ACHIEVING THE SDGs:
Physics Propelled Multidisciplinary Emerging Areas

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ABSTRACT

The Sustainable Development Goals (SDGs) of the United Nations are a collection of 17 well-researched objectives aimed at promoting worldwide sustainable development by 2030. The 17 SDGs perceive how interwoven they are and how decisions made in one area can influence outcomes in other areas. Sustainable development involves balancing social, economic, and environmental growth. Healthcare, Renewable energy, sustainable agriculture, sustainable industrialization, sustainable cities, high speed transportation, climate action, and responsible production and consumption of products, all have the potential to be revolutionised by physics-based innovations and insights. The aim of the present paper is to reflect on the impact of the physics based & driven interdisciplinary strategy, aimed at achieving the SDGs. It is well established that in order to understand the universe around & within us, and to acquire the capabilities necessary for survival and sustainable life, physics offers a strong foundation both in terms of materials as well as the requisite imaginative & innovative mindset; and henceforth ensuring sustainable happy future for humans on this earth. The current work addresses to, as how the discipline of physics plays a significant role explicitly as well as implicitly, towards achieving some of the critical SDGs.

KEYWORDS: Sustainable Development Goals (SDGs), Renewable Energy Technology, Climate Change, Social Physics.

1. INTRODUCTION

As part of the 2030 Agenda, the United Nations adopted the Sustainable Development Goals to enhance the living conditions on our planet. To achieve these 17 objectives, it is necessary to raise awareness and carry out numerous projects and activities that necessitate the involvement of multiple stakeholders, including businesses, local governments, civil society, and international institutions.

As a fundamental science, physics is of the utmost importance in solving some of the world's most serious concerns and contributes directly as well indirectly, to multiple SDGs. The purpose of this paper is to reflect the role that physics can play in achieving sustainable development through the discussion of specific instances such as renewable energy technology, high-speed transportation, climate change mitigation, marine conservation, healthcare and living systems, and even sustainable agriculture, etc. In the present paper, the authors have attempted to highlight the contribution and power of physics to scientific research and development and its importance towards achieving the SDGs

The discipline of physics has undergone a paradigm shift in the last century. Prior to the 1970s, it was an era of nuclear physics mixed with cosmic-ray physics, followed by a few decades belonging to high-profile particle physicists. Since around year 2000 & thereafter, it has been Nano-science & Nano-technology all throughout. In last 50 years of so, there has hardly been any big breakthrough idea or a quantum leap experimentally, although there have been great advancements in high-precision science experimentation & new technological spinoffs thereon. Simultaneously, the recent past has seen the emergence of a number of new directions like environmental physics, physics of life & living systems, physics of medicine, physics of sustainable developmental studies, etc., which are expectedly highly multi-disciplinary & inter-disciplinary in nature. The physics of active matter is another interesting major subject of research in recent times. Examples abound amidst the flowing, orderly, and leaderless flocks of birds in the natural world, structure forming cytoskeletons of cells, etc. The progress in these directions is crucially dependent on establishing strong and active inter-disciplinary research communities that include physical scientists, clinicians, mathematicians, & biologists and are open to insights from outside their respective domains. Early career researchers' ability to establish this kind of open-minded mindset is crucial, and inter-disciplinary networks play a key role in encouraging possibilities for informal cross-discipline debate. The present work focuses mainly on the role of physics in SDGs 3, 7, 9, 11, 13, & 15. The progress in these SDGs involves explicit use of the principles of physics, although the physics law does enter implicitly or indirectly into the other SDGs as well .

A newer perspective is necessary for an effective, meaningful, and long-lasting social transformation, which is possible only through multi-disciplinary and trans-disciplinary working methodologies. For physicists, this entails working with engineers, chemists, biologists, social scientists, & medical researchers, as well as with economists, solicitors, policy experts, leaders, and officials from the government. In order to promote a green economy, advance structural and behavioural social change, science & engineering may create technologies that address global concerns . Physics is essential to the creation of economical and clean energy solutions, which have been critical for attaining Sustainable Development Goal 7 (SDG 7) of providing affordable, reliable, sustainable, and modern energy to all. Physics is important for understanding fundamental energy concepts such as thermodynamics, electromagnetism, electronic devices, material science and quantum mechanics, which are essential to creating new energy technologies and upgrading existing ones. One way that physics helps to produce cheap and clean energy is through the harnessing renewable energy sources like solar, wind, and hydroelectric power. Physics principles are utilised to build and optimise the efficiency of clean energy sources such as solar panels, wind turbines, and hydroelectric dams. Understanding the physics behind these technologies enables the development of more efficient, cost-effective, and long-term sustainable energy solutions". Similarly, Physics can play important role to achieve SDGs (Fig. 1):

