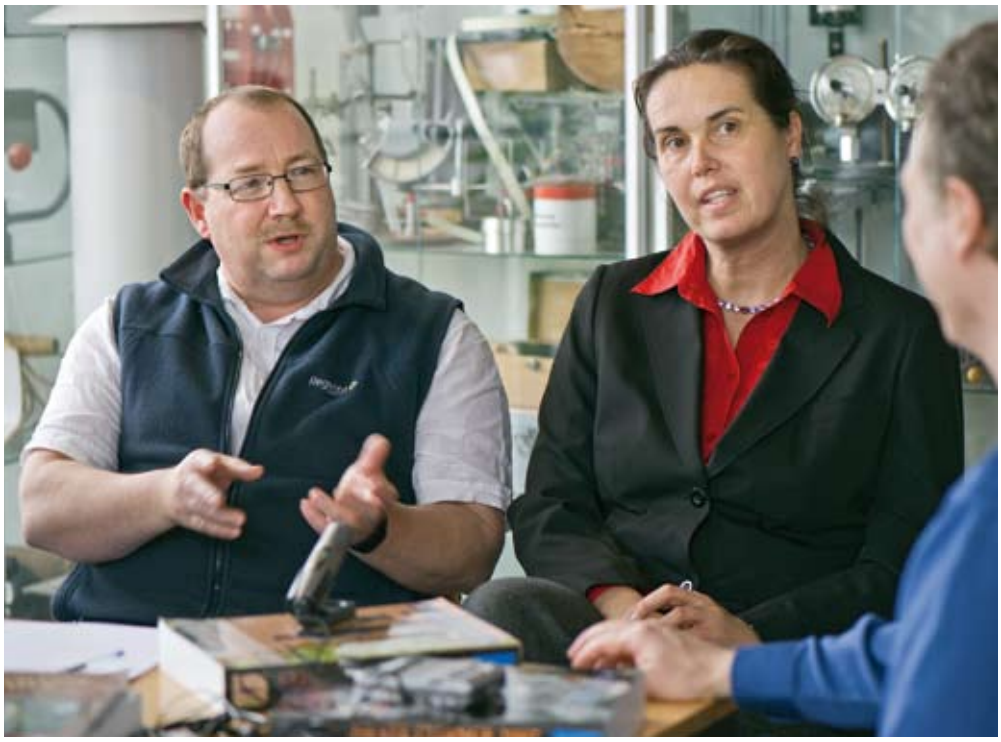
In Focus **Global Change**

Excerpts from an interview on February 15, 2011

Patrick Regan



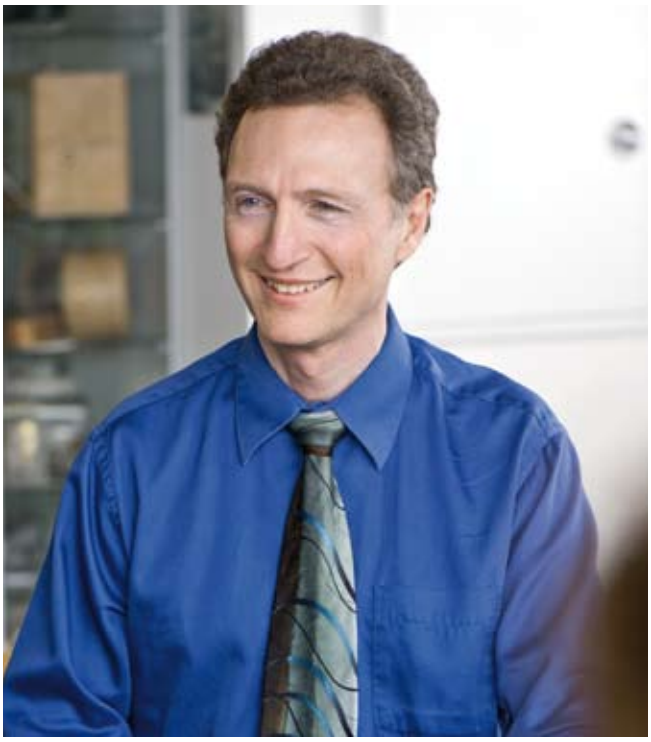
Tim Sparks, Annette Menzel

I can't recall a single interview (out of thousands over the years) more generously peppered with laughter than my session with five members of the TUM-IAS Global Change Focus Group: Hans Fischer Senior Fellow ***Tim Sparks*** *(TS), his Host Professor* ***Annette Menzel*** *(AM), postdoctoral researchers* ***Nicole Estrella*** *(NE) and* ***Christian Zang*** *(CZ), and doctoral candidate* ***Anna Bock*** *(AB). More often than not, the explosion of laughter would have been set off by the aptly named Sparks, who himself sat quietly at the epicenter, looking innocent. But this lively group is dead serious about climate research. On that subject they expressed not only a feeling of urgency, but also what they called a sense of duty. (PR)*

PR: Is it getting warmer? The measurements say yes. Is human activity making it get warmer faster? The evidence seems overwhelming. There are open scientific questions about the speed of global warming, about where the tipping points might be, about the degree of human influence – but you are focusing mainly on potential impacts and responses. Why?

TS: Too many people don't see climate change as a threat. I don't think there's anything being proposed to try to lessen the effects of climate change that is going to damage the planet in any way, shape, or form – reducing CO_2, reducing travel, making things more sustainable, none of those are going to be damaging. So I can't understand the resistance to change. You can imagine a situation some years down the road, where someone, maybe your grandchild, says, "Why didn't you do more?" And that I think is quite humbling. There's an urgent need to know more about what's going to happen.

AM: I like your first two points. First they doubted that it was getting warmer. Now they have to believe it. Second, they doubted the human influence, and now it seems clear that there is a very strong human influence. And now they say: OK, it's getting warmer, maybe even because of human influence – but it's nice. Don't you like warm summers? And if you look in long paleoclimate data, the warmer periods have been linked to periods of higher biodiversity. Or look at the planet itself. We have tropical