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SUMMARY

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2D-ACAR: Using Positrons to Determine the Electronic Structure of Materials

Quantum oscillations, which has high demands concerning the ambient conditions, and the mostly surface sensitive angle-resolved photoemission spectroscopy (ARPES) are two well known techniques for the measurement of the electronic structure of materials. One less common experimental technique is angular correlation of annihilation radiation (ACAR) which employs positrons, the antiparticle of electrons, to measure projections of the electron momentum density (EMD). ACAR is a pure bulk probe, with low experimental demands, which offers the possibility to e. g. investigate temperature effects like phase transitions.

Josef Ketels
cohort 2014-2016

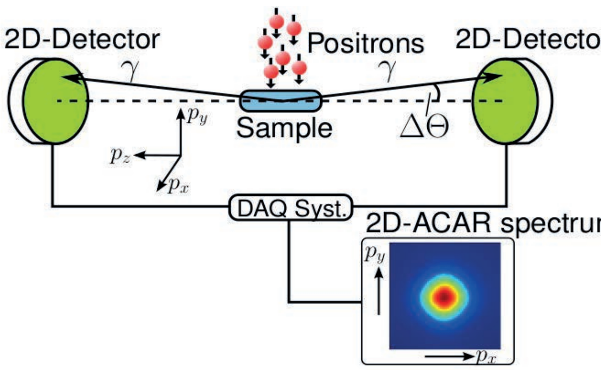

Figure 1: Principle of 2D-ACAR setup: Positrons from 22 Nasource annihilate in the sample. The two coincident annihilation gammas are detected by position sensitive 2D detectors

A basic 2D-ACAR setup, as illustrated in figure 1, consists of two position sensitive 2D detectors (in our case so-called Anger cameras), a sample which is located exactly in the middle of the detector-detector-axis and a 22Na-source that produces positrons through β+-decay. After implantation into the sample the positrons thermalize within a few picoseconds and thus loose their momentum. After diffusing through the crystal (100 ps – 200 ps) the positron finally annihilates with an electron under the predominant emission of two gamma particles. Due to the momentum carried by the electron of the material (Pauli principle) and conservation of momentum, the gammas are not emitted at exactly anti-parallel directions but with a slight deviation from 180°. Using small angle approximation, the deviation ΔΘ is proportional to the momentum of the electron. By neglecting the small influence of the positron and integrating over many such annihilation processes, we can finally measure a two-dimensional projection of the EMD. This basic principle is depicted in figure 2.

One additional advantage of 2D-ACAR is the possibility to conduct spin-resolved measurements which directly results from the usage of the 22Na-source (see figure 3). Due to the parity violation of the weak interaction in the β+-decay the positrons are spin-polarized. By magnetizing a ferromagnetic sample the majority and minority spin-channels can be probed separately as the annihilation predominantly occurs in the singlet state.

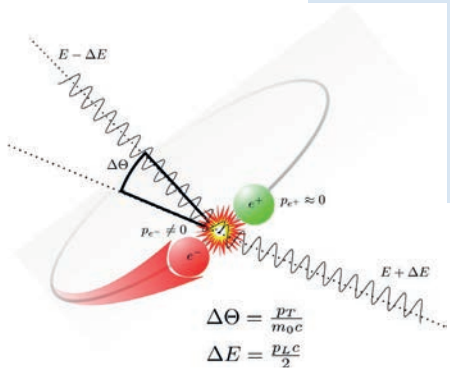

Figure 2: Basic principle of ACAR spectroscopy: annihilation of a thermalized positron with an electron

