Azamat Abdoullaev

SCIENCE AND TECHNOLOGY XXI: New Physica, Physics X.0 & Technology X.0

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Аннотация

Книга о Науке и Технологии 21 века. Какая будет лидирующая наука – Физика X.0 и какая Технология X.0 будущего ждет современное человечество. Ключевые понятия будущего, Первичная Физическая сила, Темная сила и Темная энергия, Теория Всех Вещей и Технологическая сингулярность, связаны одной идейной нитью. Все природные процессы, явления и эффекты обьединяются на основе универсального закона обратимости всех природных процессов, а также физической материи, энергии и силовых взаимодействий. Разработана универсальная модель физических сил в рамках новой единой физики,New Physica. Предложена общая концепция будущих прорывных технологий.

SCIENCE AND TECHNOLOGY XXI:
Physics X.0 & Technology X.0

Azamat Sh. Abdoullaev, PhD

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Annotation
The first book of monographic series of Science &Technology of the 21st century is devoted to the Natural Science of Physics and Technology of tomorrow: Physics X.0 and Technology X.0.

New Physics X.0 as the leading natural science naturally unified in terms of convertibility and conservation of all natural forces and reversibility of all physical entities and processes

is promising a dramatic advance in research, knowledge and understanding of the physical world.

All basic assumptions and principles, as symmetry principles and conservation laws, and the latest conceptual developments, as theory of everything or "dark energy" and "dark force", imply the necessity of Unified Physics X.0 as a replacement of modern fragmentary and overspecialized Physics 2.0.

It is shown that most future technologies and breakthrough innovations will be the engineering products of Natural Science XXI and Physics X.0 coming from the universal reversibility mechanism.

The interconnection of physical phenomena, convertibility of all physical forces, and reversibility of all physical entities and effects, all is enabling to create revolutionary intelligent applications, like as Encyclopedic Knowledge Base in Physical Science for General AI.

Preface

It is the first book of monographic series of Science &Technology of the 21st century, devoted to the Natural Science of Physics and Technology of tomorrow. The idea of the Science X.0, Physics X.0, and Technology X.0 is rooted in the terms "Web 2.0" and its indefinite extension, the Web X.0, both superseding the old and static business model of Web 1.0 of Netscape. Initially it was introduced as an "Internet operating system", "Inventing the Future," http://www.oreillynet.com/pub/a/network/2002/04/09/

future.html; "What Is Web 2.0," www.oreillynet.com/pub/a/oreilly/tim/news/2005/09/30/what-is-web-20.html.

The Science X.0, Physics X.0, Technology X.0, and Engineering X.0 make the key parts of the World Sustainable Development Roadmap, showing the human civilization development directions, combining scientific achievements, technological breakthroughs and engineering deeds with political, economic, social or organizational innovations.

The Roadmap shows a high way to the New World of Science and Technology, Intelligence and Innovation, Progress and Prosperity:

WORLD 1.0 (Industrial World) ::

Science 1.0 > Physics 1.0 > Technology 1.0 > Engineering 1.0 > Economy 1.0 > Industry 1.0 > Infrastructure 1.0 > Network 1.0 > Telecom 1.0 > Internet 1.0 > Web 1.0 > Service 1.0 > Medicine 1.0 > Human 1.0 > City 1.0 > Government 1.0 > Nation 1.0 > Society 1.0 > Global Community 1.0 >…Space 1.0

WORLD 2.0 (Post-Industrial Information World) ::

Science 2.0 > Physics 2.0 > Technology 2.0 > Engineering 2.0 > Economy 2.0 > Industry 2.0 > Infrastructure 2.0 > Network 2.0 > Telecom 2.0 > Internet 2.0 > Web 2.0 > Service 2.0 > Medicine 2.0 > Human 2.0 > City 2.0 > Government 2.0 > Nation 2.0 > Society 2.0 > Global Community 2.0 >…Space 2.0

WORLD 3.0 (Post-Information Smart World) ::

Science 3.0 > Physics 3.0 > Technology 3.0 > Engineering 3.0 > Economy 3.0 > Industry 3.0 > Infrastructure 3.0 > Network 3.0 > Telecom 3.0 > Internet 3.0 > Web 3.0 > Service 3.0 > Medicine 3.0 > Human 3.0 > City 3.0 > Government 3.0 > Nation 3.0 > Society 3.0 > Global Community 3.0 >… Space 3.0 …> POST-HUMAN SINGULARITY WORLD

……

WORLD X.0 (Post-Human Singularity World)::

Science X.0 > Technology X.0 > Engineering X.0 > Economy X.0 > Industry X.0 > Infrastructure X.0 > Network X.0 > Telecom X.0 > Internet X.0 > Web X.0 > Service X.0 > Medicine X.0 > Human X.0 > > City X.0 > Government X.0 > Nation X.0 > Society X.0 > Global Community 3.0 >…Space X.0

Science (Mathematics and Physics), Technology, and Engineering are the root causes of historical human development and all the future progress and prosperity of humanity as the socio-technological civilizations.

Science (Mathematics and Physics) is the systematic study of the world, looking for general truths, empirical laws, scientific theories, theoretical systems, and the operations of fundamental laws.

Technology is generally viewed as the systematic study of techniques for changing the world, the human environment, by making and doing things, from simple machines to complex

machinery, as cars or airplanes. It applies science to practice, the theoretical into the practical, associated with scientific products, artefacts, and the useful arts. There are as many technological sciences as scientific disciplines, mathematical, physical, chemical, biological, social, political, ecological, etc.

Engineering is engaged with converting natural resources into machines, machinery, engines, structures, systems, products and processes, applying fundamental scientific principles and technological sciences. Being one of the oldest professions in the world, after physics and mathematics, and producing the Industrial Revolution, it involves such major engineering disciplines, as civil, mechanical, chemical, electrical, as well as geological, nuclear, electronics, communications, instrument, computer, medical, biological, cognitive, social or environmental engineering, with numerous specialties and sub-disciplines.

Common to all diverse fields of science, technology and engineering, they all are grounded on a few fundamental principles of fundamental sciences, mathematics and physics; or, there are no professional technologists and engineers without knowing the fundamental sciences.

Physics X.0 & Technology X.0 & Engineering X.0 aimed to consistently unify a chaotically growing number of new sciences, technical sciences, and new engineering disciplines, focusing on emerging technologies, sophisticated technical innovations and complex cyber-physical ecosystems.

This Big Knowledge Unification covers such complex

intellectual technological and engineering activities, as the Future Internet of Everything, Encyclopedic AI, Intelligent Industry, or Technological Settlements of the Future, Intelligent Nations or Smart Green Cities.

While pursuing the high goal of knowing the unifying principles of nature, the best methods of reversing of natural forces, and optimal converting of natural resources for public utility, *the Physics X.0 is to operate with all the Fundamental Units of Matter, Life, Heredity, Brain and Mind:*

Forces,
Atoms,
Energy,
Neurons,
Genes,
Bits,
Ideas

PHYSICS X.0: Reversible Universe, Prime Force, and Theory of Everything

Natural science is about the whole Nature. It studies the entire material universe, its natural causes and phenomena, as the sum total of physical entities and forces, as the infinite system of natural entities, forces, changes and events.

Natural Science XXI makes the New TRIVIUM of major sciences: Physical science, Biological science and Mathematical science.

Physical science is the leading natural science, as doing the systematic study of the inorganic world, being completed with the life science of biology engaged with the systematic study of the organic world.

Its subject is treating of the general properties of matter as a whole, its composition and structure, properties and states, energy and force to formulate the first laws of behavior of the universe and nature, all divided among four interrelated branches: Astronomy, Physics, Chemistry and the Earth science.

The key idea of the physical science and physics itself consists in the insight that ALL THE FORCES OF NATURE AND FORMS OF MATTER AND ENERGY are INTERRELATED and INTERCONVERTIBLE.

Paradoxically, these universal phenomena have never been expressly formulated as the basic principles of nature:

THE UNIVERSE, NATURE, THE WORLD, or THE COSMOS is UNIFIABLE and REVERSIBLE.

FORCE, MATTER, MOTION, or ENERGY are neither created, nor destroyed, but CONSERVED, CONVERTED and REVERSED.

EVERYTHING REVERSED IN THE WORLD, MATTER INTO ANTIMATTER and PROCESS INTO REVERSE PROCESS.

