Why fund basic science?

Position Statement of the High Energy and Particle Physics Board of the European Physical Society

Why should the general public pay for the pursuit of fundamental research? Why, in a time of austerity, should taxpayers' euros (or pounds, or dollars) be spent on accelerators and telescopes, while hospitals and schools struggle with low budgets? Although the individual amounts involved are actually small, as the costs of research projects are spread over many countries and many years, this question is a valid one. Those engaged in fundamental research have an obligation to give an answer, and we do so here. Our illustrations and examples are taken from the fields we know: other areas can certainly supply equally forceful cases.

Firstly, this urge to understand the basic laws of nature is a fundamental human quality. Our curiosity drives us to it: this is what makes us human beings, and this is how our shared knowledge progresses. Particle physics, astroparticle physics, and cosmology, in themselves, and through their links to other sciences and to society, make major contributions to human progress. In recent years we have seen how the quest for the ultimate building blocks of matter has revolutionised our understanding of the small-scale quantum world. New telescopes and satellites have given us a radically different vision of an expanding universe. Remarkably, these have come together. The discovery of the Higgs boson has verified our explanation of the origin of mass, which is a cornerstone of the theory of elementary particles. This theory is crucial for understanding the early universe, and is linked to many cosmological observables, in particular those accessible through precise measurements of the cosmic microwave background. The effect of such developments in understanding is not confined to the specialists but propagates out, partly through the media, and partly through the thousands of participating graduate students from schools and universities worldwide, to contribute to a common human culture. The realization that, at cosmic scales, we live on a grain of dust in the periphery of an ordinary galaxy among billions of galaxies is a cause for a deep sense of wonder and humility, and concern about the precious fragility of all human life.

Secondly, the global nature of science is providing an example of an open society which abolishes boundaries of countries, political systems, religion, race and class. This happens formally within the structure of international collaborations, and informally whenever experts communicate at conferences, workshops, by email or video-link. The development of the World Wide Web occurred at CERN because of the need for communication between people through computers, without technical barriers, and this has had a massive impact on the world's population.

Thirdly, frontier research 'irrigates' the general area of technology. As it always pushes the envelope of existing technology, it drives the high-tech companies that build the equipment to ever more powerful, more precise and faster performance. These benefits are then passed on to use by the general public. Most detectors used in medical isotope imaging were developed for use in nuclear and particle physics. The superconducting magnet technology used in MRI scans was driven by the requirements of particle physics detectors. Basic research, which provides publicly available results, is a very efficient driver of technological improvement. It also helps provide the scientists and engineers for the future. Many young people are first attracted into the subject at school or university by the excitement of learning about particle physics and astronomy, and then go on to provide the physicists needed in industry, medicine, and commerce.

Finally, basic science has always been at the origin of major progress in applied science, providing long term benefits to society. Attempts to understand the atom and the dual nature
of light brought the quantum revolution, and all modern electronics and communication
technologies rely on this. The understanding of the nature of the atomic nucleus in the 1920's
and 30's has led, among other things, to the accurate chronology of historical artefacts through
measurement of isotope ratios. The marriage of relativity and quantum mechanics brought the
prediction of the existence of anti-matter, now routinely used in medical PET imaging.

Nature has always been generous but subtler than could ever be planned by humans, so such
breakthroughs in the application of science cannot be predicted. Ernest Rutherford, the first
man to split the atom, said in 1933 “Anyone who expects a source of power from the
transformation of these atoms is talking moonshine.” Today it would be foolish to predict
applications for the Higgs boson, or for gravitational waves, but it would be even more foolish
to deny the possibility. Furthermore, these developments may take many years to come to
fruition. In 1850 the British statesman Gladstone asked the physicist Faraday what the use of
his research into electromagnetism was, prompting the famous reply “One day, Sir, you may
be able to tax it.” Which proved true, but not for another thirty years. Plausible and well-
meaning attempts to steer basic research into areas where applications are likely are doomed
to fail. Fundamental research is research into the unforeseen, where, by definition, prediction
is impossible.

In conclusion: theories of the infinitely small and infinitely large have met: the discovery of a
new type of boson confirms the mechanism at the origin of mass, but the presence of dark
matter in the universe is still a mystery. Basic research is continuing to ask the questions that
are part of human culture: it does so as a collective endeavour on behalf of us all, and it is
appropriate that we support it through our taxes.

This support will enhance the general scientific infrastructure, and lead towards international
co-operation. But the unknown cannot be planned. Flexibility and freedom are vital to allow
for the creativity needed to track down new ideas. History has shown the need to fund both
large and small projects, developments ranging from large scale low risk guaranteed results to
small scale high risk but high payoff projects. Such support has in the past provided
breakthroughs in our understanding of basic science, and enormous improvements in
technology, and it will surely do so in future. However it will, as always, do so in unexpected
and unpredictable ways.

Note: This statement is currently being adapted to become a general EPS statement.