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Dr. Syed Salman Ahmad Warsi is an accomplished physicist, academician, and educator with extensive expertise in condensed matter physics. He currently serves as an Associate Professor in the Department of Physics at Integral University, Lucknow, and brings more than 25 years of experience in teaching, research, and academic mentorship.

Throughout his academic career, Dr. Warsi has taught undergraduate and postgraduate students, making significant contributions to physics education through his dedicated teaching and research guidance. He has successfully supervised numerous B.Sc. and M.Sc. dissertations and projects and is actively involved in mentoring doctoral scholars pursuing Ph.D. research in Physics.

His research interests include liquid-crystal systems, nanoscale materials, and contemporary topics in condensed matter physics. Dr. Warsi has published several peer-reviewed research papers in reputed journals and continues to contribute actively to scientific research and academic development.

In addition to his research contributions, Dr. Warsi has co-authored important educational books, including:

- *ICSE Physics for Class X (2025)*
 - *ISC Practical Physics for Classes XI & XII (2021)*
- He has also served as editor of the following scholarly books:*
- *Characterization of Liquid Crystals and Photonic Crystals (2022)*
 - *Advances in Contemporary Physics: High Energy, Cosmology and Soft Matter (2025)*

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HYDROGEN ATOM: FUNDAMENTAL PHYSICS AND CONTEMPORARY SCIENTIFIC APPLICATIONS

Haroon

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Hydrogen, the simplest and most abundant element in the universe, has played a fundamental role in the development of modern physics, chemistry, and energy science. This chapter presents a comprehensive overview of the hydrogen atom, covering its historical significance, fundamental physical properties, isotopes, nuclear structure, electronic configuration, and quantum mechanical description. Classical atomic theories, including the models of J. J. Thomson, Ernest Rutherford, and Niels Bohr, are discussed alongside the Schrödinger treatment of the hydrogen atom and important quantum corrections. The chapter further explores the role of hydrogen in nuclear physics, computational modeling, materials science, catalysis, semiconductor technology, and clean energy systems such as hydrogen fuel cells and fusion research. Contemporary frontier topics, including the Proton radius puzzle, metallic hydrogen, quantum sensing, and superconducting hydrogen-rich materials, are also highlighted. Overall, the chapter demonstrates the central importance of hydrogen in both fundamental scientific investigations and emerging technological applications.

INTRODUCTION:

Why Hydrogen is Fundamental? Hydrogen is the simplest, lightest, and most abundant chemical element in the observable universe, occupying the first position in the periodic table with atomic number one. The discovery of hydrogen as a distinct substance is credited to Henry Cavendish in 1766, who identified it as “inflammable air” during metal-acid reaction experiments and distinguished it from other combustible gases. Later, Antoine Lavoisier demonstrated that the combustion of hydrogen produces water and introduced the term “hydrogène,” meaning