

❖ The Average Value of the Square of Hermitian Operators

The expectation value of the square of every Hermitian operator is always positive. In other words, we can say that if A is a Hermitian operator, then

$$\langle A^2 \rangle > 0 \quad (393)$$

This can be proved by taking a well-behaved function ψ as discussed below.

$$\langle A^2 \rangle = \frac{\int \psi^* A^2 \psi d\tau}{\int \psi^* \psi d\tau} \quad (394)$$

The right-hand side of equation (394) will be positive only if the numerator as well as denominator, both are either positive or negative. Since the wave-function is well-behaved (normalized), the value of denominator is

$$\int \psi^* \psi d\tau = 1 \quad (395)$$

Since the denominator is positive, the numerator must also be positive. Now owing to the Hermitian nature of operator A , we can evaluate the numerator as given below.

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$$\int \psi^* A^2 \psi d\tau = \int \psi^* A A^* \psi d\tau \quad (396)$$

$$= \int (\psi^* A^*) A \psi d\tau \quad (397)$$

or

$$= \int |A\psi|^2 d\tau \quad (398)$$

Hence, the value of numerator given by equation (398) is greater than zero i.e. positive, making the average value of the square of the Hermitian operator (A) also positive.

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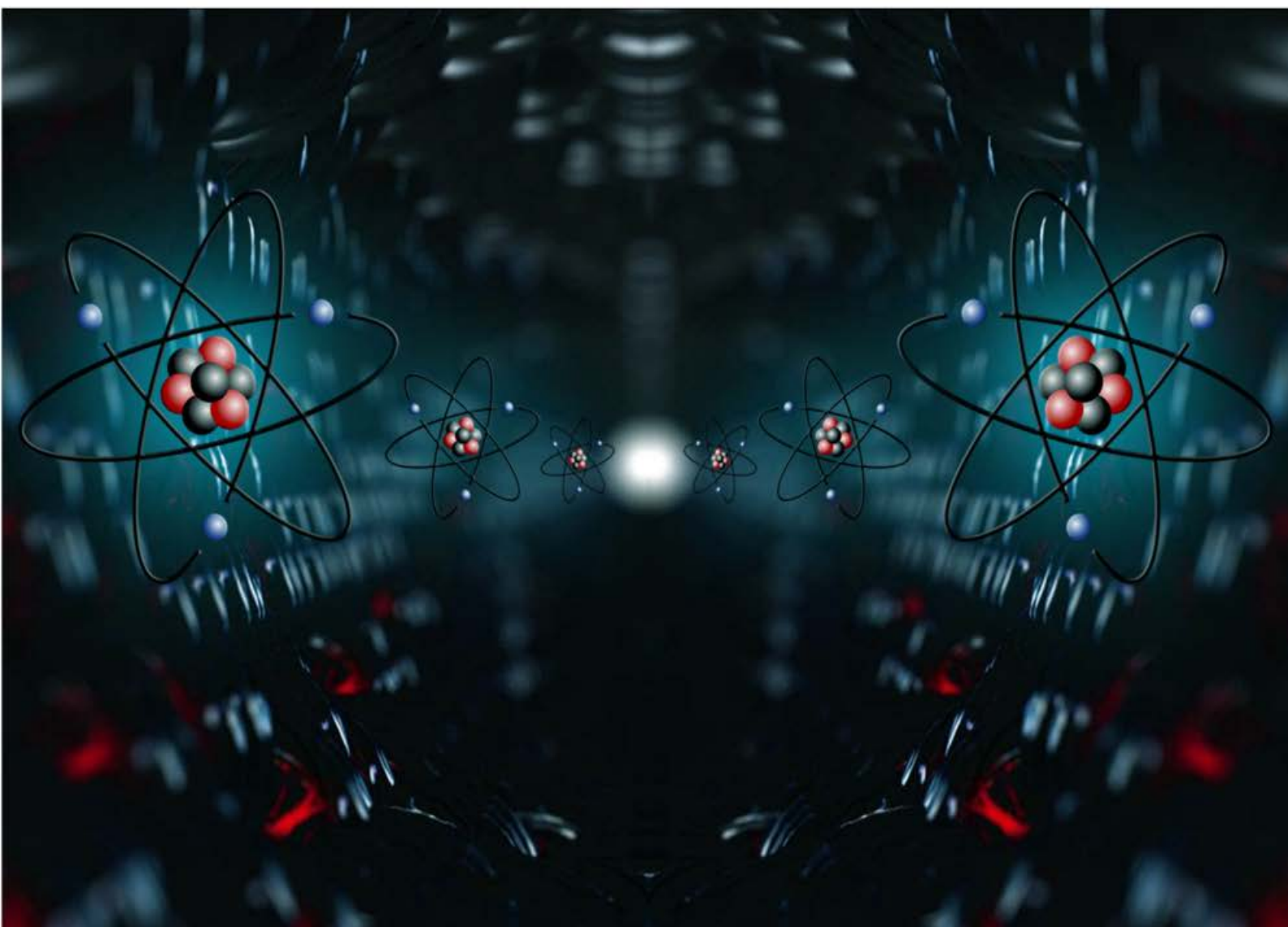
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Volume I

MANDEEP DALAL



First Edition

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