

Quantum Mechanics - Historical Background

Physics in the Late 19th Century (prior to quantum mechanics (QM))

- Atoms are basic constituents of matter
- Newton's Laws apply universally
- The world is deterministic

According to classical mechanics (CM):

Given initial positions \vec{r}_0 and velocities \vec{v}_0 , and given all forces $\vec{F}(t) \Rightarrow$ all the future can be predicted!

$$\vec{v}(t) = \int_{\vec{v}_0}^{\vec{v}} d\vec{v}' = \int_{t_0}^t \frac{\vec{F}}{m} dt' \quad \left(\vec{F} = m\vec{a} = m \frac{d\vec{v}}{dt} \right)$$

$$\vec{r}(t) = \int_{\vec{r}_0}^{\vec{r}} d\vec{r}' = \int_{t_0}^t \vec{v} dt' \quad \left(\frac{d\vec{r}}{dt} = \vec{v} \right)$$

Physics was complete except for a few decimal places !

- Newtonian mechanics explained macroscopic behavior of matter -- planetary motion, fluid flow, elasticity, etc.
- Thermodynamics had its first two laws and most of their consequences
- Basic statistical mechanics had been applied to chemical systems
- Light was explained as an electromagnetic wave

— However there were several experiments that could not be explained by classical physics and the accepted dogma !

- Blackbody radiation
- Photoelectric effect
- Discrete atomic spectra
- The electron as a subatomic particle

— Inescapable conclusions would result from these problems

- Atoms are not the most microscopic objects
- Newton's laws do not apply to the microscopic world of the electron

OUTCOME

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New Rules!!!

Quantum Mechanics!

- □ Describes rules that apply to electrons in atoms and molecules
- □ Non-deterministic, probabilistic ! A new philosophy of nature

— Explains unsolved problems of late 19th century physics

— Explains bonding, structure, and reactivity in chemistry