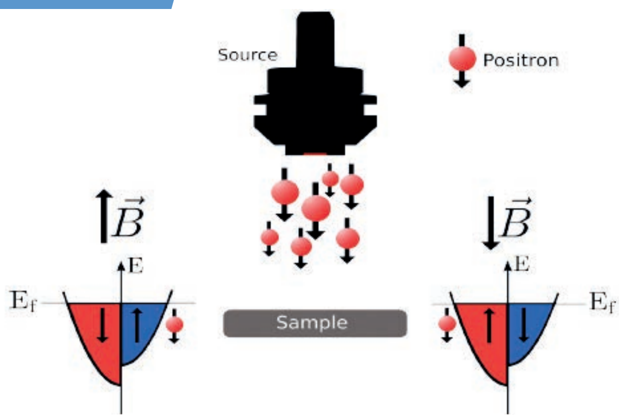

Figure 3: Positron annihilation in a ferromagnetic sample under a magnetic field

One approach on how to use this technique in condensed matter physics is the direct comparison of 2D-ACAR measurements to theoretical calculations. Two examples how this was employed are the benchmarking of different theoretical calculation schemes like LDA, LDA+U or LDA+DMFT on vanadium [1] or the determination of the electron-electron correlation strength in nickel [2]. The second approach is based on taking several 2D projections of the EMD and reconstructing the 3D EMD from those. At the Fermi-surface the EMD shows sharp steps and thus this important surface in momentum space can be extracted from a set of measurements. This was e. g. shown in the well known Heusler alloy Cu2MnAl in which the minority and the three majority Fermi sheets could be measured (see figure 4) [3].

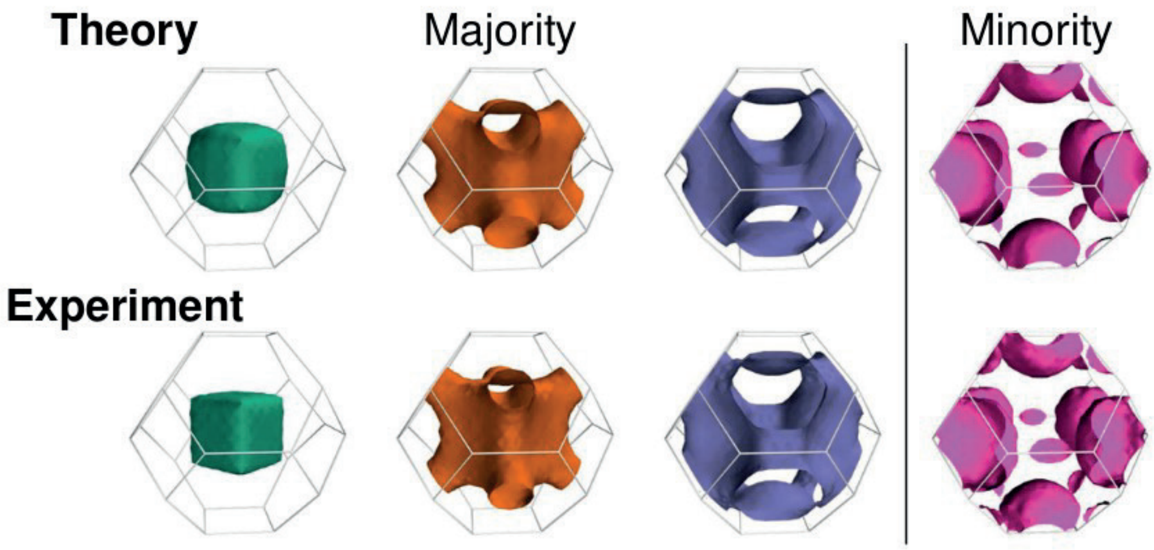

Figure 4: Majority and minority Fermi sheets of Cu2MnAl [3]

Plasma catalysis: synergy between plasma and catalyst

The interaction between catalysts and low-temperature plasmas may lead to synergetic effects that can improve the conversion and energy efficiency and selectivity of a process. In the context of plasma catalysis, we can define synergy as an additional effect upon combining the plasma with a catalyst, in other words, the effect of putting together the plasma and the catalyst is greater than the sum of their individual effects. Plasma catalysis presents a variety of applications for gas conversion such as air pollution control (volatile organic compound (VOC) abatement) and greenhouse gas conversion into value-added chemicals or fuels (syngas). Catalysis is defined as the process in which the rate of a reaction is increased (by lowering the activation energy barrier) while the thermodynamics remain unchanged. Catalysis is divided into three types, homogeneous, enzymatic and heterogeneous.

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More specifically, in the case of plasma catalysis heterogeneous catalysis (in which the catalyst occupies a different phase from the reactants and products) is mostly used and brings the selectivity towards specific compounds. A heterogeneous catalyst is usually a nanostructured solid (presenting nanoparticles, nanopores, …) containing a high number of active sites (large surface area) responsible of its catalytic activity. Catalysts used in plasma catalysis are transition metals, metal oxide such as CoOx, MnOx, TiO2 and zeolites (solid acids). Plasma (also referred to as the fourth state of matter) is described as a partially ionized gas composed of charged (electrons, ions) and neutral species (electronically or vibrationally excited) and radicals, exhibiting a collective behaviour.

