# A Modernizing View of Heisenberg's Matrix Mechanics

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In 1925, Heisenberg, Born, and Jordan developed matrix mechanics as a strategy to solve quantum-mechanical problems. While finite-sized matrix formulations are commonly taught in quantum instruction, the logic and detailed steps of the original matrix mechanics has become a lost art. In preparation for the 100th anniversary of the discovery of quantum mechanics, we present a modernized discussion of how matrix mechanics is formulated, how it is used to solve quantum-mechanical problems, and how it can be employed as the starting point for a postulate-based formulation of quantum-mechanics. We focus on the harmonic oscillator to describe how quantum mechanics advanced from the Bohr-Sommerfeld quantization condition, to matrix mechanics, to the current abstract ladder-operator approach. We show how experiment motivaties a matrix representation via the Rydberg-Reisz combination principle, how the Ehrenfest theorem is motivated by the correspondence principle, and how just these two postulates allow us to derive the canonical commutation relation. Then by moving from matrices to operators and abstract vectors in a Hilbert space, one can finish thepostulate-based formulation of quantum mechanics with the Born rule and a measurement postulate (the Born rule can be strongly motivated via a simple counting approach). This talk will not focus on a historical treatment of the materials, but instead on how we can revive and use a modernized version of these ideas to make the foundations of quantum mechanics clearer, and experimentally motivated.

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