THE FOUNDATION FOR SCIENCE AND TECHNOLOGY

Christmas Reception

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Christmas parties are occasions to drink and chat, so that I'm sorry to interrupt the proceedings. Blame Dougal Goodman if you must; he's the one who asked me to say a few serious things about science policy. Because of the season, I'll begin with some reasons for good cheer. And there are some.

The government's positive rhetoric about fostering research excellence and innovation has been matched, in the 10-year framework announced a few weeks ago, by practical measures that should help to keep some of our universities high in the international league. We are firmly number two in the world — and way ahead of any country on mainland Europe — in the quality of our best universities. That is a competitive advantage we should cherish.

There's also good news for science throughout Europe, particularly in 'big science' — particle physics, astronomy and space — where we belong to European consortia. CERN is destined to be the world's leading laboratory in particle physics for the next 15 years. The European Southern Observatory now has the world's best ground-based telescopes, on a mountaintop in Chile. Europe has never had a space programme to match America's, but even here we could gain an ascendancy if we focussed on science, miniaturisation and robotics, leaving NASA to squander its far larger budget on ill-conceived projects for manned spaceflight that are neither practical nor inspiring.

But we've had some negative headlines. It's dismaying when any of our most eminent and charismatic scientists — Paul Nurse and Harry Kroto — defect across the Atlantic. It sends a bad signal when we should surely be striving for a 'brain gain' to match that the United States enjoys. And closures of university departments in 'core science' subjects have made gloomy headlines this week. The underlying problems are not unique to this country. Declining enrolments are far more drastic elsewhere in Europe: I was recently at the University of Leiden, which has a proud tradition in physics. They now admit fewer than 20 physicists per year — but hundreds of law students. However much we in Britain welcome mobility, it would surely be demeaning if we one day had to import our science teachers from India and Korea.

A serious and timely effort is being made to raise the profile of physics: 2005 will be International Physics Year, featuring roadshows, conferences and so forth. It's focussed on Einstein, because it marks the centenary of the *annus mirabilis* when he wrote his first four classic papers. We're not quite in 2005, but I'd like this evening to share some thoughts on Einstein. His work in 1905, and — even more — his theory of general relativity of 1916, gave him a status in the pantheon of science matched only by Newton. We always visualise Einstein as an old man: the benign and unkempt sage of poster and T-shirt. He's as much an icon of creative genius as Beethoven (who also looks good on T-shirts). But Einstein's great work was over well before he was 40 — photos from that time show him as a nattily dressed young professor.

Einstein did not rest on his laurels. He worked till his dying day, seeking a unified theory of nature's forces. It was, we now realise, a premature quest at that time. Perhaps it still is. Cynics have said that Einstein might as well have gone fishing from 1920 onwards. But there's something rather noble about the way he persevered, and raised his game, mindful that his reach might exceed his grasp. (Likewise, Francis Crick, the driving intellect behind molecular biology, shifted, when he reached 60, to the 'Everest' problems of consciousness and the brain.) Advancing years actually take a heavier toll on scientists than on artists. For many composers and painters, their greatest creations were among their last. That's seldom true of scientists: even the ones who don't become administrators tend at best to stay on a plateau. As we get older, it's harder to absorb new ideas and techniques, as scientists must. But an artist's work can deepen through internal development alone.

In one respect the Einstein cult sends the wrong signal. It unduly exalts 'arm-chair theory'. In reality, 95 percent of scientific progress stems from new technology and instruments. We need high-profile role-models in those other fields. Most people can readily name great dead engineers — from Brunel to Barnes Wallace. Those who've given us today's amazing technologies deserve as much acclaim. Indeed, engineers are even worse at PR than physicists there seems on reason why their leading practitioners should not have the same glamorous profile as our more celebrated architects).

Despite the failure of his unified theory, Einstein in old age was a potent and benign symbolic public figure. When the nuclear threat first loomed over us, he was an inspiration and moral compass to other scientists. Back in 1955, just a week before he died, he co-signed, with Bertrand Russell, the manifesto that launched the Pugwash movement. It was Joseph Rotblat who organised that manifesto — he's happily still active at 96. Rotblat

emerged from the Manhattan Project deeply marked by the experience. He, and many other atomic scientists, deemed it their duty to alert the public to the implications of their work — 'downstream engagement', to use current jargon. They set an admirable example.

