Nuclear Physics

The following program descriptions are offered to provide more in-depth information on scientific and technical areas of interest to NP:

Program Website: https://science.osti.gov/np/.

The mission of the Nuclear Physics (NP) program is to discover, explore, and understand all forms of nuclear matter. One of the enduring mysteries of the universe is the nature of matter—what are its basic constituents and how do they interact to form the properties we observe? The largest contribution by far to the mass of the matter we are familiar with comes from protons and heavier nuclei. Although the fundamental particles that compose nuclear matter—quarks and gluons—are themselves relatively well understood, exactly how they interact and combine to form the different types of matter observed in the universe today and during its evolution remains largely unknown.

The priority areas for NP include the following:

- Understanding how nucleons—protons and neutrons—combine to form atomic nuclei and what are the limits of nuclear existence in nature.
- Understanding how heavy nuclei have emerged since the origin of the Universe and continue to be created via nucleo-synthesis in cataclysmic cosmic events.
- Using particle accelerators to carry out tomography of the nucleon—the core building block of matter to understand how the quark and gluon fields inside the nucleon dynamically generate its properties including its mass and spin.
- Searching for undiscovered forms of nuclear matter.
- Searching for new physics via high precision, very high sensitivity measurements illuminating fundamental properties of the neutron and the neutrino as well as possible violations of well-established symmetries of nature.
- Conceiving, constructing, and operating national scientific user facilities and developing novel detector and accelerator instrumentation.

Within each of these priority areas, unique nuclear physics opportunities to advance or benefit from Artificial Intelligence or Machine Learning, and new developments in Microelectronics are also of NP programmatic interest.

To carry out its mission and address these priorities, the NP program addresses three broad, yet tightly interrelated, scientific thrusts: Quantum Chromodynamics; Nuclei and Nuclear Astrophysics; and Fundamental Symmetries and Neutrinos. NP supports basic research in seven subprograms or areas:

- Medium Energy
- Heavy Ion
- Nuclear Structure and Astrophysics
- Fundamental Symmetries

- Nuclear Theory and Nuclear Theory Computing
- Nuclear Data.

The program is also the steward of Accelerator Research and Development for Current and Future Nuclear Physics Facilities. A comparatively new initiative in QIS has been established to support this priority initiative of SC and leverage opportunities for Nuclear Physics to benefit from advances in this topical area