Quantum Science and Technology

Increasing or decreasing the technology and social gap between nations?

One century ago, people like Niels Bohr, Louis de Broglie, Erwin Schrödinger, Werner Heisenberg, and others created the theory of Quantum Mechanics. This Workshop of the Pontifical Academy of Sciences is convened in part to recognize that historic achievement, especially in view of the fact that some of the founders of Quantum Mechanics were members of the PAS. More importantly, we gather to examine the current state of Quantum Mechanics and the prospects for its future in science and technology. Quantum Mechanics gave birth to a revolution in both science and technology. It gave us a theoretical framework for understanding the physical world at the sub-microscopic level of atoms, molecules, and their constituents. And, Quantum Mechanics changed the way we think about reality, introducing fundamental limits on what can be known, even in principle, about a physical system, limits that were inconceivable to pre-quantum thinkers.

Through its influence on science and technology, the quantum revolution has touched nearly all aspects of modern life. Quantum-based electronics have progressed to the point that consumer devices like computers, watches, and mobile phones are indispensable in most industrialized countries. Even our standards of measurement—our modern metric system—is based upon quantum principles.

Many have identified a second quantum revolution, one in whose midst we now see amazing new developments in science and technology. This second revolution has elevated the strangest aspects of QM, superposition and entanglement, to technological status. Quantum information, with its promise of quantum computers able to perform calculations beyond the capabilities of any imaginable classical computer; quantum communication whose security is guaranteed by the laws

of physics; quantum measurement with sensitivity that defies the usual limits to precision; and quantum simulations that promise new understanding and design opportunities for materials and medicines are part of the second quantum revolution.