

Charge transfer through DNA - A new perspective from Human Genetics

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The hypothesis that quantum effects could influence the functioning of DNA in living cells at the molecular level has existed for a long time [1,2]. However, the question of whether this hypothesis is founded remains unanswered, as it is still unclear if quantum phenomena could occur at the necessary scale to affect biological processes, and if so, if they could influence the epigenetic regulation of cells.

We propose a clear formulation of this hypothesis in the form of a well-defined research question [3]. To this end, we put forward a potential mechanism that could enable quantum influences on DNA self-regulation, based on the idea that charge transfer could serve as an underlying mechanism to trigger the regulation of gene expression in cells. We then develop a complex, coarse-grained model that can capture the essential features of DNA and be scaled up to tens of bases, in order to address the typical scales of epigenetic mechanisms in living cells [4-6]. Finally, we will outline the next steps of our research and present a sketch of the experimental setup that is currently being developed, with the aim of further refining and validating the theoretical modelling that has been carried out so far.

- [1] J. C. Genereux and J. K. Barton, Chem. Rev. 110 (2010) 1642.
- [2] B. Giese, Acc. Chem. Res. 33 (2000) 631.
- [3] R. Siebert, M. Rossini et al., Clin. Epigenetics 15 (2023) 160.
- [4] D. Herb, M. Rossini and J. Ankerhold, Phys. Rev. E 109 (2024) 064413.
- [5] M. Rossini, O. Ammerpohl, R. Siebert and J. Ankerhold, Sci. Rep. 15 (2025) 17543.
- [6] D. Herb, M. Trenti, M. Mantela, C. Simserides, J. Ankerhold and M. Rossini, Comput. Phys. Commun. 313 (2025) 109626.