regions with high biodiversity. Or think about the contrast between living conditions in the warmer periods of medieval times and the cold, dark times of barbarian migration. These are the kinds of arguments coming up now, to say that getting warmer is not all bad. And now we come on the scene to say, have you seen these impacts, those reductions in growth in the course of the European summer heat wave of 2003, for example, that might be a very good idea of what might happen in a hundred years? Or have you seen farmers changing this or that habit? We know – as Nicole showed in one paper – that farmers are not reacting as appropriately as the plants are. So I think this is more or less our duty at the moment.



Patrick Regan

TS: Duty is a good word.

NE: And you have to keep in mind that the face of change is different, compared to former times. We have now around seven billion people living in the world, and many areas that have something to fear from climate change are heavily populated. And there is something we don't even know from the paleo records: What happened to animals directly while it was changing? Not when it was nice, when it was warm, but the transition times. We don't know much about it, and therefore you have to be careful – especially if climate critics state, oh well, warming might be nice. What about the rest of the world?

AM: It's also the speed we have to care about. Here's a local example. Our university is part of a consortium that operates the environmental research station Schneefernerhaus just below the Zugspitze. We recently took a look at vegetation below the station, which will have to move upwards 500 meters when it's three degrees warmer. You can imagine beautiful green alpine meadows – but the reality will be landslides, rock falls, permafrost melting, and no

vegetation, because there is no soil, and there won't be any soil in a hundred years.

PR: Your approach to investigating climate change and its likely impacts contrasts sharply with computer modeling, which necessarily deals with global averages and abstract representations of physical processes. Here you are looking at phenology, events in the life cycles of plants over time, on a regional or even local level – such as the timing of Bavarian hops and grapevine cultivation. What does this add to our ability to understand what's happening globally, and to plan for the future?

