



Physics for Human Security

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Abstract

Physics is the basic natural science that studies fundamental constituents of matter and related entities, with the main goal being to understand how the universe behaves. Its contribution to human security is, therefore, at least twofold. On the one hand, physics contributes valuable knowledge to addressing various critical issues confronting the world today, including peace, human rights, inequality, health, food, education, jobs, safe communities and personal safety, energy, pollution, biodiversity, and climate change. On the other hand, physics creates a breakthrough about every hundred years, like the introduction of quantum physics and relativity in the early 20th century. Such a breakthrough leads to an entirely new worldview, followed by new technologies that resolve the most critical problems with completely new technologies that neither existed before nor could have been imagined. Similarly, as quantum physics led to the microelectronic revolution of the late 20th century and current smart machines, another breakthrough in our understanding of nature is possible that could create an even larger revolution, e.g., in the field of quantum computing or understanding of cellular and molecular biology.

1. Introduction

Physics is the most fundamental natural science, discovering basic natural laws describing the world around us. As more and more layers of understanding are uncovered, physics is becoming more relevant to our daily lives and understanding of human beings. In this contribution, we discuss the relevance of physics and its education for human security [1].

In its quest for a deeper understanding of the universe, physics has continued to push the boundaries of knowledge. Throughout history, it has produced groundbreaking discoveries that revolutionise how we see the universe and pave the way for remarkable technological advances. These crucial breakthroughs occur sporadically, about once a century, and change our world with entirely new scientific paradigms. The advent of quantum physics and relativity at the beginning of the 20th century, for example, led to a radical shift in our worldview and eventually to the development of transformative technologies that were previously unimaginable.

However, the importance of physics goes beyond technological progress. It encompasses many critical global issues that directly impact human security. The contemporary world faces various challenges, from peace and equality to health, energy, and environmental

sustainability. With its rigorous scientific methods and analytical frameworks, physics contributes valuable knowledge and innovative solutions to these pressing issues.

This paper highlights two distinct but related aspects of physics' contribution to human security. On the one hand, physics offers insights into societal challenges, including peacemaking, human rights, inequality, education, public safety and environmental protection. By harnessing the principles and theories of physics, we can understand the complicated dynamics underlying these problems and develop effective strategies to mitigate their effects. On the other hand, physics has a remarkable track record of groundbreaking discoveries that revolutionise our understanding of nature. These leaps in scientific knowledge often trigger paradigm shifts that lead to the development of entirely new technologies. From the microelectronic revolution of the late 20th century to today's era of intelligent machines, physics has been instrumental in shaping the technological landscape. At the moment, the possibility of another transformative breakthrough in quantum computing or cellular and molecular biology holds immense potential to revolutionise society again.

This paper explores the contributions of physics to human security by highlighting its role in solving critical global problems and its potential for breakthrough advances. By analysing the impact of physics in these areas, the true importance of physics in shaping the contemporary world can be understood, as well as its potential for shaping the world of tomorrow.

2. Human Security

Although the concept of human security is rather old [2–4], the WAAS project “Human Security for All”^{*} brings a new and expanded understanding.

Defining human security and its multidimensional aspects is critical to understanding the comprehensive nature of the concept and its implications for global well-being. Human security encompasses far more than traditional notions of national security and extends to the protection and flourishing of individuals and communities in various dimensions. At its core, human security is about protecting individuals' and communities' fundamental rights, dignity and well-being and ensuring they are free from threats and vulnerabilities. It recognises that security goes beyond military defence and encompasses many interconnected factors that affect people's lives.

The multidimensional aspects of human security include various dimensions such as personal, economic, food, health, environmental and community security. Personal security refers to protection from violence, crime and human rights violations and ensures the safety and freedom of the individual. Economic security relates to access to decent work, livelihoods, and equitable economic opportunities to reduce poverty and inequality. Global challenges' interconnectedness highlights today's world's complexity and interdependence. Issues such as peace, poverty, climate change and inequality are not isolated problems but are closely interlinked, adding to the urgency of comprehensive solutions.

^{*} The project financed by the UN started in October 2022; more information at <https://new.worldcademy.org/human-security/>.

Addressing global challenges requires a holistic approach that considers the interaction between social, economic, environmental, and political factors. For example, conflict and insecurity can hinder sustainable development and spread poverty, while poverty and inequality can fuel social unrest and contribute to conflict. Environmental degradation also has far-reaching effects on food security, public health and livelihoods. The consequences of these challenges often transcend national borders, highlighting the need for joint and coordinated efforts at the global level.

