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After-dinner remarks at the 60th birthday celebration for Celso Grebogi, in Aberdeen, September 2007

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The organisers of this delightful celebration for Celso have persuaded me to reminisce about my involvement with the beginnings of what has cometo be called ‘quantum chaos’ (though since that phenomenon is hard to find I much prefer the term ‘quantum chaology’ [1], which describes what we really do.)

In 1972, Kate Mount and I wrote a review article on semiclassical approximations – what I now call prehistoric semiclassical mechanics: mostly WKB theory. Towards the end of the writing, I encountered papers by Martin Gutzwiller and was tremendously impressed by them and praised them in the review because he explicitly considered nonintegrable systems. I don’t think Gutzwiller had thought about chaos at that time and it wasn't mentioned in our review.

The publishers sent our article to be reviewed by Ian Percival. When I met him, he told me that he had just spent a year in the USA where he had encountered the work of “a wonderful Russian mathematician called Vladimir Arnold who is making very spectacular discoveries about a phenomenon that underlies those papers by Gutzwiller that you feature in your article. It’s called chaos, and you should learn about it.” Percival had already come to the view that associated with chaos there should be a different kind of quantum state. He called it the irregular spectrum, and published a paper about it in 1973 – the first paper explicitly about quantum chaology, for which he deserves credit. It had a big influence on me, though not for several years.

Then I encountered the writings of Joseph Ford: a great man, a passionate man, an infuriating man, a lovely man. What a pity Joe is no longer with us. He called himself the evangelist of chaos and that is a very good description. From

his papers I finally and fully realized the importance of what had been achieved by Arnold and also Yakov Sinai and Boris Chirikov in classical chaos, and determined to understand the impact this would have on quantum mechanics, that Percival had alerted me to. The best way to learn a new subject is to give lectures about it, so I gave a graduate lecture course in Bristol, based on the papers of those
pioneers.

Attending my lectures was Michael Tabor, an intellectual refugee from the wastes of theoretical chemistry (as he and I put it in those days),. He was very excited and wanted to work with me. But I told him: “I don't have much time, because we’ve just bought a new house, and I’ve promised to decorate it." A few weeks after moving in, there was a knock on the door. It was Tabor: “I've come to put my paint brush where my mouth is.” So we spent the summer up a ladder, painting and thinking about chaos and quantum physics and we published three papers.

Meanwhile I was bold enough to send the notes for my lectures to Joe Ford. I was overwhelmed when he called me from Georgia; in those days, an international phone call was fairly unusual. In his wonderful southern accent, he arranged for the notes to be published in the proceedings of a meeting I had not attended, and invited me to the first international meeting on chaos, that he was organising with Giulio Casati in Como. This was 1977; I went there with Tabor.

At the meeting, I had the idea that the quantum stationary states of classically chaotic systems would have the structure of gaussian random functions with a local coarse-grained intensity given by the classical microcanonical ensemble. André Voros was also at the meeting, and had a similar idea, but we published separately. Later, we learned that Alexander Shnirelman had published the microcanonical part of the idea a few years earlier.

A year before the Como meeting, Tabor and I had understood that random-matrix theory should give a good description of the statistics of energy levels in the irregular spectrum. This was as a result of the suggestion from my colleague Balazs Gyorffy that this subject – until then regarded as a branch of nuclear physics, might be relevant to chaos. George Zaslavsky had had a similar idea in 1974, but unfortunately he did not identify the central feature; universality. Tabor and I published a brief account of the envisaged random-matrix connection in one of our papers. This was taken up by Steven McDonald and Alan Kaufman, who we then met in Como; they made the first computations to check the idea (with the stadium quantum billiard). About seven years later, the

definitive and very influential statement of the connection was made, and supported by more accurate numerics, by Oriol Bohigas, Marie-Joya Giannoni, and Charles Schmidt, who knew much more than me about random matrices.

In a separate development, the head of the theory group in Bristol, John Ziman, a condensed-matter physicist with whom I never worked but who was something of a mentor to me, had shown me the papers on period-doubling by Robert May and by Jim Yorke. In Como I met Mitchell Feigenbaum, who made such a spectacular contribution by explaining the universality of these phenomena in terms of renormalization. My encounter with Gulio Casati soon led to discussions about the Aharonov-Bohm effect, and thus, indirectly, through connections I will not elaborate here, to the geometric phase in 1983. That Como meeting was unforgettable!

Ziman also showed me the book by René Thom on Catastrophe theory, thereby inspiring another major chapter in my scientific life (universal diffraction decoration of waves near caustics), but that too is another story.

Several years later, Alfredo Ozorio de Almeida, who had been my undergraduate student in the 1960s and my graduate student in the early 1970s, and my colleague John Hannay, made a major discovery about universality in the distribution of the long periodic orbits that appear in Gutzwiller's representation of the irregular spectrum. This became the basis of my 1985 understanding of the origin of random-matrix universality, and, equally important, how random-matrix theory fails for correlations between distant energy levels – an understanding that has been so ably developed and deepened by Jonathan Keating and Eugene Bogomolny, and most recently by Martin Sieber and Fritz Haake and others.

It was in the early 1980s (I do not remember the year) that I visited Maryland and first met the very creative classical chaos group of Jim Yorke, Edward Ott, and of course Celso Grebogi, who soon became a friend. I congratulate him today on reaching sixty: no younger person's age has more distinct prime factors.

1. Berry, M. V.,1989, Quantum chaology, not quantum chaos *Physica Scripta* **40**, 335-336.