

Modeling DNA Separations in Self-Assembled Magnetic Arrays: Comparison of Theory and Experiment

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Self-assembled magnetic matrices, formed by applying a magnetic field to a suspension of superparamagnetic particles, are a simple, low-cost solution for the rapid separation of long DNA. We present a theoretical model of macroscopic DNA transport in the device, where the fundamental geometric and transport parameters are either determined experimentally or from a microscale model. Using simple models for the collision probability and retention time, we predict that the mean velocity and dispersivity scale linearly with the applied field, the band broadening scales inversely with the field, and the separation resolution is independent of the field. The scaling results are confirmed experimentally. We achieve reasonable quantitative agreement between theory and experiment with an experimental measurement of the average trapping time.

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