- Goal 3 (Healthcare and Wellness)
- Goal 9 (Industry, Innovation and Infrastructure)
- Goal 11 (Sustainable Cities and Communities)
- Goal 13 (Climate action) and
- Goal 15 (Life on Land)

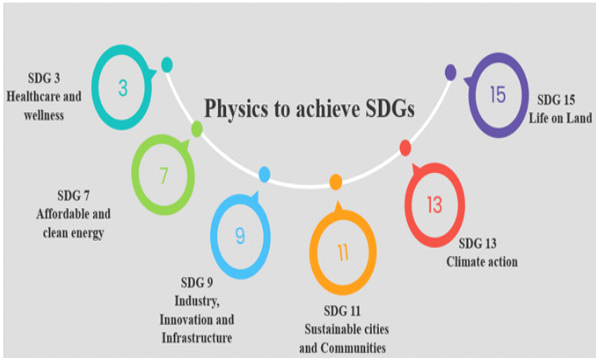

Figure 1 Physics to achieve sustainable development goals

For example, physics is essential in the design and development of new technologies and stronger, lighter and more durable materials that can improve infrastructure and boost economic growth. Designing and developing environment friendly constructions, transportation systems, and infrastructure will lead to build sustainable cities and communities, which is goal 11. By applying physics principles such as thermodynamics and fluid dynamics to complex systems, physicists help to build more energy-efficient and sustainable cities and communities. In Goal 13 (Climate Action) physics does provide a basic scientific understanding of climate change and its environmental consequences . Physicists are well equipped with tools & techniques to the advancement of technology that can aid in the reduction of greenhouse gas emissions, such as carbon capture and storage and renewable energy technologies. In last, for goal 15 Life on Land Physics can assist us in evaluating the effects of human actions on land and on the entire ecosystem . In addition to this, physicists use satellite data to monitor deforestation and land degradation, and develop models to predict the impacts of climate change on ecosystems. Also, it is essential for energy storage studies, which is important for the widespread adoption of renewable energy. Physics concepts are applied to the development or improve the critical characteristics of batteries, fuel cells, and other energy storage systems that can store and distribute energy supplied by renewable sources. Efficient energy storage devices are important for addressing present-day energy consumption demands, lowering carbon emissions, and building a more sustainable energy system. The main objective of current work is to explore & establish the role of physics in achieving the SDGs. In this paper, we will discuss all the above-mentioned points in detail. By doing so, we can gain a deeper understanding of how physics can help us address the challenges faced by humanity and work towards a more sustainable future for all. In order to understand the universe and acquire the abilities necessary for success in a variety of spheres of life, physics offers a strong foundation. To the best of the author's knowledge, there have been no studies that explicitly link physics to the SDGs goals 3, 7, 9, 11,13 and 15 at one place. As a result, this paper makes a significant contribution to achieve SDGs goals using the fundamentals of physics.

2. SDGS 3: HEALTHCARE & WELLNESS: INTERACTION OF PHYSICS WITH THE LIVING SYSTEMS

Living systems use information and energy to sustain a stable low entropy state while being away from thermodynamic equilibrium, according to the physical sciences. Despite being unique in nature, the intricate dynamic systems that make up life must adhere to the basic laws of physics, which in turn yields the evolutionary first laws of biology. Given the difficulties with Covid-19, this trend is particularly pronounced now. Medicine has historically relied on technology and procedures first created in the physical and biological sciences. Pharmaceutical sciences are already deeply impacted by nanoscience. In order to solve truly large challenges and establish an integrated understanding of life from single molecules to systems biology and medicine afterward, inter-disciplinary techniques are essential to make real scientific progress. It is as important to pay attention to this prospect as it is to the Higgs Boson, quantum computing, or the hunt for dark matter. Science from several, formerly dissimilar fields is now focusing on these difficult & intractable problems, and it appears that significant progress will be made. Inter-disciplinary activities, that characterise these new areas extend much beyond the development of technologies such as nano-electronics, novel imaging, to applications of theoretical techniques from mathematics and physics to biology and pathophysiology as depicted in Fig 2 .

