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# **Introductory Chapter: Introduction to New Trends in Nuclear Science**

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Additional information is available at the end of the chapter

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## **1. Introduction**

Nuclear energy is still one of the most thriving technological sectors in our modern life. It is considered by far one of the leading sources of alternative energy. That modern energy many driving forces worldwide are looking for, since, it does not share limitations and setbacks of the current energy sources based on fossil materials which are costly, depletable, and most importantly not environmental friendly. In a recent major interdisciplinary study from the “MIT Future of Series” initiative, a comprehensive report on the future of nuclear energy in a carbon-constrained world was published, suggesting strongly that nuclear energy is a potential solution to the challenge facing our modern world to establish sustainable mechanisms for producing energy that is based on low carbon technologies.

Many researchers, scientists, and engineers alike on the fields of nuclear science have come with similar conclusions of the MIT study on nuclear energy and insist that more efforts are needed to lower the cost of nuclear technology and optimize its applications in our daily life at the same time. Therefore, many research groups on nuclear science from around the globe are actively working in a variety of fronts to expand the body of knowledge available on nuclear materials and explore new ways for their utilization in modern and futuristic applications. Hence, this book is going to shed light on some of the advances taking place within nuclear science research in recent time. It is a small effort to show interesting results of some modern nuclear science research carried out by bright scientist and research in different parts of the world.

The book is divided into five chapters. The first one is a short introduction to explain the nature and purpose of the book and the logic and significance of its contents. The second one is a concise introduction to the core subject of nuclear science, which is nuclear reaction. The chapter

touches lightly on the fundamental and basic physics underlining major nuclear reactions, i.e., nuclear fissions. In addition, the chapter shows different generations of nuclear reactors as important tools to harness energy resulting from nuclear reactions. Some of these reactors are relatively modern and hold great potentials for future nuclear technology. The second chapter comes with many figures and charts along with two appendices to point out many aspects of nuclear fission reactions and their utilization in modern nuclear reactors.

In the third chapter, attention is directed to another important field of nuclear science that is nuclear detectors. To be more precise, the third chapter addresses some recent advances related to the famous nuclear detector material namely CdTe. Maslyanchuk et al. [1], suggest that the modern detector based on CdTe materials can be developed as multielement detection platform that allows for the direct conversion of information generated by passing X/ $\gamma$ -radiations through an examined object into an array of digital electrical signals without using an intermediate visible image on a fluorescence screen. Such an approach will facilitate real-time visualization and sufficiently enhance image resolution. In the chapter, discussion on different aspects of the semiconductor nuclear detector based on CdTe material and Schottky effect shows progressive research into one of the modern nuclear detection devices that will enable developers to utilize nuclear technology in safe and practical ways [2, 3].

In the next chapter, a new study on the effect of unintended and accidental nuclear impact on the environment is discussed. Recently, Joji M. Otaki, from the department of chemistry, biology, and marine science at the faculty of science of the University of Ryukyus, Japan, has investigated the multifaceted biological effects from the tragic Fukushima nuclear accident caused by Mother Nature. Such study may help researchers to understand the correlation nature of low-dose exposure and field effects on the environment and may eventually lead to resolving the field-laboratory paradox on the environmental damage caused by the low-dose radiation. The study concluded that the “low-dose” exposure from the Fukushima nuclear accident imposed potentially non-negligible toxic effects on organisms including butterflies and humans through environment field effects. At the high-dose exposure, same field effects can exist, but would likely be masked by the acute radiation damage on the subjected environment [4].

In the last chapter, Thomas W. Grimshaw, from the University of Texas at Austin, USA, has composed an interesting study on the so-called cold nuclear fusion or as widely known the low-energy nuclear reaction (LENR). He, among others, argued that nuclear cold fusion if realized and understood could be a significant source of cheap and clean energy. When LENR was introduced to the scientific communities in early 1989, it was greatly dismissed by the mainstream scientists. However, as the chapter’s author mentioned, despite such rejection of LENR concept, the research activities on the subject are growing by the time, and the matter of LENR is still alive and vibrant. According to many researchers around the world, there is accumulating evidence on the reality of LENR phenomena. Such advances on the LENR subject should encourage interested communities and potential stakeholders to come up with policymaking and regulations to facilitate the growing research endeavors on LENR for its realization and harnessing its great benefits. Moreover, it is important to work on mitigating its secondary effects since LENR is expected to evolve into disruptive technology. Author has concluded that due to the recent updates, the support for LENR developments and preparations to mitigate its anticipated adverse secondary impacts is largely needed [5, 6].

Although the presented book does not provide a comprehensive treatment by any means to its topics, it is still a very constructive venue to direct readers' attention to some of the advanced trends of nuclear science research. This book will definitely encourage readers, researchers, and scientists to look further into the frontier topics of modern nuclear science and make the needed efforts to develop its cause and uses.

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