Contribution ID: **36** Type: **not specified**

Building the Next Generation of Particle Accelerators: Atomic Scale Insight to the Mechanisms of Cavity Limitation

Linear particle accelerators composed of superconducting radio-frequency cavities will be used in future high energy physics projects, such as Project-X and the International Linear Collider, and can be used for other applications, such as neutron sources and nuclear waste management. The materials science of the particle accelerator is at the core of optimizing both the performance of the accelerating structure and its production procedure. For example, impurities can be absorbed into a cavity's surface during chemical processing and form structures that affect the cavity's quality factor. My research involves building atomic scale models of niobium, which composes niobium superconducting radio-frequency cavities, and analyzing their properties via density functional theory calculations. The studies that will be presented provide insight to the effects that cavity production processes, such as electropolishing and low temperature baking, have on the cavity's structure and resulting performance.

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