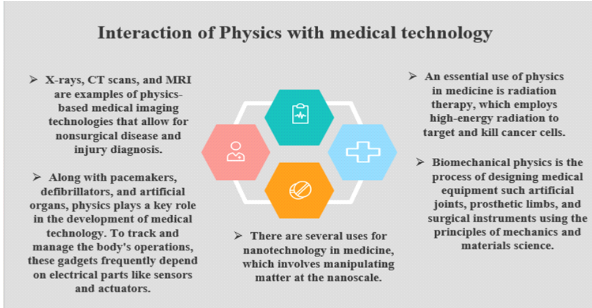

Figure 2 Physics and medical technology

For many cancer patients, radiation therapy is the most effective form of treatment. It shrinks tumours by using high- energy radiation beams to kill cancer cell. Radiation therapy, nevertheless, can also harm the healthy cells that surround the tumour, resulting in unfavourable side effects. Medical physicists can help in this situation. To guarantee that the radiation therapy is precisely planned, administered and monitored, they collaborate closely with radiation oncologists and other medical specialists . Medical physicists create treatment regimens that deliver the right amount of radiation to the tumour while limiting exposure to healthy tissues using their knowledge of physics and radiation. Prior to the initiation of radiation therapy, medical physicists use cutting-edge imaging techniques including computed tomography (CT) scans and magnetic resonance imaging (MRI) to create a detailed accurate map of the tumour and surrounding tissues. This map makes it possible for the medical physicist to create a treatment plan that delivers radiation to the tumour while minimising exposure to healthy tissues by pinpointing the exact location and shape of the tumour and healthy tissues. After the treatment strategy is created, radiation therapists and medical physicists collaborate to make sure the radiation is administered precisely as intended. To guarantee that the radiation therapy machinery is operating properly and that the patient is receiving the right amount of radiation, quality assurance tests are carried out. Along with doing this, they keep an eye on how the patient is responding to radiation therapy and adjust the course of treatment as necessary.

3. IMPACT OF PHYSICS ON AFFORDABLE AND CLEAN ENERGY TECHNOLOGIES FOR SDG 7

SDG 7, aims to provide everyone with economical, accessible, sustainable, and modern energy. SDG 7's goals are enunciated as follows:

a) Ensure everyone's access to affordable, dependable, and advanced energy services.
b) Increase the global energy mix's contribution to renewable energy.
c) Twice the global rate of energy efficiency improvement.

d) Increase international cooperation to make renewable energy research and technology more accessible.

The SDG 7 targets implicitly lead to a road map for tackling these issues and making the transition to a future with more sustainable energy sources as shown in Fig. 3. By ensuring that everyone has access to inexpensive, dependable energy services, increasing the share of renewable energy in the global energy mix, and improving energy efficiency, we can reduce greenhouse gas emissions, improve public health, and promote economic growth. Collaboration between organisations and communities from all over the world will be necessary to meet these goals, as well as financial investment in clean energy infrastructure and technologies. In following the above factors are discussed as of how they might be used to accomplish SDG 7.

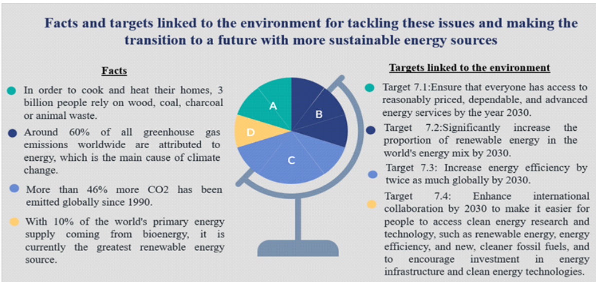

Figure 3 Facts and targets linked to the environment

3.1 Renewable energy:

The development and progress of renewable energy technologies, including solar, wind, hydropower, and geothermal energy, can be considerably and successfully aided by physics. Using physics principles, researchers develop more efficient solar cells, wind turbines, and other renewable energy systems, reducing the expense of clean energy and rendering it more accessible. Physics plays an important role in developing and to improve solar energy technologies. Solar energy is produced by converting sunlight into electricity using photovoltaic cells (PVC) composed of semiconductor materials like silicon. Numerous physical factors influence the efficiency of PVC in converting sunlight into energy, including:

