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On the Geometry of Diffusion and the Limits of Biosensing¹

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As the future of Moore's law of transistor scaling appears uncertain, Electronics is trying to reinvent itself by broadening its focus to other areas including macroelectronics (electronics of large, possibly flexible and transparent displays), bioelectronics (e.g. nanobio sensors for geomomics, proteomics), and energy-harvesting (e.g. solar cells). In this talk, I focus on the recent progress in the field of bioelectronics, specifically on nanobiosensors for gene and protein identification. While capabilities of classical techniques based on optical detection of biomolecules is already impressive, the method is too expensive to preclude its routine use in clinical setting for personal medicine. As an cost-effective alternative, (optical) label-free electronic detection of biomolecules has long been a cherished dream for researchers involved in Genomics and Proteomics. Despite significant interest and almost monthly reports of groundbreaking experimental results in leading journals by researchers all over the world, the elements that dictate response of a biosensor has remained – until recently – poorly understood. In this talk, we discuss how the elementary use of fractal geometry of diffusion, percolative transport in random networks, electrolyte screening-limited response, etc. are finally allowing us to establish the performance potential of such sensors and how ‘form’ or geometry is fundamental in defining the sensitivity of biosensors.

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