Technology X.0 is innovated as fostering an intelligently expanding human environment and big quest to explore the depths of an infinitely wonderful physical universe.

It is shown that the most advanced technologies and breakthrough innovations and revolutionary applications are to reversibly convert natural forces, chemical, thermal, electrical, magnetic, electromagnetic, nuclear, gravitational and mechanical, in a closed loop, with zero-waste of matter and energy.

The level of development of future technology and intelligent socio-technological communities is the capacity to control the forces of nature as according the Great Schema of Forces studied by new Physics X.0:

Prime Force (ToE)::

Quantum Gravity Forces (Space Curvature, Standard Model of Cosmology; Electronuclear Force (GUT, Standard Model of Particle Physics)::

Strong Interaction (SU (3); Electroweak Interaction (SU(2) x U(1))::

Weak Interaction and Electromagnetism U(1em)::

Magnetism and Electricity::

Non-Fundamental Forces (contact forces, elasticity, viscosity, friction, pressure, etc.)

Read "SCIENCE AND TECHNOLOGY XXI: Physics X.0 & Technology X.0" to completely change your current conception of PHYSICAL REALITY.

Physical Science as the Base of Science and Technology

Physical science is both the key science and the leading natural science, being simple in its principles but universal in the scale

and scope of its application.

Regardless of increasing numbers of experiments and observations, discoveries and divisions, effects and their applications, a small number of universal laws are operating all the acts of the universe, and the same principles regulate all complex processes and all natural forces.

All physical science has three common characteristics while studying the world of changing things, matter in motion, energy in conversion, forces in action, and processes in effects:

1. experimentation and observation and scientific method to study, demonstrate and discover,

2. applying mathematics and strict symbolical formalism to formulate hypotheses, empirical laws, generalizations and their consequences,

3. putting all the phenomena of nature and actions of universe under the fewest number of primary principles and basic laws of nature in the simplest mathematical statements, logical formulations and consistent theories.

All the forces of nature and forms of matter, energy, motion and change are interrelated and interconvertible, so that a network of forces in the n-dimensional space of physical quantities, as space and time, ties the cosmos into a unity, the universe.

These universal properties and fundamental phenomena in need of having been expressly formulated as the basic principles of nature, namely:

I. the UNIVERSE, NATURE, THE WORLD, or THE COSMOS is UNIFIABLE and REVERSIBLE

II. FORCE, MATTER, MOTION, and ENERGY are neither created, nor destroyed, but CONSERVED, CONVERTED and REVERSED

III. EVERYTHING REVERSED IN THE WORLD, MATTER INTO ANTIMATTER and PROCESS INTO REVERSE PROCESS.

If the reversibility properties of nature and the convertibility of energy and unity of the forces of nature had been formulated as a universal principle and basic laws since the very beginning of modern physics, we'd have different physical science, more logical and systematic, predictive and productive, more esthetic and attractive, smarter or more intelligent and machine-wise.

Physical science is the base of modern technology, innovation and applications, which laws and principles are at the core of most engineering sciences and future technologies, see Supplement1.

So to create future Technology X.0, we need new physics, Physics X.0.

The State of Affairs of Physical Science

Physical science is traditionally defined as the natural science doing the systematic study of the inorganic world, as being completed with the life science of biology doing the systematic study of the organic world.

Its subject is treating of the general properties of matter as

a whole, its composition and structure, properties and states, energy and force-relations to formulate the first laws of behavior of the universe and nature basing on natural ontology and mathematics, as divided among four interrelated branches:

Astronomy

Physics

Chemistry

the Earth science

Astronomy

Astronomy, including astrophysics and cosmology, studies the entire universe beyond the Earth, including the universe's structure and evolution, its cosmic objects (as stars, galaxies, planets, moons, asteroids, comets and nebulae) and their physical processes (as supernovae explosions, gamma ray bursts, and cosmic microwave background radiation, etc.), and how the Earth relates to interactions with the solar system.

Chemistry

Chemistry treats of the structure, composition and properties of substances and all possible changes, transformations or reactions they undergo, being about the properties and reactions of molecules. It is about the interactions of substances through chemical reactions to form different substances, including analytical chemistry, inorganic chemistry, organic chemistry, biochemistry, polymer chemistry, physical chemistry, and industrial chemistry.

The Earth science

Earth science is dealing with planet Earth, how the natural environment (ecosphere of geosphere and biosphere or Earth ecosystem) works and evolves, including the study of the atmosphere, hydrosphere, lithosphere, and biosphere, involving atmospheric science and environmental science, geology and geography, geoinformatics, glaciology, oceanography and soil science.

Physics

The core of physical science, physics, deals with the structure of the matter and the interactions of the fundamental constituents of the universe, including all the hypothetical constructs like as "dark energy", "dark matter", or "dark force". It is the science that treats of matter and energy, forces and interactions and their regularities and laws governing the reciprocal interplay while being tested and proved by analysis and observation, control and measurement.

Mathematics

Mathematics, as the key tool of natural science, is emerging as the abstract science of structure, order and relationship. As applied mathematics, mathematical physics has to generate a complete and consistent representation of nature as the system of natural entities, forces and changes, the total sum of material existences and forces in the universe, all in terms of mathematical systems of definitions and axioms, rules, as the function rule, principles, as duality, and theorems, deduced laws.

Natural Ontology

Natural ontology is the study of the universe as such, the basic features of all the universe, as the nature of force, matter and energy, space and time, natural entities and cause-effect relationships. As an example, mathematical and theoretical physics is to combine physics, mathematics and theoretical ontology of nature. Or, the unity of the all forces of nature is an ontological axiom.

Therefore, despite seeming differences, all the physical sciences are interrelated by the basic principles underlying all natural processes, phenomena and interactions, provided by the principal natural science of physics.

Modern Physics: Its Key Subjects and Principles

"Physics has evolved and continues to evolve without any single strategy", while its ultimate goal to find a unified set of principles and laws governing force and energy, matter and change, at micro-, meso– and macro-world (*Physical Sciences, the New Encyclopedia Britannica, 25, Knowledge in Depth, Chicago-Toronto, Encyclopedia Britannica, Inc., 1994).*

Generally, the key achievements in physical science lie in the serendipitous and intuitive and ingenious discovering of empirical physical laws and effects, subatomic entities, symmetry principles, conservation laws, or unified force fields *(See Supplement 1. All Nobel Prizes in Physics. Available: https://www.nobelprize.org/nobel_prizes/physics/laureates/).*

Modern physics was founded as an empirical synthesis of separate sciences: mechanics, optics, acoustics, electricity,

magnetism, heat and studies of matter and its properties.

Meantime, the whole idea of physics consisted in the intuitive understanding that different forces of nature and forms of energy are INTERRELATED and INTERCONVERTIBLE, but **these universal phenomena have never been expressly formulated as the basic laws of nature**. The Faraday's intuitive belief in the unity of the forces of nature, or that all the forces of nature are but manifestations of a single universal force and must be convertible one into another made possible the classical electromagnetic field theory, the foundation of modern physics.

Modern physics includes the subjects of gravitation, mechanics and sound, particles and atoms, thermodynamics and heat, electricity and magnetism, light and electromagnetic radiation. Its main task is the nature, origin, actions and interactions of force-fields, gravitational, electromagnetic and nuclear, the strong color force between quarks and the weak nuclear interactions, all mediated by the quanta exchange, as vector gauge symmetry bosons.

In all, modern physics viewed as natural science doing the general analysis of nature to understand how the universe behaves, while being in the space of force fields and relying on a few simple laws and principles of nature and the universe.

Among the fundamental principles, causes and theories of the universe there are

unity and diversity,

reversibility and convertibility,

regularity and order,
symmetry and conservation,
change and motion,
relativity and space and time,
mass and energy,
fields and forces,
as well as thermodynamics, equilibrium and nonequilibrium, classic and statistical,
mechanics, classical and statistical, quantum and relativistic, field theory, nonlinear dynamic systems theory, quantum gravity, or theory of everything.

The fundamental axioms and postulates of physics are that "all is relative", interrelated and interacted, in the physical universe, *space and time, mass and motion, energy and force, but the basic principles and laws, as reversibility and convertibility, symmetry and conservation*.