a. Bandgap: In a semiconductor material, the bandgap is the energy difference between the valence and conduction bands. It calculates the amount of energy required to move an electron from the valence band to the conduction band, where it can contribute to electrical current. PVC with a narrow bandgap absorbs more energy from sunlight, but some of that energy is lost as heat, whereas PVC with a wider bandgap absorb less energy but may be more efficient at converting that energy into electricity. Physicists can use their expertise of bandgap to optimise PVC for certain applications and environments.

b. Absorption: A material's ability to absorb sunlight is determined by optical qualities such as refractive index and absorption coefficient. Physicists can research the interaction of sunlight and materials at the atomic and molecular levels in order to build PVC that absorbs the most sunlight.

c. Carrier mobility: In a semiconductor material, the mobility of electrons and holes (positively charged electron vacancies) governs how efficiently they can contribute to electrical current. Physicists are leveraging their knowledge of carrier mobility to create PVC with increased electrical conductivity and reduced resistance.

d. Cell design: The amount of sunlight absorbed and the efficiency of energy conversion of PVC can be enhanced by varying the thickness of the semiconductor layer, the size and structure of the electrodes, and the application of anti-reflective coatings.

Over the past few years, perovskite solar cells' efficiency has grown significantly. The underlying technology for perovskite solar cells is solid-state sensitised solar cells, which are based on dye-sensitized Gratzel solar cells. The cubic lattice of metal ions surrounded by halide ions that makes up the perovskite crystal structure, which gives perovskite solar cells their name. A hybrid organic-inorganic lead or tin halide-based material is used as the light-harvesting layer in this kind of thin-film solar cell. The unique crystal structure of Perovskite crystals allows them to absorb a wide spectrum of light wavelengths and convert them into electrical current . These kinds of solar cells have attracted significant attention in recent years due to their high efficiency and low cost of production. Copper indium gallium selenide (CIGS) solar cells made of semiconductor material that is deposited on a flexible substrate, such as glass or plastic, are another type of thin-film solar cell. Photons are absorbed by the semiconductor material when sunlight falls on the CIGS layer. The photons' energy is subsequently transmitted to the electrons in the substance, activating them and allowing them to move . As the excited electrons move around, they create an electrical current. This current flows through the CIGS layer and into the electrical circuit of the solar cell. A grid of metal contacts on the surface of the solar cell collects the electrical current generated by the CIGS layer. After that, the current is transmitted from the solar cell to an external circuit. The CIGS solar cell's electrical current can be used to power devices or saved in a battery for later use. CIGS solar cells outshine other types of solar cells in various ways. They are lightweight, flexible, and may be produced at a relatively low cost. In addition, CIGS solar cells have high efficiency, which means they can convert a huge amount of sunlight into power. In 2018, Q Jing and S. Kar-Narayan studied nanostructured polymer-based piezoelectric and triboelectric materials and devices for energy harvesting applications. As a result, they are a feasible and environmental friendly technology for the future. These are only a few of the many research efforts aimed at creating and enhancing materials used in solar cells in order to fulfil SDG 7. We can work towards the goal of cost-effective, reliable, sustainable, and contemporary energy for all by continuing to invest in research and development in this field .

3.2 Physics in the Advancement of Energy Storage Technology

Electrochemical devices, such as batteries, transform chemical energy into electrical energy. They operate by transporting charged particles known as ions between two electrodes separated by an electrolyte solution. A potential difference or voltage applied across the electrodes drives the flow of ions. The chemical reactions that occur at the electrodes during charging and discharging involve the transfer of electrons and ions, and these processes are governed by electrochemistry and thermodynamic laws. Fuel cells, on the other hand, are electrochemical devices that directly convert a fuel's chemical energy into electrical energy. They generate electricity, water, and heat by reacting a fuel, like hydrogen, with an oxidant, such as oxygen, over an ion-conducting electrolyte. Understanding the electrochemical reactions that occur at the electrodes, the transport of ions across the electrolyte, and the thermodynamics of the chemical reactions involved are all part of the fundamental physics of fuel cells.