TS: We need to exploit every little bit of information that we can get hold of. I have someone in Scotland that Annette laughs about because he recorded, I think since 1983, every time he cut his lawn. So you get from that the first cut dates, last cut dates, the cutting season, and the number of cuts. And there's a remarkable linkage with temperature. I see a great need to look at existing data sets, and these are data that people can associate with. I think it's something that has a public face to it. About sixteen years ago, I was working as a statistician in ecological research, and I came across a strange box, which contained a strange graph. And it became apparent from this graph someone had left when he retired that the U.K. had something in the order of two hundred years' worth of data on the leafing dates of trees, which seemed to be forgotten. It had been published in 1926 and forgotten about subsequently. So to me it was very obvious that those data could be used to look at how leafing varied with the weather of that particular year. It turned out that the family had continued to record this data; it had been recorded by a single family from 1736. They carried on recording until at least 1958, in the same village, generation after generation recording the same events. And we ended up with a very long time series of data, collected in the same way, to the same formula if you like, and I published that in about 1995 – at roughly the same time Annette published a Nature paper on trees across Europe.

PR: Does your collaboration go back to that time?

AM: During my first visit to the U.K., Tim did show me this famous village with its famous family, and the graveyard where they were buried. We began writing papers on phenology together a bit later, about 2000. And when I served as a lead author for the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, both Tim and Nicole were contributing authors. Within the working group that focused on impacts, adaptation, and vulnerability, we were among others responsible for the assessment of observed changes and responses in natural and managed systems, the so-called fingerprint of climate change. We wrote about changes all over the world, during the previous four decades, that could be attributed to climate change. I was a member of the German delegation in Brussels when the Fourth Assessment Report of IPCC was adopted in April 2007. A few nations disliked the idea of saying it was "very likely" that these changes in nature could be attributed to human influence and increasing greenhouse gases.

PR: Do you see your TUM-IAS Focus Group as a framework for extending that collaboration, or as something new entirely.

TS: It's going to intensify it. There's no doubt about that. This is the first time it's put it on a concrete basis,

Tim Sparks

Annette Menzel, Christian Zang

that research collaboration. So I'm anticipating a lot more research jointly between us. There's such a diverse group of people, working on lots of different things, and I'm just sticking my nose in everywhere.

AM: We are covering a wide range of different research questions, all of which address atmosphere-biosphere interactions. So we are always looking at interdisciplinary questions. And they are mostly related to impacts, how to detect them, what's statistically significant, what's due to climate change, what can be attributed and what might have other causes like invasive species, pollution, too much nitrogen and so on. Then we have another branch of interest that is related to extreme events, because it's not only the change in mean values, a rise of one degree Celsius in temperature, that matters, but especially the effects of extreme events. This is the second one. These investigations range from phenology to changes in wild forest fires, for example, and forest fire regimes in the alpine region, as well as questions of influences of photosynthetically active radiation and radiation indices on competition in mixed forests. Nicole has worked in both areas.

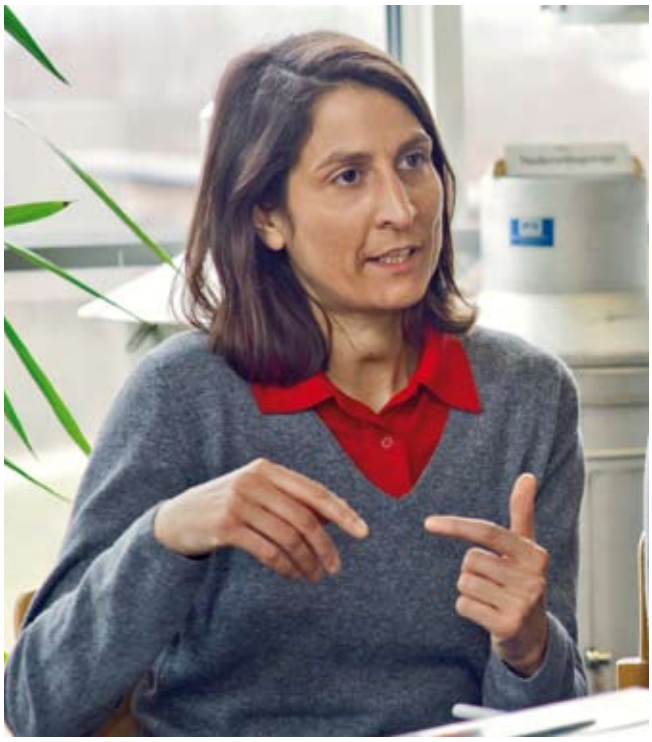
NE: First I started with phenological observations and connections to temperature, and now I have switched more to the extreme side of it. I try to find the connection between the climate and the environmental reactions of plants. For example, I took photographs of trees in autumn and spring, and I want to connect the phenological observations to the LAI, the leaf area index, and then connect it with the climatological parameters. To do that I use both existing data sets and outputs of regional climate simulation models.

