard)
15:15 – 15:45	**Coffee break**
15:45 – 16:45	**Session 4: Planetary sciences**
15:45 – 16:00	Evolution of the porosity of the grains during their growth: a solution to planetary formation? (A. Garcia)
16:00 – 16:15	3D simulations of protoplanetary disks with 2 planets: the case of HD100546 (N. Cuello)
16:15 – 16:30	Sr and Ba nucleosynthetic anomalies in meteorites (E. Yobregat)
16:30 – 16:45	Thermoelastic properties of superionic water (J.-A. Hernandez)
16:45 – 17:00	Closing speech
17:00 -	**Poster session**

Abstracts – Session 1:

Extragalactic

Supersymmetric Dark Matter

G. Robbins[1]

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The existence of dark matter, this invisible mass in the Universe, is supported by various observational evidences, from galaxy rotation curves to the analysis of the cosmic microwave background. However, the Standard Model (SM) of particle physics contains no particle with the necessary characteristics to account for dark matter. Therefore, theories beyond SM, such as Supersymmetry, which postulate the existence of new particles, are needed. The neutralino is one of the new particles introduced by supersymmetry and could be a perfect candidate for dark matter. However, the simplest model of supersymmetry has more than 100 free parameters. It is therefore necessary to constrain these parameters to know if the neutralino has a chance to be detected by the current experiments of dark matter detection. It can be done, to a certain extent, by combining the results that have emerged from both dark matter detection experiments and colliders.

Automatic selection of multiple images in a deep galaxy cluster field of view

G. Mahler[1]

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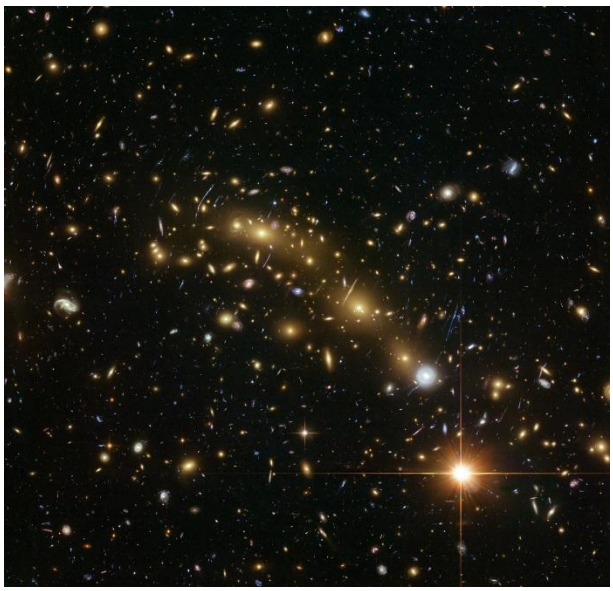
Probing the central mass distribution of massive galaxy clusters is an important step towards mapping the overall distribution of their dark matter content. Thanks to gravitational lensing and the appearance of multiple images, we can constrain the inner region of galaxy clusters with a high precision. The Frontier Fields program conducted with HST telescope (FF) provide us the deepest data ever in such clusters.

In such massive clusters you would see multiple images of the same background galaxy, this effect appear because the inner part of the galaxy cluster is massive enough to bend the path of light and give you the illusion of at least two objects.
Currently, we faced a challenge, most multiple-image systems are found by eye, yet in the FF program, we expect hundreds of them.
Thus, In order to deal with such huge amounts of data, we need to develop an automated detection method. I present a new tool to perform this task, MISE (Multiple Images SEarcher), a program which identifies multiple images by combining their specific properties. There are known to have a) similar colors, b) similar surface brightnesses, and c) appear in locations predicted by a specific lensing configuration.



