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Molecular motors

Macro-scale thermodynamic engines convert the random motion of fuel-produced heat into directed motion. Such engines cannot be downsized to the nanometre scale, because thermodynamics does not apply to single atoms or molecules, only large assemblies of them. A great challenge for the field of nanotechnology is the design and construction of microscopic motors that can transform input energy into directed motion and perform useful functions such as transporting of cargo. Today's nanotechnologists can only look in envy at the biological world, where molecular motors of various kinds (linear, rotary) are very common and fulfil essential roles.

Inspired by the fascinating mechanism by which proteins move in the presence of thermal noise, many physicists have been trying to establish novel concepts and strategies that might lead to the construction of man-made motors and machines on mesoscopic to molecular scales. Operating far from thermal equilibrium, molecular motors successfully combine noise and space-time asymmetry to generate useful functions such as transport, pumping, separation or segregation of particles. Such man-made molecular machinery, when realized, will not only be able to perform useful tasks on the atomic and molecular scales, but will also provide fundamentally new ways to manipulate molecules and nanoscale objects. Various mechanisms suitable for converting supplied energy into directed motion are discussed in this special issue of *Journal of Physics: Condensed Matter*. An important problem that has been raised in this issue, and has still to be resolved, concerns the possibility of controlling induced motion. In particular, a major problem is that of resolving the contradiction between the fascinating idea of feeding the energy by a driving random motion, and yet being able to control that motion; for example: starting the motion, stopping it, changing the velocity, and so on.

This special issue aims to provide an overview of current theoretical and experimental works on molecular motors and possible applications. In selecting the papers we have tried to maintain a balance between new results and review-like aspects, such that the present issue is self-contained and, we hope, readily accessible to non-specialists in the field. We believe that the particular appeal of this collection of papers also lies in the fusion of both experiment and theory, thus providing the connection to reality of the sometimes demanding, mathematically inclined contributions.

Profound thanks go to all our colleagues and friends who have contributed to this special issue. Each has made an effort not only to present recent results in a clear and lucid way, but also to provide an introductory review that helps the reader to understand the different topics.