AM: We are also working with the medicine faculty here, on questions related to pollen and human health. Now with this Focus Group we want to settle up these research topics. And we have broadened our interest further to dendro-ecology questions by hiring Christian, working in more paleoclimatological issues.

PR: So you're using tree rings to put contemporary or recent data into the context of a longer timeline?

CZ: In tree rings we have very long time series and large data sets to be explored, with annual resolution. One project will be to sample data from a historic wooden building in the Berchtesgaden Alps and do a local climate reconstruction from late medieval times, maybe 1200 or so, to the present, just to get an idea about how tree growth recently changed.

AM: You might get the idea that we are doing tiny little things on a regional scale, but it has global implications. And one research focus is the timeline. We are not working on ice cores, so the 800,000 years in Antarctica are out of our scope. But even the question of the climate in the past thousand years is a very interesting one, with the discussion of the warm medieval ages. Christian's tree ring research gives us a handle on a topic called the divergence effect. If we calibrate our tree ring reconstructions with temperature data and pretend we are not measuring temperature now but just ask the trees about the temperature, we would fail to get these current warm temperatures. And this is called divergence. Knowing this fact you have then some doubts: What about the warm medieval ages reconstructed by different proxy data? Because there were no measurements, we can only rely on



Nicole Estrella

phenological data and historical data, as well as dendroclimatological data.

CZ: I encountered some shortcomings of dendroecological research during my PhD work, namely the need for recalibration of data. I was focusing on tree growth subject to climate, looking at extremes, but also at mean values as well. The background was that foresters need to know which species of trees to plant in the future. And I worked mostly on how droughts and other extreme climate events influence tree growth, and which species are more susceptible than others. In order to make some climate reconstructions, I had to calibrate recent tree growth with recent climatic conditions and transfer it into the past. Now I want to focus on improving these relations between climate and tree growth. Dendroscience is a lot about methods, but most of them date back to the sixties or seventies and haven't improved much since that time.

PR: So this could be an opening for you to create tools for the whole field?

CZ: Of course it is.

AM: And we want to find out more about this divergence effect. What's behind that? Is it connected to some other factor being now at a minimum – not temperature, but maybe not enough precipitation – or could it be there's a statistical, methodological reason behind the divergence?