Color image of galaxy cluster MCS J0416.1 - 2403

Study of distant faint galaxies in galaxy clusters

J. Martinez[1]

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I will present a way to study low-mass galaxies even lower than the actual limit, by using the gravitational lensing. But to make use of the gravitational lensing effect, we need to observe objects through galaxy clusters. And for low spatial resolution images it can happen that interesting objects are blended with cluster galaxy. The aim of my work is to use the information of cluster galaxy on high spatial resolution images, to deblend the low spatial resolution image and study the interesting object.
Firstly, I will introduce the general method I worked on during my master internship, why is it needed and in which cases. I will briefly present the different software I used and illustrate the method by focusing on one object in the galaxy cluster MACS0744. This allowed us to build its Spectral Energy Distribution (SED) and derive its physical properties such as its mass. The limits of the method will be discussed.
Secondly I will present my PhD project, what I did until now, what are the next steps and what are the objectives. I will present the several improvements done until now and their results, especially for a galaxy-galaxy lensing system study where the multiple images and the cluster galaxy are very blended. You will see how the method handle that and how I helped it, and the improvement of the result.
Finally I will conclude briefly by presenting the advantage of such a method, and how I will use it to study low mass galaxies.

Resolved properties of high-redshift lensed galaxies

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Gravitational lensing gives us a unique opportunity to see extremely far galaxies in high detail. A spectacular class of such lensed sources are galaxies which are so magnified that are seen as very extended arcs. These constitute unique objects where to study spatially resolved properties, in particular kinematics, which provides us additional clues to understand galaxy evolution. In my talk, I'll present the first results on a sample of 8 arcs, derived from Hubble Space Telescope images and spectra obtained with the Multi Unit Spectroscopic Explorer, installed in the Very Large Telescope.

The lyman alpha dress of galaxies

F. Leclercq[1]

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Understanding galaxy evolution is a long-standing problem. Current assumptions are mainly based on numerical modelisations suggesting that a galaxy interacts with its environment through gas inflows and outflows. These gas exchanges, by modifying the quantity of gas within the galaxy, may impact the star formation rate and thus influence the evolution of the galaxy. Considering that gas is extended beyond galaxies, we assume that they could be all linked together in a larger scale structure called the cosmic web.

I will show you the first results of the study of the extended gas, called 'halos', around galaxies observed with the Multi-Unit Spectroscopic Explorer (MUSE).

Abstracts – Session 2:

Bio-geochemistry

The hydrothermal reactivity of glycine: a Raman study for the origin of life

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The abiotic formation of oligopeptides is a major requirement for the emergence of enzymatic activity and the first metabolic pathways of life. In water, the polymerization reaction is considered unfavorable, but close-to-equilibrium dehydration of the system is possible under hydrothermal conditions. Unactivated amino acids in solution, under such conditions, (i) are degraded to simpler molecules such as carbon dioxide, methane, dihydrogen; (ii) polymerize linearly producing longer oligomers; (iii) form diketopiperazines by cyclization of the dimer product. The last pathway is considered to be a dead end for the evolution of the system. Hence, we focus our study on the dimerization step of the reaction and intend to understand what physical and chemical parameters control the ratio of linear to cyclic dimers produced from a non-activated solution of an amino acid monomer. We submitted the simplest amino acid, glycine (Gly), to high temperature and high pressure conditions, up to 300C and 30 kbars, in aqueous solution using a diamond anvil cell and analyzed its fate in situ using high resolution Raman spectroscopy. This technique allows us to discriminate accurately between the products formed during the experiments without the potential bias of the quenching of the sample. Our first results suggest that temperature activates polymerization and degradation of the monomer whereas pressure can stabilize the starting material and inhibit further reactions. Moreover, under some conditions, polymerization can form the linear dimer in greater quantity than the cyclic one, which has never been shown in literature to our knowledge. One of the experiments produced up to 10% of linear diglycine against 1% of cyclic dimer. Further work is still needed in order to understand this crucial step in polymerization, but these preliminary results demonstrate the strong potential of the method we used in order to analyze the fate of amino acids under hydrothermal conditions.

