Education

Fly your Thesis! 2010 - Letter of Intent

Instructions for the Letter of Intent

This letter will include an abstract outlining the scientific objectives of the project. Please note that the focus should be on the scientific purposes of the project, NOT on the technical and practical details of the implementation of the experiment. In other words, the participants are invited to explain WHAT they wish to investigate, rather than HOW.

Prior to writing the abstract, please carry out some research to see whether some work has been done on the same topic. References to literature that you have found will be highly appreciated. Remember: the project's main objective should be to achieve relevant scientific results.

The Letter of Intent must also explain the relevance of zero-g in your project, and more particularly the relevance of parabolic flights as a means of achieving your objective. It should be noted that parabolic flights do not only offer zero-g, but also a sequence of different gravity levels (0 – 1 – 2 g) that can be specifically used in your experiment project.

As it is an important objective of the programme, the applicants are asked to explain in full detail how their project is related to their syllabus. They should include the type of university projects in which they are involved, the topic and how the experiment project would be relevant.

Please note that the **non-respect of the conditions will lead to the rejection of the proposal**.

While filling the form, please use the standard Arial font in size 10pt.
Please submit this document in a MS Word (no .docx) format.

The letter of Endorsement should be included with the LoI in a zip file to upload on joinspace.org.

Education

Team's Name: **SUPERMASSIVE B.**

Team's Number: *(As defined while registering on joinspace.org)*

Title of the project: **DEEP IMPACT**

Contact e-mail address: **vandeportal.julien@gmail.com** *(Please specify only one address)*

Contact postal address: *(Please specify only one address)*
Jean-Charles Augereau
414 rue de la piscine
domaine universitaire
38400 saint martin d'Here

Scientific objectives of the project

Please summarise the scientific objectives in the field below. Insist for instance on the scientific concepts and the background of the experiment, timescales of the phenomena, relevance of micro-g and parabolic flights, results expected, etc.
Max 100 lines of text + 1 page with figures and references

Education

The purpose of our project is to test in zero-G conditions small bodies collisions to give an experimental support to the existing models. There are loads of different models treating chocs between asteroïds, based on experiments with air gun shooting sample and numerical models. But no zero-G experiment have ever been carried out to test them. A zero-G environnement would enable us to probe a wide range of parameters as well as different aspects of the problem.

First of all, high velocity shocks (few km per second) can permit to make statistics concerning the kinematics of the asteroïds. We would like to test the speed, the angle, the surface composition (rumble pile, condritic, metallic, etc...), its shape , the impact parameter... This investigation could be used afterwards in the study of Earth-crossing asteroids deflections.