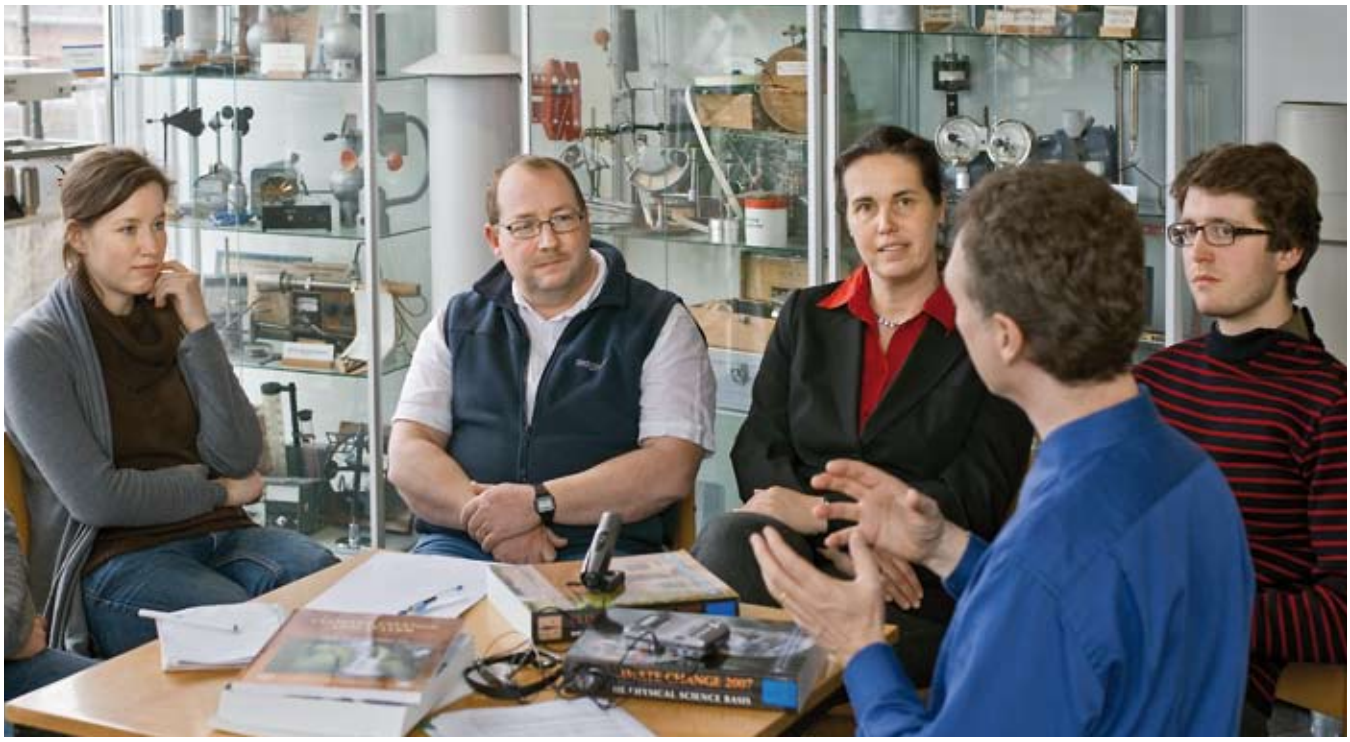
PR: Are there other questions that have a direct bearing on the reliability of predictions?

AM: When we talk about whether the trees have green leaves or not, this might seem like a tiny thing. But it's a very important question. It's one of the boundary conditions of the climate models. As soon as vegetation is in leaf, more latent heat and less sensible heat is transferring energy. Whether there is green vegetation doing photosynthesis, whether it is acting as a sink or a source for carbon, the leaf area changes biogeochemical cycles and the energy budget of the atmosphere. And a longer growing season could, for example, give more competitive force to those species that might be able to take advantage of it. Everything is related to changes in the growing season.

PR: One of the biggest advances ever in climate studies was coupling ocean and atmosphere models. Is the biosphere the next frontier?

AM: It's done, coupling atmosphere-ocean models to dynamical global vegetation models. We had a look at their procedures and sub-models to get the growing season.

NE: Of course these kinds of models are definitely needed, and they are useful. But there's work to be done. If you take for example Germany, or the temperate climate zone, then you always have a problem with the broadleaf trees in autumn. The models need an ending of the growing season, but if you try to trigger it by climatic parameters, it's hard. They're not taking into account the temperature of the foregoing month or anything like that, because leaf senescence might



Anna Bock, Tim Sparks, Annette Menzel, Patrick Regan, Christian Zang

integrate all the climate over the whole year. And it's not only climate but eventually pollution or the competition situation among the trees, and then the appropriate data might be something like the life span of the leaves. It's not possible, so far, to accurately model leaf coloring or falling of leaves in these regions. But of course the models need these dates. So they either simplify it or do some kinds of calculations.

