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Drift, diffusion and barrier crossing of small objects on a surface assisted by an external noise: roles of non-linear friction

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We study experimentally the behaviors of several driven diffusive systems that involve the sliding and rolling of small solid objects or liquid drops on a surface with an external noise and an external field. The displacement statistics here are non-Gaussian at short observation time, but they tend towards a Gaussian behavior at long time scale. Furthermore, in each of these cases, the drift velocity increases sub-linearly, but the diffusivity increases super-linearly with the strength of the noise. These observations reflect the underlying non-linear friction control of their stochastic dynamics. Specific experiments have also been designed to study the hopping of a small object over a physical barrier assisted by an external noise. These results mimic the classical Arrhenius behavior from which an effective temperature may be deduced. However, the regimes controlled by a Coulombic like friction and a linear kinematic friction need to be treated somewhat differently. All the drifted diffusive systems studied here exhibit substantial negative fluctuations of displacement at a short observation time that diminishes at longer time scale. Using the integrated fluctuation theorem, we characterize the persistence time of negative fluctuations in terms of the diffusivity and the drift velocity that can be measured experimentally.