Autonomous Nanomechanical Error Correction

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Over the last sixty years, semiconductor electronics have evolved to become the basis of all modern computers. Despite being extremely powerful, the performance and lifespan of electronics are severely affected in high radiation environments. In contrast, mechanical computation promises inherent robustness in high radiation environments combined with ultra-low power consumption. This, combined with recent advances in nanomechanical systems, has resulted in a renewed interest in mechanical computation for use in specialized applications [1].

Despite the resistance of nanomechanical components to permanent damage from radiation, they may still experience random impulses leading to undesired bit flips. Hence, error correction algorithms, analogous to those in conventional computers, are pivotal to reliable mechanical computation. In this talk, I will propose the first error correction architecture for integrated nanomechanical systems. Specifically, adapting from the well known "majority voting" error correction scheme, this novel architecture employs a network of three coupled non-linear oscillators (see Fig. 1). Numerical simulations demonstrate that, if implemented, this design will completely correct isolated errors and partially correct multiple simultaneous errors.

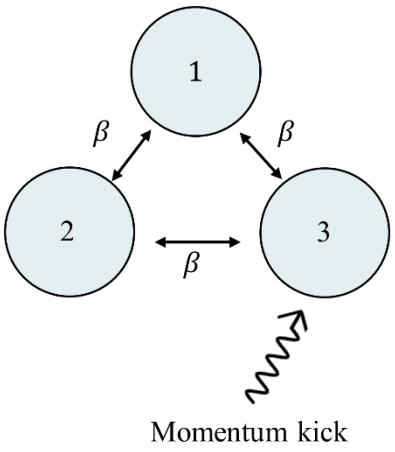

Fig. 1 Schematic of the proposed mechanical error correction system.

[1] E. Romero, N. P. Mauranyapin, T. M. F. Hirsch, R. Kalra, C. G. Baker, G. I. Harris and Warwick P. Bowen, Scalable Nanomechanical Logic Gate (arXiv:2206.11661, 2022)