DAMOP09-2009-020050

Abstract for an Invited Paper
for the DAMOP09 Meeting of
the American Physical Society

Molecular Programming with DNA

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Information can be stored in molecules and processed by molecular reactions. Molecular information processing is at the heart of all biological systems; might it soon also be at the heart of non-biological synthetic chemical systems? Perhaps yes. One technological approach comes from DNA nanotechnology and DNA computing, where DNA is used as a non-biological informational polymer that can be rationally designed to create a rich class of molecular systems – for example, DNA molecules that self-assemble precisely, that fold into complex nanoscale objects, that act as mechanical actuators and molecular motors, and that make decisions based on digital and analog logic. I will argue that to fully exploit their design potential, we will need to invent programming languages for specifying the behavior of information-based molecular systems, to create theoretical tools for understanding and analyzing the behavior of molecular programs, to develop compilers that automate the design of molecules with the desired behaviors, and to expand experimental techniques so that the implementation and debugging of complex molecular systems becomes as commonplace and practical as computer programming.