Photo: Reidar Hahn, Fermilab

The balance of science

Particle physics, particle astrophysics, and cosmology are all extreme sciences. They investigate phenomena at one end or the other of various scales: the highest energies, the smallest sizes, the rarest events, the longest distances. Even though they work at the extremes, all these sciences have close ties to the rest of physics, and to other fields of science. This issue of *symmetry* highlights a few of these connections.

One of the most important technologies to come from the development of accelerator physics is the X-ray light source. It has such a vast range of applications that it is hard to list all the contributions this technology has made toward investigating materials, proteins, energy conversion processes, archaeology, and the environment. The next step in the use of accelerator technology developed by particle physics is the creation of super-bright, ultrafast X-ray lasers. The Linac Coherent Light Source, or LCLS, under construction at Stanford Linear Accelerator Center, will be able to take freeze-frame images of chemical reactions or molecular interactions in process and then combine them into movies that will revolutionize how scientists understand the machinery that makes up the atomic-scale world.

The relationship between particle physics and other sciences is by no means one-way, and the most common path to innovation has particle physics technologies and science combining with those from other disciplines to create something entirely new. For example, magnetic resonance imaging, or MRI, relies on principles of nuclear physics combined with superconducting wire developed for particle physics applications and magnet systems developed in atomic, molecular, and optical physics. All of these fields and others could claim responsibility for the creation of MRI in their own ways, but the truth is that the application came from the combination.

The science and technology of the LCLS come from too many areas of science to name, but include particle, atomic, molecular, and optical physics; medical, environmental, and materials research; chemistry, biology, engineering, and earth sciences.

This is true for many scientific developments, and highlights the need for scientific research programs to be well-balanced between fields. We never know where the next development will come from, but we can almost be certain that many of the technologies that end up being used by consumers will have originated in basic research done decades earlier in fields that didn't seem to have much in common at the time.

As scientists scramble for funding in difficult budget times, it is vital that they remember, and emphasize to funding agencies, that it is the balance of the research portfolio that is a driver of innovation and that will deliver benefits we can only begin to imagine.

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