MOLECULAR EVOLUTION: A ROLE FOR QUANTUM MECHANICS ON THE DYNAMICS OF MOLECULAR MACHINES THAT READ & WRITE DNA

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Abstract: Biological information in DNA is replicated, transcribed or otherwise processed by molecular machines called polymerases. This process of reading and writing genetic information can be fine-tuned by the motor's environment. Theoretical physics concepts in concert with emerging nanoscale tools are elucidating how various "knobs" in a motor's environment can control its dynamics. As it becomes possible to probe the dynamics of these motors at increasingly smaller length and time scales, quantum effects on their dynamics, if relevant, are likely to become experimentally detectable.

Here we heuristically examine the role quantum mechanics may play in the information processing capabilities of these motors. We use Wigner's relations for a quantum clock to derive constraints on the accuracy and precision with which a motor can read DNA and to calculate its information processing power. We calculate that the longest decoherence times for our motor-DNA system can range from several minutes to hours. Lastly we discuss how understanding the dynamics of these biomolecular motors may lead to new perspectives in answering fundamental questions like "Does Quantum Mechanics play a nontrivial role in Life?"