The symmetry concept and its symmetry operations, what led the natural philosophy of Newton and defined relativity and quantum theory, are mutually related to the conservation concept and its laws of invariances. Each conservation law (of energy or momentum or mass-energy, quantum numbers or baryon number and lepton number) has a corresponding symmetry, or invariance and uniformity (as time reversal or space inversion or parity and internal symmetries).

And all is generally specified by the algebraic concept of symmetry groups, as Lie and finite groups, going as the

foundation for the fundamental theories of modern physics. The idea is to further unify the electroweak forces with quantum gravity forces transmitted by the massless quanta of gravitons.

Most of modern theoretical physics is about the types of symmetries of the Universe and finding the invariants (under all the symmetries) to construct field theories as its general models, like as the Standard model of CPT symmetry. It is to describe the fundamental forces and fields predicting that the exchanged particles called gauge bosons are the fundamental means by which forces are emitted and absorbed.

New Physics: From the Elemental Forces to the Prime Proto Force and Inverted Universe

In modern physics, all of the forces in the universe are based on four fundamental interactions: the strong and weak forces as nuclear forces acting at very short distances and responsible for the interactions between subatomic particles; the electromagnetic force acting between electric charges, and the gravitational force acting between masses, as the Earth-body system.

All of the forces in the universe are tended to be interrelated and united as a single super symmetrical force or supra power, *one proto force.* The idea of force as pervading all space and matter revolutionized Newtonian physics of classical mechanics. In 1820, Orsted made a critical discovery guided by his firm belief that chemical affinity, electricity, heat, magnetism, gravitation and light are simply manifestations of the basic forces

of attraction and repulsion. The unified field theory of a single fundamental force had fully occupied Einstein for 30 years.

The weak and electromagnetic forces are already manifestations or expressions of a more fundamental electroweak interaction. A Grand Unified Theory (GUT) is to relate the electroweak interaction with the strong force of QCD.

Theories of everything are to integrate GUTs with quantum gravity theories, which include string theory, loop quantum gravity, or twistor theory, looking for a graviton or the time-space quantum properties to close the Standard Model list of force particles. Which are force carriers or messenger particles of underlying fields, such as photons mediating the interaction of electric charges, gluons mediating the interaction of color charges, hypothetical gravitons for gravitation, or virtual gauge bosons interacting with matter particles, fermions, attracting and repelling each other.

If electroweak unification occurs just at around 100 GeV and grand unification, at 10^{16} GeV, the unification of the GUT force with gravity is expected at the Planck energy, with a proto force particle, say, the prime force particle of God, at 10^{19} GeV.

Some theories beyond the Standard Model include the modern cosmology forces: an inflationary force and dark energy, a hypothetical fifth force, the search for such a force is an ongoing line of experimental research in physics. In the super symmetry theories, there are scalar fields such as quintessence or moduli, dynamic quantities whose energy density can vary in time and

space, acquiring their masses through super symmetry breaking to exchange new forces. New forces might account for the recent discovery of the universe expansion accelerating, or *gravitational repulsion*, a nonzero cosmological constant, vacuum energy, some changes of general relativity, as well as CP violations, dark matter, dark flow, or dark energy, having a strong negative pressure (acting inversely repulsively), with a view to come to a dynamically reversible cyclic model of the universe.

In fact, there might exist a reversed, or inverted, negative form of matter, with negative gravity, which qualitatively different to antimatter, materials composed of antiparticles, invisible to us as the curving of space, but detectable through its anti-gravitational effects of repulsion. This condition could be referred to as Dark Matter existing in a 5th dimensional hyperspace, being part of space-time's matter and equal in amount to ordinary, baryonic matter. Then inverted space-time becomes negative hyperspace and formally described by imaginary numbers, with all the nonstandard consequences as to its properties and behavior. There is a cosmological speculation as to a real composition of the universe. The standard model of cosmology indicates that dark energy contributes 68.3% of the total energy in the whole observable universe, with its density as low as ($\sim 7 \times 10^{-30}$ g/cm3), uniformly occupying empty space and having negative pressure (acting repulsively), while the mass–energy of dark matter makes 26.8%, ordinary (baryonic) matter contribute 4.9%, plus the rest components, such as neutrinos and photons,

giving in a negligible amount. Other observations are figuring a universe made up 71.3% of dark energy and 27.4% of a combination of dark matter and baryonic matter.

Whatever, knowing the nature of dark energy and dark matter, as the fundamental cosmological constant and quintessence, how it all interacts with the ordinary matter, as subjected to numbers in terms of extension, change, force, mass, energy and radiation, is most critical for a single theory of the universe

Since, ultimately, four or five main force-interactions, strong, electromagnetic, weak, gravitational, and dark, would combine into *the proto force, the Faraday's universal force*, in the ToE, like as in a super string theory, at the beginning of the universe (up to 10^{-43} seconds after the Big Bang), the four fundamental forces were once a single fundamental force. One might add up here a hypothetical fifth fundamental force of nature, "dark force of dark energy and matter", theorizing as a force pushing the galaxies aside accelerating the expansion of the universe up to half of the age of the universe (7,5 billion years) (*Krasznahorkay, A. J. et al. Physical Review Letters 116, 042501 (2016)).*

That might implies that all the fundamental force-interactions might come out as different manifestations of the *prime natural force*, the prime mover, the first cause of all changes in the universe, including the original event of the hypothetical Big Bang, the singularity referring to the early hot, dense state considered the "birth" of the universe.

So, the final cause of natural science of physics is, in the most

general way, to formulate a system of comprehensive principles uniting and explaining all physical phenomena, physical causes and forces, mechanical, gravitational, thermal, electromagnetic, and nuclear forces, weak and strong.

The very universality and convertibility of natural forces and the reversible relationships of physical causes and thence their inherent integrity inspired Faraday, Maxwell and Einstein to seek unification of all the physical processes by a single set of physical laws.

The very universality and symmetry of interactions of natural forces, or reversibility of physical processes, has inspired great physical minds to discover the basic laws of physics, as symmetry principles and conservation laws, and formulate the quantum theory and relativity principle, as Einstein's matter-energy relationship or space-time relationship.

The very universality of conservation laws of interactions of natural forces, as gravity, nuclear interactions, or electromagnetic interactions, has inspired to discover one of the basic principles of nature, that the laws of physics remains valid in all places and times in the universe. Regardless of all the changes taking place with physical systems, of any scale and complexity, basic physical quantities, as mass, momentum, mass-energy, or baryon number, remain unchangeable or constant.

But, regardless that the great ideas of forcible interactions, process reversibility, energy and effect convertibility have been guiding physical science since its origination, neither has been

properly formulated as the fundamental principle and general law of nature and the universe.

To contribute, we introduced the concepts of

universal force-relationship
convertibility laws
reversibility principles

They are introduced as the highly integrative principles of physical sciences, especially, the natural science of physics and theoretical physics, as the most fundamental laws of nature and the universe (*Новик И.Б., Абдуллаев А.Ш. "Введение в информационный мир", М. Наука, 1991, in Russian; see Supplement: Encyclopedic Knowledge Base in Physics*).

As a result, the interactions of natural forces are formulated in the new terms of force-relationships, covering the current constructs forces, force lines, force-interactions, or force-fields. Forces are constructed as symmetrical force-relations, forceful interrelationships, efficient interrelations, powerful interrelationships, energetic interconnections, effective mapping, or forcible interactions producing physical changes and effects.

Natural forces are engines of the universe and being studied much less than the whole subject deserves. It is forces, their actions and interactions, determine the structure of the universe at all its levels, microscopic or macroscopic or cosmological. We know little about forces, their nature and properties, kinds and laws and relationships, some even hypothesizing that in unified field theories “all forces are fictitious”, or pseudo forces. Most

references here traditionally go to the use of Newton's Second Law for a definition of force, which was disparaged as essentially a mathematical truism by notable physicists, philosophers and mathematicians looking for a more substantive definition of the concept of force, as the principle of all physical science.

Still, applying symmetry to forces, the third law pinpointed the key feature of forces: all forces are interactions between different bodies. That means that they have the nature of interrelationships of power, efficiency and energy, what could be generalized as a symmetrical force-relationship. In other words, there is no such thing as a unidirectional force or a force that acts on only one body, in one progressive direction. Whenever a body exerts a force F on another body, the other one exerts a force −F on the first body, now in the regressive direction. F and −F are equal in magnitude BUT opposite in direction, having both magnitude and direction as vector quantities.

