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Complex Dynamics in Quantum Systems
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H G S F P

Heidelberg Graduate School
of Fundamental Physics

Tutorial on Quantum Chaos

nHS, Phil.weg 12, Wednesday 14:15 - 16:00 (SS 2012)

Problem Sheet 2 – Integrable Systems

Problem 4

Given the Hamiltonian $H(x,p) = p^2/2 + V(x)$, with $V(x) = a|x|^n$, for a particle of unit mass, determine the period of oscillations as a function of a and of the energy E.

Problem 5

A particle of unit mass moves in 1D in the potential $V(x) = \omega^2 x^2/2 - ax^3/3$, with $a > 0$.

a) Prove that the Hamiltonian is a constant of the motion.

b) Sketch the potential $V(x)$ as a function of x.

c) Sketch the flow of trajectories in phase space (p, x). Locate any hyperbolic (unstable) and elliptic (stable) fixed points. Draw any separatrix of the motion.

Problem 6 – Mathematical Pendulum

Show that the area enclosed by the separatrix of the pendulum, with $H = p^2/2 - k\cos(\theta)$, equals $16\sqrt{k}$. Deduce from this result the maximum action for librating motion.