The ring of Brownian motion: Its beneficial use for physics and elsewhere

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Since the turn of the 20-th century Brownian noise has continuously disclosed a rich variety of phenomena in and around physics. The understanding of this jittering motion of suspended microscopic particles has undoubtedly helped to reinforce and substantiate those pillars on which the basic modern physical theories are resting: Its formal description provided the key to great achievements in statistical mechanics, the foundations of quantum mechanics and also astrophysical phenomena, to name but a few. Recent progress of Brownian motion theory involves the description of relativistic Brownian motion and its impact for relativistic thermodynamics, or its role for fluctuation theorems and symmetry relations in recent developments for equilibrium and nonequilibrium thermodynamics/statistical mechanics.

Although noise commonly is hold as the enemy of order, it in fact also can be of constructive influence. The phenomena of *Stochastic Resonance* and *Brownian motors* present two such archetypes wherein random Brownian dynamics together with unbiased nonequilibrium forces beneficially cooperate in enhancing detection and/or in facilitating directed transmission of information. The applications range from information processing devices in physics, chemistry, and physical biology to new hardware for medical rehabilitation. Particularly, additional nonequilibrium disturbances enable the rectification of haphazard Brownian noise so that quantum and classical objects can be directed along on *a priori* designed routes (such as with Brownian motors). We conclude with an outlook for potential new applications and unsolved issues occurring with the theory of Quantum Brownian and Quantum Thermodynamics.