Keywords: Glycine, Raman spectroscopy, polymerization, origin of life

Calcium stable isotopes in dental enamel and dietary transitions in Human

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The chemical and isotopic toolbox for reconstruction of early-life dietary transitions in palaeontology and especially in human archaeology is restricted to a few systems. The enamel of the different human deciduous teeth form successively in utero, after birth (during milking) and after weaning of the child. Human milk displays an extreme calcium (Ca) isotopic composition (expressed using $\delta^{44/42}$Ca, in unit). Contrarily to average diverse diet of adults ($\delta^{44/42}$CaICP = - 0.40), human milk shows one of the most 44Ca-depleted compositions ($\delta^{44/42}$CaICP = - 1.60) measured so far. Our project aims to test the hypothesis that Ca of deciduous tooth enamel records variations in Ca sources during early-life, both along the enamel growth axis and during the formation of the entire deciduous dentition, from a tooth to another. We explored the spatial variations of $\delta^{44/42}$Ca in enamel of deciduous tooth series and in wisdom teeth from modern humans, knowing their early-life history. The enamel being made of up to 40% wt. of Ca, sampling of only 60 µg bioapatite using micro-drilling technique is required for classical mass-spectrometry analysis. Also, a method for in situ measurement of $\delta^{44/42}$Ca in enamel using Laser Ablation technique was developed. Results show that the $\delta^{44/42}$Ca values increase systematically from early formed dental crowns to lately formed enamel of second premolars. These observations are compatible with a Ca source change from milk to a standard adult diet, reflected by the higher values of wisdom teeth, that form from 4 to 15 years old. Calcium isotopes constitute a promising isotopic marker for study of milking and weaning ages in past populations.

Keywords: Isotopes stables, Calcium

The Out of Water of First Tetrapods: Insight from Sulphur Stable Isotope Analysis

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Vertebrate evolution has been punctuated by many episodes of major ecological transition between terrestrial and aquatic environments. These episodes are very brief regarding geological timescale but are nonetheless of paramount importance as many of them set up the roots of major evolutionary radiation among vertebrates. However, these ecological transitions remain very often poorly understood. Indeed, fossil remains are rarely complete and thus their morpho-anatomical characteristics can be difficult to interpret in term of living environment. Furthermore, the sediments that contain the fossil remains do not necessarily correspond to those of their living environment. In this context, the analysis of sulphur isotope composition ($\delta^{34}S$) of biologic tissues can be very useful to decipher the living environment of organisms. Indeed, marine, freshwater and terrestrial environments have sulphur isotope compositions very different. Those isotope fingerprints can be recorded in animal tissues as it grows up in a particular environment. The method has already proved to be valuable when applied to the soft tissues of present-day organisms. However, due to technical difficulties, it remains to be developed for skeletal tissues, precluding until now its application to the fossil record. Thus, I am trying to develop the analysis of sulphur isotope composition in skeletal tissues in order to open up a new field of palaeoenvironmental investigations. I will first calibrate this tool using present-day skeletal tissues from many vertebrates. Then, I will apply this tool to fossil skeletal tissues in order to test the preservation of the original isotopic signal. Finally, this tool will be used to shed some light on the first major ecological transition in vertebrate history: the out of water of the first tetrapods.

Keywords: Sulphur isotopes, First tetrapods

Abstracts – Session 3:

Deep Earth

Fluid-rock interactions in subduction zones

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Fluid circulations are a major feature for subduction zone dynamics. In the mantle wedge and along the subducting plate interface, seismologists observed tremors, which constitute a type of earthquakes induced by fluid circulations. The slab ejects fluids during subduction when temperature and pressure conditions affect the stability of hydrated minerals of the slab. This hydrates the overlying mantle and forms serpentine, which is a hydrated phyllosillicate. Some authors assume that once ejected, the aqueous fluids reach the mantle wedge by travelling along the plate interface through this serpentinite layer. But the pathways of these fluids are poorly understood, as well as fluid-rock interactions at the temperature and pressure conditions of the plate interface (T = 300-600C and P = 1-5 GPa). To understand the fluid-rock interactions at these conditions, we ran experiments at high pressure and high temperature on serpentinite samples mixed with Ni powder. Scanning electron microscopy (SEM) associated with energy-dispersive X-ray spectroscopy (EDX) reach resolutions large enough to observe the Ni-rich recrystallizations occurring during the experiment. These recrystallizations are also visible on natural samples, showing that variations of fluid pressure and local precipitation-dissolution thresholds control opening and closing of circulation paths between grains.

