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Dr. Eberhard Möbius, Professor in the Department of Physics

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mentor highlights

Professor **Eberhard Möbius** is the current chair of the Department of Physics at the University of New Hampshire, where he has been on the faculty since 1990.

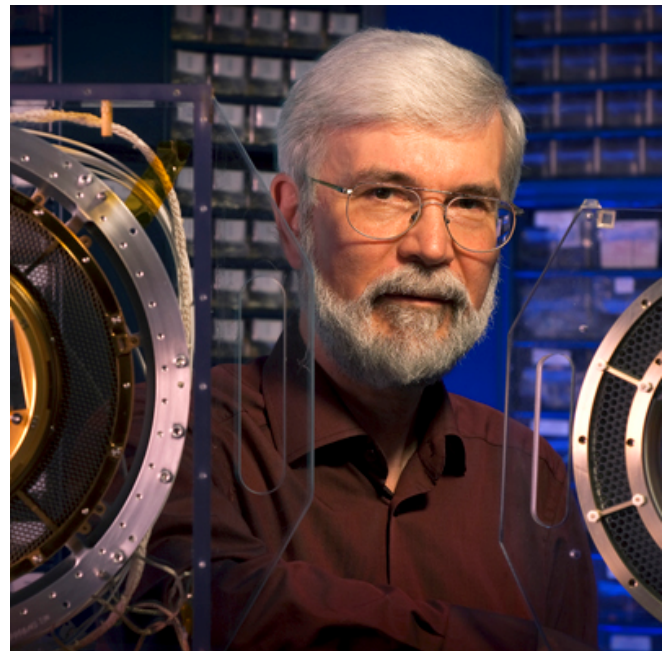
Below is an edited correspondence with Professor Möbius about his own research and his mentoring experiences with undergraduate students.

Inquiry: What is your current research? Did your undergraduate studies point you toward it? What interests you most about it?

EM: I studied in Germany, and at that time there was no distinction between undergraduate and graduate study. The first degree to be earned was a Diploma in Physics, which included a full-fledged research thesis that required a lot of independent work and took about two years to complete. I concentrated on laboratory plasma physics while eyeing astrophysics at the same time. My rationale was: More than 99% of the matter in the universe is in the form of plasma. Ergo, I should study plasma physics to get close to astrophysics. My having this specialty also opened opportunities in several technical disciplines. Needless to say, I finally ended up in space physics at the Max-Planck-Institut für extraterrestrische Physik (MPE) in Garching, Germany, right after completing my PhD that was still rooted in laboratory plasma physics. My work at MPE with spacecraft instruments and data paved the way to the faculty position that I am in now.

I would characterize my current research as focused on the interaction of the heliosphere, the protective bubble around the solar system formed by the solar wind, with the surrounding gas and plasma in interstellar space—the space between the stars. What guided me to this research line, which has now culminated with the Interstellar Boundary Explorer Mission (IBEX), was the partially serendipitous discovery of so-called pickup ions of the interstellar gas, using my first self-designed space instrument. This discovery was the first direct observation of particles from interstellar gas and was made right at our front doorstep. It opened a brand new field to detailed studies.

For me, it is most fascinating that, with particle detectors not so far away from Earth, we can probe the composition and behavior of interstellar gas—the raw material for the formation of stars, planets, and ultimately creatures like us. In this way, we can gain insight into the evolution of matter in our Milky Way galaxy from the beginning until today,



Components of measuring instruments designed by his UNH team for the IBEX satellite flank Eberhard Möbius (Perry Smith, UNH Photoservices)

and we can learn what the outer boundary conditions are for our solar system. They determine the size and shape of our protective bubble, which shields us against energetic cosmic rays from the galaxy, so-to-say as the first shield.

Inquiry: What is the purpose of a mentoring relationship? What should the student and you gain from it?

EM: I find it important that students gain confidence in what they are doing. Research sounds exciting and exhilarating, but it is also scary. You are going where nobody has gone before, and often you arrive at blind alleys. Then there needs to be a nudge to try something else and the reassurance that having gone down this path (avoid calling it a wrong path) is not a disaster. A researcher has to attain (or maintain) the courage to try something untried after making some prudent choices. I find it very important to pass on this experience of "failure" that all of us who are doing research have run into so many times. The students need to see that they have to step up their attempts to venture more and more independently, while they should still have the feeling that they are not alone. They are encouraged to come back and ask questions after having explained what they have done, achieved, and where they feel they got stuck.

For me it is important to see that, after some time of initial investment of detailed guidance, a younger colleague is growing who can take over some of the tasks and, step-by-step, start to run with them. In the end, it is very satisfying to see an excellent mentee going on to the next level and to feel that I contributed something to that evolution. Although at that point, I simply would like to keep some of them because now they have really grown very valuable.

Inquiry: Please describe some positive, memorable mentoring experiences or mentees.

EM: After having talked to a student presenter about the contents and layout of the poster for the Undergraduate Research Conference (URC), being worried whether the poster would be ready on time, but then, almost the last day, getting presented with a pretty well thought-out poster. This was trumped only by the surprise during the URC that the poster won an award. And so it happened repeatedly with Robert DiFabio, Morgan O'Neill, George Clark, and most recently Lee Petersen.

One of the most memorable moments was Morgan storming into my office first thing in the morning, out of breath, and telling me all excited that she was accepted by the Massachusetts Institute of Technology. Her conclusion was "I don't need to visit any other school. I knew that I wanted this the most."

Inquiry: Please describe any difficulties or problems you have had in mentoring undergraduates.

EM: In the beginning of my career at UNH, when I started to take on undergraduate students to help with research in the lab as hourly employees (which, along with a mentoring component, is one alley for getting them involved), I had a couple of cases where a student sometimes would not come for weeks, without notice, and then show up again. I had to make clear that there was a job to be done and on a certain schedule. Of course, it was understood that students may have times with other, more pressing demands, but an upfront warning by the student and a discussion about how the job could be done or transferred was required. For most of the students, that was the understanding anyway, but there seemed to be some for whom that is a new concept.

Inquiry: What advice or tips would you give a faculty member new to undergraduate mentoring?

EM: It is important to feel out in the beginning what the students are really interested in, whether experimental hands-on work, data analysis, or number crunching on computers. It goes a long way toward getting them started on something they really want to do. If there is not a good match at the moment, one shouldn't force it.

The more specific the first tasks are, the better the students can get into their jobs. Frequent meetings about progress and where they get hung up are important. If possible, it helps a lot to have also a more experienced student engaged as a collaborator who can transfer some of his/her knowledge already gained in the group. Also, it is important to point out that there are other folks in the group who are happy to help out on certain issues and are better equipped to explain them than the immediate supervisor. The students need to learn teamwork.

Inquiry: Please add anything else you feel is relevant.

EM: I feel that research as an undergraduate adds incredible value to students' education. They learn skills that they otherwise would have to learn on their first job out of school. Working in a group, being confronted with something whose solution isn't known yet or even may not have anything close to an expected answer, are not what you can learn in course work, even with the most elaborate course design. On the flip side, over time, students have contributed substantially to the research results in my group. The commitment of mentoring time has paid off.

To read more in this issue about Professor Möbius and his space research, go to the Commentary by George Clark and Morgan O'Neill and to Joshua French's article.