IMPRS UFAST

MAX-PLANCK-GESELLSCHAFT

IMPRS UFAST Focus Course

The Infinite Dimensions of Quantum Physics

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Abstract:

It is common practice to equate quantum physics with the manipulation of matrices and quantum states with their eigenvectors. This is a very helpful pedagogical simplification and is often sufficient to understand and perform calculations. However, the basic tenets of quantum physics make the use of infinite-dimensional vector spaces and unbounded operators necessary, which diverge in their properties significantly from matrices. And the differences between (even infinite-dimensional) matrices and unbounded operators have many important and unfortunately often very subtle consequences. While many of these consequences can become important when developing new theoretical methods, they are commonly not covered in the standard courses on quantum physics.

https://www.ias.edu/ideas/2016/pires-hilbert-hotel

In this focus course we will discuss the most important of these consequences in the context of quantum mechanics and non-relativistic quantum electrodynamics. Among others we will highlight how the necessity for infinite dimensions and unbounded operators arises and why this implies that not all wave functions of the basic Hilbert space are physically allowed. Furthermore, we discuss how unbounded operators lead to different forms of eigenstates as well as to different forms of solutions to the time-dependent Schroedinger equation and how these different types of solutions are connected to Floquet theory. Finally, we comment on the existence of ground states and the stability of matter. We will mostly avoid a theorem-proof style of presentation and instead try to give simple and instructive examples. Along with these results we will give many surprising examples of inconsistencies that arise if the infinite-dimensional nature of quantum physics is not properly accounted for.

12th – 19th July 2021 14:15h – 17:15h (online)

Register on Geventis I-UF FC6

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