

2019 NSE Grantees Conference

Imaging at the nanoscale with centimeter fields of view

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Abstract

Automated high-throughput-imaging tools in biology may soon offer us an unprecedented insight into microscopic connections across scales. In neuro-anatomy, identifying a synapse requires 10 nm resolution, but neurons themselves have cm-scale connections: this makes measuring the brain connectome a “zettabyte” problem. Serial electron microscopy has the required resolution, but only recently have techniques emerged that can take this technique to scale – the complete mouse brain connectome is now within reach as a multi-year project. X-ray imaging will be revolutionized by 4th generation synchrotron sources that within five years will have enough flux for whole-brain imaging at the nanoscale. The data rates – many petabytes per day – are within range of next generation high-performance computing pipelines providing algorithms keep pace with hardware. The focus of this talk will be emerging applications in neuroanatomy, but the techniques themselves should have wide employability. But a concerted effort in technology, tools, analysis, and theory is needed to make them functional.

Bionote

Peter B Littlewood is a Professor of Physics at the University of Chicago, who was previously Director of Argonne National Laboratory, and before that a Professor of Physics at the University of Cambridge and Head of the Cavendish Laboratory. He began his career with almost 20 years at Bell Laboratories, ultimately serving for five years as head of Theoretical Physics Research.

His research interests include superconductivity and superfluids, strongly correlated electronic materials, collective dynamics of glasses, density waves in solids, neuroscience, and applications of materials for energy and sustainability. He is a fellow of the Royal Society of London, the Institute of Physics, the American Physical Society, and TWAS (The World Academy of Sciences). He serves on advisory boards of research and education institutions and other scientific organizations worldwide. He holds a Bachelor's Degree in Natural Sciences (Physics) and a Doctorate in Physics, both from the University of Cambridge.