the door to academia is not necessarily closed (see *Nature* **466,** 402–403; 2010). Several former IBM researchers have moved on to become university faculty members, helped by the prestige of working in a high-profile industry lab.

Some academics fear that industrial PhD students may not acquire the full set of skills and knowledge required for independent scientific research in academia, ranging from methods to research ethics. "Academia and industry have fundamentally different roles and it is not helpful if they imitate each other," says Peter Blöchl, a theoretical physicist at Clausthal University of Technology in Germany. He worked for ten years at IBM's research laboratory in Ruschlikon, Switzerland, before moving to academia in 2000. Academia's mission is pre-competitive research and student education, he says. "Companies can tap into this knowledge base to develop innovative products, but I see little purpose for a PhD in industry." Joint projects, consultantships and sabbaticals are more productive, says Blöchl.

In general, students must be prepared for companies to tweak a research proposal to strengthen its commercial potential, says Thomsen. To avoid misunderstandings, they should make sure from the beginning that they are willing to accept such input. Early interviews with company researchers should help, but subsequent problems are best addressed with the help of the supervisor. In structured programmes, the funding agency will also review any complaints, and may intervene.

In the Danish scheme, says Thomsen, complaints are rare. If serious problems do arise — for example, if a host company goes bankrupt, or a PhD student is asked to do experiments or tasks unrelated to their project — the agency will try to mediate and, if necessary, demand the return of subsidies.

Concerns that industry is in it mainly for the cheap labour, and that projects lack scientific depth, are unfounded, says Martin. "All companies we're working with — even the manufacturing sites — have a serious interest in supporting genuine research."

But as industrial PhDs become more common, some do worry about exploitation of students and 'over-industrialization' of higher education. Eurodoc in Brussels, which lobbies for the rights of PhD candidates, warns that early-career research should be a free intellectual endeavour and not subject to the needs of business and industry. "Vanguard industrial PhD programmes are an opportunity to do what we all want to do — get work," says Greg DeCuir, a dramatic-arts PhD student at the University of Arts in Belgrade, and a member of Eurodoc's career-development group. "But we are not apprentices. If you feel that your scientific creativity is compromised, there should be a concern." ■

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TURNING POINT
Christopher Wilson

Christopher Wilson, a physicist at Chalmers University of Technology in Gothenburg, Sweden, led one of Physics World*'s 2011 'breakthrough' experiments: he and his team proved that a vacuum, rather than being completely empty, contains detectable virtual particles. He explains his motivation for taking a working sabbatical at a biotechnology start-up in California.*

You did your undergraduate degree at the Massachusetts Institute of Technology (MIT) in Cambridge. How did this affect your career?

I was able to attend MIT after I won a US Naval Reserve Officers Training Corps scholarship, so I was expected to go into the navy afterwards. But I realized while I was at MIT, which is a very intense place, that I would rather do science. Between the second and third years of my degree, I notified the navy that I didn't want to join. They could have drafted me, but they allowed me the option of paying back the scholarship money, which I've been doing ever since.

How has your move to Chalmers influenced your research?

I worked at Yale University in New Haven, Connecticut, for two years and then moved to Chalmers to work on a quantum computing project, ostensibly for a year. I've now been there for seven years. In Sweden, the work dynamic is hierarchical, like a company. There is a top professor who has several professors at different levels working under him or her — and younger researchers work their way up. It's a good system if you have a good boss. It gave me more time and freedom to get this one big experiment to work than I would have had in the United States.

Describe your breakthrough experiment.

When I got to Chalmers in 2004, my team started work on superconducting circuits for quantum computing. Around 2007, we realized that the work could allow us to measure the virtual photons inside a vacuum. These virtual photons are generated and annihilated in pairs. About 40 years ago, it was suggested that a mirror moving near the speed of light could capture some of these photons. The effect had never been observed, because it is very hard to move a massive object that fast. We made an electronic 'mirror' that we could effectively move at one-quarter of the speed of light using magnetic fields. This allowed us to separate the pairs, stopping them from annihilating and turning them into real photons that we could observe (C. M. Wilson *et al. Nature* **479,** 376–379; 2011).

Could the media attention have a career benefit?

It certainly helps to put the paper in a certain light, especially for people outside our physics sub-field. For example, when applying for jobs, you are evaluated by a whole department. It can be difficult even for other types of physicists to evaluate the details of papers.

Why did you choose to take a sabbatical year at a start-up biotechnology company?

Last July, I was promoted to associate professor, which is tenured at Chalmers. In the US system, it is typical to take a sabbatical after getting tenure. Sweden doesn't follow the same timing, nor does the university pay academics to go on sabbatical, but I had planned to do it. I happened to see an ad on a job-posting site from a start-up company working on biomedical devices and proteomics. They needed someone skilled in algorithms and advanced statistical tools to analyse the enormous amount of data being generated about proteins, and I liked the people involved. It has turned out to be a good fit.

What kind of career impact do you expect the sabbatical to have?

I really wanted to do something to diversify my skills and develop some research lines that were completely my own — which can be a struggle in Europe's hierarchical system. I want to see if I can contribute algorithms to the field of proteomics. It would be pure hubris to think I could jump into biology, but I would like to find collaborators and see if I can develop a new aspect of my research. ■

INTERVIEW BY VIRGINIA GEWIN