University of Crete
**Department of Physics**

# *Physics Colloquium*

Thursday, 15 June 2023 | 17:00 – 18:00, Seminar Room 3rd floor

# Universality of Bose-Einstein Condensation: from photonic and atomic condensates to cosmological fuzzy dark matter

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## ABSTRACT

*Nearly 100 years after its first prediction, the phenomenon of Bose-Einstein condensation – through which a macroscopic system of many particles manifests collective behaviour and quantum coherence – has been observed or proposed to be at play across all physical scales, from the microscopic to the cosmological. Following a general introduction to the 'universality' of such a phenomenon [1,2], I will present results across 3 distinct physical systems: ultracold atomic gases in magnetic and optical traps, exciton-polariton condensates in microcavities and presumed implications on the cosmological scale in the context of fuzzy dark matter. Following a brief presentation of those systems, I will discuss the phase transition leading to the onset of macroscopic coherence and the subsequent relaxation process in laboratory systems, while highlighting its dependence on system details (such as geometry and dimensionality) and related dynamical effects. Remarkably the ideas of quantum coherence may also give credible predictions to the properties of dark matter, with the analogy to laboratory condensates and arising implications also discussed [3].*

[1] Universality of Bose-Einstein Condensation and Quenched Formation Dynamics (N.P. Proukakis) (Encyclopedia of Condensed Matter Physics, Elsevier, 2nd Ed., 2023)

[2] Universal Themes of Bose-Einstein Condensation (N.P. Proukakis, D.W. Snoke, P.B. Littlewood), Cambridge University Press (2017).

[3] Coherent and incoherent structures in fuzzy dark matter haloes (I.K. Liu, N.P. Proukakis, G. Rigopoulos), Monthly Notices of the Royal Astronomical Society 521, 3625 (2023).