Keywords: serpentine, antigorite, subduction zones, recrystallizations, high pressure experiments

Subduction drives the size of Earth's tectonic plates

C. Mallard[1]

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The plate tectonic theory splits the Earth surface into 7 (Le Pichon 1967) to 52 tectonic plates (Bird 2003). These plates are separated into two groups: the first of 7 large plates and the second of numerous smaller plates (Morra et al 2013). Previous studies using the reconstruction of the past 200 My, suggest that the size of large plates is driven by mantle flow (Van der Meer et al 2009). But the tools employed are descriptive, hence ignoring forces and physical principles within the lithosphere and the mantle. The processes at the origin of the small plate size remain unknown.
We developed a new approach to study the origin of plate sizes. We demonstrate that the physics of convection drives it. We applied plate tectonics theory on 3D spherical convection models generating plate-like motions, which give access to a complete survey of data: velocities, viscosity and heat flow.

I will show that (1) the large plates depend on the dominating scale of the convective flow due to the initiation or the shutdown of subductions; (2) the smaller plates are generated thanks to large variability of regional stresses along subduction zones by slab pull and suction influenced by the geometry of trenches.
Our results are consistent with the quick reorganizations of back-arc basins occurring synchronous with the modification of subduction zones geometry around the Pacific plate (Sdrolias et al 2004). Hence, we conclude that (1) the decreasing numerous of small plates in the plate reconstructions back in time (Morra, seton) is an artifact induces by their short-lived that is why they are artificially ignored; (2) the geometry of past trenches is simplified allowing an underestimation of length of subduction zones. Our results explain why the observed seafloor-spreading record in small back-arc plates strongly reflects dramatic changes in plate motions during times of major plate reorganizations. Our study opens the way to use convection simulations with plate-like behaviour to unravel how global tectonics and mantle convection are dynamically connected.

Geoid and true polar wander in convection models with plate tectonics

M. Arnould[1]

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For the last fifty years, geodynamicists have tried to reconcile the kinematic plate tectonics theory derived from surface observations, with the dynamics of mantle convection, described by continuum mechanics, especially thanks to numerical modelling. With our team Augury, we aim at redefining the ways to reconstruct the Earth's mantle evolution thanks to Data Assimilation methods using a broad set of Earth data and state-of-the-art geodynamic models of mantle convection. During the first part of my PhD, I will focus on the development of a set of models of mantle convection generating surface plate tectonics, sufficiently complex to explain Earth global observations, such as its geoid (which is the Earth shape), and true polar wander (which is the relative motion between the Earth rotation pole axis and the mantle frame of reference). Both signals are linked to mantle internal density heterogeneities distribution and evolution through time and thus represent interesting observations of mantle dynamics and history. In particular, I will study the influence of the presence of continents at the surface of the Earth and thermo-chemical heterogeneities at the base of the mantle on the convection regime in free models, in order to evaluate their role in the geoid and true polar wander.

Keywords: geodynamic modelling, plate tectonics, geoid, true polar wander

Global attenuation model of the upper mantle

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We present a three-dimensional shear attenuation model based on a massive surface wave data-set (372,629 Rayleigh waveforms analysed in the period range 50-300s by Debayle and Ricard, 2012). For each seismogram, this approach yields depth-dependent path average models of shear velocity and quality factor, and a set of fundamental and higher-mode dispersion and attenuation curves. We combine these attenuation measurements in a tomographic inversion after a careful rejection of the noisy data. We first remove data likely to be biased by a poor knowledge of the source. Then we assume that waves corresponding to events having close epicenters and recorded at the same station sample the same elastic and anelastic structure, we cluster the corresponding rays and average the attenuation measurements. Logarithms of the attenuations are regionalized using the non-linear east square formalism of Tarantola and Valette (1982), resulting in attenuation tomographic maps between 50s and300s. After a first inversion, outlyers are rejected and a second inversion yields a moderate variance reduction of about 20%. We correct the attenuation curves for focusing effect using the linearized ray theory of Woodhouse and Wong (1986). Accounting for focussing effects allows building tomographic maps with variance reductions reaching 40%. In the period range 120-200s, the root mean square of the model perturbations increases from about 5% to 20%. Our 3-D attenuation models present strong agreement with surface tectonics at period lower than 200s. Areas of low attenuation are located under continents and areas of high attenuation are associated with oceans. Surprisingly, although mid oceanic ridges are located in attenuating regions, their signature, even if enhanced by focusing corrections, remains weaker than in the shear velocity models. Synthetic tests suggests that regularisation contributes to damp the attenuation signature of ridges, which could therefore be underestimated.

