Large-deviation function during the reverse buoyancy of an intruder within a granular media

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We re-visit the Brazil Nut Effect (BNE) problem addressing the large-deviation function (LDF) properties calculated from the normalized velocity of the intruder. By means of molecular dynamics simulations in two dimensions, a large disc - the intruder – is confined into a rectangular box filled with a polydisperse granular medium, under gravity and the box subjected to a sinusoidal external force. From the vertical intruder velocity probability distribution we have obtained the analogous to the entropy production rate and observed that, for sufficient large integration times, there is a linear relation between the LDF and this quantity. A striking aspect of the results is the fact that the intruder has no asymmetry, differently to the case of polar self-propelled particles which the asymmetry is essential to dynamics. We argue that two mechanisms are responsible for the observed behavior: the so-called granular ratchet, which arises from volume exclusion of the intruder during the solid/liquid phase transition-like induced by external force under gravity, and convection forces resultant of frictional walls.