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Book Review

The Physics of Climate Change: A Book Review

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Introduction

Climate change is inevitable. It stands as one of the triple planetary crises, along with pollution and biodiversity loss, impacting countries worldwide. People across the globe have a responsibility to achieve Goal 13 of SDGs, which emphasizes the urgency for immediate and concerted efforts to address climate change and its multifaceted consequences (Juniper, 2021). The adverse effects of climate change exacerbate existing issues such as poverty, food insecurity, and public health crises, thereby undermining global progress towards sustainable development. Consequently, this issue has gained significant political and technocratic attention, necessitating coordinated efforts to address its challenges.

Significantly, the response to the challenge of climate change is grounded in a robust scientific framework. The 2021 Nobel Prize in Physics reaffirmed the importance of science-based policy by honoring a group of scientists for their groundbreaking research on Earth's climate system. This recognition underscores the irrelevance of the question, *"Do you believe in global warming?"* (Hegerl, 2022). However, certain individuals still fail to grasp the scientific foundation of climate change, resulting in limited awareness and disregard for the issue. Therefore, mainstreaming the climate change issue needs an approach focused on literacy and science education.

In *The Physics of Climate Change*, Lawrence M. Krauss (2021) delves into the scientific principles underlying climate change, using physics as a framework to explain the mechanisms driving global warming. This English-language book, consisting of 12 chapters, aims to demystify complex climate science concepts, making them accessible for readers without a scientific background. Krauss highlights

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the necessity of understanding these principles to address the pressing issue of climate change effectively. The cover, featuring a stark image of Earth, underlines the urgency of the topic. This review focuses on the book's key arguments and its relevance to sustainable development planning, particularly in addressing the global climate crisis.

Overview of Climate Science

Krauss begins by explaining the fundamental physics of greenhouse gases, emphasizing how carbon dioxide and methane trap heat in the atmosphere. He argues that Earth's temperature is a delicate balance, and human activities have tipped the scales. In other words, human-induced emissions play a significant role in disrupting the planet's natural equilibrium. Furthermore, Krauss illustrates the importance of thermodynamics and energy conservation in understanding Earth's climate system.

In Chapter 4, *Earth's Blanket,* Krauss explores the origins of somewhat as it became later known as the Greenhouse Effect. In 1824, French physicist and mathematician Joseph Fourier was the first to propose that the Earth's temperature was increasing. Krauss explicates, *"Fourier reasoned that Earth would radiate much of its heat out into space if something were not trapping that heat—something like a blanket, which keeps us warm at night by stopping us from radiating our own heat out into the room when we are sleeping."* Fourier's hypothesis was empirically validated through laboratory experiments conducted by John Tyndall in 1861.

Krauss' explanation aligns with the discussion by Zhou et al. (2022) regarding the evolution of climate science from the 19th century to the present. A significant milestone in this development was reached when Syukuro Manabe and Klaus Hasselmann, alongside Giorgio Parisi, were bestowed the 2021 Nobel Prize in Physics for their groundbreaking contributions to the understanding of complex physical systems. The conclusion indicates that the circulation of thermal radiation in the atmosphere remains consistent with the Second Law of Thermodynamics. The Earth can be conceptualized as a giant heat engine that governs atmospheric air circulation, analogous to the operation of a Carnot engine within a simplified thermodynamic model (Singh & O'Neill, 2022).

Radiative Forcing and Climate Models

In chapter 6, Krauss introduces the concept of radiative forcing (expressed in watt/m^2), which measures the imbalance in Earth's energy system caused by factors like greenhouse gases, aerosols, and solar radiation. He writes, *"Calculating radiative forcing has become the standard tool for quantifying the changing infrared absorption in the atmosphere and its effect on changing the energy balance between incoming radiation from the sun and outgoing radiation from Earth."* A positive radiative forcing value indicates that less energy escapes from the atmosphere into space, resulting in a net positive imbalance between incoming solar radiation and outgoing infrared radiation. Consequently, this imbalance contributes to an increase in the Earth's surface temperature.

