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Astronomy Education and Research in Germany

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Abstract. I briefly summarize the state of Astronomy research and education in Germany as I see it. In a world-wide comparison conditions are excellent, however, specific problems remain. While Science and Astronomy teaching is offered free to everyone (including foreigners) at schools and universities, the quality and effectiveness of science education could be improved. In the academic research and teaching system a number of problems are currently discussed and proposals to increase effectiveness and international competitiveness are being made, like the evaluation of teaching and research, introduction of more competition, and the reform of post doctoral career paths and the tenure system.

1. Introduction

The International Symposium on Astrophysics Research And Science Education sponsored by the Vatican Observatory in 1998 has seen a wide variety of contributions from all parts of the world. In this respect the situation of astronomy students, teachers, and scientists in Germany is on the extreme end of the presented spectrum, if compared to the situation in developing countries: Germany has a well developed and well funded educational system, starting at the school level and going up to the universities, which are freely accessible for everyone (no student fees). Basic and applied research in all areas are equally well funded and supported by the government and there is no general debate questioning this support. Hence, all criticism, naturally contained in such an article, has to be seen on this overall positive background.

2. Astronomy education in school and for the general public

Germany has a highly differentiated school system with a large number of different types of schools, too many to be described and covered in detail here. Sciences like physics, chemistry, and biology are basically taught at various levels in all schools. Usually, astronomy is not a separate course but is included in the curriculum for other subjects, especially physics. There is, however, enough flexibility that interested teachers can offer special interest groups, projects, or even short-term courses which focus entirely on astronomy. This is, of course, most effective if the teacher him/herself is an enthusiastic amateur astronomer. Quite a number of schools also have some basic astronomy equipment like telescopes and sometimes even domes. Hence, if a student is interested in astronomy there is a good chance he/she can get some basic education in school, on the other hand, however, astronomy education is probably inconspicuous enough that many students escape it without harm and without much knowledge.

This is reflected in the general public today, where one can sense a certain interest in astronomical topics, but where one also finds a lack of basic astronomical concepts. Another consequence is a generally poor science journalism in larger newspapers, headlines like: "First object outside Milky Way detected" (in the 1990s, not the 1920s!) or

"Black Hole swallows Milky Way - no danger for earth yet" are not uncommon. Unlike in the US where there are organizations like NASA or the AAS, which sponsor actively public relation and outreach efforts, the astronomical community in Germany as a whole is very disorganized when it comes to educate the general public. At least there are a number of individual institutions which sponsor outreach activities themselves—for example the 100m radio telescope in Effelsberg run by our institute is a favourite tourist attraction—and a number of amateur astronomers associations which run "Volkssternwarten" (people's observatories) that offer basic information for the interested public.

3. Astronomy education at Universities

Quite a number of universities in Germany offer astronomy PhD programs. Typically a student first graduates in physics (diploma) with astronomy as a minor subject before her/she can go on as a graduate student in astronomy. There is no specific degree for astronomy. To obtain a physics diploma a student needs roughly 5-6 years, including a one year diploma thesis, while graduate school usually only consists of writing a PhD thesis within 2-3 years in a research group. This has the advantage of giving the student more freedom and independence than in graduate programs which are burdened with too many classes. Main centers of astronomical research can be found in Munich, Heidelberg, Bonn, Berlin, Göttingen, Hamburg, Tübingen, Bochum and other big universities. Special attention should also be given to the universities in eastern Germany which had to undergo serious changes after the unification. While their international reputation may not be as high yet as those of established Universities in western Germany, they may have a lot to offer for new students because of their smaller sizes and renewed structures. Another possibility for graduate students are Max-Planck-Institutes which have a high reputation as research institues but, unlike universities, have no teaching duties. Nevertheless, all these institutes participate in teaching activities at nearby universities and offer fellowships for undergraduate and graduate research.

4. Support for foreign students and research

Within an international context, like this workshop, one needs to briefly mention the possibilities open to foreign students in Germany. There are in fact a number of programs for exchange and funding of foreign students. The most important organization in this respect probably is the DAAD (Deutscher Akademischer Auslandsdienst, http://www.daad.de/ where one also can get a much more detailed overview of the academic system in Germany than given here). All German universities accept foreign students, but usually require language knowledge and the student may spend the first year learning German in special schools. Staying in Germany, of course, usually requires a visa and funding—for living not student fees—has to be assured in advance. One problem in transferring to a German university is the transfer of degrees, diplomas, and credits obtained in another country since our systems has some peculiarities. Many universities have now started to experiment with international programs: Bonn University, for example, has just started the "Bonn International Physics Program (BIPP)" which allows international students to attend lectures given in English. It is also possible to take exams in English. PhD theses written in English have already been possible in various places for quite a while. Moreover, a number of Max-Planck-Institutes offer PhD and PostDoc positions for foreign students.

