Can a Rock be a Wave? From 100 years of De-Broglie's Wave-Particle Duality, to Quantum-Gravity.

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It is almost exactly 100 years since De-Broglie made public his outrageous hypothesis regarding Wave-Particle Duality (WPD), where the latter plays a key role in interferometry. In parallel, the Stern-Gerlach (SG) effect, found a century ago, has become a paradigm of quantum mechanics. I will describe the realization of a half- [1-3] and full- [4-5] loop SG interferometer for single atoms [6], and show how WPD, or complementarity, manifests itself. I will then use the acquired understanding to show how this setup may be used to realize an interferometer for macroscopic objects doped with a single spin [5], namely, to show that even rocks may reveal themselves as waves. I emphasize decoherence channels which are unique to macroscopic objects such as those relating to phonons [7,8] and rotation [9]. These must be addressed in such a challenging experiment. The realization of such an experiment could open the door to a new era of fundamental probes, including the realization of previously inaccessible tests of the foundations of quantum theory and the interface of quantum mechanics and gravity, including the probing of exotic theories such as the Diosi-Penrose gravitationally induced collapse. Time permitting, and as an anecdote noting also De-Broglie's less popular assertion, namely, that the standard description of QM is lacking, I will also present our recent work on Bohmian mechanics, which is an extension of De-Broglie's ideas concerning the pilot wave [10].

PS I will not talk about quantum technology in this talk, but I invite those interested to talk to me about it, for example, our NV sensor or Yb optical atomic clock projects. Here are two recent quantum technology references [11,12]. More work from our group such as on Dark-Matter can be found on our website: https://tzin.bgu.ac.il/atomchip/

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