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Thermal Replication Trap

DIETER BRAUN, Ludwig Maximilians University

The hallmark of living matter is the replication of genetic molecules and their active storage against diffusion. We have argued in the past that thermal convection can host the million-fold accumulation even of single nucleotides and at the same time trigger exponential replication [1]. Accumulation is driven by thermophoresis and convection in elongated chambers, replication by the inherent temperature cycling in convection. Optothermal pumping [2,3] allows to implement the thermal trap efficiently in a toroidal [4] or linear [5] geometry. Based on this method, we were in a position to combine accumulation and replication of DNA in the same chamber [5]. As we are missing a solid chemistry of prebiotic replication, we used as a proxy reaction for to replication the polymerase chain reaction. Convective flow both drives the DNA replicating polymerase chain reaction (PCR) while concurrent thermophoresis accumulates the replicated 143 base pair DNA in bulk solution. The time constant for accumulation is 92 s while DNA is doubled every 50 s. The length of the amplified DNA is checked with thermophoresis. Finite element simulations confirm the findings. The experiments explore conditions in pores of hydrothermal rock which can serve as a model environment for the origin of life and has prospects towards the first autonomous evolution, hosting the Darwin process by molecular selection using the thermophoretic trap. On the other side, the implemented continuous evolution will be able to breed well specified DNA or RNA molecules in the future.

[1] Baaske, Weinert, Duhr, Lemke, Russell and Braun, PNAS 104, 9346 (2007)
[2] Weinert, Kraus, Franosch and Braun, PRL 100, 164501 (2008)
[3] Weinert and Braun, Journal of Applied Physics 104, 104701 (2008)
[4] Weinert and Braun, Nano Letters 9, 4264 (2009)
[5] Mast and Braun, PRL 104, 188102 (2010)