TS: For leafing out of trees in spring, we are looking at extremely good models just on temperature alone, across a whole range of tree species. It does vary from area to area, but that seems to be the major controlling influence. Trying to predict leaf fall, as Nicole is saying, is much more difficult. You know, it could be a single frost event, it could be gales, it could be heavy rainfall, it could be a mixture of those; it could be drought in the summer that influences it. But the end of the season can be quite important for how much carbon is being stored in trees. It can be quite important for fungal activity at the forest floor level, because the fungi are basically cycling basic elements in the plant food if you like.

PR: Do you mean the mycorrhizal communities among the roots?

TS: Basically the mycorrhiza but also the fungal fruiting bodies, the above-ground bits. That is what becomes active when the trees stop being active. And that's all very interesting, that interaction, and we know so little about autumn. We've got much more data on spring. The timing of it, as Nicole said, could be critical to a lot of these models of what's going on, how the atmosphere and the biosphere are interacting. We need to know what's driving it, and how it will change in the future.

AM: There is more. Now we are focusing more in the middle of this vegetation period, the summer vegetation period. We know of a huge treasure of notes since 1934 about seed quality changes, for around thirty different species of trees, which could tell us a lot about flowering and fruiting regimes. This matters. It is not only the vegetative period but also the regeneration – how fast, how often and how successful – which drives natural regeneration,

adaptation, and shifting of species ranges. Also, we have the suspicion that the amount of pollen in the air in Europe is increasing, and it took us some time just to work out whether we could find any relationship to climate.

This too depends on finding good data sets. Tree rings can tell us something more about water, and water use efficiency. There is more in the air than temperature! The Focus Group on Global Change gives us a good framework for broadening our research, and for pulling these separate strands of evidence together.

PR: How do the doctoral candidates' research projects fit into the big picture?

AB: My project is to find data sets, long-term data sets – well, strange data sets. The idea is to find the footprint of climate change in things that have not been analyzed yet. One example is grape phenology, harvest dates, and composition. I already have a book of wine yields covering a period from 1804 to 1904. From the cultivation of hops, I have data from 1924 to 1998. There's another idea about bee data, such as swarming dates and the yield of honey.

TS: I'm going to take Anna back to Cambridge so she can go through some old German manuscripts in the library there, which I can't cope with. So we're hoping that there's something there as well. I see Anna as more of a historian, looking at past data sets and seeing what they can tell us, whereas Julia Laube, our other TUM-IAS-supported PhD candidate, will be generating and analyzing new data. Julia is a botanist, and she will be manipulating environments or, for example, looking at altitudinal transects and how things vary with environment going up a mountain slope, as well as what's happening with alien or invasive species.

