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Monte Carlo simulation of single-molecule trapping via electrophoresis WILLIAM ROBINSON, LLOYD DAVIS, UTSI — For many biophysical studies, there is a need to observe a molecule for an extended duration without immobilizing it on a surface. The problem of trapping a single fluorescent molecule in solution is examined here via Monte Carlo numerical simulation. Optical forces are insufficient for trapping small molecules. Instead, trapping is executed by sensing the position and applying real-time feedback of flow to compensate diffusional displacement. Using a nanochannel as the volume of interest reduces the problem to one dimension, and with such a configuration the position of the molecule can be measured from its fluorescence in the presence of a two-focus irradiance pattern. The collected photons are analyzed by an algorithm developed for a field-programmable gate array controller for experimental implementation, and an electrophoretic flow provides the trapping mechanism. Trapping is also possible in three dimensions with two-photon excitation of the molecule from a four-focus irradiance pattern arranged as a tetrahedron or with a single focus scanning over a three-dimensional volume.

William Robinson
UTSI

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