This action-reaction law, with F called the direct "action", or progressive force, and −F the reverse "reaction", retrogressive or inverse force, is making a decisive inductive case for the most fundamental truth about nature.

The truth of natural causes or forces is that the action and the reaction relationships are universal phenomena applied to all physical interactions and forces, fundamental and non-fundamental.

The Diversity and Unity of the Force-Interaction: the ToE as the Holy Grail of New Physics

All forces are hierarchically related, making up the natural hierarchy of forces, forces, force lines and force fields, topped by the super symmetry force-interaction, a single universal force of coming Theory of Everything (ToE), or Final Theory, Ultimate Theory, or Master Theory, a single, all-encompassing, consistent and complete theoretical framework of physics linking together all the physical properties and phenomena of the universe.

At present, there is no theory of everything that includes the standard model of particle physics and general relativity, such as to calculate the fine structure constant and the mass of the electron, hoping that a deeper search for new particles and dark force at the large particle accelerators could provide critical input for the ToE. There are a number of candidate theories to unite general relativity and quantum field theory, designed as the working theories of quantum gravity: string theory, superstring theory, M-theory, loop quantum gravity, causal fermion systems, and causal sets.

The last two theories are recent developments and in line with our Causal Category Theory of Everything capable to generalize and complete new candidates for a unified physical theory, as causal sets program and the theory of causal fermion systems, considering general relativity and quantum field theory as limiting cases. In the causal sets program, the founding principles are that space-time is fundamentally discrete and that space-time events are related by a partial order, having the physical meaning of the causality relations between space-time

events.

Ultimately, the ToE would unify all the fundamental interactions of nature, gravity, strong interaction, weak interaction, and electromagnetism, as well as shedding light on a postulated inflationary force, dark energy and dark matter.

As such, it is makes the Theory of All Forces in the Universe, ordered by the subordination and inclusion relationships (*Abdoullaev A., Reality, Universal Ontology and Knowledge Systems: Toward the Intelligent World, IGI Global, USA, 2008*):

Prime Force (ToE)::

Quantum Gravity (Space Curvature, Standard Model of Cosmology; Electronuclear Force (GUT, Standard Model of Particle Physics)::

Strong Interaction (SU (3); Electroweak Interaction (SU(2) x U(1))::

Weak Interaction, Electromagnetism $U(1_{em})$::

Magnetism and Electricity::

Non-Fundamental Forces (contact forces, elasticity, viscosity, friction, and pressure, etc.).

The non-fundamental forces are classified as

normal force,

friction,

tension,

elastic forces,

continuum mechanics forces of pressure,

drag and stress,

fictitious forces coming from non-inertial reference frames, as the centrifugal force and the Coriolis force,

general relativity gravity.

The pressure gradients and differentials is said to cause the buoyant force for fluids in gravitational fields, the aerodynamic forces of lifting in flight, winds in atmospheric science, like trade winds and anti-trade winds in the tropics.

Besides, forces are also classified as conservative or not conservative, where conservative forces are equivalent to the gradient of a potential energy field while not conservative forces are not. The former includes gravity, the electromagnetic force, and the spring force, while the latter friction, contact forces, tension, compression, and drag.

By their very nature, natural forces are natural causes and effects, all of the same kind of natural entities: events, actions, processes, or changes of states of some physical system, like the motive force is a rate of change of momentum. They are the mutual and reciprocal actions of one physical system or body to another to produce effects, or interactive relationships, the force-interrelationship.

Forces are not only what causing efficient changes of physical properties, but also what opposing any agency and efficiency. Both the active processes producing changes and the reactive processes opposing changes, as the inertial force and motive force, change of momentum-motion, acting power and operating energy, force-fields. And the actions of forces are always

in both directions, progressive and retrogressive, direct and inverse, inductive and resistive, attractive and repulsive, forward and backward, while defining the symmetry operations and conserving critical physical quantities as mass, momentum and energy, parity and baryon number.

So forces are not only active agencies, but also passive agencies. Inertial forces, opposing any agency and efficiency, are the universal and inherent power of physical entities and systems to resist physical changes, mechanical, thermal, magnetic, or electric. Such resistive forces are opposing changes in the initial state of equilibrium, in motion, in electrical current, in magnetic fields, in electrical fields, in electromagnetic fields, etc. There are then mechanical inertia measured by mass, electrical inertia measured by conductivity and resistance, magnetic inertia by inductance and magnetic resistance, electromagnetic inertia by induction and permeability, etc.

In other words, the space is inverted (Parity or P-symmetry) and the direction of time is reversed (T-symmetry, or time symmetry) because there are symmetrical forces in their actions and directions, as active and retroactive forces. All the complex physical processes are reversed, converted, retroacted and there is R-symmetry (force-relation symmetry), both global and local, the fundamental principle of nature or the physical universe.

What's Necessary for the Physical Science of the 21 Century

Our research in theoretical physics, mathematics of

relationships and formal ontology has been leading to the necessity of formulation of the new integrative concepts of physical science of the 21st century: Force-Interaction, or Force-Interrelationship, and its Principle of Reversibility and Convertibility Laws, as being among the most basic principles and fundamental laws in nature. That also reflects the general fact that we live in the dynamic universe of force-interactions defining all ensuing regularities in the order of physical entities and processes, including the symmetries and conservation laws (*Abdoullaev A., Reality, Universal Ontology and Knowledge Systems: Toward the Intelligent World, IGI Global, USA, 2008*).

The enormous theoretical value and practical utility of Force-Interrelationship, Reversibility and Convertibility as the basic constructs and laws of physics and physical sciences are proved by the reverse force-relationships, reversible actions, of all natural effects and physical processes, of all interacting physical forces and fields.

As a consequence of the Reversibility and Convertibility of all physical forces, phenomena and energy forms, each real physical process must have its inverse counterpart, like as there are magneto-optical processes and there converse, opto-magnetic processes, otherwise their nature, law and description should be properly reviewed.

As another consequence, each real direct physical effect, when properly defined, must have its inverse counterpart, as the Faraday effect relating magnetism and optics has the inverse

Faraday effect; otherwise its nature, law and description need a deeper study and should be properly reviewed.

Currently, there may be about 10000 physical effects specified by a multitude of physical materials, systems, or force fields, of which the most part happens to be represented by only one-side effect, see the Supplement 3.

On the intuitive level, the idea of convertibility/reversibility in nature complete with the concept of unity of natural forces were guiding principles in Faraday's discovery of magnetic and electric effects and Maxwell's prediction of electromagnetic fields caused by the mutual interactions of magnetic and electric force-fields.

If such is the case, many inverse effects are to be discovered under particular experimental conditions, thus giving new physical laws for new physical devices, technology systems, and machines performing the transformation of physical changes and energy (mechanical, thermal, electrical, magnetic, electromagnetic, nuclear) into each other.

Moreover, regardless their multitude and variety, all the existent and not yet uncovered physical effects are falling into one or another of a few physical processes, a self-consistent system of physical phenomena, distributed network of physical processes, first presented as an encyclopedic knowledge base for physical science in 1989 (*А. Ш. Абдуллаев, База знаний энциклопедического искусственного интеллекта: Об исследовательском прототипе энциклопедической системы по физике, Москва,*

ВИНИТИ, 1989).

It is all demonstrated below by widely known physical facts and theories, as well by the mathematical formalism of abstract algebras. Mathematics as the study of quantitative relationships and its branches, as mathematical analysis and abstract algebra of abstract structures, is the critical tool in the natural science of modern physics. Specially, theoretical physics has made many successful achievements due to the functional analysis, linear algebra, groups, fields and rings, while lattice theory, relation algebras and categories got the least application.

Because of its nature, the most full formal description of natural forcible relations exchanging forces, power and energy, can be given in terms of ordered sets, functions, and categories instead of the group-like concepts well-fitting for symmetrical transformations of physical systems and processes and fundamental force-interactions.

In all, the new physical science stands in need of a universal principle of nature to be accountable for the interconnection and convertibility of all physical phenomena, as inverse physical effects, for all nonlinear phenomena and complex dynamic systems, like as the concept of the Fundamental Force-Interrelationship, the Principle of Reversibility and Convertibility of physical phenomena, standard or quantized.

This might be expressed shortly: if there is the Doppler effect or the Faraday effect, there must be the Inverse Doppler effect or the Inverse Faraday effect just BY LAW; otherwise it is not

a real effect.

