properties of spectra of systems whose classical analogues are either integrable or chaotic. We shall not confine the discussion to the presence or absence of level repulsion but, for reasons that should be clear to the reader from the discussion of Section II, take as reference patterns the entire Poisson- and GOE- fluctuations.

IV.1 VIBRATIONS OF THE MEMBRANE (QUANTUM BILLIARDS)

Towards the end of Section III, reasons were given for putting special emphasis in the study of billiards. And examples were shown of integrable, chaotic and pseudo-integrable billiards. Let us now study some of their properties in the quantum case, specifically their spectral properties. The cases to be discussed are shown on Fig.IV.1: circle (integrable), Sinai's billiard and stadium (both strongly chaotic, in fact Bernouilli systems). Mention should be made of the pioneering work in the direction we follow: Refs.[MK-79,CVG-80] for the stadium and ref.[Be-81b] for Sinai's billiard. To determine the eigenvalues of Eq.IV-2 with Dirichlet boundary conditions, an efficient method has been proposed by Berry [Be-81b]. It is inspired on the work in solid state physics, by Korringa, Kohn and Rostoker, to determine the high-energy bands at the centre of the Brillouin zone. Once a sequence of eigenvalues is obtained, there is no ambiguity in separating the average part and the fluctuating part of the spectrum. Indeed, we know that for the systems we are considering the smooth part is given by Eq.(I-24) (see Fig.I.7). The procedure is therefore to first compute a sequence of eigenvalues \( \{ E_n \} \) and then to unfold the spectrum via Eq.(I-27), where \( N_\text{av} \) is given by Eq.(I-24). One finally has a sequence of points \( \{ x_\text{av} \} \) with mean spacing equal to unity, all over the spectrum.

Let us now present some results. To illustrate how the analysis is performed, we consider first a "trivial" case, the case of the circular membrane. To avoid two-fold degeneracies, we take a semi-circle or a