The plasma thus provides high energy and chemically activated species in the gas phase. Low-temperature plasmas (LTP) electrons have an energy in the range of electron volts corresponding to typical bond dissociation and ionization energies of atoms and molecules while the heavy species (ions and neutrals) have a temperature close to the gas temperature (300–1000 K). The combination of reactivity, non equilibrium situation, and low-temperature operation enables plasmas to be used for numerous applications such as catalysis. Typical examples of LTP are low pressure glow discharges, RF discharges, DBD, etc.

Synergism is a complex phenomenon as it results from the interdependence of the plasma-catalyst interactions and it may not always be observed. Typical effects of the catalyst on the plasma, mainly due to the nanofeatures and dielectric constant of the catalyst, are: the enhancement of the electric field, the formation of micro discharges inside of the pores, the change in discharge type, and the change in species concentration. Vice versa, the plasma triggers physicochemical and morphological changes in the catalyst. Plasma photons (generated by decaying excited plasma species) could activate photocatalyst and electrons could induce surface reactions.

Finally, by impact of charged species, photons, metastable and excited neutrals and through exothermic surface reactions the plasma can heat up the surface. The plasma itself may change the energy barrier of activated process such as chemisorption by creating radicals, by modifying the morphology of the catalyst or by providing some of the energy necessary to surmount the activation barrier (e.g. by vibrational excitation of the reactants). In addition, the plasma enables one to modify the feedstock (gas or gas mixture) via elementary processes in the gas phase (electron impact ionization, excitation, dissociation…) and via the plasma/catalyst interactions.

Measurement of oxygen atoms density and gas temperature using Two-photon Absorption Laser Induced Fluorescence (TALIF) signal in low pressure CO2 direct Current discharge

Despite being very successful for some applications, plasma catalysis remains an expensive process, thus, the major challenge is to improve the energy efficiency and reduce the energy cost as much as possible. However, the additional energy costs associated to the acquisition of plasma equipment and the generation and sustainment of the plasma may be counterbalanced exploiting the synergistic plasma-catalytic processes. Moreover, the possibility to switch on/off the plasma source may allow to use renewable energy sources. Finally, the various effects of the plasma on the catalyst, and inversely, have been investigated experimentally and the results as well as modeling efforts are already described in the literature [1-3]. Further research combining experimental, theoretical and modeling studies will ensure great advances in this field both in terms of understanding the underlying mechanisms involved and in terms of turning this fundamental knowledge into practical outcomes.

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Nanocellulose from banana waste

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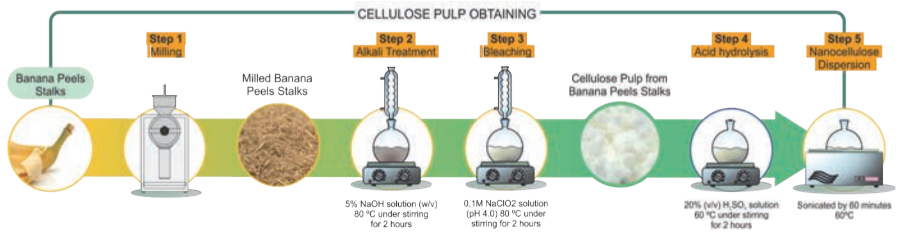
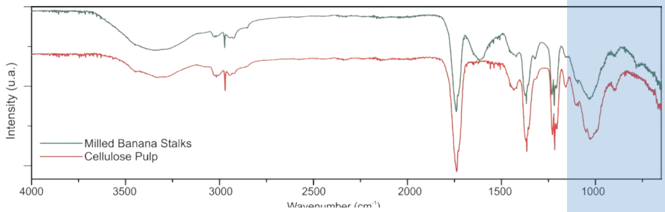
Banana is the most consumed fruit in Brazil, mainly due to factors as continuous production, ease of handling and rapidity of ripening. Due to the large volume consumption, there is a high generation of banana waste like peels and stalks. This waste, nonetheless, have great potential for scientific exploitation. These stalks and banana peels are rich in polysaccharides with potential applications as raw material for the production of nanocellulose. Cellulose is the most abundant natural polymer in the earth and has an enormous industrial application, but in the last decade, the interest in the nanometric version has increased mainly for biological applications. This is due to their interesting properties like high mechanical strength, tailorable mechanical and rheological properties, broad chemical modifying capacity and biocompatibility.

