11 Professor Ortwin Hess
Professor of Quantum Nanophotonics

→ "The unique element in Trinity is that it has long tradition of photonics which is now combined with recent expertise in nanomaterials physics and chemistry – when you get these two together, you can design materials appropriately to do targeted photonics research and that's very exciting."

Ortwin Hess, recently appointed Chair of Quantum Nanophotonics, is talking about Trinity's quantum tradition, which goes back to Erwin Schrodinger's work in Dublin and his seminal public lectures in Trinity in 1943 'What is Life?', and now incorporates the university's expertise in nanotechnology through CRANN (Centre for Research of Adaptive Nanostructures and Nanodevices) and in materials through the SFI Centre AMBER (Advanced Materials and Bioengineering Research), which Trinity hosts.

These three elements – light, nano and new materials – are instrumental to Professor Hess' pioneering research into quantum photonics at room temperature. Usually, he explains "quantum effects only work at very low cyrogenic temperatures because the greatest enemy of quantum processes is noise – fluctuations can derail the coherence in a system – and at room temperature things are much noisier. Google has built a quantum computer to work at cyrogenic temperatures and so has IBM, but my position is that quantum processes are too important to limit to quantum computers. If we can get quantum processes to happen at room temperatures, in realistic conditions, then we can explore further, with much greater potential for real-world applications."

This is where CRANN and AMBER come in: by working with particular metals on the nano-scale, you can "create a special kind of light which moves on the surface of tiny metallic structures – and suddenly you can use light at the nanoscale." This results in better understanding and potential control of quantum processes, which is a goal in itself, and also in potential real-world applications: "You could dramatically enhance sensitivity in a sensing process – for example, currently in immunoassay, you need a minimum concentration of antigens to be present in order to measure them; through quantum sensing, you would only need a single molecule." This has obvious applications in test and trace for Covid-19 and other pandemics.

Another potential application is "to harness quantum fluctuations to have a quantum generator of random numbers. You need random numbers for encryptions but currently all random number generators are based on algorithms, and can be cracked with a powerful computer. If you have a quantum physical generation of random numbers, then the numbers are genuinely random and that delivers heightened security." Again, this has obvious applications in the light of the recent hack and ransom of HSE data.

As well as his appointment to the Chair in the School of Physics, Professor Hess has an SFI research professorship which comes with significant funding for his research – the METAQUANT project is centred in CRANN but collaborates with teams in the universities of Cambridge, Singapore, Würzburg and Yale. He took up his appointment in Trinity in December 2019 but, due to Covid delays, it was only in March 2021 that he

finished assembling his team and setting up their workspace. As theoreticians, he and his team "work a bit like architects – based on our ideas and quantum theory we perform simulations on the computer and then we interact very closely with experimentalists who 'build' what we design on the nano-scale."

His father was also a Professor of Physics but he initially considered studying medicine or engineering – what finally decided him on physics was that "it's a subject where you constantly and continually learn – this is the most important bit. If I stopped learning, I think I would stop working." After his BSc in the University of Erlangen in Franconia, he did his PhD in Edinburgh but "as part of an EU arrangement where you present your thesis at a different place from where you researched, the award was presented in Berlin." After postdoc and lecturing jobs in Stuttgart, Finland and Stanford, he got a full professorship in the University of Surrey, and then proceeded to Imperial College London where he held a chair in metamaterials.

His route to Trinity and SFI funding came when he was awarded the Royal Society 2016 Rumford Medal [awarded since 1800 for outstanding research in physics; notable previous recipients include Michael Faraday, James Clerk Maxwell, John Tyndall, William Henry Bragg and Peter Debye]. "At the presentation ceremony I got talking to some people from SFI and like so many I was worrying about Brexit because my research team is very international and I can't do what I do without open collaboration. I said that maybe I have to think about alternatives, and the SFI people said, maybe there is an opportunity… so that was the start of it. I felt at home at Imperial but sometimes a fresh change, a new perspective, is what you need. A move like this allows you to bring new ideas to a place, and take ideas from it."

Since his appointment, he has helped develop a new masters in quantum science and technology to start in September, as part of the government's human capital initiative (HCI) for continuous professional development. He is looking forward to spending more time on the Trinity campus, which he loved in the brief time he got to know it before lockdown, and to exploring Dublin and Ireland. "I love baroque music and Dublin has a great baroque tradition. And last summer I cycled the Wild Atlantic Way around Clare with my younger son and it's so beautiful. In Dublin, it's great that you don't have to go far to get to sea and mountains."

In Trinity, his goal over the next few years is "to set up a cross-faculty initiative on quantum science and technology, drawing on Trinity's strengths in quantum and interdisciplinarity. Typically, it's physicists and computer scientists who partner for quantum research but I'm keen to bridge further into the living sciences, biology and medicine. That's in keeping with Schrodinger – 'What is Life?' set the foundations of what we now know as DNA."