Imagine all the students... living zero-G

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Abstract:

Microgravity and spatial activities appear as very attractive topics for many pupils. In order to convert this naive curiosity into a real interest in physical sciences, we offer our students the opportunity to experience zero-g environment. We propose them to take part to one of the Student Parabolic Flight Campaigns organized by ESA. This begins with finding an experiment to be conducted in microgravity environment and ends up with the results analysis in the lab. Between both steps, they build their own experimental rack, take part to international meetings preparing the flights, give some hypothesis on the future observations... and verify them in zero-g !

1 Introduction

For many years, the interest for students into experimental sciences, and particularly physics, has been continuously decreasing. Different reasons can be proposed for that, one being that a large part of the physical community uses computers for 'virtual experiments' rather than real experimentation. Another reason may also come from the fact that most of the physical lectures are theoretical ones and, therefore, students are not familiar with experimental works. While students are able to discuss theoretical concepts they are generally unable to describe an experiment allowing to evidence them.

Thinking that physics, as every exact science, needs high-level experimentations in order to progress, we now proposed our student to performed an experiment by themselves during their last year in physics at University of Liège. The idea is to ask the student, by groups of four, to propose an experiment to be performed in one the department labs. In this paper, we report the issue proposed at GRASP (Group for Research and Applications in Statistical Physics). The particularity of our laboratory is to help students in performing their experiment in a microgravity environment (realized on board of an aircraft). We have indeed noticed that the possibility of feeling zero-G is a very attractive and motivating perspective for pupils. Herebelow, we expose the different steps to be followed in order to flight. This includes looking for an experiment, passing selective tests from ESA, preparing the experimental rack, performing the experiment on board and, eventually, coming back to the lab for results analysis. As mentioned in the last section, in case of concluding results, scientific paper can be written.

The paper is organized as follows. Each section corresponds to one of the main step of a project. Next section exposes the experiment choice as well as the way the experimental setup

▪ "Astrophysics, and how to attract young people into Physics"; Proc. JENAM 2005 *Distant Worlds*, Liège (Belgium), eds. Nazé et al., p. 12-15 ▪

is built. Section III presents the flight itself, while Section IV illustrates results interpretation. A summary is given in Section V.

2 Preparing the experiment

The choice of the experiment to be performed results from a discussion between student teams and lab members. This step is necessary because at this stage of formation, students do not have in mind what is doable in practice and what is pure theoretical point of view. Moreover, researchers of the lab take part to professional campaigns of experimentation in micro-gravity. They are thus able to prevent the students for going in a direction that would only lead to deception.

Students are then asked to write a proposal and submit it to an ESA commission. In case the project fits ESA interests and appears as well fitted for micro-gravity, the young team can start building the flying machine ! Drawing plans is the first and generally the apparently fastest step. Screwing, gluing and hammering is an hard job but one of the most amazing task. This is actually the first time students can build an experimental setup by their own. Figure 1 shows one of our students starting from zero and ending up with a safety visit validating the experiment. Time delay between the first and last images is typically two months.

Figure 1: (First row) Starting from scratch but with fournitures and help, students are able to come up with an experimental rack. (Bottom row) This setup is approved as ESA conform.

3 Performing

As soon as they apply, students have in mind the final deadline, that of the flights. These take place at Bordeaux (France) under control of Novespace. On board of an Airbus A300 [see Fig. 2 (left)] all experimental racks are well fixed in place of seats. Front and rear areas are left with seats for landing and taking off. During the flight, students have to make all possible to make the experiment going the right way and... not to be sick.

