Breaking the mould of Chinese science

The Kavli Institute for Astronomy and Astrophysics in Beijing is designed to carry out international-quality research. But, as **Matin Durrani** discovers, while its staff are highly talented and well supported, encouraging Chinese researchers to learn how to generate truly innovative ideas is not always easy

Minfang Lu

Sparkling innovation Douglas Lin wants staff at the Kavli Institute for Astronomy and Astrophysics to mature into original thinkers.

"People are incredibly busy in China and I probably work three times harder than I ever did before," says Douglas Lin, as he reflects on how his life has changed since taking over as founding director of the Kavli Institute for Astronomy and Astrophysics in Beijing in 2007. Located in a newly refurbished building on the leafy campus of Peking University, the institute aims to become a global centre that conducts research to the highest international standards. It certainly has the potential to succeed, being jointly funded by Peking University – rated the fifth best university in Asia by *Times Higher Education* in 2010 – and by the Kavli Foundation, which has set up some 14 similar leading research institutes around the world in astronomy, nanotechnology and neuroscience (see box).

But the fact that Lin and his colleagues work so hard does not necessarily mean that this is the best route to success, as far as the 62-year-old director is concerned. While Chinese researchers are good at beavering away for hours analysing data or solving problems, in Lin's view what they are less good at is coming up with ideas that will lead to genuine and revolutionary breakthroughs. And without a steady stream of innovative thinking, China cannot reap the most from its recent heavy investment in basic research and new science facilities.

"I often advise our students and postdocs to take time off from working so hard," says Lin. "Many people ask their mentors 'What is the question at the frontier of my field?' and then want to go away and work intensively on the problem. However, I suggest to them that they have to find out for themselves what the question is." Lin feels that Chinese scientists need to learn how to follow their curiosity and try out different ideas. "To mature into original thinkers, they need to venture outside the box where some new ideas may one day pop up," he says.

While Chinese scientists are certainly talented and highly productive – a recent Royal Society report concluded they publish more papers than any other nation bar the US – changing the culture of Chinese science to enhance innovation is not easy. However, Lin is determined to do what he can in that quest, with his top priority being to develop the institute's intellectual environment. He has even helped to design the physical infrastructure of the Kavli Institute, which has plenty of open space with lots of white boards to draw researchers out of their offices.

"I don't want people just sitting in front of their computers creating the perfect PowerPoint presentation," says Lin. "I am trying to develop a stimulating setting for researchers to talk and to interact." That approach has, for example, led Lin's colleagues to set up a course based on the highly acclaimed "order-of-magnitude" physics class designed by Peter Goldreich at the California Institute of Technology. Their hope is that Kavli's Chinese students, who are well trained technically, can learn the art of making sensible guesses to scientific problems – rather than feeling they have to solve them exactly. "I hope this approach also provides an effective communication tool for specialists with diverse expertise to exchange ideas and to collaborate," adds Lin

Don't work so hard

In encouraging staff and students at the Kavli Institute to take time out and contemplate "the big picture", Lin draws inspiration from Lord Rutherford, who would close his lab every day at 6 p.m. on the basis that "it would be better to go home and think about what one had done today and what one was going to do tomorrow". But telling one's staff not to work so hard is an unusual message in China, where universities often offer bonus payments to researchers based on how many scientific papers they get published. These bonuses, which are given to anyone appearing as the first or second author on a paper, are often the only way for researchers to boost their otherwise meagre official salaries. Those salaries are kept deliberately low by the Chinese government, whose official policy is to stop any one group earning much more than any other.

Ensuring equality in pay may be a laudable aim to prevent the formation of a rich elite, but the drawback of the bonus system in science is that it can hinder collaboration between researchers and encourage salami-slicing of research results. "In order to take advantage of the system, some researchers rewrite the same papers many times, which dilutes the overall quality," says Lin. The temptation to try to publish what one can is high though: two researchers at Zhejiang University College of Medicine recently revealed that their institution pays ¥200 000 (about £19 000) to any staff member who is lead author of a paper appearing in *Nature* or *Science* (*Learned Publishing* **24** 95).

Low salaries are, moreover, a disin-

centive when it comes to attracting scientists from other countries to come and work in China. With faculty members at most Chinese universities earning barely half of what a postdoc in the West would get – no more than 20% of a grant budget from the National Science Foundation of China is allowed to go on salaries – many foreign researchers will simply look elsewhere to further their careers. However, the Kavli Institute has an advantage: being outside the mainstream Chinese scientific system, it can use its endowment from the Kavli Foundation to top up the salaries of its staff.

Moving to China

The institute currently has more than a dozen PhD students, some 10 postdocs and seven research professors, three of whom are Chinese and have returned home after spells abroad, with the other four being from the West. Among the latter is Richard de Grijs, who moved from Sheffield University in the UK to China in 2009, after seeing looming cuts to astronomy in the UK. Currently working on the end-products of galaxy collisions, De Grijs thinks the Kavli Institute "is among the best places I've ever been".

