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Understanding Heavy-ion Fusion Cross Section Data Using Novel Artificial Intelligence Approaches

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We modeled an unprecedentedly large dataset of complete fusion cross section data using a novel artificial intelligence approach. Our analysis aims especially to unveil, in a data-driven way, nuclear structure effects on the fusion between heavy ions and to suggest a universal formula capable to describe all previously available data. The study focused on light-to-medium-mass nuclei, where incomplete fusion phenomena are more difficult to occur and less likely to contaminate the data. The method used to derive the models exploits a state-of-the-art hybridization of genetic programming and artificial neural networks and is capable to derive an analytical expression that serves to predict integrated cross section values. For the first time, we analyzed a comprehensive set of nuclear variables, including quantities related to the nuclear structure of projectile and target. In this talk, we describe the derivation of two computationally simple models that can satisfactorily describe, with a reduced number of variables and only a few parameters, a large variety of light-to-intermediate-mass collision systems in an energy domain ranging approximately from the Coulomb barrier to the oncet of multi-fragmentation phenomena. The underlying methods are particularly innovative and are of potential use for a broad domain of applications in the nuclear field.

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