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Fermi Acceleration in a Periodically Driven Fermi-Ulam Model

O.F. DE ALCANTARA BONFIM, University of Portland — The dynamics of a particle bouncing between two harmonically vibrating walls is analyzed in the context of the static wall approximation. Fermi acceleration is observed for a wide range of the ratio between the frequencies of the oscillating walls and their relative phases. However, no acceleration is observed if the frequency ratio is an integer. In the phase versus frequency-ratio diagram, the region in which Fermi acceleration is observed is separated by an upper and lower boundary. At the lower boundary, after a large number of collisions the particle average velocity increases with the square-root of the number of collisions (n) with the walls. Between the lower and upper boundaries, the particle average velocity behaves as $V(n) \sim n^{\beta}$, with β in the interval [0.5, 1.0]. Below and near the lower boundary, the average particle velocity initially grows with the number of collisions until it eventually reaches a plateau. In this region, for a fixed frequency ratio, the velocity of the particle exhibits scaling properties over a range of the relative phases of the vibrating walls. Inelastic collisions with the walls cause suppression of the Fermi acceleration inside the previously accelerating region and lead to the particle velocity exhibiting scaling properties with respect to changes in the coefficient of restitution.

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