The Nobel Prize in Physics has been awarded 109 times to 201 Nobel Laureates between 1901 and 2015, according to the Nobel Foundation. Of which the foundational achievements were performed in serendipitous empirical and intuitive discovering of special physical effects, like the Einstein's law of photoelectric effect, the Compton effect, the Cherenkov effect, the Mössbauer effect, the Hall effects and many other effects (like as listed in the Supplement 2).

This great empirical performance has been enriched with new performance in the fields of symmetry and conservation, prediction and detection of new physical entities and properties as superconductivity and fluidity, climaxing with formulating integrating models for the fundamental force fields, or rather the basic force-interactions.

Seeking to streamline physical science, making it more efficient, simple, up to date and systematic, we formulating the universal principle of reversibility in terms of the first principles of force, convertibility, unity, symmetry and conservation, and the fundamental principles of the mathematics of relationship and category theory, The Reversibility Principle is advanced as the essential construct of nature integrating the basic natural phenomena and bringing forth a single strategy of physical science for the future Nobel Prize discoveries. It produces a systematic modelling of diverse physical forces and energies, processes and phenomena to predict the actions of physical

forces and effects, to discover and exhibit natural relationships.

The fundamentality of discovery implies if there is the Faraday effect, Lorentz-Zeeman effects, Doppler effect, Einstein's photoelectric effect, Compton effect, Cherenkov effect, Mössbauer effect, Hall effects…., there MUST be the Inverse Faraday effect, Lorentz-Zeeman effects, Doppler effect, Einstein's photoelectric effect, Compton effect, Cherenkov effect, Mössbauer effect, Hall effects,…, by LAW, of Reversibility of Effects and Convertibility of Forces and Energies.

In brief, we proposed a model of Nature, with the Force, Reversibility, Convertibility and Unity as its essential constructs, integrating the natural phenomena, causes, forces, processes and effects, and bringing forth a single strategy of physical science.

We showed the universality of reversibility properties of nature as the Principle of Reversibility, being correlative with the Principle of Symmetry and the Law of Conservation, and stating "if there is a physical process or effect in nature, there must be its inverse, converse or reversed process". Otherwise it is hardly a real effect.

THE LAW OF GLOBAL REVERSIBILITY strictly implies that there MUST be the inverse effects, as of the above-mentioned, just by LAW, of Reversibility of Processes and Effects and Convertibility of Forces and Energies, and that Matter, Energy or Force can be neither created nor destroyed, but reversed and converted.

The discovery involves all the key features of universal laws of nature, being illustrated by an increasing number of inverse effects, as discovered or under discovery, experimental studies or innovative applications.

As such, the Law of Reversal combines all the key attributes of universal laws:

asserting the interdependence between varying quantities of physical properties;

stating that physical events occur an invariant order;

dealing with cause and effect relationships;

stating a constant regularity in the relations or order of physical phenomena in the world, thus embracing all empirical regularities of numerous physical effects.

In sum, an "outstanding scientific importance" of the Principle of Process Reversal and its Effect Conversion Laws consists in enabling the prediction of physical processes and actions of physical forces and effects as well as the nonlinear interactions and macroscopic behavior of complex systems in the systematic and consistent ways without having to consider the details of the courses of physical processes and systems (*Abdoullaev, A. (2008). What Determines the World. IGI Global; http://www.igi-global.com/bookstore/chapter.aspx?titleid=28314).*

Mathematics of Nature: A Categorical Theory of Everything: the Principle of Reversibility or the Laws of Convertibility

Mathematics of Nature is the key theme of Mathematical Physics X.0, which involves physics, experimental and theoretical, and general ontology of the universe (the first, as its key subject, and the second, as the guiding discipline) and pure mathematics, like as partial differential equations, geometry and topology, abstract algebra and category theory (*Abdoullaev A., Reality, Universal Ontology and Knowledge Systems: Toward the Intelligent World, IGI Global, USA, 2008*).

As such, it has to generate a complete and consistent representation of Nature as the total sum of material entities, changes, forces and interactive relationships, ideally, in terms of mathematical systems of definitions and axioms, rules, principles, and theorems, as deduced laws. As it was published in a famous list of mathematical problems, in Hilbert's sixth problem, challenging researchers to find an axiomatic basis to all of physics.

In brief, New Physics X.0 is about creating the ToE as a Final Theory, Ultimate Theory, or Master Theory, as a single, all-encompassing, consistent and complete theoretical framework of physics interrelating together all the physical properties and phenomena of the universe.

A Theory of Everything: the Universe as a Pre-Ordered Category of Change Sets

The algebraic language of relations, categories and functors looks the effective mathematical instruments for a formal unified description of interactions of all physical phenomena in nature.

All is in terms of force (cause-effect) relationships as the force-interactions and the productive interrelationships of force, energy or power, activity and efficiency, represented by the state-change-variables, or varying quantities of physical changes, or causal sets of events. For the interactive forces of relations are the interrelationships among specific kinds of entity variables, neither object variables nor state variables, but change variables, presented in the material world as physical forces involving changes in quantity (state) variables.

The Reversibility Principle and Convertibility Laws being deduced from the mathematical physics of universal forcible relationship have a close analogy to the duality principle, an essential property of mathematical structures having a lattice order, as set theory, symbolic logic or projective geometry. It states that one true statement, operation, function or effect can be obtained from another by converting, transposing, or interchanging its correlatives. The dual formulation in the natural science of physics is as true as in mathematics.

Bearing in the mind that the nature of force-relations $\mathbf{R_C}$ is described by the mathematics of relations, relation algebras and abstract algebra of categories, a formal definition of a category of $\mathbf{R_C}$ is to be obtained by the standard axioms and postulates of Causal Category Theory (CCT):

There is a class of disjoint change sets C_X, C_Y, C_X …of a universal change set **C**;

There is a class of transformations R_1, R_2, R_3 , … of

a universal force-interrelationship set $\mathbf{R_C}$, named functions describing the forcible relationships between change sets, namely from the domain change sets to the change range sets;

There exists an identity force-relationship of interactions $I_C = = R_C(C, C)$ which may be associated with each change set $_X = I_X: C_X \rightarrow C_X$;

To each ordered couple of change sets C_X, C_Y in R_C, it is assigned the set of one-to-one transformations R_1 (correspondences, morphisms, or maps) from C_X to C_Y, as well as the set of inverse morphisms R_1^{-1} from C_Y to C_X;

To each ordered triple of change sets C_X, C_Y, C_Z in R_C, it is ascribed a composition function (a law of composition) $R_1 (C_X \text{ x } C_Y) \rightarrow R_2 (C_Y \text{ x } C_Z) = R_3 (C_X \text{ x } C_Z)$;

Then it follows that the category of force-interrelationship is to be figured as a pre-ordered category (with involution $^{\#}$) of two disjoint change sets, C_X and C_Y, together with four morphisms: $_X$, $_Y$, $R(C_Y / C_X)$, and $R(C_X/C_Y)$.

The structure corresponds to a full graph depicted as a symmetrical graph with all the possible interrelations (arcs) between nodes (loops).

As a result, the total of force-relationships can be constructed as the totality of ordered classes of changes. Seeing that the force-relationships belong to the class of causally ordered processes, $\mathbf{R_C}$ **C x C R**, the entirety of its connections will

constitute the relational structure of the universe, or the physical world **W**:

$$\mathbf{R_C} < \mathbf{C}, \mathbf{C} \times \mathbf{C}, , \circ, , {}^{\#} > \mathbf{W} \quad (\mathbf{1})$$

The algebra of natural force-relations on a set of change variables involves the binary operations of set union and intersection , , direct product x, the unary operations of negation $^{-1}$ or inversion #, the order relation , and the operation of composition ∘, all is liable to the laws and rules which are valid for formal relationships in general (*Abdoullaev, A. (2008). What Organizes the World: N-Relational Entities. IGI Global; http://www.igi-global.com/bookstore/chapter.aspx?titleid=28313*).

From Basic Force Fields to Fundamental Natural Force-Interaction

In the language of class variables, **the fundamental natural force-relationship of set changes (natural, physical, or chemical)** can be formulated as a system of interconnected change variables:

$$\mathbf{R_C} = C_i \, C_j \quad (\mathbf{2})$$

Here indexes i and j are subject to conditions: ij=; 0 i, j n; R^2 is a composition of relation R such that $C_i R^2 C_j = C_i R C_k \circ C_k R C_j$. The force-relation formula indicates that the interplaying forces, or action-causes and effect-effects must be always of distinct types of changes and processes.