Keywords: Sismologie, tomographie, atténuation sismique, manteau, ondes de surface, ondes de Rayleigh

The properties of silicate melts at high pressures and temperatures

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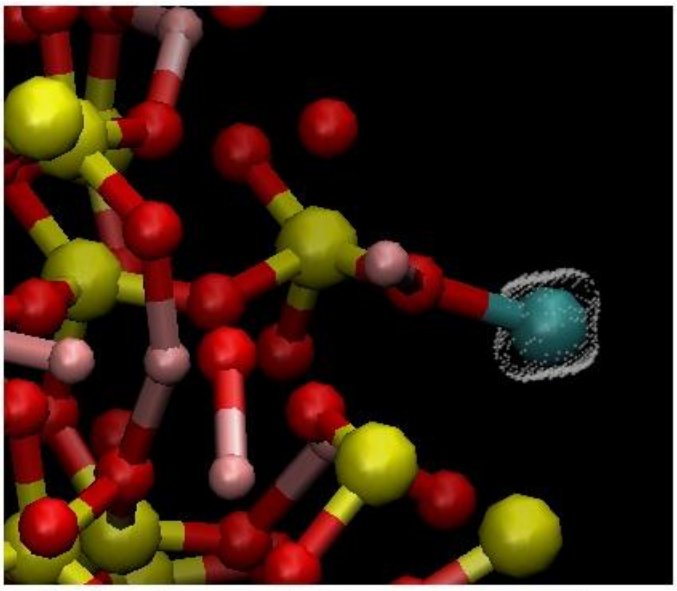
Silicate melts represent one of the most important phases in the evolution of the Earth. Without them the segregation of the core and crust would have not been possible. They even might play important roles in the current deep mantle structures and overall mantle dynamics. But what makes them so special? By comparison to crystalline phases they represent chaos. The beauty of chaos is that it always contains order. We will present new data on how small changes in the chemistry of silicate melts can affect their properties and how patched together, these small changes can have big impacts.

Keywords: Silicate melts, first principles, transitional metals, ULVZ



The dx2-dy2 orbital of Ni at 60GPa and 3000K in an MgSiO3 melt. Yellow-Si, Red-O, Pink -Mg

A tracers method for studying double diffusive convection in the liquid layers of planetary interiors

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Convection in the liquid layers of planetary cores is usually driven by the combination of two sources of buoyancy: a thermal source directly related to the planet's secular cooling, the release of latent heat and the heat generated by radioactive decay, and a compositional source due to some process of crystallisation, for example the growth of a solid inner core which releases light elements into the liquid outer core. The molecular diffusivity of composition is typically 3 orders of magnitude lower than that of temperature which can produce significant differences in the dynamics inherent to thermal and compositional convection, respectively. However, the description of weakly diffusive fields on the Eulerian grids employed in current codes of geodynamo raises technical issues, because the numerical diffusion generated on these grids is potentially larger than the real diffusivity, therefore hiding appropriate transport phenomena with low diffusivities. During my first year of PhD, I developed a Lagrangian description of composition based on the introduction of tracers in PARODY, a geodynamo code initially developed by Emmanuel Dormy and Julien Aubert. The absence of numerical diffusion inherent to this method allows modelling of thermo-chemical convection at infinite Lewis number, which has never been feasible to date. The implementation of such a method in the core is however a technical challenge, partly because of the spherical geometry of the code, but mainly because the turbulent nature of the core ow requires the use of higher order time and velocity interpolation schemes to guarantee a correct advection of the tracers in strong vorticity regions. To validate this new tool, we tested it on two benchmark cases with positive results. Current work is now focused on the implementation of thermodynamically consistently coupled boundary conditions for temperature and composition. A first application will then address non-magnetic thermo-chemical convection in the ocean of Ganymede.

Keywords: geodynamo, numerical methods, double diffusive convection

Abstracts – Session 4:

Planetary sciences

Evolution of the porosity of the grains during their growth: a solution to planetary formation?