Physics is important in the design and optimization of energy storage systems, in addition to knowing the electrochemical and thermodynamic principles that control energy storage. The performance of batteries and fuel cells, is influenced by physical parameters such as the electrode, electrolyte materials, the device's size, geometry, and operating circumstances. Researchers can develop new materials and designs that improve the performance and efficiency of energy storage devices by combining principles of materials science, solid-state physics, and fluid mechanics. Physics can also help to create new energy storage technologies like batteries and fuel cells, that can ensure a continuous supply of electricity from intermittent renewable sources like solar and wind power. Supercapacitors another energy storage technology still in research stage, have gained a lot of attention recently because of their high-power density, long cycle life, and quick charge/discharge characteristics, often referred to as ultracapacitors or electrochemical capacitors. These are different from conventional capacitors in that they have substantially high energy storage capacities, which makes them useful for a variety of applications such as electric vehicles , renewable energy systems , and portable gadgets. In the development and storage of renewable energy, superconductors may have a substantial impact. Superconducting cables, for instance, have a far higher efficiency when transmitting electrical power than conventional copper cables, decreasing energy losses and enabling the transportation of electricity over greater distances without the use of pricey and energy-intensive boosting stations. This might make it simpler to link distant renewable energy sources to the grid, like offshore wind turbines or solar farms in arid regions.

3.3 The physics in increasing energy efficiency in construction, appliances, and transportation

Physics is a fundamental science that focuses on how energy and matter behave under different conditions. It is essential for enhancing energy efficiency because it provides a theoretical understanding of how energy is consumed, transformed, and transported in various systems. Physicists, in particular, are investigating the dynamics of heat transfer and energy consumption in buildings, appliances, and transportation systems in pursuit of more efficient designs. Improved design and performance of heating and cooling systems in buildings is one example of how physics can help boost energy efficiency. Physicists are utilising their knowledge of thermodynamics to explore how heat is transmitted within a building and develop more energy-efficient methods for maintaining a pleasant indoor temperature. For example, physicists might discover possible areas for improvement by analysing the heat transfer mechanisms involved in the design of windows, insulation, and HVAC (heating, ventilation, and air conditioning) systems. Physics can contribute to energy efficiency in appliances such as refrigerators, ovens, and washing machines, in addition to buildings . Physicists are examining these gadgets' energy consumption and providing solutions to minimise energy waste. For instance, they looking into the thermodynamics of heat flow within refrigerators and fine-tune the design adjustments to lower the amount of energy necessary to maintain a cool temperature. Physics also aids in the improvement of energy efficiency in transportation systems such as automobiles and aeroplanes as well as in computers & mobiles. For example, they can evaluate the drag forces operating on a moving car and work out strategies to lessen the amount of energy required to counteract them. To distribute electricity from power plants to end customers, smart grids rely significantly on electrical circuits. Understanding circuit behaviour, such as voltage, current, and resistance, is necessary for establishing efficient and durable smart grids. Electromagnetic principles govern the behaviour of electrical energy on the grid. Researchers use electromagnetic theory to better understand how electricity flows across transmission lines, transformers, and other grid components. Power electronics is an important branch of physics used to study the conversion and control of electrical power. This field is used to design the essential components of a smart grid, like power management systems, converters, and inverters. Similarly, signal processing is important for developing the communication system for handling the massive volumes of data generated by smart grids. It is required to regulate the flow of electricity and balance the supply. A massive amount of data regarding system status and information about energy production, consumption, and storage is created by smart grids. Physics based high reliability data analysis techniques are utilised to extract meaningful information to improve the grid operations. These smart grids are vulnerable to cyberattacks. Cryptography and information theory both focus on the transmission, processing, and security of information. Creating secure communication networks and data storage systems that can fend off cyber assaults requires the use of physics-based concepts from information theory and cryptography, and more recently, algorithms based upon quantum information & quantum computational techniques. Finally, physics helps developing countries gain access to energy by creating and deploying economical and sustainable off-grid energy options. Researchers use physics concepts to design small-scale renewable energy devices, such as solar panels and micro-hydro generators, that can offer electricity to areas without grid access.

