Introductory Remarks

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Hilda Cerdeira and Ramakrishna Ramaswamy, who worked so hard and successfully to organize the conference and workshop in Trieste of which this book is a partial record, have kindly asked me to write a few words of introduction. This will not be a summary of the written contributions, because that would simply repeat the task Martin Gutzwiller has so ably undertaken in the accompanying article. Rather, I will take the opportunity to give a more personal response.

When I first learned that the meeting was being planned, my immediate reaction was unenthusiastic. What purpose could be served by yet another gathering on 'quantum chaos', with the same faces, the same ideas ... ? But the pessimism was not justified. I was pleasantly surprised, and doubly so.

First, by discovering that at last the subject has escaped the paradox of its name. As we learned many years ago from Giulio Casati, Boris Chirikov, Joseph Ford, and Felix Izraelev, there is no chaos in quantum mechanics. A kicked (or, more generally, periodically driven) quantum system ultimately absorbs energy more slowly than its chaotically evolving classical counterpart. This exemplifies a more general principle: the semiclassical limit $\hbar \to 0$ and the long-time limit $t \to \infty$ are not interchangeable - the origin of the $\hbar, t^{-1}$ plane is mightily singular. In all except some very special cases (e.g. the 'quantum' system got by regarding the Liouville equation of a chaotic classical system as a Schrödinger equation, whose specialness is that its 'Hamiltonian' is linear in the 'momenta') $\hbar$ smooths away the fine classical phase-space structure, and prevents chaos from developing.

The inaccurate phrase 'quantum chaos' is simply shorthand, denoting quantum phenomena characteristic of classically chaotic systems, quantal 'reflections' or 'parallels' of chaos (I do not know why people are slow to adopt for such studies my explicit and precise term 'quantum chaology', which avoids these circumlocutions). I was pleased that in Trieste it was not necessary yet again to waste time on profitless discussion of definitions. Everybody was thoroughly aware of the point, and concentrated on seriously exploring these novel and lovely quantum phenomena.

My second surprise was the large number of contributions where periodic classical orbits are invoked as a basis for understanding the quantum mechanics. Even in the last century, Henri Poincaré, when laying the foundations of classical chaology, advocated the study of periodic trajectories as a skeleton on which the chaos hangs. In quantum chaology, it was Martin Gutzwiller who in the early 1970s pointed out that the relevance of these orbits persists even when the classical motion is nonintegrable. Despite several applications and developments of this idea over the years, the subject remained 'subterranean'. This is no longer the case. Many people realise that with periodic orbits it is possible to understand, for example, scars of wavefunctions, and why energy levels obey random-matrix statistics. There are fascinating and promising new ideas, like the curvature expansions. The periodic-orbit sum is an idea whose time has come, abundantly confirming the insights of Gutzwiller and Poincaré. I expect rapid developments in this area, possibly leading to the solution of some of the deepest problems (including, I like to dream, proving – or disproving – the Riemann hypothesis).

About the delights of a meeting in the beautiful setting of Miramare and the congenial atmosphere of the ICTP, it is not necessary to elaborate. Those who know do not need to be told, and those who do not would only be envious... Many thanks to Hilda and Rama for making it possible.