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Protoplanetary disks are disks of dust and gas around young stars. The dust, originally micrometer-sized, grows by coagulation during collisions up to reach planetesimal sizes. During their growth, the grains experience the effect of the gravity of the star and friction of the gas phase. The second effect slows down the grains which migrate towards the star. Weidenschilling (1977) showed that the radial drift is maximum for decimeter-sized compact grains, those grains are finally accreted without decoupling from the gas and planetesimals cannot be formed. Considering porous grains provides a more efficient growth and a slower migration which can avoid the accretion and keep growth to reach large sizes.

Keywords: protoplanetary disks, porous dust, accretion, planetary formation

3D simulations of protoplanetary disks with 2 planets: the case of HD100546

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In the last 10 years, several observations of the Herbig Be star HD 100546 have provided strong evidence that planet formation might be occurring in this system. Recent millimetric observations reveal an inner cavity in the disk at approximately 15 AU. This feature could be well explained by the presence of one or several planets. In addition, Quanz et al. (2015) have directly detected a giant protoplanet at a radius of about 53 AU. Also, Pineda et al. (2014) report a sharp cutoff of millimeter-sized particles at 60 AU. In this work, we present 3D SPH simulations of a disk with two planets orbiting a star with the same fiducial parameters as HD 100546. We run a series of simulations where we vary the semi major axis and the masses of the two planets. By comparing the dust distributions obtained for different grain sizes with the observations, we attempt to better constraint the outer planet parameters.

Keywords: Dust, Protoplanetary disk, Planet, Grain growth, HD100546

Sr and Ba nucleosynthetic anomalies in meteorites

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A common feature of all terrestrial planets and most meteorites is their significant depletion in volatile and moderately volatile elements compared to the solar composition. Several hypotheses have been proposed to account for this depletion. Volatile loss can occur through partial condensation of the nebular material due to removal of the vapor phase prior to further cooling of the protoplanetary disk. Alternatively, volatile elements were lost due to evaporation by heating of the solids. A third possibility is that large impacts could lead to loss of a vapor phase containing moderately volatile elements. Volatile depletion induces elemental fractionation with refractory elements and in this study we aim at coupling the radioactive chronometers ^{87}Rb-^{87}Sr and ^{135}Cs-^{135}Ba to determine the timescale of volatile depletion.

Nucleosynthetic isotope variations among meteorites have been found for several elements (Nd, Sm, Ti, Cr, Mo, Hf, Sr, Ba...). The presence of those small isotopic anomalies have important implications for interpretations of ages obtained by radio-isotope chronometers [1]. Nucleosynthetic anomalies could also be a tool to assess the possible building blocks of terrestrial planets [2, 3].

In this study, we developed a new protocol for high-precision isotopic measurements of Sr, and Ba by thermal ionization mass spectrometry. Our method allows the separation and purification of both elements from the same aliquot. Repeated measurements of the Sr isotopic standard NBS987 yield ^{84}Sr/^{86}Sr = 0.0564918 ± 52 ppm (2 SD) in multidynamic mode.

For Ba we achieved a precision of 49 ppm for the low abundance p-process 132Ba in static mode, and 9 ppm for ^{135}Ba in multidynamic mode on a standard solution, within the range of published data [4, 5].

Previous studies reported a ~-23 ppm deviation in ^{84}Sr for terrestrial samples relative to the standard [6, 7]. Our measurements of terrestrial samples are identical to the NBS987 standard within error, in agreement with [1]. Preliminary results show that ordinary chondrites do not show any nucleosynthetic anomaly in ε^{84}Sr. Our data for Ba isotopes show no hint of ^{135}Cs decay. Angrites, ordinary chondrites and Martian meteorites have the same isotopic composition as Earth. The anomalies found in carbonaceous chondrite Allende can be attributed to a nucleosynthetic origin.