Radiative forcing serves as the primary driver of climate change, with human activities substantially intensifying its impacts. Krauss highlights the extent to which anthropogenic influences exacerbate natural processes, thereby accelerating global warming. Through clear examples, such as the warming impact of CO_2 and the cooling effect of aerosols, he elucidates the role of radiative forcing in shaping the Earth's climate. Additionally, Krauss examines how this phenomenon contributes to increasing global temperatures and evaluates climate models that project future warming trends based on prevailing emissions scenarios.

Historical Context and Evidence

Krauss discusses historical CO_2 measurements, starting from observations at Mauna Loa Observatory in the 1950s and extending to ice core data that reveal unprecedented levels of atmospheric CO_2. He presents empirical evidence demonstrating that global temperatures have risen significantly, with a notable increase of approximately 1.2 degrees Celsius since the late 19th century. Krauss builds a compelling case, using data from ice cores, temperature records, and climate models, that overwhelmingly links human activity to climate change. This analysis reveals that the fingerprints of human influence are unmistakable in the rising temperatures and melting ice caps, underscoring the irrefutable scientific consensus.

Contemporary research continues to validate the scientific relevance of Krauss's measurements. The Copernicus Climate Change Service's most recent report highlighted the unprecedented increase in global temperatures. Specifically, January 2025 exceeded the January 2024 average by 0.09 degrees Celsius, representing a 1.75 degrees Celsius increase above pre-industrial levels (1850 baseline). In addition, a study conducted by Hansen et al. (2025), published in *The Journal of Environment: Science and Policy for Sustainable Development* on February 3, 2025, indicates a heightened sensitivity of Earth's climate to escalating greenhouse gas emissions relative to prior estimations. Current projections suggest an acceleration of global warming, with a potential increase of 2 degrees Celsius by 2045. Based on the trends, the United Nations Intergovernmental Panel on Climate Change (IPCC)'s ambitious scenario, which posits a 50 percent probability of limiting global warming to below 2 degrees Celsius by 2100, appears increasingly untenable.