The relation = C_iRC_j C_iRRC_j C_iRRRC_j …being a complete enclosure of a finite class of change sets is represented by a full graph where all the nodes symmetrically linked up with each other by directed arrows. That suggests that the bondage or linkage of things can be firstly measured as the set of all possible efficient links (ties, bonds, and connections) among them, plus spatial and temporal relations. Also it suggests that there is no such a strictly fixed priority of input causes before output effects like as given by asymmetrical expression C_X x C_Y, where the order of their being is assumed not to be reversed.

In fact, physical entities interact, being in reciprocal actions and mutual influences, every entity can change (act on) other entities or be changed (is acted upon by) by other entities. Such a universal regularity in the relationships of changes and order of phenomena in the world is described by the Process Reversibility Principle formulized as the equation:

$$\mathbf{< C_X , C_Y > =\# < C_Y , C_X >} \quad \mathbf{(3)}$$

Where the function **# R#** is *reversal operator* #: $R_C R_C^{\#}$ which describes the operation of reversing the order of two disjoint changes or actions or force-causes. The reversion rule can be formulated like as $\mathbf{C_X}$ is a necessary and sufficient for $\mathbf{C_Y}$, meaning

A change of type C_X would bring about a change of type C_Y if, and only if, C_Y were to produce C_X.

This fundamental principle of change confirms that **any fundamental process of the universe stands in a relation of convertibility (reversibility), reciprocity and mutuality,** thus accounting for inverted, reversed, reciprocal and interactive phenomena in nature. Alternatively, the principle of inverse force-relations may be read as:

Whatever comes into being as a process just as well will come as the inverse process.

Thus, the real interrelationships of forces, power and energy are transitive, symmetric, and reflexive; for, additionally to the property of *transitivity* of changes (or actions) when *cause of cause is cause of effect*, there is also other essential characteristic of process reversibility: **the inherent quality of all real processes to be reverted, retroacted or retrogressed in opposite order**.

In the natural world, due to the universal phenomena of convertibility and reversibility, processes are arranged in a circle of changes, actions or events; thus making up the mutual,

reciprocal natural relationships, as in: $R_C\ R_C{}^{\#}\ C_XC_YC_X$*, where the symbol* R_C *stands for a forward process and* $R_C{}^{\#}$ *for the backwards process. As a result, we obtain a full interrelationship or a circular process made up of distinct changes,* C_X *and* C_Y*; of any kind, substantial, quantitative, qualitative, variable, or relational:*

$$(C_X\ C_Y)\circ(C_Y\ C_X)=C_X\ C_X$$
(4)

The formula indicates that when the forward process has come-to-be, the backwards process must always come-to-be too. In other words, real processes are nothing but mutual relationships of cause-changes and effect-changes, that it is a reciprocal process between two or more kinds of changes.

For such a tendency is retained for more complex cases of ternary, quadruple, quintuple, or n-tuple circles of changes, actions, or causes. So, for the recurring series of actions of the length 3, which is a case of ternary relations ($C_XC_YC_Z$) ($C_ZC_YC_X$), we obtain a circular chain of three changes C_X, C_Y, C_Z such that $C_X\ C_Y\ C_Z$ or $C_Y\ C_Z\ C_X$ or $C_Z\ C_X\ C_Y$, i.e., forming a ternary loop or cycle of physical changes standing to each other in the relation of mutual intermediacy.

Essentially, the class of natural processes as a species of the class of relations preserves a lattice-ordered structure, too,

thereby constituting a partially ordered set of changes subject to the standard Boolean operations, and all other algebraic relations, along with the operation of composition and reversion.

The above rule allows a comprehensive and systematic analysis of force-relations in any knowledge domain due to the generality of mathematical account of efficient relationships of forces, as generalizing the cause-effect relationships as the major subject of empirical sciences as physical science.

So, the CCT of Everything (CCToE) is to generalize and complete new candidates for a unified physical theory, as Causal Sets and the theory of causal fermion systems, considering general relativity and quantum field theory as limiting cases.

The Totality of the Natural Forces and Unity of Physical Processes: A Graph Network of Physical Phenomena

The totality of physical processes could be now modelled as a reversible network of mechanical phenomena, quantum-mechanical phenomena, thermal phenomena, magnetic phenomena, electrical phenomena, and electromagnetic fields. Or, isomorphic to it, a symmetrically directed graph network of mechanical energy, quantum-mechanical energy (e.g., atomic energy, activation energy, binding energy, and chemical energy), heat energy, magnetic energy, electrical energy, and radiant energy.

Each link, edge, arc, or line of which, bearing a forcible or energetic relationship, interconnects its nodes, vertices, nodes,

or points, as a cause-input and an effect-output in a reversely ordered way.

The general formula for the totality of (natural) physical processes $_{p}\mathbf{R}_{C}$ will be represented as $_{p} = C_i\, C_m$; here indexes i, m and n are subject to conditions: i m=; 0 i, m 5 and n=5.

The transitive enclosure satisfied due to ***the fact of convertibility of natural phenomena, physical processes and reversibility or retroactivity of all physical effects***.

As a result, a full self-consistent network of physical processes will be expressed as symmetrical force-interrelationships of physical changes having the property of a tensor quantity:

$$C_i\, C_m = C^{M}{}_{i}\, R\, C^{T}{}_{j} \circ C^{T}{}_{j}\, R\, C^{E}{}_{k} \circ C^{E}{}_{k}\, R\, C^{Ma}{}_{l} \circ C^{Ma}{}_{l}\, R\, C^{EM}{}_{m} \circ C^{EM}\, R\, C^{M}{}_{i}$$

(5)

Where accepted the following symbolic representations:

C^{M} represents mechanical changes, as motions and inertial or motive forces,

C^{T} refers to all thermal changes and temporal differences,

C^{E} stands for electrical changes,

C^{Ma} symbolizes magnetic fluctuations,

C^{EM} is used to represent electromagnetic changes.

Note that the formalism covers more complex

forcible interrelationships of physical forces and processes, like magnetohydrodynamics involving the interactions of electromagnetic, mechanical, thermal, and hydrodynamic forces.

It is crucial, each complete process is a force-interralationship, a forcible and energetic relationship of cause (an input change or energy or power or force) to effect (an output change or energy or power or force) which in order to occur requires a specific physical entity, object, system, material, or force field. Now, depending on the physical properties of a given material entity (size, mass, composition, weight, temperature, magnetization, etc.), a given process can be materialized as various physical effects subject to measurements and experimental observations.

Basing on the mathematical model of physical processes, we could develop a unique knowledge innovation product: the global base in physical science for AI, added with functional descriptions readable by machines.

The totality of physical phenomena and reversibility of all physical effects is enabling to create Encyclopedic Knowledge Base in Physics for General AI systems.

(*А. Ш. Абдуллаев; База знаний энциклопедического искусственного интеллекта: Об исследовательском прототипе энциклопедической системы по физике, Москва, ВИНИТИ, 1989*).

How Modern Physics Reversibility Lost

The reason why the Reversibility Principle of the Physical

Universe has been missing as the fundamental law of nature is the matter of scientific methodology: how we see and formalize the cause-effect relationship, the most important concept in empirical sciences. It is often overstated that "the great conceptual revolutions of modern natural science of physics" consisted in displacing the "causal interactions of physical entities" with the "functional relationships of variables"".

Here is a standard approach typified by Nobel Prize laureate Herbert A. Simon claiming the asymmetry of a causal relation, that a strict ordering is its key feature, that it is an asymmetrical relation between variables or their values, a function of one variable (the cause) on to another (the effect). And that, given a system of equations and a set of variables appearing in these equations, one can introduce a series of asymmetric relations among individual equations and variables following such a partial notion of a causal ordering of physical processes.

In physical sciences, theoretical causality is viewed as a lawful relationship of general changes to matter and energy occurring to different objects in different places at different times, involving fundamental processes and physical effects, where the input variables function as causes and the output variables as effects.

On the other side, physical causation, the working causality, will be the actual productive connections among distinct change-occurrences happening to a specific object (or a system of objects) at a unique spatiotemporal location. This level applies to so-called "singular causation", deterministic or probabilistic,

as a temporally ordered asymmetrical and irrefexive relation of individual events, still acting in forward or backward directions.

