



Contribution ID: 1484

Type: **Invited Speaker / Conférencier invité**

The Information Age in Condensed Matter Physics

Monday 13 June 2016 14:45 (30 minutes)

Monte Carlo simulations have been ubiquitous in efforts to simulate and characterize properties of matter and materials since the advent of computers themselves. In the last decade, condensed matter physicists have turned simulation technology to the study of a new set of phenomena, loosely termed as “emergent”, with correlations not manifested in traditional correlation functions. Motivated by this, a new set of tools was recently developed that allows one to probe emergent phenomena in Monte Carlo simulations through their entanglement entropy - a concept borrowed from quantum information theory. Remarkably, since certain scaling terms in the entanglement entropy are universal, this provides a powerful general method to characterize phases and phase transitions in a wide variety of physical theories. Thus, Monte Carlo simulations are beginning to play a central role for physicists who increasingly rely on information quantities to study correlations not only in condensed matter systems and quantum devices, but even in quantum fields and theories of quantum gravity.

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Session Classification: M-MEDAL CAP Medal Talk - Roger Melko, U. of Waterloo / Perimeter Institute (CAP Herzberg Medal Recipient / Récipiendaire de la médaille Herzberg de l'ACP)

Track Classification: Herzberg Public, Plenary, and Medal Talks / Conférenciers des sessions Herzberg, plénières et médaillés (CAP-ACP)