

The Permanence of Forms in Quantum Mechanics

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The requirement that the algebra of infinite dimensional quantum mechanics be a “proper” extension of its finite dimensional algebra is justified, on von Neumann’s view (after 1935), by the so-called principle of the permanence of forms. Explicitly formulated by the Cambridge algebraist George Peacock in the first half of the 19th Century, this principle was later propagated by Hermann Hankel, whose conception of it appears to have been very influential not only in the German speaking world. The principle played a significant role in the work of great mathematicians like Hilbert, as well as great philosophers like Husserl. It has also been opposed by eminences like Russell.

The principle of permanence of forms, however, does not appear to be only one thing. For it has been regarded as a principle of theoretical rationality, i.e., one that is indispensable for the development of a genuinely scientific theory, but also as a principle of practical rationality, i.e., one that is merely thought to save brain energy in this development. Some conceived of it as a metaphysical principle, due to its alleged connection to mathematical intuition, others as a merely semantic principle, due to the connection it stipulates between a formal theory and a non-formal interpretation of it. Yet others considered that permanence of forms can play a probative role, and thus used it as an axiom in the derivation of mathematical results.

In this talk, I explore the historical roots of the principle of permanence of forms, and then discuss its influence by carefully distinguishing its various interpretations. Coming back to von Neumann, I consider which of these interpretations, if any, may best accommodate his later view on quantum mechanics, and why.