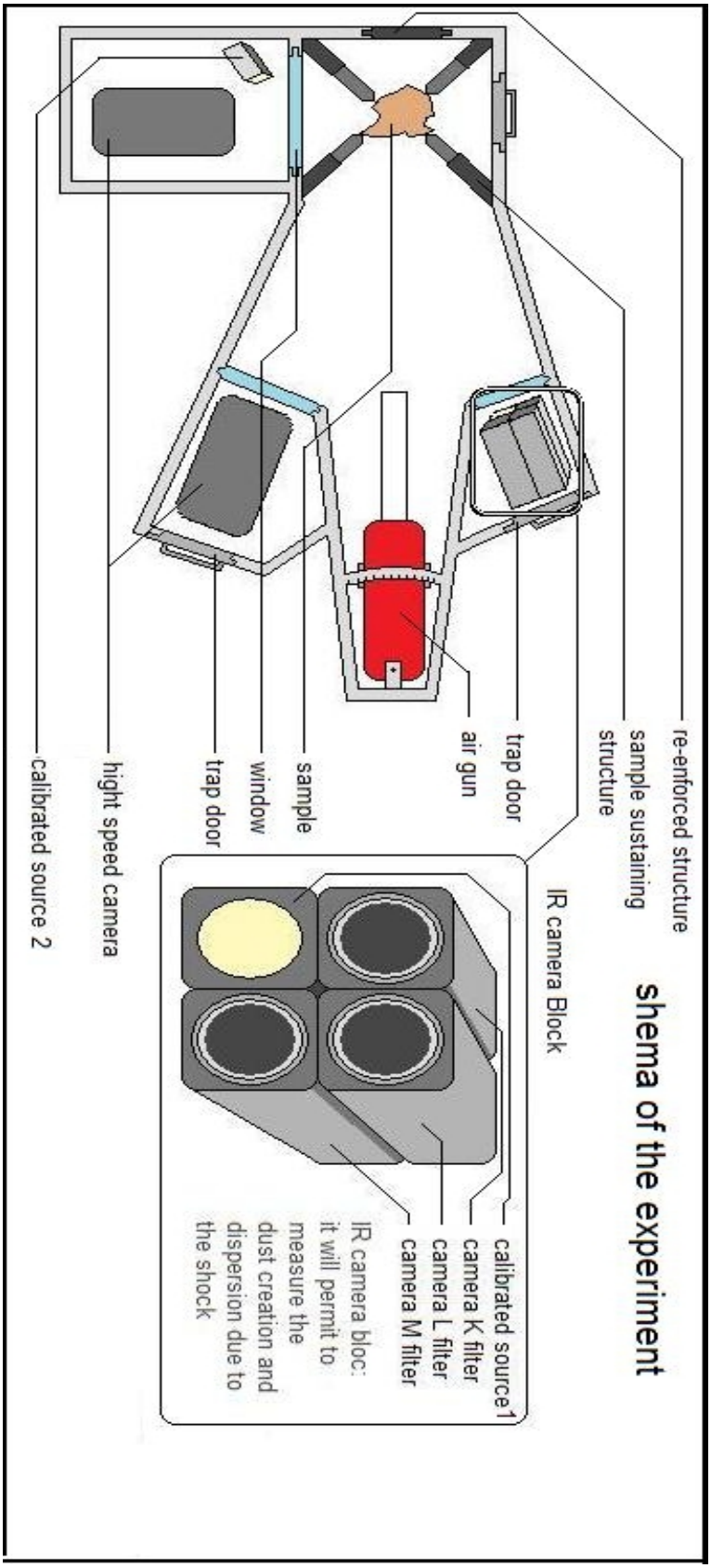
This investigation would also lead to a significative progress in planetary formations. The calculations made show that planets have to be formed very rapidly (a few thousands of years) but simulations show that there are significant barrier that are difficult to pass, such as the so called kilometer barrier. A body can grow from micromettre size to centimetre/decimeter size. At this moment, fragmentation process and accretion process doesn't permit to form bigger bodies. If we can pas from decimeter to a size of a kilometer, gravitation begin to be significative and the bodies can grow again. We also propose to test the agglomeration of small bodies, at lower velocities, to experiment the agglomeration at the centimeter scale.
An experiment in Zero-G could permit to improve our knowledge of the binding energy of a centimeter body and therefore to understand how to pass through the kilometer barrier.

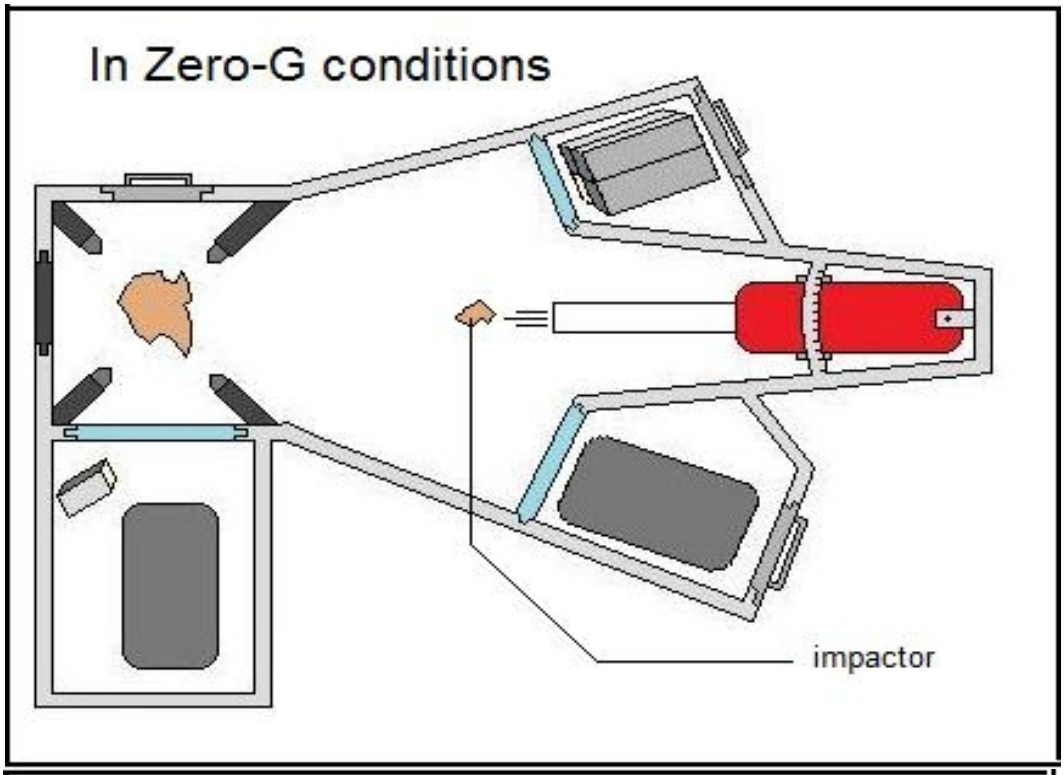
A third field that can be explored with this experiment is the dust production of asteroids. An important observational domain concerns the detection of dust around young (and older) stars. Since the ration between cross section and the body size is more important for micrometre particles, we therefore detect more easily the dust. However, most of the mass is contained in bigger bodies, ie in kilometric objects, which create the dust we observe. The key point we want to investigate is the dust formation rate from kilometric objects. Models as well as numerical simulations have been developped throughout the years to quantify this rate, however it has never been confronted to experiments, and even less to zero-G experiments. Therefore, confirming the current dust formation rates currently used would enable us to confirm the estimations given on the amount of material orbiting around stars already probed. Also, measuring the quantity of dust created and its dispersion could help to test models. And knowing better the dust will probably permit to detect more easily exoplanets with the structures created by them in the dust ring around stars.