Future Implications and Call for Action

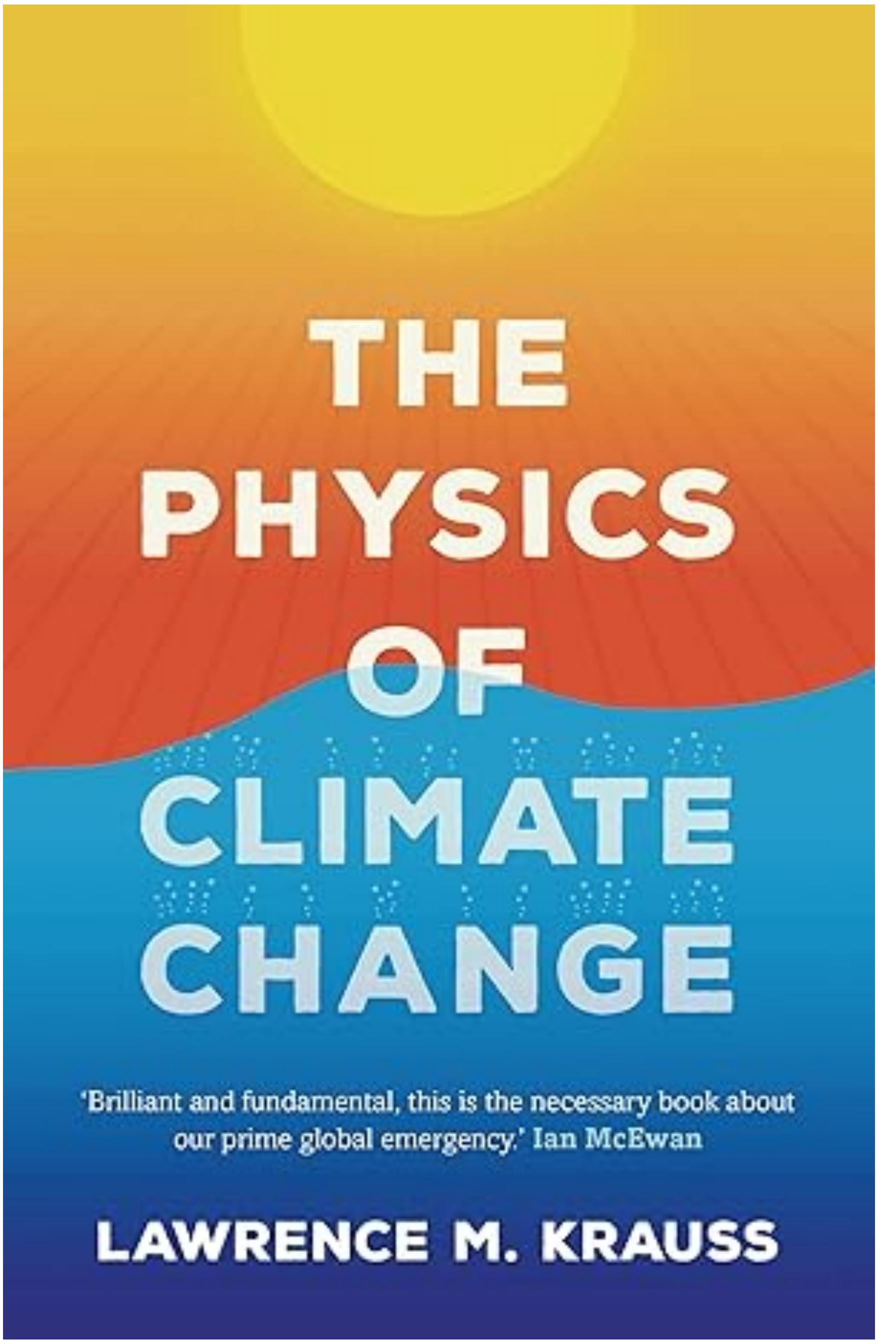
In last chapters, Krauss addresses potential future scenarios resulting from climate change, including rising sea levels due to melting ice sheets in Greenland and Antarctica. He warns that even if emissions were halted immediately, some effects of global warming would persist for centuries. Krauss concludes with a call to action, warning of the dire consequences of inaction. He implicitly says, *"We need to face that future with open eyes if we are to plan for how to overcome it, or at the very least, ameliorate it. The only way to do that is to understand where we have come from and where we are heading, as well as what the impacts of our action, or inaction, might be".* This serves as a compelling reminder of the pressing need to address climate change. Krauss states that while the challenges are immense, solutions are within reach if we act decisively.

Conclusions

Krauss concludes with a discussion on the imperativeness of addressing climate change, highlighting that delaying action will only exacerbate the challenges ahead. He stresses that understanding the physics behind climate change is crucial for informed decision-making regarding environmental policies. This book serves as an indispensable reference for fostering public awareness, especially among policy makers, to address and potentially rectify anti-science attitudes. Krauss concludes with an epilogue that conveys a powerful and unequivocal message: *"Scientists like me, not elected by the public, should not be making public policy. But we do have an obligation to use the results of our work to help inform public policy and, where possible, create technologies to aid in its enactment."*

By breaking complex physics into understandable terms, Krauss empowers readers to grasp the urgency of the climate crisis. The book is praised for its clear explanation of climate science, making it a valuable contribution to popular science literature. However, critics note its limited discussion of policy, solutions, and socio-political challenges, leaving some readers seeking more actionable strategies. While ideal for understanding the physics of climate change, those looking for comprehensive mitigation approaches, such as a roadmap to address climate change, may need additional resources. Nevertheless, it is undoubtedly worth reading and an excellent choice for those seeking a deeper knowledge of the science behind climate change.

Cover book



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