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Relativistic Heavy Ion Collisions: Status and Future

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Dennis Kovar's critical role in overseeing funding for the construction and early operation years of RHIC helped to launch a new subfield exploring unique quantum many-body manifestations of QCD in quark-gluon matter. In relativistic heavy-ion collisions at RHIC, and now at LHC as well, unanticipated discoveries and remarkable progress have been made in characterizing ultra-hot matter created under conditions akin to those of the early universe about one microsecond after the Big Bang. I will summarize the intellectual advances by presenting highlights of the learning curves (early results, recent developments, open questions) for a few key properties of the matter related to fundamental aspects of QCD. Included will be manifestations of nearly perfect quantum fluid behavior, of jet quenching, of high-temperature quantum fluctuations and of features of the QCD phase diagram. Considerations of the initial states of the colliding nuclei, and of manifestations of gluon proliferation and recombination, will also lead naturally to properties of cold nuclear matter unveiled to date in deuteron-nucleus and polarized proton-proton collisions at RHIC, and to be studied quantitatively at a future Electron-Ion Collider. I will also discuss how ongoing and planned facility upgrades will enhance the unique capabilities RHIC brings to this science and complement QCD matter explorations at LHC.