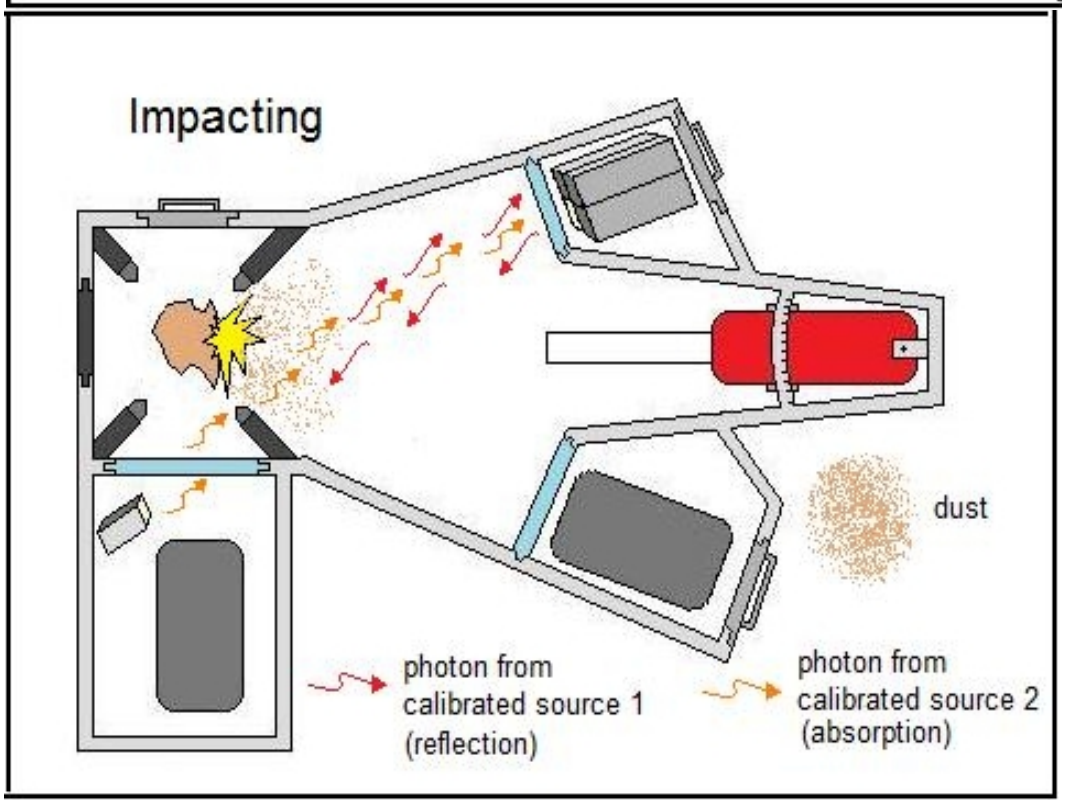
The dispositive is quite easy to implement. We just need a target easy enough to change (after the impact), an impacting room, a compressed air gun and an impactor. The kinematics analysis of the impact will be performed with the use of a high speed camera, and the dust creation will be measured by using IR absorption and refraction (from a well calibrated source). We can also very easily mesure precisely the mass of the rocks before and after the experiment to know how much dust has been created.