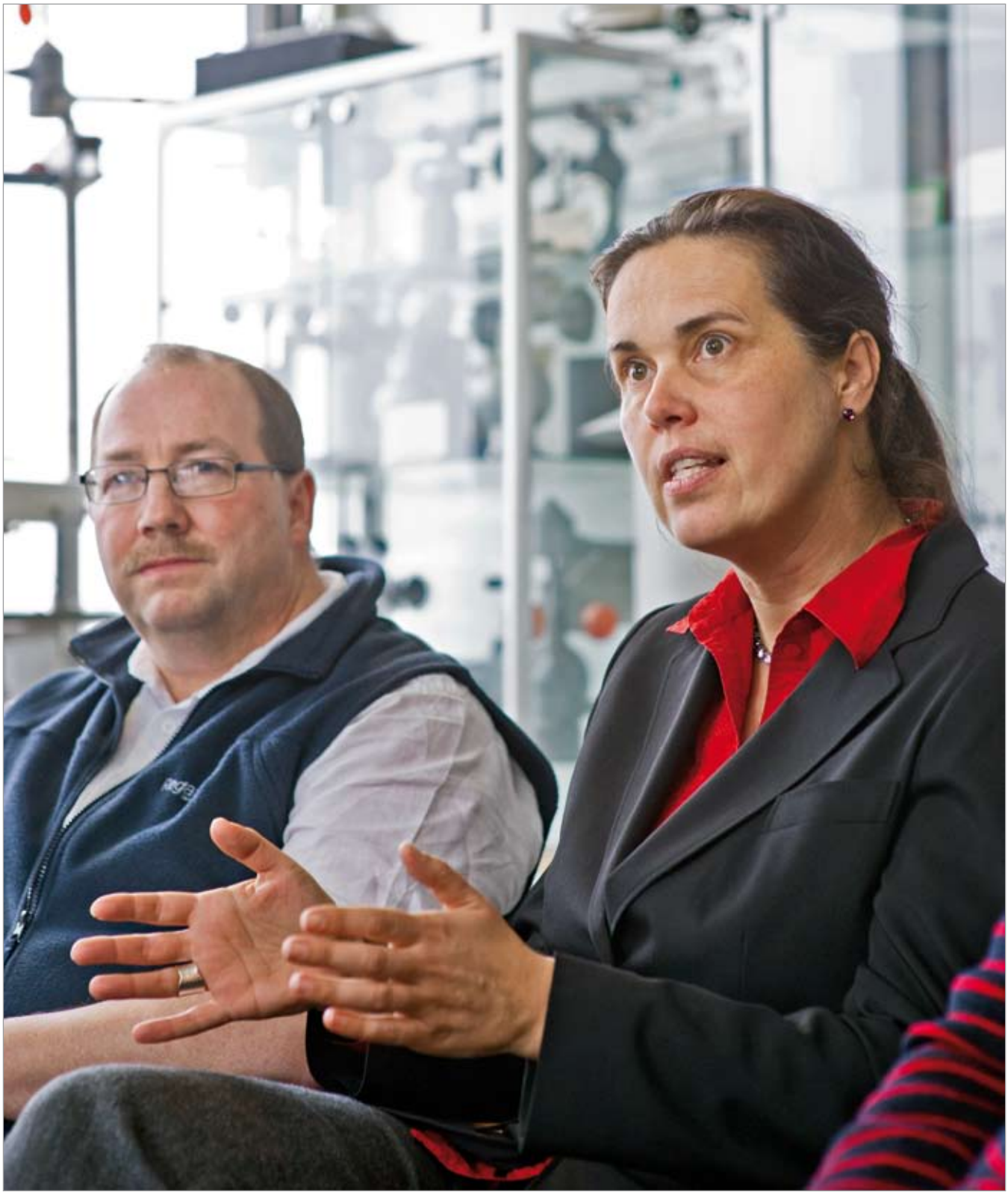
PR: Do you see advantages in doing this research as part of the TUM-IAS, as opposed to some other arrangement?

TS: The TUM-IAS funding makes this collaboration possible, including the two PhD studentships and Christian's postdoc position. I don't think it would have happened otherwise, or it would have been much harder.

CZ: For me it's quite attractive because I am free to do what I want. I'm free to develop my own focus within the Focus Group.

NE: That is a real advantage, that the research areas are open, so that you are really free in choosing your own direction. But there is also this amazing interdisciplinarity. At TUM-IAS workshops, for example, it's always very interesting to see how other people are handling data, and to consider adapting techniques from one field to totally different types of data sets. Of course there's literature, and other ways of finding things out, but if you're taking part in these workshops, it's a totally different atmosphere and a great way of working.

AM: I would go even farther. It's a pity to admit, but I think it's our only chance to work in such an interdisciplinary cross-faculty way. In typical department meetings you're much more likely to find people talking about funding issues or structural problems than about research topics. And if you want to see something beyond your own interests – especially if your interests are already very broad – you would never attend any congress in math or theoretical physics. Nobody would pay you to go there, and you wouldn't understand a thing. But here you have people who are trying to get their message across in a way that can help someone from a different field really understand the broad ideas. And I have no other idea where to go to get this same kind of information.



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