The interplay between quantum symmetry, integrability and solvability: the Rabi model

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As participants of this conference, we fully appreciate that symmetries and integrability are arguably the most powerful concepts in the mathematical description of physical systems. Nevertheless, for quantum systems, the definition of integrability is not as straightforwardly defined as for classical systems. Among the various definitions, the concept of Yang–Baxter integrability is particularly powerful and seems most appropriate for $(1+1)$-dimensional quantum systems. Yang–Baxter integrability is known to underpin the exact solvability of a number of iconic models. In this talk I will discuss the interplay between quantum symmetry, integrability and solvability in the context of the quantum Rabi model. The Rabi model describes the simplest interaction between light and matter, thus having widespread applications in quantum physics. Despite its simplicity, the eigenspectrum of the fully quantised version of the Rabi model has only recently been obtained analytically, with the eigenstates given in terms of confluent Heun functions. Based on a phenomenological criterion of quantum integrability without presupposing the existence of a set of commuting operators, the Rabi model has been claimed to be integrable. However, it does not appear to be integrable in general in the Yang–Baxter sense. Similar considerations apply to the more general Dicke model. Among others, this talk is based on the publications:

[1] D Braak, Integrability of the Rabi model, Phys. Rev. Lett. 107, 100401 (2011).

[2] H Zhong, Q Xie, M T Batchelor and C Lee, Analytical eigenstates for the quantum Rabi model, J. Phys. A 46, 415302 (2013).

[3] M T Batchelor and H-Q Zhou, Integrability versus exact solvability in the quantum Rabi and Dicke models, Phys. Rev. A 91, 053808 (2015).

[4] Z-M Li and M T Batchelor, preprint.