4. PHYSICS-BASED INNOVATIONS IN INDUSTRY, INFRASTRUCTURE, AND SUSTAINABILITY: SDG 9

Physics plays an important role in the development of new technologies and materials that can improve infrastructure and boost innovation, which is a key goal of Sustainable Development Goal 9 shown in Fig 4.

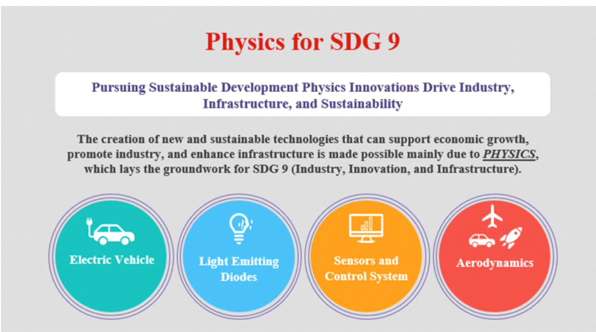

Figure 4 Physics for SDG 9

One of the most recent physics innovations driving sustainable development is in the field of transportation, which is more efficient, environmentally friendly, and sustainable. This innovation revolutionised battery technology, leading to the development of electric vehicles that can travel farther on a single charge . The main source of energy for an electric vehicle is its battery pack, which is made up of numerous individual battery cells. The electrochemical reactions that occur within these cells, such as the flow of ions between electrodes, are governed by the laws of electrochemistry. Motor operations in an EV involve the interaction between electric currents and magnetic fields, which is governed by the laws of electromagnetism. The charging process of an EV is governed by the laws of electrical circuits. Also, physicists are exploring the use of wireless power transfer technology, which uses magnetic fields to transmit electricity from the road to the vehicle, allowing electric vehicles to charge while driving. Besides this, they are working on the development of sustainable aviation technologies. The principles of fluid dynamics and the study of airflow around objects help to design EV body shapes and air flow management to enhance efficiency with minimum energy consumption. Aerodynamics and fuel efficiency of aircraft engines are being improved by the application of physics advancements. For instance, scientists are investigating the use of biofuels, to reduce greenhouse gas emissions compared to traditional jet fuels. Improvements in lighting technology have resulted in the creation of LED lights that are more energy-efficient than conventional incandescent bulbs, a widely used example of physics innovation. Light-emitting diodes, use the electroluminescence process to transform electrical energy into light. In this process, electrons flow inside a semiconductor material, which emits photons. LEDs are based on quantum principles that involve the interaction between electrons and holes. Recombination of holes and electrons results in the emission of energy in the form of photons. The wavelength, or color, of LEDs depends on the energy difference between electrons and holes. This energy difference is determined by the bandgap energy of the semiconductor material, which is a characteristic property of the material. For a number of applications, including lighting, displays, and communication systems, LEDs have emerged as a key technology. They have a number of benefits over conventional lighting systems, such as significantly increased energy efficiency, durability, and longevity, apart from ease & convenience of use. The study of the properties and behaviour of various materials is known as materials science. This expertise can be used by physicists to create new materials with superior qualities such as increased strength, durability, and sustainability. For example, physicists are creating novel building materials that can tolerate extreme weather conditions or are more corrosion resistant. Sensors and control systems that monitor the functioning of infrastructure systems such as bridges, motorways, and water treatment plants are being developed by physicists. These systems can detect issues and undertake preventative maintenance, lowering the likelihood of infrastructure failure and enhancing overall performance. Automation and robotics can be utilised to increase efficiency and lower the cost of infrastructure development and maintenance. Physicists innovate new robotic systems that can examine bridges or lay pipes, decreasing the need for human labour and enhancing safety.