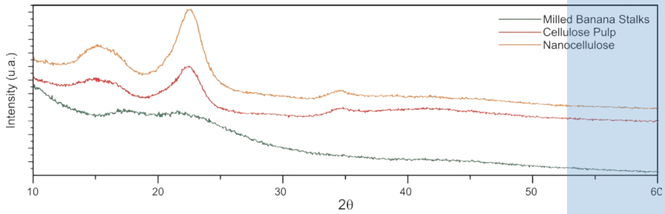
In this work banana peels stalks were used to produce nanocellulose fibers (NCF). The methodology used to obtain the NCF followed the flow chart below.

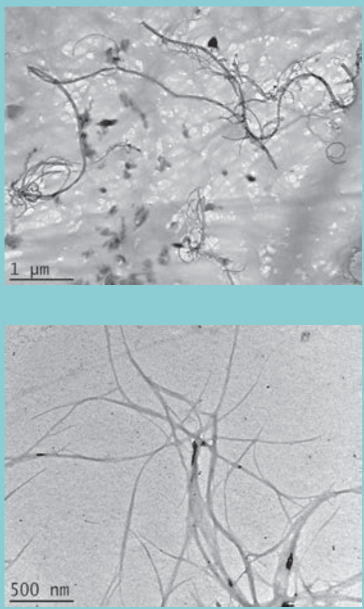


The milled banana peels and stalks, and cellulose pulp produced were characterized according to the TAPPI standards and FTIR, XRD and TEM techniques. Chemical evaluation of stalks and post-treated pulp indicated the presence of over 52% of cellulose and 40% of hemicellulose at the pulp, and nearly complete elimination of lignin after chemical treatment.

Pulp characterization by FTIR and XRD confirmed the presence of cellulose, and indicated that this cellulose is in the nanoscale. FTIR spectra evidenced above showed that the chemical treatment of the banana waste changes its structure. Although the spectra of milled banana stalks and cellulose pulp are similar, a decrease in band at about 1700, 1350 and 800 cm-1 (both related to the aromatic ring of lignin) indicate the removal of lignin. In addition, 1090 cm-1 indicates less xylenes of hemicellulose reduction. Larger bands seen at about 1450 and 1020 cm-1 for the pulp is an evidence of larger amount of cellulose.







XRD patterns show an increase on crystallinity from banana stalks to cellulose pulp, followed by nanocellulose. The increase of crystallinity is related to the removal of amorphous compounds, lignin and hemicellulose. The peaks at 16° and 22° are characteristics of the cellulose. Transmission Electron Microscopy (TEM) images showed below prove the presence of NCF at the pulp obtained after the treatment. NCF presented diameters of a few nanometers. Based on the results evaluated so far, the conclusion reached at this study are that the methodology employed was effective to remove almost all non-cellulosic compounds and obtain nanocellulose from banana waste. It was possible to aggregate value to the banana waste, an eco-friendly raw material, to be used in many potential applications.

Correlated Quantum Materials: Exploring spin transport properties in non-stoichiometric iridium oxide thin films and single crystals

Recently spin-Hall Magnetoresistance (SMR) technique has been proved as a tool to probe the interfacial magnetic ground state in Metal/Magnetic Insulator (MI) heterostructures. To have a deeper understanding of the underlying correlated effects vis-a-vis structural aspects, synchrotron facilities are required. We propose a systematic study to probe correlation of oxygen non-stoichiometry and strain effects in Pyrochlore iridate single crystals and thin films to construct a detailed magnetic phase diagram. This will help the scientific community to bridge a gap between probing novel magnetic phases through SMR studies in conjunction with synchrotron measurements which should be addressed through experiments and theoretical studies. Currently these studies are in a preliminary stage.