The amount of parametres to test requires us to design an experiment with an easy way to change the sample and the impactor. Another experimental point is that ideally we should make a vacuum in the impacting room, but we can admit that at these time and space scales, the presence of air will be a problem only for the dust dispersion. Furthermore the presence of an atmosphere will probably have no effect on the low velocity shock. For the well calibrated source used with three camera with IR filters (K,L,M) we can put them around the impacting room.

This experiment is easy to implement, quite cheap, safe and could give lots of results in different important domains concerning astrophysics. That's why we are convinced that it is an interesting subject to submit to the "fly your thesis" project.


shema of the experiment
re-enforced structure
sample sustaining structure
trap door
air gun
sample
window
trap door
hight speed camera
calibrated source 2
IR camera Block
calibrated source1
camera K filter
camera L filter
camera M filter
IR camera bloc: it will permit to measure the dust creation and dispersion due to the shock


In Zero-G conditions
impactor


Impacting
dust
photon from calibrated source 1 (reflection)
photon from calibrated source 2 (absorption)

Has this subject been investigated in micro-g in the past? Does some literature refer to that topic?
Max 20 lines including references

theoretical work:

Dohnanyi J. S. Collisional model of asteroids and their debris. Journal of Geophysical Research, Jul 1968.

Philippe Thebault and Jean-Charles Augeau Collisional processes and size distribution in spatially extended debris discs 2007
http://www.citebase.org/abstract?id=oai:arXiv.org:0706.0344

experimental work:

G. Wurm, G. Paraskov, O. Krauss, (2005), "Growth of Planetesimals by Impacts at ~25m/s", Icarus, Vol. 178, pp. 253-263.

J. Blum, R. Schräpler, (2004), "Structure and Mechanical Properties of High-Porosity Macroscopic Agglomerates Formed by Random Ballistic Deposition", Physical Review Letters, 93, 11, pp. 115503.

arXiv:0906.3977
A Zero-Gravity Instrument to Study Low Velocity Collisions of Fragile Particles at Low Temperatures
D. M. Salter, D. Heißelmann, G. Chaparro, G. van der Wolk, P. Reißaus, A. G. Borst, R. W. Dawson, E. de Kuyper, G. Drinkwater, K. Gebauer, M. Hutcheon, H. Linnartz, F. J. Molster, B. Stoll, P. C. van der Tuijn, H. J. Fraser, J. Blum

Melosh J. Impact hotering : a geological process

Would you be interested in using other gravity research facilities (Drop Tower, Centrifuge, Sounding Rocket, etc.)[1]?
Max 10 lines

It could be interesting to use the Drop Tower since the precision on the weightlessness is better, however, since the time scale for one drop is the time required for one impact, it would require a lot of drops to obtain the same statistics than with the flights.

It couldn't be done with a rocket or a drop tower. Maybe, when the phase space will be completely explored and the critical parameters identified, it will be more interesting to have a better precision on these parameters.

[1] For more information on PF and DT: Human Spaceflight users webpage, http://spaceflight.esa.int/users/index.htm
Information on the LDC: ESA Technical and Quality Management-Mechanical Engineering, http://www.esa.int/esaTQM/1202207743187_mechanical_0.html

Team members

Endorsing Professor/Academic: **Jean-Charles Augereau**
University, Department, Country: **Université Joseph Fourrier, Isère, France**

e-mail address: **augereau@obs.ujf-grenoble.fr**
Please attach Letter of Endorsement from the Professor/Academic, including his/her current activities, research topics, experience in the field of micro-gravity as well as how he/she is related to you and his/her involvement in the project.

Participating students

1. Name: **Vandeportal julien**
   Current studies:
   - University, Country: **Université Joseph Fourrier France**
   - Level of Study:
   - Title of Studies and Topic *(e.g. Mechanical Engineering, Physical Sciences, etc.)*: **Astrophysique et milieux dilués**
   - Level of Studies (Year): **5**
   - Thesis' subject: **exozodiacal dust**

   Mini-CV (ex: Involvement in the field of Space, Extra-Curricular Activities, Past Diplomas, etc.) *(Please fill in below, max 5 lines)*:
   Terminal (2002): TPE project concerning distance measurement in astrophysic

   Licence (2005): options in astrophysic and cosmology

   Maitrise (2006): options in astrophysic

   M2 (2007): cosmos particles and field in Montpellier

   M2 (2009): astrophysic and diluted matter

2. Name: **Laurianne PALIN**
   Current studies:
   - University, Country: **Université Joseph Fourier France**
   - Level of Study:
   - Title of Studies and Topic: **Master de recherche en astrophysique et milieux dilués**
   - Level of Studies (Year): **5th**
   - Thesis' subject: **Influence of solar wind protons on planet's neighbourhood spatials environment**

