Chapter 1

Introduction

The behaviour of non-linear systems, at classical and quantum level, rises fundamental questions and is important in several applications. In classical mechanics, once the Hamiltonian systems become non-integrable, a sensitive dependence of the dynamics on the initial conditions manifests. This corresponds to chaotic dynamics and leads to several specific phenomena. In particular, the phase space is no longer filled by tori and depending on the energy, several trajectories will have an erratic behaviour in the available volume. An important question which is intensively debated in literature is related to the way in which the corresponding quantum system reflects this classical properties. The purpose of the present work is to explore the features of the energy levels statistics in relation with the departure from the integrable case and also as a function of excitation energy. We try to obtain a correlation between the global phase space structure in a given energy domain and the associated energy level distribution for the corresponding quantum system.

In ?? we review the basic concepts from classical Hamiltonian dynamics which are useful to the characterisation of chaotic dynamics.

In ??, after a brief review of the principles of quantum mechanics, we discuss the nearest neighbour distributions and their relation to the non-integrability.

?? is devoted to a detailed description of the numerical procedures and to the analysis method of the level distributions performed with the aid of a `Python` program.

?? presents the main results of our investigations. We discuss the possible deviations from the Wigner distribution by proposing an effective level distribution which can interpolate between the Wigner and Poissonian one. We show that the behaviour of this distribution can reflect the energy variations in phase space. Moreover, it has peculiar behaviour at the variations of the parameter with the departure from integrability.

In the last chapter, the main conclusions of our work are summarised.