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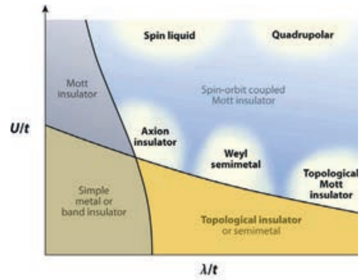
We propose a detailed study on spin ordering in single crystals by tuning the oxygen stoichiometry which in turn can tune the Ir-valence state that can significantly influence the Ir-O-Ir bond angle bringing about variations in the whole structural and electronic band structure which in turn affects the spin Hall conductivity. Recent studies have revealed that the oxygen doping level can drive the system to novel ground states as Ir5+ has an intrinsic magnetic order. Spin transport measurements will be carried out to probe the magnetic phases as a function of oxygen content in PIO and SIO thin films which will be further elucidated through synchrotron like XMCD and XMLD. A comprehensive understanding of these oxide systems in terms of spin conversion efficiency and its complete phase diagram while varying the oxygen content will be achieved through this project.



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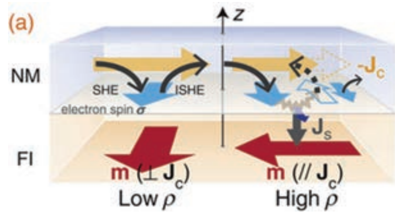

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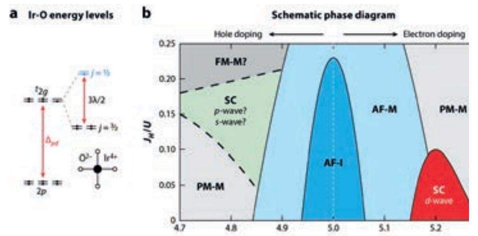

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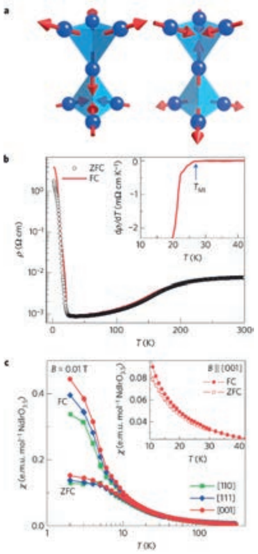
C)

In addition to Pr2Ir2O7 with pyrochlore structure, SrIrO3-x with Perovskite structure as well as a series of stoichiometries (B = Ir ; B' = Fe, Co, Ni, Cr, Sc, In) with Perovskite and Brownmillerite type frameworks A2BB'O6-x, showing characteristic 2D-layers of BO6 octahedra and B'O4 tetrahedra. The combination of IrO6 octahedral layers alternating with tetrahedral layers of 3d-metals is expected to give rise to a different magnetic coupling compared to the same compounds with Perovskite structure. For the perovskites, the oxygen stoichiometry together with the choice of B-cations allow to tune Ir valence states from Ir(III) to Ir(IV) and Ir(V), giving rise to complex scenarios of charge and spin ordering, which becomes tunable through the oxygen stoichiometry. The project aims to explore spin transport properties in epitaxial thin films (PLD@IITM) and single crystals (TSFZ@UM), which will further get characterized in a multi-technique approach, essentially using Large Scale Facilities (X-ray synchrotron and neutron scattering techniques @ ESRF). Both PIs are heavily involved in MaMaSELF program thus naturally allowing direct cooperate with different beam line scientists from different facilities.



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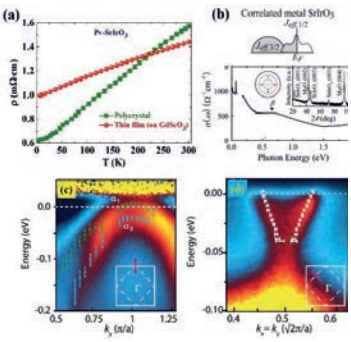

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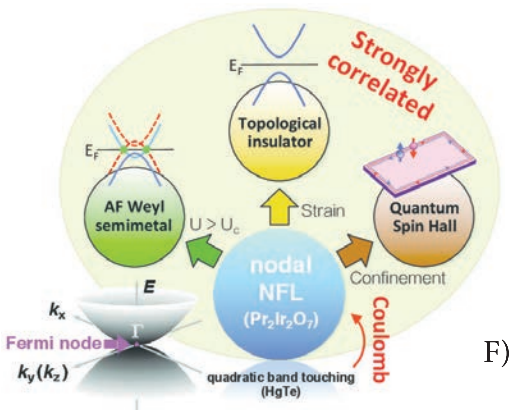

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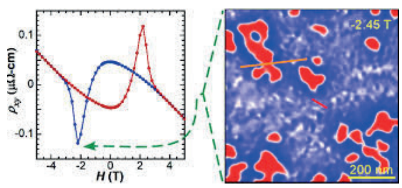

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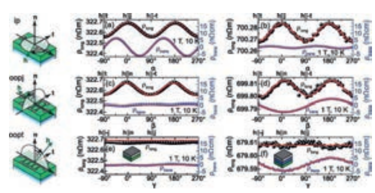

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Finding Home in a foreigner country

Elizabeth Di Geronimo
cohort 2011-2013

I have always wondered what makes us who we are. Is it our life experiences? The culture and traditions around us? The people that we meet? Our beliefs? While there are many influences at work, how much is simply a matter of choice?

