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Statistics of time delay and scattering correlation functions in chaotic systems. I: Random matrix theory. (English) Zbl 1322.81050

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Given a quantum mechanical, chaotic cavity with M open channels the scattering matrix $S(E)$ is an energy dependent, complex $M \times M$ matrix and the Wigner time delay matrix is defined as $Q := -i\hbar S^\dagger \frac{dS}{dE}$. In this article the author calculates, for a system without time reversibility, the random matrix expectation values $\langle s_\lambda(Q)\rangle$ where $s_\lambda(Q)$ is a general Schur function of Q. From these expressions random matrix expectation values for general polynomials

$$\mathcal{M}_{n_1,n_2,\dots} = \frac{1}{M}\mathrm{Tr}[Q^{n_1}]\frac{1}{M}\mathrm{Tr}[Q^{n_2}]\dots$$

can be derived. In particular, for the time delay moments $\mathcal{M}_n$, the formula

$$\langle \mathcal{M}_n\rangle = \tau_D \frac{M^{n-1}}{n!}\sum_{k=0}^{n-1}(-1)^k\binom{n-1}{k}\frac{[M-k]^n}{[M+k]_n}$$

is obtained. Here, τ_D is the classical dwell time, and

$$[x]^n = x(x+1)\dots(x+n-1), \quad [x]_n = x(x-1)\dots(x-n+1)$$

are raising and falling factorials. In a subsequent article of the author [J. Math. Phys. 56, No. 6, Article ID 062109, 14 p. (2015; Zbl 1322.81049)], these expressions for $\langle \mathcal{M}_n\rangle$ are compared to semiclassical approximations for energy averages of the time delay moments.

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MSC:

81Q50 Quantum chaos
81Q20 Semiclassical techniques, including WKB and Maslov methods applied to problems in quantum theory
81U35 Inelastic and multichannel quantum scattering
15B52 Random matrices (algebraic aspects)
60B20 Random matrices (probabilistic aspects)

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random matrix theory; scattering theory

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