

ΓΕΝΙΚΟ ΣΕΜΙΝΑΡΙΟ ΤΜΗΜΑΤΟΣ ΦΥΣΙΚΗΣ

# *PHYSICS COLLOQUIUM*

Thursday 13 March 2008

17:00-18:00

3<sup>rd</sup> Floor Seminar Room

*“Collective phases in electronic matter - Beyond reductionism”*

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## ABSTRACT

In the 1970s independent electron approximations worked well for most semiconductors and metals, the phase transition problem seemed solved, and the fundamentals of magnetism, ferroelectricity, and superconductivity appeared to be known. In the past two decades however, we have had to adjust to a climate of discovery in which many of the long accepted rules of solid state physics are boldly flouted by complex materials with many of our existing theories failing to capture the full complexity.

Last century witnessed three turning points in science: relativity, quantum mechanics, and Brownian motion. Uniting the first two was dominant theme of particle physics and the study of fields. Following advances in complex electronic matter we may ask whether the unification of quantum mechanics and Brownian motion would be a fertile ground for the collective organising principles governing the properties of complex systems.

Identifying and understanding the emergent collective behaviour may be the way forward to engineer and control the spontaneous tendencies toward complex pattern formation, allowing the emergence of new general concepts and paradigms. It may provide the framework for understanding mesoscopic organisation in biology and help create artificial systems with complex adaptive behaviour characteristic of life. Ideas developed to explain mesoscopic organisation on Earth may be useful in explaining the origin of large-scale structure in the universe and perhaps even its change from a disordered to an ordered state.