I grew up Venezuela, and it was there where that I learned a set of values about what is most important in life. I assumed these values were universal. However, over the last seven years I have learned that my perspective is not universal; that my concept of "common sense" sometimes isn't common; and that life, values and relationship can be seen from many different perspectives. It was in Venezuela that obtained my bachelors degree in materials engineering, and it was in there that I discover a whole new world about science but also learn many things about life and goals, and we can say as well.. to dream. Nine years ago, I left my home country to pursue professional studies. During this process, I have lived in three different countries : France, Italy, and the United States. In each case there are obvious differences: the language, the geography, the food. But there are also similarities. In each place the people are delighted to share their traditions, boast about their superior gastronomy, promote their language's advantages, and suggest amazing historical, environmental or artistic wonders to visit. I love that !

Nonetheless, navigating a new place is always challenging. To aid in the transition, my first step has always been to find things or places that remind me of home.. to own the place and feel that I belong to the new city. However, my expectations have frequently been different from reality. Beyond the language barriers there are always very real cultural dividers. Before experiencing it, I had not imagined how much the culture of a country could influence the social life and how different my point of view can be so different from one place to another. This realization made me feel like a foreigner and changed the way that I saw and perceived the world around me. Social integration isn't easy. Looking around I realized that sometimes foreigners often remain foreigners for years and years on their host land. For some, it is a lifetime compartmentalization. The process of discovering this truth has provided me many opportunities for personal reflection and growth. In the end, rather than feeling cornered, I have come to terms with being a foreigner for the odd sense of freedom, it affords me to express ideas different from the norm.

However, it has taken me a long while to get to this point. Perhaps that is why I initially sought friends among other foreigners. Like me, other foreigners were without roots in the country. However, over time I realized that in choosing to live in the safe zone and primarily hanging out with other foreigners, I was not fully experiencing life in my host country, and I certainly wasn't integrating into the local society. In many ways I was just like a tourist, viewing everything from the outside. I wasn't happy with this arrangement and realized I had to change something. I knew that I could not change what was happening around me. I wasn't going to be able to change the culture of France, or bring the Italians around to my point of view. The Americans weren't going to slow down and relax. Really, the only lever I had to change was myself. I realized that I had to be more open and assertive in seeking connections. Life became incrementally easier when I understood the social rules pertaining to how people behave, what they value and why. For example, one of my first realizations was that the definition of hospitality is not universal. You might expect that because you are new in a place, people would offer to show you around, or offer their availability in case you need something. However, this immediate familiarity is not evident everywhere. In some cases it might take longer to break down barriers and I have found that once people open their arms, they will hold you up.

A better understanding of cultural norms is only part of the solution. The second part is meaningful interaction. I knew I had to move beyond my safety zone — my area of comfort — and be more open to others. Previously, as the newcomer, I had waited for someone else to invite me to be part of the group. The locals I knew were busy with their lives and didn't have the time or incentive to seek me out. So, I tried reversing the roles. I was the one who showed interest in getting to know them. I became the one who proposed an activity. It was often nerve wrecking. It took a lot of courage, and still takes courage. As I dared to extend my hand of friendship, I found angels all around me. These angels came in the form of people who believed in me and took me under their protection, people who gave me a sense of home, or people who motivated me to keep going when I was ready to give up. They included a missionary couple, the Mamaself community, my Ph.D. supervisor, and friends who became so dear, they are now like family. Thus, while it some cases it as a big effort, I did break down some of the foreigner walls and now, with hindsight, I can say the effort was worth it.