In addition to paying a glowing tribute to Lin's "vision and ambition", De Grijs is also impressed with the quality of Chinese researchers. "We have some wonderful students," he says, "and it's great to work in a country where science and engineering are really encouraged." De Grijs also highlights the promising intellectual environment for the Kavli Institute's fellows – postdocs who are supported for three years and who earn twice what those supported by government grants get. However, he admits that the very best young Chinese researchers do tend to get seduced by the West – and the US in particular.

Apart from his research, De Grijs also serves as a volunteer "international coordinator" for the Institute of Physics (the publishers of *Physics World*). Supported financially by the Institute, the role involves him running projects to encourage Chinese school pupils to get interested in science. He has, for example, taken pupils on trips to the Kinglong Observatory in Beijing. De Grijs is also going early this month to Sichuan province in southwest China to help science teachers at two local schools set up physics classes based on the Institute of Physics' *Teaching Physics in Remote Places* educational material. "We will be taking the teachers manuals as well as boxes of simple materials for enhancing lectures with hands-on experiments, something that is not usually done in China," says De Grijs, who will also visit a school in Xinjiang province.

As for adapting to life in China, De Grijs had a head start in that his wife is Chinese – they met while she was a postdoc in the US – and that he had been collaborating with Chinese astronomers since 2002. "You just have to be open-minded," he says. "Living here is fine. Apart from housing, life is pretty cheap and my language is slowly improving, although it doesn't hurt that the working language of the Kavli Institute is English." De Grijs, who is Dutch by birth, does, however, admit to "missing cheese" and finding coffee and chocolate "expensive".

International credentials

But when it comes to the future of Chinese science, De Grijs is optimistic, citing the $34m Large Sky Area Multi-Object Fibre Spectroscopic Telescope (LAMOST) in Hebei province, northeast of Beijing, as an example of a facility that is "helping China to get to an international level". LAMOST, which is still being commissioned, will be able to survey the universe in the finest detail yet and obtain the spectra of up to 4000 celestial objects at a time. The current best survey instrument – the Sloan Digital Sky Survey in New Mexico – can, in contrast, obtain just 600 spectra simultaneously.

Another problem with encouraging Chinese researchers to innovate is the fact that the Chinese Academy of Sciences (CAS) gets the vast majority – 90% – of the government's budget for science and it is the CAS that primarily decides which researchers to fund and what national facilities should be developed. With the CAS monopolizing so much resource, many university institutes or laboratories spend more of their efforts on fighting to maintain their income than they do on research innovation.

"But at the Kavli Institute, these barriers fortunately can be bypassed," says Lin. "We hope to set an example for the Chinese community of how to do things differently. Students are starting to get involved in state-of-the-art research projects and the opportunities we provide are helping people to think up creative ideas and sort the best ideas out. It's hard though. Students here are extraordinarily well prepared and technically brilliant but they've spent their whole lives solving problems – other people's problems."

While the Kavli Institute is unlikely to change Chinese science single-handedly, it is certainly a great opportunity for Lin to break the mould.

We hope to set an example for the Chinese community of how to do things differently

The Kavli Foundation: a force for change in China

The Kavli Institute for Astronomy and Astrophysics (KIAA) in Beijing was set up in 2007 by the Kavli Foundation, which has the lofty goals of "advancing science for the benefit of humanity and promoting increased public understanding and support for scientists and their work". The foundation was set up in 2000 by the Norwegian-born physicist and philanthropist Fred Kavli, 85, who moved to the US in the 1950s after studying at the Norwegian Institute of Technology in Trondheim. He went on to become head of the Kavlico Corporation, which grew into one of the world's largest suppliers of sensors for aeronautic, automotive and other industrial applications.

The KIAA is one of a network of 15 Kavli institutes around the world dedicated to astronomy, nanotechnology, neuroscience and theoretical physics, 10 of which are in the US, with two in China and one each in the Netherlands, Norway and the UK (the Kavli Institute for Cosmology at the University of Cambridge). The KIAA focuses on three main fields of astrophysics: cosmology and the birth and death of galaxies; gravitational physics and high-energy phenomena; and the interstellar medium, stars and planets. The institute, which works closely with the Department of Astronomy at Peking University, is one of two Kavli institutes in Beijing – the other is based at the Chinese Academy of Sciences and focuses on theoretical physics.

The Kavli Foundation also awards $1m prizes each year in astronomy, neuroscience and nanotechnology, as well funding workshops, symposia, Kavli professorships and a programme for science journalists. The foundation even has a new "residential working retreat" for scientists at the 18th-century Chicheley Hall in Buckinghamshire, UK, known as the Kavli Royal Society International Centre. The hall was bought for £6.5m by the Royal Society, part-funded by Kavli himself. In an interview with *Physics World* in 2007 (November p49), Kavli said that physics was, for him, "the most interesting and fascinating subject because it deals with the most fundamental questions and forms a foundation for most science because it [gives] us an understanding of nature, the universe and the world in which we live".

Michael A Mariant

Founding father Fred Kavli.