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Small Is Different: Emergent Phenomena at the Nonscalable Size Regime[1]

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When the scale of materials structures is reduced to the nanoscale, emergent physical and chemical behavior often occurs, that is not commonly expected, or deduced, from knowledge learned at larger sizes. Such new behavior may be found when the size of the interrogated physical system becomes comparable to a phenomena-dependent characteristic length-scale; for example, the width of a quantum wire approaches the Fermi wave- length of the conducting electrons, or the dimensions of a liquid bridge, or a nanojet, approach the wave-length of a hydrodynamical instability underlying collapse or droplet ejection. Using computer-based simulations we highlight and discuss such emergent phenomena. Systems that we discuss include: electrons in 2D semiconductor quantum dots, nanoscale junctions, liquid bridges and jets, and interfacial control of the chemical catalytic properties of surface-supported gold nanoclusters.

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