5. Ecosystem Dynamics for Effective Conservation Strategies (SDG 15) and Physics-Based Models

SDG 15 seeks to prevent desertification, halt and reverse land degradation, halt biodiversity loss, and advance the sustainable use of terrestrial ecosystems. It also aims to conserve, restore, and manage forests sustainably. Physics driven technologies are helpful to SDG 15 in a variety of ways:

The design and interpretation of remote sensing instruments are fundamentally based on the study of electromagnetic waves and optics. Key components of classical electromagnetism describe the behaviour of EM waves used to study the Earth's surface and atmosphere. Also, optics an important part of physics, is essential for designing and interpreting optical remote sensing instruments such as cameras and spectrometers. Additionally, quantum sensors, where quantum mechanics is useful for remote sensing, can detect minute changes in the Earth's magnetic field and other features. In order to realise the goal of SDG 15, modelling ecosystem dynamics is a powerful application of physics depicted in Fig. 5. The main areas of physics that are relevant to analysing and forecasting ecosystem dynamics are statistical mechanics, fluid mechanics, and thermodynamics. A subfield of physics called statistical mechanics studies complex systems of interacting particles, like ecosystems. Statistical mechanics & chaos theory are successfully used in ecosystem modelling to simulate how ecosystems would behave under various circumstances, such as alterations in temperature, precipitation, or land use. These models can help with conservation and improve management decisions by predicting how ecosystems will respond to environmental changes.

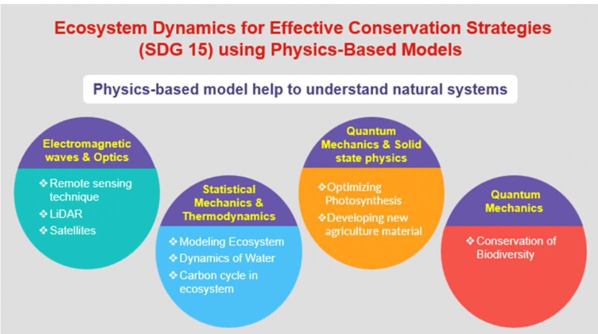

Figure 5 Physics-based models help to understand natural system

6. ECOLOGICAL MONITORING

Monitoring ecosystems is essential for achieving SDG 15, and physics-based sensors are extensively used to monitor ecological damage, ecosystem health, the extent of forests, changes in land use, the quantity of vegetation cover, the presence of invasive species, & even the migration of preserved and protected animals. Findings based upon these technologies assist policymakers in making educated decisions and effective conservation plans. Furthermore, satellite-based sensors can provide information on the extent and health of forests, allowing conservationists to identify regions that require conservation and track the impact of deforestation. These sensors can be used to detect alterations in water resources under water quality regulation. In order to track the health of aquatic ecosystems and the presence of pollutants, physics-based sensors can monitor the data such as temperature, salinity, and turbidity required to establish water resource protection policies .

6.1 Ecological dynamics expertise

Ecosystems are diverse systems with lots of biotic and abiotic component interactions. Physics can be used to better comprehend the physical and chemical factors that drives & affect ecosystem dynamics. Designing effective strategies for restoring and conserving ecosystems requires an understanding of processes like how water travels through soil and how nutrients cycle through ecosystems. Physics-based models can be used to simulate ecosystem dynamics and provide deep insights into how ecosystems function. For example, in the thermodynamics, the principles of fluid dynamics are used to replicate the movement of water, energy, and nutrients across an ecosystem and nutrients. Also, these models help to examine the behaviour of ecosystems under different conditions and forecast them. Beyond that, understanding the transport of water through soil is another area where physics-based models have proven extremely beneficial. Because soil moisture is an important aspect of plant development and survival, as well as the overall functioning of ecosystems. These physics-based models can be used to analyse the cycling of nutrients across ecosystems as well as to simulate the transport of water through soil and anticipate how it will be absorbed by plants or evaporated into the atmosphere. Carbon, nitrogen, and phosphorus are needed for plant growth and are complexly cycled through ecosystems" . Physicists can uncover the key processes and components that influence nutrient availability and uptake in ecosystems by simulating these nutrient cycles. This data can be utilised to create effective ecosystem restoration, the development of effective strategies for managing water resources, alleviating the effects of drought, water shortages and other ecosystem protection programmes .

7. PHYSICS FOR SDG 13 AND TUSSLE CLIMATE CHANGE

Man-made greenhouse gases, mostly from the use of fossil fuels in the energy sector and agriculture, as well as changes in land use, such as deforestation, are also responsible for the changing climate. Extreme weather, arctic ice cap melting, and effects on crops are all results of this. Deforestation decreases the Earth's capacity to absorb carbon and contributes to climate change. Deforestation increases greenhouse gas emissions, whereas forests can slow global warming by storing carbon. The rise in temperature and associated effects, including cyclone intensity, sea level rise, mass extinction, and disease transmission, are all projected to result from the increase in atmospheric carbon dioxide concentration .