Through this process of discovery and integration, not only have I met incredible people, but I have also learned to recognize nobility and good intentions. I have found the universality of the people in the authentic expressions of love and friendship. And, in the end, I have realized that who we are doesn't impede our inclusion nearly as much as we may think. Our outward desire to know each other, to seek out meaningful interactions can form new connections much stronger than past divides. As a result of my experiences, I have learned that who we are at any moment is the result of many influences, culture being just one of them. I have also learned that as we grow and encounter differences, we have the capacity to understand, the ability to adapt, and the freedom to remain a bit different. And that in so doing, we become more inclusive people who can find home anywhere.

Working with International teams

A most crucial and exciting part of the Erasmus Mundus experience is when one learns how to adapt to new environments and develops good relationships with people of different culture/ethnics/religion. MaMaSELF is such a program that puts a strong emphasis on international mobilities and aims to create a group of scientists that have become acquainted with the soft skills needed to perform well within an international team during and after the program. As a researcher, international collaborations are of the utmost importance and could yield from your periods abroad as young scientist. Everyone has its personal view on how to be productive and/or efficient in the workplace, and the differences tend to be quite large depending on which country you are working in. During these two years, I had the opportunity to empirically determine what works best for me.

David Simonne
cohort 2017-2019

My first international experience was my Bachelor thesis in München, with a team composed of Belgium, Russian and otherwise German members. I had the chance of learning under separate advisors: first-hand theoretical approaches, but also 3D-modelling. My first time abroad allowed me to get used to different accents in English, to try and improve mine, and to find that international research really is a group of people from very different background working together on a project they are interested in. The project, which consisted in optimising a cell used in an instrument, would always benefit from the varied opinions of both physicists and engineers. However, I was the only student inside the lab, besides one Master student and one PhD student, both very busy. Nevertheless, the group would sometimes meet to play cards and share drinks on the evening. I came back to Munich for my Master thesis, 3 years later, and I quite enjoyed the efficacity of the system, the absence of any barrier between my advisor and me. He was closely following my work and always making himself available if needed.

After the Bachelor, I had gone to Japan, at the university of Tohoku, where I had spent one year working on short projects with fellow Japanese students. Indeed, after the third year (a bachelor lasting 4 years), Japanese students spend their time attached to a laboratory, sharing the same office with other Bachelor, Master or PhD students and assistant teachers. They spend most of their time in the office on their own project, the lab really turning into a living place; some experiments would even start running after 8 pm. The fact that Bachelor students took part in independent lab activities for the whole fourth year with poster presentation results in an incredible baggage towards academia and I found Bachelor students in Japan to be better prepared than Europeans in general. One of the most interesting features was the weekly reunions during which one student would either discuss a topic or his current work in front of the other students that would share some constructive criticism.

Nevertheless, the atmosphere inside the office would always remain extremely serious and silent, quite different from Munich where we could casually converse within the office. Respecting the hierarchy is very important in Japan, even just in the language, Sensei, Sempai; respectively the head of the office and the students ahead of you in their studies, whereas in Europe people are on a first name basis. However, the whole lab would sometimes go to a restaurant or a karaoke for an evening, hence taking a break of the heavy working environment, forgetting the hierarchy, and sharing a very friendly evening. If the language barrier was at first a bit difficult, my fellow students were always very friendly and helpful with Japanese.

A further comparison can be taken from my time had in Uppsala, Sweden. The team shared an extremely different state of mind, co-workers would take breaks together at the office but rarely meet outside of it. If it is quite rare to find international students in physics departments (none besides me in my lab in Japan, nor in Munich), the university of Uppsala was very international, the atmosphere in the workplace very relaxed, everyone spoke English constantly and I quickly made the acquaintance of numerous people despite working alone on my project. My classmates almost exclusively came from abroad: Lithuania, Brazil, India, China, Japan, Turkey and Italy and we all went to a summer school together in Paris, during which I learned a lot about everyone, their career paths, goals, current research, etc... It felt very different from Japan where it took more time to get to know my colleagues/classmates.

The international team of Uppsula during a summer school in Paris

I am now in Torino with an excellent team of Europeans and non-Europeans researchers. This is my first work experience as a graduated individual, and overall quite like my previous experiences in Europe. MaMaSELF gives a very good background to any aspiring researcher. Today, I am very happy of having worked with many international teams and know that it had a big impact on me, teaching me how to adapt and be efficient while greatly improving my English.

