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Chaotic Dynamics of a Harmonic Oscillator Interacting Linearly with a Free Particle[1] ALEXANDER SILVIUS, University of Missouri - Rolla, STEPHAN DE BIÈVRE, Universitè des Sciences et Technologies de Lille, PAUL PARRIS, University of Missouri - Rolla — We study the closed Hamiltonian dynamics of a free particle moving on a ring, over one section of which it interacts linearly with a single harmonic oscillator. On the basis of numerical and analytical evidence, we conjecture that at small positive energies the phase space of our model is completely chaotic except for a single region of complete integrability with a smooth sharp boundary showing no KAM-type structures of any kind. This results in the cleanest mixed phase space structure possible, in which motions in the integrable region and in the chaotic region are clearly separated and independent of one another. For certain system parameters, this mixed phase space structure can be tuned to make either of the two components disappear, leaving a completely integrable or completely chaotic phase space. For other values of the system parameters, additional structures appear, such as KAM-like elliptic islands, and one parameter families of parabolic periodic orbits embedded in the chaotic sea. The latter are analogous to bouncing ball orbits seen in the stadium billiard. The analytical part of our study proceeds from a geometric description of the dynamics, and shows it to be equivalent to a linked twist map on the union of two intersecting disks.

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