As a matter of physical science, the efficient interrelationships among physical changes are expressed by symmetrical differential equations containing change-differentials of a state function, such as:

Maxwell's equations describing the changes of electromagnetic field;

Schrodinger's wave equation, the basic equation of wave mechanics;

Einstein's equations describing the changes of gravitation field.

In the equations, change of quantities (or of the state functions f(x), F (x)) is mathematically represented either as a differential d, increment Δ, derivative dy/dx with respect to x, or as a variation δ.

This all leads to the following significant conclusion. Underlying all the formal interrelations of physical changes in the state variables, **reciprocal forceful relationships determine the structure of the physical world**, its phenomena and mechanisms, as well as the physical artifacts, their structures and functions, as applications designed to realize in practice natural effects or processes.

For instance, the operation and the components of such important devices as electric generators, transforming mechanical motions from primary sources to electricity, and

electric motors, converting electric energy to mechanical phenomena using electromagnetic induction, is regulated by two convertible principles, Ampere's law and Faraday's law. Since the same reversible natural process underlies the laws and the action of the physical artifacts, both electric machines are complementary: motors may work as generators and inversely, generators may function as motors.

The Engine of the Physical World

There are remarkable laboratory experiments directly suggesting or testifying to the Reversal Principle in Nature. And they are as diverse as the classic Faraday experiments of relationships of magnetism, electricity and gravitation, QM test of Bell's inequalities with correlated photons, the asexual genetic cloning of a mammal using adult somatic cells, and the rescue of somatic cells from senescent death.

At first sight, the experimental tests were designed to illustrate different truths of nature, like as. 'An experimental polarization of Einstein-Podolsky-Rosen type correlation' is thought to bear witness of spatial-temporal and causal non-localities of physical quantum reality. Or, the nuclear transplantation test discovered that the genetic material of adult somatic cells doesn't undergone irreversible changes. Or, ageing is not an irreversible process, but must be completed with its opposite process, rejuvenation. The cell aging experimental research established 'a causal relationship between telomere shortening and in vitro cellular senescence'; what became possible by the discovery of the

reverse transcriptase subunit of telomerase from eukaryotes.

In fact, the laboratory experiments once more tested that the inherent quality of any natural processes to run both forward and backward also applies to all natural phenomena, electromagnetic effects, biochemical reactions or quantum physical processes. Faraday' effects, Bell's inequalities, the asexual genetic cloning of mammals, and the extension of somatic human cells' lifetime, all this do testify to the universal fact of Nature – *the process reversal mechanism*.

The rule that **any natural process (phenomena) has a converse (relation)**, that any natural phenomenon (physical, chemical and biological) caused by some previous phenomenon is to be reversed in its order of action, has a profound extent and depth. The rule states that the opposite of physicochemical phenomena, where physical change produces chemical change, is the chemo-physical phenomena, where the chemical changing inversely produce changes in the states of physical systems. The same happens with biophysical and physico-organic processes standing in converse relations of actions and influences.

The case of leading natural science, physical science, studying matter and energy and their interactions, can be fundamental to the argument of process **reversibility or convertibility**, though with some important reservations. The process reversal shouldn't be confused with the physical notion of reversibility of thermodynamics. For the latter implies reverse changes of a system from a final state to its initial position, like the reversible

processes of a mathematical (frictionless) pendulum, where we only observe the inversion of the order of states involving one thing or the inversion of the order of changes again involving one and the same thing, simple or complex.

In fact, a real natural process is to be identified with an efficient interrelation between changes of distinct systems, or distinct processes. Things receiving a change, as passing-away, coming-to-be, alteration, or any another sort of change whatsoever, must be of different sorts, one system may undergo the processes of passing-away, another coming into existence, growth or degeneration, useful or harmful alterations, increase or decrease, forward motion or reverse motion.

For the case of the real pendulum, the physical device consists of two distinct objects (or systems) undergoing distinct changes, a compressed spring and a swinging pendulum, which are acting on each other.

So, **there is the thermodynamic reversibility of the way of behavior in the equilibrium state, without exchanging matter or energy, and the universal natural reversibility of the order of actions of force-relationships of energy and power.**

To sum up, any physical phenomena has a reversed process, any physical effect has a converse, the reciprocal, reverse, inverse, opposite effect, where the change-cause and the change-effect are turned about in order of interactive relationship.

The reversibility principle is universal in its scope and scale, applying to the dynamics of the whole universe as well. That means if there is "the accelerating expansion of the Universe", so there must be (or going to be) a cosmic retrogression, or the universe's retroaction: "the accelerating compression of the Universe", to reach a true cyclic model of the universe.

Gravity or gravitation, as the universal force of attraction affecting all matter, as with other fundamental forces being both attracted and repelled, must have its counterpart, antigravity, as the proposed "gravitation repulsion" in a number of "dark forces" theories, with nonidentical particles and antiparticles of gravitons and antigravitons, as the massless? carriers of the gravitation fields of attraction and repulsion.

If the entropic regression from order to disorder is about chaotic disruptions of structure and organization of the universe, then its inverse, the entropic progression from disorder to order is about creative disruptions of structure and organization of the universe.

Process Reversibility as the Ground for Symmetry and Conservation

In all, the description of physical phenomena is rested on several basic concepts: *matter or substance or body, energy, states, time and space, cause, motion and changes, interactions, and systems*, the distinct collections of matter. Most of them are

presented as physical quantities:

Matter by mass, as related to weight, and subject the law of conservation: matter is neither created nor destroyed, but converted and reversed;

State by energy, mechanical, potential, kinetic, thermal, atomic, etc., subject to the law of conservation: energy is neither created nor destroyed, but only converted from one form to another;

Change by motion, measured by momentum, velocity and acceleration;

Duration by time, which is numbering change and motion;

Extension by space: the matrix of figures and distance;

Cause by force and force fields, the powerful force-relation, integrating mass, distance, direction, momentum, velocity and acceleration, and defining the operating symmetries, invariances, uniformities, transformations, and the conservation laws.

Most physical quantities, as mass, energy, momentum, electric charge, are subject to the correlated Principle of Conservation and Symmetry stating that nature remains constant with the passage of time, and most physical laws are subject to the Symmetry Principle implying that "all the laws remain valid in any time or place in the world".

Its ideas of physical symmetry and that processes changing the physical or chemical properties of substances (within an isolated system) leave some total quantities, mass, energy or mass-energy, unchanged or invariant during interactions are correlated with

the prime concept of the Force-as-active-reactive-Relationship, the Principle of Reversibility and the Laws of Convertibility.

It is thus allowing predicting the behavior of any system, natural or social, without considering the detailed course of a process, be it a natural process, chemical reaction, biological processes, conscience, a set of responses to social stimuli, or consciousness, mental actions toward natural objects, the environment conservation, or social interactions.

To know the states of systems is to know all the possible properties, measured or observed, while to know the changes of states of systems is to know all the possible actions, alterations and modifications, manifested as different sorts of forces and fluctuations of force fields represented as changes of physical quantities.

To know all the possible relationships among changes is equivalent to knowing the results and outcomes of all possible interactions among systems, and thus being able to explain or predict the behavior of complex physical entities (objects and force fields, gravitational, electromagnetic, nuclear) under the action of given forces.

Reversing All Processes and Converting All Forces and Effects: to Encyclopedic Knowledge Base in Physics

It is the universality of the reversibility of physical processes and convertibility of natural forces and thence their inherent unity inspired Faraday, Maxwell and Einstein to seek unification

of all the physical processes by a single set of physical laws.

It is the universality and completeness and reversibility of scientific laws enabled all the variety of modern technological applications.

It is the universality and completeness and reversibility of the conservation principles, like the energy conservation and transformation laws, enabled all kinds and manner of productive applications like energy-conversion systems, from chemical batteries to thermonuclear fusion reactors.

It is the reversibility principle and its correlative of the conservation law of energy determines all the energy changes from one form to another: nuclear, radiant, mass, gravitational, kinetic, thermal, elastic, electrical, and chemical.

Again, it is the reversibility principle and its correlative of the conservation law is enabling the relativity theory, the principle of interdependence of matter, energy, space and time, as mathematically formulated by Einstein.

Currently, there may be about 10000 physical effects specified by a multitude of physical materials, systems, or force fields, of which the most part happens to represent only one-side effects.

