



Evaluation of an international doctoral educational program in space life sciences: The Helmholtz Space Life Sciences Research School (SpaceLife) in Germany

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Abstract

Training young researchers in the field of space life sciences is essential to vitalize the future of spaceflight. In 2009, the DLR Institute of Aerospace Medicine established the Helmholtz Space Life Sciences Research School (SpaceLife) in cooperation with several universities, starting with 22 doctoral candidates. SpaceLife offered an intensive three-year training program for early-stage researchers from different fields (biology, biomedicine, biomedical engineering, physics, sports, nutrition, plant and space sciences). The candidates passed a multistep selection procedure with a written application, a self-presentation to a selection committee, and an interview with the prospective supervisors. The selected candidates from Germany as well as from abroad attended a curriculum taught in English. An overview of space life sciences was given in a workshop with introductory lectures on space radiation biology and dosimetry, space physiology, gravitational biology and astrobiology. The yearly Doctoral Students' Workshops were also interdisciplinary. During the first Doctoral Students' Workshop, every candidate presented his/her research topic including hypothesis and methods to be applied. The progress report was due after ~1.5 years and a final report after ~3 years. The candidates specialized in their subfield in advanced lectures, Journal Clubs, practical trainings, lab exchanges and elective courses. The students attended at least one transferable skills course per year, starting with a Research Skills Development course in the first year, a presentation and writing skills course in the second year, and a career and leadership course in the third year. The whole program encompassed 303 h and was complemented by active conference participation. In this paper, the six years' experience with this program is summarized in order to guide other institutions in establishment of structured Ph.D. programs in this field. The curriculum including elective courses is documented. The applicants' statistics revealed that personal contacts and the DLR website were most important the recruitment of doctoral candidates. The evaluation of the application and selection procedure revealed that prediction of thesis success based on master thesis mark or evaluation by the selection committee is difficult. SpaceLife Doctoral Students greatly contributed to the scientific output in terms of peer-reviewed publications of the Institute of Aerospace Medicine with a peak in the fourth year after start of the thesis and they continuously received awards for their scientific work.

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1. Introduction

In the field of space life sciences, interdisciplinary interaction, working in large teams with tight time schedules (especially in the case of parabolic flight experiments, space

missions, balloon or rocket starts), the extensive requirement of documentation and safety tests and confrontation with extraordinary environmental factors make a special education of the future scientific workforce necessary. To face the challenges, a structured Ph.D. program in space life sciences, the Helmholtz Space Life Sciences Research School (SpaceLife), was established in 2009 at the Institute of Aerospace Medicine, German Aerospace Center (DLR), in Cologne, Germany, in cooperation with several universities (Hellweg et al., 2011). SpaceLife aimed at promoting young researchers in the field of space life sciences with an interdisciplinary doctoral training and support by a scholarship. A maximum of 25 students per generation with two generations within 6 years was planned to be admitted. The participating organizations intended to promote important research fields in space life sciences with SpaceLife doctoral candidates and thereby to contribute to the understanding of the opportunities, capabilities, and limitations of humans living and working on the space frontier and the origin, evolution and spread of life in the universe. At least one peer-reviewed first author publication and one conference presentation per doctoral student was expected. Furthermore, established cooperation was expected to be strengthened and new cooperation to be built.

This program encompassed up to now two generations of doctoral students, starting 2009–2010 and 2012–2013. It embedded the individual promotion (Knobil, 1996) in a structured doctoral program with a focused curriculum and intensive supervision by a thesis advisory committee (TAC) with two supervisors (one from the DLR and one from the partner university) and a mentor.

The program centered on the development of research skills and mastery of a discipline (space life sciences with specialization in radiation dosimetry, radiation biology, gravitational biology, astrobiology or space physiology). The program's objective was to investigate the complex interactions of space environmental factors such as microgravity and radiation for humans or other organisms. This research is accomplished using ground-based laboratories, microgravity environments (parabolic flights, sounding rockets, drop towers), space-analog simulation facilities, heavy ion accelerators and if available, space flight opportunities. The cooperating universities award the doctoral degree, while the DLR as member of the Helmholtz Association awards the Helmholtz Certificate for successful completion of the SpaceLife curriculum.

Here, the development of the curriculum over the last six years will be summarized. A quantitative approach regarding doctoral students' numbers, scientific output and applications was taken to evaluate SpaceLife.

2. SpaceLife management and funding

The scientific members of SpaceLife formed the faculty (Fig. 1). The faculty elected a faculty panel who assisted the supervisors and the spokesperson in the student

selection process and in formation of the curriculum. The spokesperson bears responsibility for SpaceLife. SpaceLife was organized by the coordinator and the secretary. This included initiation of cooperation contracts with the member universities, organization of the selection procedure, management of the scholarships and the financial resources, organization of the curriculum and general support for the doctoral candidates. The doctoral students elected a doctoral spokesperson during the first Students' Workshop. The doctoral spokesperson participated in meetings of the faculty panel or the full SpaceLife faculty. During these meetings, e.g. upcoming selection procedures, the curriculum and work progress of the doctoral students were discussed. In conflict situations, the mentor and the doctoral spokesperson developed a solution together with the doctoral student and the supervisors, the head of department and the spokesperson.

The annual funding of SpaceLife by the Helmholtz Association amounted to 300 k€. The DLR contributed the same amount from funds of the Aerospace Executive Board and the Institute of Aerospace Medicine. Therefore, a total of 600 k€ was available yearly for six years. The personnel costs included a scientist as coordinator, a secretary (50% of a full position), 13–16 scholarships for the doctoral students, financial support for five partner universities (10 k€ per university and year), and expenses for the curriculum (annual workshop 15 k€ in average, soft skills ca. 13 k€ per year). A small yearly budget for travel costs and materials and supplies of ca. 1.5 k€ per student was also covered. Expenditure on material exceeding this limit and personnel costs for the supervision of the doctoral students were not included in the SpaceLife budget and were covered by the participating departments and universities. The universities also contributed doctoral positions (seven for the first generation, five for the second generation of doctoral students). Furthermore, the three Chinese SpaceLife students received a scholarship from the Chinese Scholarship Council (CSC), resulting in a total number of 22 doctoral candidates in the first generation and 24 in the second generation.

3. SpaceLife application and selection procedure

Open SpaceLife scholarships were announced in 2009 and 2012. During the first announcement, 99 inquiries for application were received. The application and selection procedure and the statistics of the 2009 applications was described in detail by Hellweg et al. (2011). In response to the 2012 scholarship announcement, the SpaceLife coordinator received 234 inquiries for application, resulting in 116 complete applications. The complete application consisted of the filled SpaceLife Application Form, the curriculum vitae and two reference letters. The applications came from 32 different countries (Fig. 2). Compared to 2009, the percentage of international applicants increased from 50% to 66%, showing that SpaceLife was better known internationally. Applications came from all continents except

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