GSC 2019- Cavendish and Abdus Salam Prize talks

14:20-14:35 - Abdus Salam Prize

Andrea Pizzi (Theory of Condensed Matter)

Time crystals and quasicrystals with ultracold bosonic atoms

At long times many-body systems generally loose memory of the initial state. However, in certain periodically driven systems, memory can persist.

Among them, some systems feature oscillations with a period that is larger than that of the driving, breaking the discrete time translational symmetry.

They constitute a novel dynamical phase of matter: a discrete time crystal. I will discuss our recent progress on these non-equilibrium phases in the setting of ultracold atoms, and present the idea of a discrete time quasicrystal that, beyond breaking discrete time translational symmetry, also features quasiperiodic dynamics.

14:35-14:50 - Cavendish Prize for Advances in Experimental Physics

Raj Pandya (Optoelectronics)

Exciton fine-structure and spin dynamics in colloidal nanostructures

Since their discovery in the 1980s solution processed colloidal semiconductors, termed nanocrystals or quantum dots, have garnered immense interest due to their ease of processing via batch methods, size and band gap tunability, high brightness and photochemical stability. Many of the key physical properties of nanocrystals e.g. photoluminescence, polarisation, etc, are governed by the energetic ordering (fine-structure) and spin quantum numbers of their lowest energy excited states. Hence understanding the nature of electronic states in these materials, is key to rationally design nanocrystals for the next-generation of optoelectronic (LEDs, transistors) and quantum technologies (logic gates, encryption).

In this talk I will summarise efforts to understand the fine structure and spin dynamics in a new class of colloidal nanocrystals, termed nanoplatelets. These consist of atomically thin, two-dimensional semiconducting sheets which, in contrast to nanocrystals that are often synthesised in spherical or rod shapes, exhibit extremely narrow emission linewidths, low lasing thresholds and high photocatalytic activity. Using a combination of low-temperature magneto-optical spectroscopy and spin beating experiments, I will demonstrate that the lowest energy (emissive) state in nanoplatelets consists of two closely-spaced linearly polarized sub-states. The small (30 μeV) energy gap between these sub-states explains the extremely bright emission of nanoplatelets and leads to unprecedently long spin-lifetimes, in excess of 1 μs. By varying the nanoplatelet material it is demonstrated that the spin coherence times could be improved even further. More generally our results suggest these materials have strong potential for use both in display technologies that do not rely on polarisation filters and novel quantum devices.

14:50-15:05 - Cavendish Prize for Advances in Computational Physics

Herschel Chawdhry (High Energy Physics)

Solving multi-loop Feynman integrals for high-precision predictions at the Large Hadron Collider

Multi-loop Feynman integrals are a core ingredient in high-precision calculations in Quantum Chromodynamics (QCD). Evaluating these integrals typically requires the solution of complicated systems of equations known as Integration-By-Parts identities (IBPs).

In this talk, I will discuss our design of an efficient computational framework for solving IBPs. A number of computational design features make our program perform several orders of magnitude faster than a naive implementation. This allowed us to solve a new class of integrals at the frontier of high-precision QCD calculations.

The solutions to these integrals played a central role very recently in the high-precision computation of 3-photon production at the Large Hadron Collider -- the first such calculation for a process with 3 final-state particles.