



The Roadrunner Universe

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Abstract:

Dark matter and dark energy are the dominant components of the Universe. Their ultimate nature, however, remains mysterious, especially so of the dark energy. Ambitious ground and space-based missions investigating different aspects of the “Dark Universe” constitute a national and international investment measured in billions of dollars. The discovery potential of almost all of these missions relies crucially on theoretical modeling of the large-scale structure of the Universe. The Roadrunner Universe project will carry out the largest high-resolution simulations of the distribution of matter in the Universe, resolving galaxy scale mass concentrations over observational volumes representative of state-of-the-art sky surveys. A key aspect of the project will be a major simulation suite covering over thirty different cosmologies, an essential resource for interpreting next-generation observations. This effort represents an improvement over the largest current equivalent measured in orders of magnitude. The resulting database will become an essential component of Dark Universe science for years to come. The Roadrunner Universe project will implement a hierarchical grid/particle algorithm that optimally matches physical aspects of the simulation to the corresponding hybrid architecture of Roadrunner, making aggressive use of the Cell BE engine. In order to handle the enormous simulation database, a dedicated analysis and visualization software framework will be developed. Running also on Roadrunner, this framework will extract science products from the simulations, in both static and “on the fly” modes, as well as filter the raw output into a manageable DataStream.