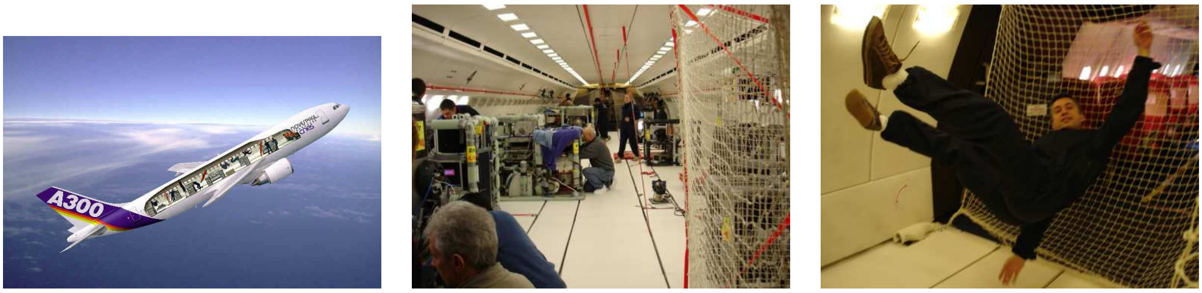

Figure 2: The flight finally takes place.

Flights span over two days. Each of these, two of the four students are with the experiment. This way, all students have the opportunity to flight in a non over-crowded aircraft. This is also more convenient to adapt the setup if something went wrong with the expeirment the first day. Each day is composed of 31 parabolas allowing each for 22 sec of microgravity. Once again, the experiment choice is important in order to have a phenomenon fitting in this small time.

4 Scientific results

Once they come back to the lab, students have to analyze the results. As for the other parts of the project, researchers help them in this task. A brief report is required by the department, while an oral presentation is proposed to other students which were not involved in the project.

In most cases, the experiment that has been achieved is quite new and related to up-to-date research. This allows us to go further in education and help the team to write a real scientific paper. This paper is then submitted to physical community for publication in a high-level journal. Figure 3 shows a typical result obtained during one of such student campaign. This experiment was related to the behavior of an aqueous foam under micro-gravity. Since gravitational forces were absent, only capillarity ones act. Therefore, the liquid located under the foam in Earth was able to reach the top of the foam. A curve giving the rising of the liquid as a function of time is also presented in this figure. It should be noted that the results obtained with this experiment were the first experimental proof of a theory proposed a few years before. Even this case is particularly excellent, each team benefits of the same help and new ideas are proposed.

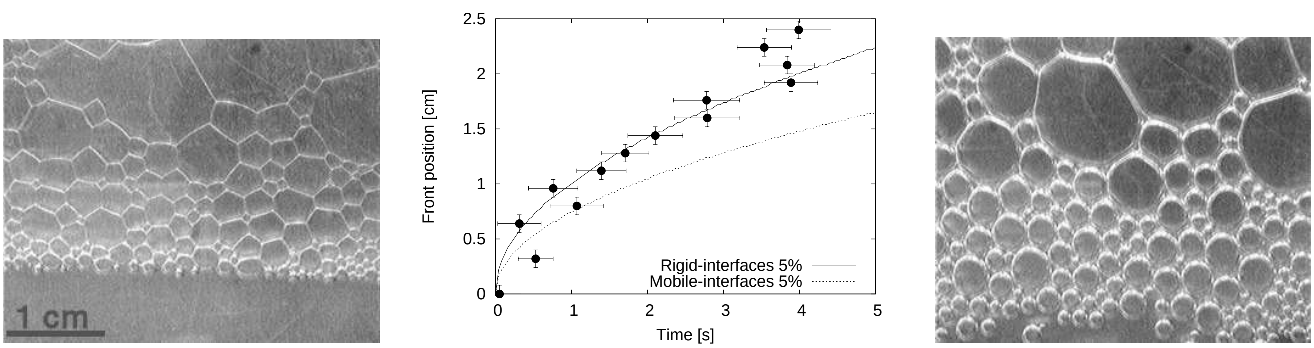

Figure 3: (Left) A two-dimensional aqueous foam under Earth condition. (Right) The same foam in microgravity conditions. The liquid is invading the foam from bottom to top, due to capillary forces. (Middle) Position of the liquid as a function of time.

5 Conclusions

Micro-gravity experimentation, as proposed by ESA under "Parabolic Flight Campaigns" is a really motivating activity for students. On the side of researchers, these constitute an opportunity for attracting pupils to experimental research. Such project is an unbelievable activity allowing to show a whole research job, from thinking of an experiment until publishing the results.

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