The bomb loomed over 20th century scientists. Twenty-first century science will bring far greater potential benefits than nuclear science — but equally grave ethical challenges and global threats. Science is changing the world faster than ever. Moreover, it is engendering extra dimensions of change. Whatever may have changed over preceding centuries, human beings have not, at least for thousands of years. But within this century, targeted drugs, genetic modification, artificial intelligence and perhaps silicon implants into the brain, may change human beings themselves — that's something qualitatively new in our history. And humanity's impact on the biosphere and the climate is also unprecedented.

I won't venture more specific predictions. We're all aware of the failures of even the best scientists (Rutherford, for instance) to predict the course of 20th century technology. But I'm deeply worried that in our ever-more interconnected world, where technology empowers us more than ever, we're vulnerable to new kinds of risks — events of seemingly low probability, but of such catastrophic consequences that their avoidance should be high on the agenda.

We need latter-day counterparts of Rotblat, not just in physics, but spanning the bio-, cyber- and environmental sciences too. Academics and independent entrepreneurs have a special obligation because they are more free than civil servants or company employees subject to commercial pressure. Such individuals can sensitise our consciences. They can also shift the spotlight onto issues that are global, and long-term.

Here at the Foundation we do often scan the horizon a century ahead, as in discussions of energy, climate and so forth. Those discussing nuclear-waste disposal talk with a straight face about what might happen in thousands of years. But the political planning horizon is seldom longer than 20 years and if often just at the next election. Even a millennium, however, is a mere 'instant' in our planet's history. The stupendous timespans of the evolutionary past are now familiar — thanks to Darwin and the geologists. But what is not yet part of the common culture is the concept that even longer vistas stretch ahead — the future allows time, potentially, for further evolution as that which led from protozoa to humans.

When Einstein died, a memorable tribute to his global status came from an American cartoonist called Herblock. He depicted the Solar System, viewed from afar. The Earth bore a plaque reading 'Einstein lived here'. I'll conclude with a cameo inspired by this image.

For about 40 years, we've been familiar with the view of Earth from Space — its fragile biosphere contrasting with the sterile moonscape where the astronauts left their footprints. Suppose some aliens had been watching our planet for its entire history, what would they have seen? Over nearly all that immense time, 4.5 billion years, Earth's appearance would have altered very gradually. The continental land masses drifted; the ice cover waxed and waned; successive species emerged, evolved and became extinct.

Yet in just a tiny sliver of the Earth's history — the most recent one millionth part, just a few thousand years — the aliens would have seen that the patterns of vegetation altered much faster than before. The start of agriculture would have set that in train. Then would have come the imprint on the terrain of humans, powered by tools. The pace of change would have accelerated as human populations rose.

But then there were quite different and even more abrupt transformations. Within fifty years, or little more than one hundredth of a millionth of the Earth's age, the carbon dioxide in the atmosphere began to rise anomalously fast. The planet became an intense emitter of radio waves (the total output from all TV, cellphone, and radar transmissions). At about the same time metallic objects, to begin with a few tonnes in mass at most, left the planet's surface and escaped the biosphere completely. Some were propelled into orbits around the Earth; some journeyed to the Moon and planets.

The aliens, using what they knew of astrophysics, could confidently predict that the biosphere would face doom in another 6 billion years, when the predictions show the Sun will die. But could they have predicted this unprecedented spike less than half way through the Earth's life, signalling alterations induced by human beings occupying less than a millionth of the elapsed lifetime of the Earth, seemingly at runaway speed?

If the hypothetical aliens continue to keep watch, what might they witness in the next hundred years? Will there be a final spasm followed by silence? Or will the planet itself stabilise? And will some of the small metallic objects launched from the Earth spawn new oases of life elsewhere?

Cosmologists worry as much as anyone about tomorrow, next week and next year. But this enlarged perspective gives an extra motive to cherish our 'pale blue dot' in the cosmos.

What happens in this uniquely decisive century will depend on new science and on how wisely its use is channelled. The irreversible consequences of our collective actions will resonate into a far remoter future.

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Sir Martin's speech is also available on our web site **www.foundation.org.uk**

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