JOB POSITION

Craft your journey

Gokhan Gumussoy
cohort 2010-2012

In our MaMaSELF applications, we were given the opportunity to craft our own study plan. Being able to make my own schedule and university order selection was a strong motivation for me because I was able to follow a precise plan which I really wanted. As much as having the opportunity to study in top ranking European Universities and practicing in large scale facilities for science, living in such a multicultural environment and making friends across the world were also great experiences which helped me to shape my future. There were more opportunities available for me to follow an academic career after graduation. However, I chose to follow my passion to take part in Automotive Industry. I have been working at Honda Turkey Automobile Division for five years and I am pursuing my career as Product Manager. In this role, I do not specifically utilize any of the learnings from MaMaSELF courses. This is an inevitable outcome of the world's current education system. Instead of that we should focus on how studying master improved our problem-solving skills, analytical thinking ability and creativity. In this sense, MaMaSELF gave me more than I could imagine.

Honda Motor Company is 4th highest valued automotive company in the world. The core DNA of the company is based on racing and competition. That is why Honda's uniqueness comes from its engines. In Turkey, Honda is also popular with strong reputation and ranking among Top 5 most selling brands in Turkey passenger car market. I am responsible of Honda Civic model. It takes around 3-4 years to fully develop and plan details of a new car. As Product Manager we start working on a new model 2 years before its launch timing. Product Manager's ultimate goal is to achieve product-market fit. Strategical thinking skills, strong market knowledge, and communication skills are the most important competencies to achieve that goal. Once the role and aim of the product is determined with precise and measurable targets, every action carried out by other departments such as marketing, sales and after sales must serve to this role and aim. Product Manager coordinates all stakeholders to keep them aligned with the schedule by organizing and leading meetings with the top management as well. It takes around two years of preparation until the launch of a new product. But launch is not the end, on the contrary it is just the beginning. Because Product Manager is responsible to follow-up sales and marketing performance of the product and to take necessary actions if it is needed. Following product sales performance, proposing campaigns and financing options as well as publishing market reports and competitor model reviews are my daily routine. Every new product is a new journey and as Product Manager we are expected to craft these journeys. In similar way, every new decision is a new beginning and every new idea is a new project in our daily lives too. All we need to realize is that we are the manager and crafter of our own journeys. Today's actions will create tomorrows earnings. I hope you all get the most out of your journey.

Brittany Foley
cohort 2017-2019

When I arrived in Rennes to begin my first year of MaMaSELF, I did so with a head swimming with expectations and anxieties of what everything would be like. To put it lightly, most of them were pretty far off.

Expectation : Customs at CDG will take forever

Reality : With my visa, I basically flew through customs and was even ushered through the EU line. Pretty sweet.

Expectation: I'll just take an Uber to campus from the train station

Reality: Uber does not exist in Rennes. Please try again. (Taxi, 12 euros). This is a blessing in disguise because after only a few weeks of getting used to it, I was comfortable walking all over! And Rennes also has an excellent public transportation system: super fast metro, bus routes all over, and even special lanes on the roads so the buses don't get stuck in traffic. With Korrigo card you get unlimited access to the public transport system all month long.

Expectation: "Bring comfortable sport shoes for welcome week" = we will go on walking tours, maybe a scavenger hunt or hike

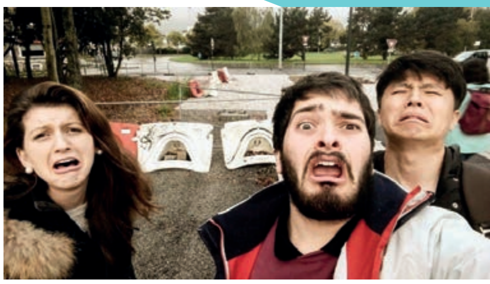
Reality: We will run across ice chasing soccerballs with broomsticks, we will run across the city solving complicated play-on-word riddles in a language only 10% of us understand, we will canoe, kayak, and raft through rainstorms. Welcome to Survivor: Bretagne!

Expectation: Everyone else will be really smart and accomplished

Reality: "I speak English, French, German, Japanese, and am learning Italian," "oh, I studied at MIT for a while," "actually, I've already worked at a synchrotron," "I already have a master's degree, this is my second."

Expectation: Everyone will be really studious and serious

Reality: "We will divide into two teams, those who like pineapple on their pizza, and those who do not."



Expectation: This is going to be a disaster

Reality: This is the greatest thing I've ever done in the most beautiful place I have ever lived with the most amazing people I have ever met.

Thanks to all newsletter writers !
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