5. Problems of astronomy education and research

In contrast to typical complaints elsewhere I do not believe that funding is the major problem astronomy is facing in Germany but rather believe that we are plagued by some serious structural problems. A recent study published in Science (1998, v.281, p.49) revealed that German science is at the bottom end of industrialized countries as far as its effectiveness is concerned while the absolute level of spending is quite good. Consequently, a large debate is currently raging aiming at an overhaul of the German university and research system. In my opinion the following problems need to be addressed:

5.1. Lack of competition:

Unlike the US, German universities need not compete with each other as far as money and students are concerned. Since there is also no regular evaluation of teaching and research (with consequences), mediocrity fares a good life. A "mentality of excellence" is often demanded, it seems, however, that the concept of "excellence" in science is very vague in Germany and often based on position rather than achievement. A self-esteem not tested in competition can easily lead to an unbalanced view of one's self—in both directions. In this respect it is quite interesting to note that none of the directorships at astronomy-related Max-Planck-Institutes—which by definition require a high degree of excellence—given out in recent years, has been given to a candidate from within Germany. Is seems as if German science does not even trust itself very much. Most structure reform proposal therefore include the call for increased evaluation of the quality of science and teaching.

5.2. Teaching

My first experience with university teaching was a mathematics course in a completely crowded lecture hall with several hundred other students where I was informed—quite proudly by the professor—that at the end of this course two third of the students will have dropped out. Another physics professor functioning as a first semester guide to students could not get tired of explaining to students how incompetent they actually are. The first lesson to learn at a German university for me was: take care of yourself, no one really cares whether you are here or not. My impression of American universities was quite different with students being treated as customers rather than an annoying crowd. My diploma as well as my PhD certificate were handed to me by the secretaries in a very unofficial setting while graduation ceremonies, a show of appreciation after all, are quite evolved in American universities (even though it sometimes can happen that Kermit—the frog—is your keynote speaker). Of course, there are excellent and caring teachers at German universities as well, however, the system itself does not really encourage a student-centered mentality. An easy way out would be to charge student fees so that students become "valuable". However, this would violate some of the basic principles of fairness and free access for everyone, that we have (fortunately) adopted in Germany. Thus, current ideas to reform teaching revolves around systems which try to couple evaluation of the quality and effectiveness of teaching to the basic funding of universities.

5.3. Career perspectives

An important question for students going into astronomy is the professional perspective offered to them in industry, basic research, and teaching. In the first half of the nineties German industry, due to a recession, was reluctant to hire new qualified R&D staff. In some cases the number of applicants—university graduates and PhDs in physics and related fields—-reached 2000 for a single job offer! It seemed that the industry showed a complete lack of appreciation of physicists as a whole. The psychological impact of this situation on a whole generation of young and prospective physicists was much stronger than it is usually deduced from official unemployment statistics only. Due to this uncertain job market the number of students starting in physics has been reduced drastically within the last few years, down to a third from its peak value. Hence, there is currently an overabundance of PhD astronomers and PostDocs in Germany looking for some of the rare long-term positions in astronomy, while one can foresee a 'supply'-problem of students in the very near future (perhaps serving as an argument to cut even more jobs in university teaching). Consequently career prospects for astronomers in Germany seem to be less than optimal.

Another interesting side-effect of this recession was that the lack of inflow of trained physicists (and astronomers of course) coincided with the explosive growth of the Internet taking place mainly at the universities. As one consequence development of Internet use in Germany was and still is significantly delayed with respect to the US. I see this as an example of a failed technology transfer caused by ignorance and lack of appreciation of academic teaching and research. Fortunately things have changed now and it seems that physicists and even astronomers are in high demand now in the industry.

The situation looks less positive for academic careers, where I see the most serious structural problems at the PostDoc/Assistant Professor level. It is commonly said that PostDocs and young scientists are essential for the creativity and activity of every institute and that they carry a lot of the burden of the actual research done. Unfortunately the important phase between the PhD and the full professor level has been completely neglected in Germany, making it difficult for many young scientists to pursue an academic career. There is an intense competition when it comes to fill vacant full professorships in Germany, however, this usually happens at a stage where scientists are already established and have reached a certain age. On the other hand no such competition and related opportunities really exist for PostDocs and I am not aware of a functioning job market for PostDocs here. Sometimes it is very difficult to find out where jobs are being offered, especially for outsiders, since many jobs are not widely advertised at all because the prospective candidate often has to be named already when the grant application is written. Moreover, the German equivalents to assistant professorships have been misused, split and tormented in so many ways over the last two decades that now very few of these positions, which combine teaching and research duties, are actually left. Nevertheless, a general prerequisite for becoming full professor in Germany is teaching experience and a second exam and thesis (called "Habilitation"), so the only chance to advance through this stage is to teach for free and without any clear perspective or security. While in other countries PostDocs are seen as an important asset for a institute to vitalize research my feeling is that this big creative potential is used relatively inefficient in Germany. A part of the reason may be the very hierarchical system in the German academic system which focusses very much on the top of the power pyramid—a top which is often reached in a single step. It might be worthwhile, and this has been proposed as well, to consider a more sophisticated system that includes several steps up the ladder, including temporary assignments of assistant and associate professorships which could eventually evolve into tenured positions at various levels.

6. Conclusion

In summary one can probably safely say that the German academic system is facing a number of changes over the next years. At least the current discussion points in this direction. German science will need to become more competitive on an international level, hierarchical structures and thinking need to be de-emphazised, teaching will have to concentrate more on the needs of those who are being taught (rather complain about their shortcomings) to become more effective, and all this should coincide with greater efforts to popularize scientific results and to strengthen the reputation of an academic education in general. Science education and research in astronomy and physical sciences in General is good, however, it may not yet quite live up to its fullest potential. In times of budget cuts we have to make sure that every "Deutsche Mark" (and soon every "Euro") is well spend and improvement never is possible without change.