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Keywords: Nucleosynthetic anomalies, barium isotopes

Thermoelastic properties of superionic water

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Recent progress in exoplanet detection has allowed astrophysicists to discover planets whose density implies the existence of large amounts of water in their interiors. Depending on the thermodynamic conditions reached in these planetary interiors, water can be solid, liquid, or in a superionic state. This last state was predicted by first-principles simulations, and is defined by an onset of hydrogen nuclei (i.e. protons) diffusion in the ice. Such behaviour may affect dynamical properties of the ice. Here, we investigate the thermoelastic properties of superionic water between 1600 K and 2000 K using first-principles molecular dynamic simulations. We use the linear elasticity approximation to calculate the elastic constants from which we obtain the bulk modulus and elastic wave velocities. We also show that the pressure dependence of elastic constants is monitored by the behaviour of the protons. Our data should allow to refine planetary models of water-rich planet interiors.

Keywords: superionic water, thermoelasticity, high, pressure ices, first, principles molecular dynamics

Abstracts – Poster session

Understanding copper fluxes in cancerous cells using natural copper isotopic compositions as a proxy

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Copper (Cu) is an essential cofactor in several proteins and is transported from blood to organs by Cu-proteins. In cancer it has been demonstrated that Cu concentration is increased in tumor cells (review by Engelken et al., 2014). The natural Cu isotopic compositions, expressed as

$$\delta^{65}Cu = 1000 \times [(^{65}Cu/^{63}Cu)_{sample}/(^{65}Cu/^{63}Cu)_{standard} -1]$$

have been shown to vary between organs and can be used to trace exchanges and fluxes within one organism (Balter et al., 2013). In 2015, Balter et al. have shown that liver cancer tumors are enriched in heavy Cu isotopes compared to healthy patients liver tissue. However, the reason for this difference is yet unknown. One possible reason for that is a difference in Cu transport in tumors cells.
To test this hypothesis, we have used the model organism Saccharomyces cerevisiae in which Cu enters cells through both high-affinity (CTR1, CTR3) and low-affinity importers (review by Pena et al., 1999). To understand their impact on the Cu-isotopic composition, Cu was monitored in three strains with different uptake systems: a wild type, a CTR1 knock-out, and a CTR1;CTR3 knock-out. The three strains have been cultivated with 0.25 µM of Cu, and then transferred in a medium with 80 µM of Cu. We have monitored the evolution of both Cu concentration and isotopic composition as a function of time.

The $\delta^{65}Cu$ in the double mutant strain cells is lower than in the ctr1;CTR3 strain cells (-0.8 versus 0). Moreover, wild type cells have a lower $\delta^{65}Cu$ than the ctr1;CTR3 strains cells (-0.6 versus 0). Thus, our study shows that each strain and therefore each high affinity importer has a different Cu isotopic signature. It is noticeable that none of these transporters leads to an increase in cells $\delta^{65}Cu$.

Liver cancer tumors have a high $\delta^{65}Cu$ (0 to 0.5) in comparison to healthy liver tissues (-0.1 to -0.5) which are very close to the values observed in wild type yeasts (-0.6). Since transporters activity does not seem to increase intracellular $\delta^{65}Cu$, we postulate that the values observed in tumor cells may result from modifications of Cu fluxes between the different organs and the tumor. Reduced Cu fluxes have been observed in connection with the apparition of resistance to cisplatin, an anti-tumoral agent, in tumoral cells [Du et al, 2012]. Therefore, our results clearly show that we could use $\delta^{65}Cu$ monitoring as a proxy for cisplatin resistance in cancer cells.

Low elevation and onset of humid climate in Jianchuan Basin (Yunnan, China) at the Eocene-Oligocene transition

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Frequent warming events during global climate cooling occurred between 40 and 34 Ma, before the Eocene-Oligocene boundary. This "doubthouse" climate has been well documented in oceanic archives but remains poorly known in continental domains. Besides, reconstructing paleoelevations at the end of the Eocene in South China is necessary to constrain Tibetan uplift models. We present new geochemical and paleoenvironmental data concerning Jianchuan Basin (Yunnan, China). We prove that the Jianchuan region was at sea level at the end of the Eocene. This result favors a diachronous uplift of the Tibetan plateau. Our data also reveal a transition from an arid to a more humid climate around 36Ma. This could be associated with the "late Eocene warming" recorded in some oceanic cores at 36Ma. It coincides well with the climate changes associated with the onset of modern monsoon and documented throughout China.

Keywords: Paleoelevation, Paleoclimate, Tibet, Geochemistry, Palynology


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