“Further advances in physics promise to bring a deeper understanding of the world around us as well as a deeper understanding of human beings and our consciousness. In this way, a powerful impact on human security for all can be achieved.”

Peace and conflict resolution are critical aspects of human security. It is essential to understand the dynamics of conflict and promote peaceful solutions. Factors such as resource scarcity, territorial disputes, and power imbalances should be explored. Understanding these can help identify potential conflict triggers and work towards preventive measures.

3. Practical Applications of Physics

Peace and conflict resolution are crucial aspects of human security. It is essential to understand the dynamics of conflict and promote peaceful solutions.

Physics-based technologies and methods have been essential in arms control, disarmament and non-proliferation efforts [5–7]. Through the development of advanced monitoring and verification techniques, physics has helped build confidence, reduce tensions and facilitate diplomatic negotiations. Physics also plays a role in conflict resolution by providing analytical tools and models for analysing complex social and political systems. By applying scientific methods to the study of conflict, researchers can develop predictive models, scenario analyses and conflict management strategies that contribute to peaceful solutions.

Physics-based technologies like remote sensing [8] and satellite imagery [9] have been used for conflict monitoring and early warning systems. These tools provide objective data and evidence that can facilitate peacekeeping operations, promote accountability and support mediation processes.

Physics education [10,11] and scientific collaborations can promote peace and understanding by helping the students overcome cultural and political barriers. By promoting scientific literacy, critical thinking and cross-cultural dialogue, physics can help build bridges between nations and foster a culture of peace.

Nuclear physics [12] provides a fundamental understanding of nuclear reactions, radioactive decay and the behaviour of nuclear materials. This knowledge is critical to developing security and verification measures to prevent the unauthorised acquisition or diversion of nuclear materials for weapons. By applying physics principles, scientists and experts can develop advanced techniques for detecting nuclear weapons, including methods for detecting and analysing radiation signatures, isotope analysis, and radiation imaging. These techniques are used in various contexts, such as border control, cargo screening, and nuclear facility inspection.

Technological advances play a critical role in conflict prevention and resolution by harnessing the power of innovation to address the complex challenges of our modern world. For example, advances in communications technology have significantly enhanced conflict prevention efforts by enabling the rapid and widespread dissemination of information. Real-time communication platforms and social media networks allow rapid reporting and monitoring of conflicts, helping to raise awareness, mobilise responses and promote early intervention.

In addition, technology-enabled data analytics and artificial intelligence (AI) algorithms offer new opportunities for conflict prediction and analysis. By analysing large amounts of data, including social media trends, news reports and historical conflict data, AI-powered systems can identify patterns and indicators of potential conflict and thus take proactive measures to prevent escalation.

Using unmanned aerial vehicles (UAVs), known as drones, has revolutionised conflict monitoring and surveillance. Drones equipped with high-resolution cameras and sensors provide real-time aerial imagery and enable remote tracking of conflict areas, border surveillance and identification of potential threats.

Technological advances can also assist in humanitarian aid in conflict-affected areas. For example, advances in 3D printing technology enable the rapid production of essential supplies and medical equipment in remote or crisis-affected regions, helping to build resilience and alleviate suffering.

Other practical applications of physics include the advancement of renewable energy [13] and energy efficiency technologies [14], research into sustainable materials [14] and energy storage solutions [15], physical models for predicting natural disasters and mitigating their effects, radiation protection and nuclear safety measures, earthquake engineering and structural analysis to ensure safe infrastructure, crop monitoring and optimisation in agricultural sciences, irrigation and water management using physical modelling and precision agriculture, innovations in food preservation, packaging and safety through physics research, remote sensing and atmospheric physics for pollution monitoring and mitigation, and many other topics explored by physicists worldwide.

The importance of teaching physics also lies in fostering critical thinking and problem-solving skills.

4. Conclusions

Physics can offer profound insight into the pressing issue of human security. Many complex challenges can be simplified, and solutions can be developed. In addition, further advances in physics promise to bring a deeper understanding of the world around us as well as a deeper understanding of human beings and our consciousness. In this way, a powerful impact on human security for all can be achieved.

In these efforts, our most essential roles are both in developing new knowledge and new educational technologies that improve the spread of the acquired new knowledge among broader audiences. Our joint efforts in this direction can contribute to a better and more secure world.

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