   Mini-CV (ex: Involvement in the field of Space, Extra-Curricular Activities, Past Diplomas, etc.) *(Please fill in below, max 5 lines)*:
   2008-2009 : master's degree in astrophysics and dilute materials, UJF, Grenoble
   Master's project at the Laboratoire d'Astrophysique et Observatoire de Grenoble
   2007-2008 : M1 physic, UJF grenoble. Astrophysical options
   2006-2007 : Licence de Physique et simulation, université Cergy-Pontoise. Astrochimie options

3. Name: **Dugué Magali**
   Current studies:
   - University, Country: **Université de Joseph Fourier**

France

- Level of Study:
- Title of Studies and Topic: **Master de recherche en astrophysique et milieux dilués**
- Level of Studies (Year): **5th**
- Thesis' subject: **Evolution of galaxies**

Mini-CV (ex: Involvement in the field of Space, Extra-Curricular Activities, Past Diplomas, etc.) *(Please fill in below, max 5 lines)*:

2008/2009: 2nd year of Master's degree in physics, Université Joseph fourier speciality Astrophysics and Diluates Materials
2007/2008: 1st year of Master's degree in physics, University of Rennes I
2006/2007: Licence of physics, University of Rennes I

4. Name: **Dimitra TOULI**

Current studies:

- University, Country: **National Technical University of Athens (NTUA)** GREECE
- Level of Study:
- Title of Studies and Topic: **Applied Mathematics and Physics : specialities: nuclear and particle elementary physics,theoritical and computational physics, stage de master2(ou diploma thesis):plasma astrophysics.**
- Level of Studies (Year): **5**
- Thesis' subject: **Fermi acceleration in relativistic shocks in gamma ray bursts**

Mini-CV (ex: Involvement in the field of Space, Extra-Curricular Activities, Past Diplomas, etc.) *(Please fill in below, max 5 lines)*:

2006 stage at LULI -Ecole Polytechnique de Paris treatment of X-ray plasma radiation
2008 summer school in advanced physics "detection of black holes in the universe" (Heraklio,)- 7th school of physics &of fusion technology(Volos,Greece)-NEB founding member of the Hellenic Society on Relativity, Gravitation&Cosmology(Thessaloniki)-ADA Astronomical Data Analysis conference(Heraklio-Creta)

One team can include 2 to 4 members.

Academic

Please describe below how the project will be involved in each team member's syllabus (involvement and benefits for the Thesis/University Project, for the students on a personal basis, etc.).

Max 20 lines

The team is composed of the students who attended the Astrophysics and Dilute Material Master's Degree in the Laboratoire d'Astrophysique de Grenoble (LAOG). We therefore all have a strong background and interest in physics and astrophysics in particular, and we all want to carry on and do a PhD in the aim of becoming an astrophysicist. Half of the year of our master was dedicated to a research project, and our "Fly your thesis" project is based on Julien Vandeportal 's master's and PhD project.

Given his research project, Julien Vandeportal his the natural teamleader. He has been working on this project for the past 6 months and is now writing an article concerning exozodiacal dust formation around Vega. He is also currently working with Torsten Loehne in Jena, Germany, to finish the article and exclude some hypothesis.

The rest of the team can play an efficient role in this project since we all attended the "Interstellar Medium and Stellar and Planetary Formation" course, and we all followed Julien's project developments for the past 6 months.

Magali Dugue, given her background, will be more focused on the technical realisation of the experimental set up. Since she is determined to be more an experimentalist than a theoretician, working on such a project will be a major benefit for her.

Dimitra Touli have a strong background in theoretical physic and will work on physical models already used by physicist and will try to find a way to test them.

Lauriane Palin will be attending the Modelisation and Simulation Master's Degree and will therefore be able to perform simulation to confront the current theories and the results we may have. She will also make the link between the theory and the experiment.

The "Fly your thesis" project is the perfect opportunity for us to learn how to sustain a project from the idea to the realisation of the experiment, and to develop this experiment with given constraints such as space, time and money, as well as analysing the data in the hope of publishing an article.
Taking part in such a reknown project will also benefit us and give us a bigger credit for other future projects.

Not only will this FYT project benefit the students, but it will also benefit the LAOG, which is mainly concerned with the theoretical aspects of the astrophysical problems, and the instrumentation (adaptative optics, ...), but not so much with the experimental aspects.