SDG 13 calls for immediate action to address climate change and its fallouts. In many a way, physics, as a fundamental science, contributes significantly towards achieving this goal. This goal calls for a significant reduction in greenhouse gas emissions and a major initiative for the development of renewable energy sources. Physics provides fundamental knowledge of the physical processes that govern Earth's climate system. This knowledge is essential for the creation of precise climate models that can facilitate the forecasting of future climate change and guide policy decisions. The Earth's climate system is also monitored and tracked using physics-based detectors & sensing techniques. Electromagnetism principles are used by remote sensing technology like radar and satellites to measure the temperature, humidity, and other aspects of the atmosphere. These measurements can be used to build climate models and track long-term changes in the Earth's climate system. Among other things, physicists research the energy balance of the planet, the connection between the ocean and the atmosphere, and the function of greenhouse gases in the atmosphere. This research is helpful for understanding the causes and effects of climate change and identifying ways to mitigate its impacts. Technologies for carbon capture and storage (CCS) are dependent on the laws of physics and chemistry. These technologies involve the pre-capture of carbon dioxide emissions from power plants and other industrial activities. After gathering, carbon dioxide can be moved and stored underground in geological formations such as saline aquifers or exhausted oil and gas reserves.

CCS technology is available in a variety of forms, such as oxy-fuel combustion, post-combustion capture, and pre-combustion capture. Post-combustion capture is the technique that is most frequently utilised among all of these. The post-combination approach entails the absorption of carbon dioxide from the exhaust gases. Pre-combination capture, on the other hand, entails the transformation of fossil fuels into a gas mixture containing carbon dioxide and hydrogen. The combustion of fossil fuels with just pure oxygen results in flue gas that contains carbon dioxide . All of these procedures heavily rely on the laws of physics and chemistry in the physical sciences.

8. DISCUSSION AND CONCLUSION

The present work is to re-enforce, the remarkable potential of physics to drive progress towards achieving the SDGs, that is both awe-inspiring and imperative. By teaming the power of physics-based innovations, research, and technologies, we unlock a world of transformative possibilities. Physics empowers us to revolutionize energy systems, enabling affordable & clean energy for all. We acquire through physics, novel perspectives on enhancing diagnosis, therapies, developing high precision-tools & techniques and general health & wellness. It lays the groundwork & help in constructing frameworks for innovative technologies, robust infrastructure, and henceforth the economic growth. We can find answers that lead us to a future in which the SDGs are not just aspirational ideals, but concrete realities for each and every person on the earth by fostering sustainable technological advancements and innovations. In summary, physics integrated applications in STEM education are fundamental necessaries to achieving the Sustainable Development Goals (SDGs). We need to develop a culture of critical thinking, innovative problem-solving skills & attitude, and analytical abilities among students & researchers those are necessary to address difficult social issues by integrating physics with other disciplines via multidisciplinary approaches. We only understand 1% of the total universe. To explain the phenomena of the rest of the universe, new physics laws will have to evolve . As time has proven, new physics studies gave rise to new directions that had a long-lasting impact on humanity. The discipline of physics provides adequate tools and techniques and above all the requisite training of mind to initiate & develop new directions [30]; in fact, several high-impact emerging areas like social physics, medical physics, environmental physics, physics for life, physics for developmental studies and so on, needs to be nurtured.

The present work reinforces a need to consolidate & re-design our research in basic and core physics. Hence, the physics-driven multidisciplinary research and innovative applications shall help to advance a number of SDGs, such as access to affordable, clean energy, climate action, industry, innovation, infrastructure, and high-quality education. Henceforth, it is crucial to the STEM education ecosystem that is multidisciplinary and well propelled by basics of physics in order to acquire the knowledge and abilities required to address to the most important issues of our time . In conclusion, a thorough redesigning and fine tuning the physics education within the overall STEM curriculum, would go a long way towards building a more just and sustainable world for everyone.

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CONFLICTS OF INTEREST

The authors declare no conflicts of interest regarding the publication of this paper.

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