On the intuitive level, the idea of convertibility/reversibility in nature completed with the concept of unity of natural forces was a guiding ontological principle in Faraday's discovery of magnetic and electric effects.

If such is the case, many inverse effects are to be discovered

under particular experimental conditions, thus giving new physical laws for new physical devices, technology systems, and machines performing the transformation of physical changes and energy (mechanical, thermal, electrical, magnetic, electromagnetic, nuclear) into each other.

Regardless their multitude and variety, all the existent and not yet uncovered physical effects are falling into one of a few physical processes, as it is briefly listed below:

- Mechanical processes relating mechanical changes, motions and forces;
- Quantum mechanical processes connecting quantum events;
- Thermal processes relating thermal changes;
- Electric processes converting electrical changes;
- Magnetic processes interrelating magnetic changes;
- Electromagnetic processes (radiation or waves) interconnecting electrical and magnetic fields;
- Mechanothermal processes generating the differences in temparature by mechanical stresses and the inverse, thermo-mechanical phenomena producing mechanical forces with temperature changes;
- Thermoelectric processes causing electricity with heat and electrothermal processes generating temperature change by electricity;
- Electro-magnetic processes generating magnetism by the action of electricity and magnetoelectric processes producing

electricity by the operation of magnetic forces;

- Magneto-electromagnetic and electromagnetic-magnetic processes (including magneto-optical and optomagnetic processes) interrelating electromagnetic radiation and magnetism;
- Mechanoelectromagnetic processes (including quantum processes and electromagnetic-mechanical processes (with reversed quantum processes) determining the interrelationships of mechanical energy and electromagnetic radiation;
- Mechanoelectric processes (classical and quantum) and electromechanical processes where mechanical stresses generate electricity and vice versa when electricity effects mechanical phenomena;
- Mechanomagnetic processes and magnetomechanical processes (quantum and classical) interrelating mechanical forces and magnetc forces;
- Thermomagnetic and magnetothermal processes interrelating heat and magnetism;
- Thermoelectromagnetic and electromagnetothermal processes interconnecting radiaton and temperature change;
- Electro-electromagnetic and electromagneto-electrical interractions pertaining to conversion of radiation into electricity and converse phenomena, transforming electricity into electromagnetic waves.

Excluding chemical changes of substances and taking the standard case of binary force-relations, we obtain a rather

exhaustive collection (network) of Natural Physical Forces, Processes, Effects and Applications, or Machines.

The mechanical forces, processes, effects and applications

The mechanical processes cover the mechanical effects ranging from the transformation of forces and motions to Hooke's law (including nonlinear law) to nonlinear interaction of acoustic waves (e.g., effects of self-action, generation of nonlinear waves, and so on).

The most visible effects mechanical forces are deformation and flow, alteration in the form, shape or size of physical substances, as solids, liquids and gases.

Rigid, plastic or elastic deformations are caused by sudden or prolonged stress, strain, pressure, or forces, mechanical, gravitational, thermodynamic, magnetic, electric, electromagnetic forces.

Conversely, mechanical deformations lead to gravitational, mechanical, thermal, magnetic, electric, electromagnetic, or chemical effects, what is studied as separate effects, piezoelectricity, electristriction, magnetostriction, etc.

It is generally described by the symmetrical stress–energy tensor, stress–energy–momentum tensor or energy–momentum tensor, with the contravariant components of energy density and momentum density, momentum flux, sheer stress and pressure, reflecting the general reversibility mechanism. So, it makes a tensor quantity T^{ik} of order two representing the density and

flux of energy and momentum in spacetime, generalizing the stress tensor of Newtonian physics. As such, it is a feature of matter, radiation, and non-gravitational force fields, the source of the gravitational field in the Einstein field equations of general relativity, like as mass density is the source of the gravitational field in Newtonian gravity..

Again, the mechanical laws of motion and equilibrium are aligned with the more general reversal law, especially, it is Newton's third law for the two-body system: while two body interacts, there is an action and reaction couple of equal and opposite forces, each acting on a different body and never on the same body.

There are mechanical inertia measured by mass and provided by inertial forces. The resistive forces is opposing any agency and efficiency of motive force of mechanical momentum to continue in the rest or forceless or zero net force motion in a constant velocity.

The reversibility law is an ultimate generalization of the basic law of motion: **to every action there is always a reaction, to every progressive process of action there is a retrogressive action in the most general physical sense and application.**

Or, the mutual actions of physical systems must have both the direct or forward action of forces as well as a reverted or backward reaction of forces. And action and reaction force-relations might act instantly, like in mechanics, or in succession, or in most times reverse effects need special discovery under

spatial physical conditions, sometimes as nonlinear natural phenomena.

The simplest application of mechanical force-relationship reversibility is the mechanical power/drive train which transmits motion (power) from the engine of a car to the driving wheels, and conversely from the driving wheels to the engine.

The engine itself is the key mechanical application, as a machine converting any of various forms of energy or forces into mechanical force, power or energy or motion.

There may be as many engines as types of force or energy:

steam engine,
jet engine,
rotary engine,
rocket engine,
heat engine,
diesel energy,
gasoline engine,
internal-combustion engine,
electric engine,
magnetic engine,
electromagnetic engine,
light engine,
plasma engine,
radiation engine,
gravity engine,
or quantum gravity engine.

The QM forces, processes, effects and applications

The concept of “force-relationship” gets a deeper meaning in quantum mechanics, introducing operators instead of classical variables and the Schrödinger equation instead of Newtonian equations. The results of a measurement are now partly "quantized", appearing in discrete quantum portions, while the potentials V(x,y,z) or forcible fields, from which the forces generally can be derived, are treated like classical position variables. Only in the framework of quantum field theory, these fields are quantized as well.

There are two nuclear interactions forces, which account for the interactions of subatomic particless. The strong nuclear force responsible for the structural integrity of atomic nuclei and the weak nuclear force responsible for the decay of certain nucleons into leptons and other types of hadrons.

The strong force is the fundamental force for the interactions between quarks and gluons as covered by the theory of quantum chromodynamics (QCD). The strong interaction is mediated by gluons, acting upon quarks,antiquarks, and the gluons themselves, and it is the "strongest" of the four fundamental forces.

The weak force is due to the exchange of the heavy W and Z bosons, with its well-known effect of beta decay (of neutrons in atomic nuclei) and the associated radioactivity, and having the field strength about 1000 times less than that of the strong

force, but being stronger than gravity over short distances. An electroweak force theory shows that electromagnetic forces and the weak force are one force in excess of 1015 kelvins, the temporal conditions of the universe in the early moments of the Big Bang.

In quantum mechanics, the particles acting onto each other possess the spatial variable, added with a discrete intrinsic angular momentum variable called the "spin", liable to the Pauli principle relating the space and the spin variables. Depending on the value of the spin, identical particles divided into two different general classes, fermions and bosons. In the case of two fermions (e.g., electrons) there is a strictly negative correlation between spatial and spin variables, whereas for two bosons (e.g., quanta of electromagnetic waves, or photons) the correlation is strictly positive.

In particle physics, forces are explained as the exchange of momentum-carrying gauge bosons. The quantum field theory and general relativity force is also closely connected with the conservation of momentum (4-momentum in relativity and momentum of virtual particles in quantum electrodynamics). The conservation of momentum derived from the symmetry of space, both being derived from the symmetrical force-interrelationship, **therefore the fundamental forces are really fundamental interactions.**

Accordingly, the same reversibility schema applies to all forces of fundamental interactions. The interactive relationships

are well predicted with Feynman diagrams, where each matter particle is represented as a straight line (a world line) traveling through time. World lines of particles intersect at interaction nodes or vertices, and any force arising from an interaction is occurring at the vertex with an associated instantaneous change in the direction of the particle world lines. Gauge bosons are emitted away from the vertex as wavy lines and, in the case of virtual particle exchange, are absorbed at an adjacent vertex. Matter and anti-matter particles are identical except for their direction of propagation through the Feynman diagram.

The Feynman diagrams covers the types of physical phenomena that are conceptually separate from forces: like as a neutron decays into an electron, proton, and neutrino, an interaction mediated by the same gauge boson that is responsible for the weak nuclear force.

The QM fundamental processes contain all the quantum-mechanical effects of the microparticles interactions (e.g., fundamental interactions, reactions between elementary particles, atomic collisions, scattering of photons, quasi-particles, quantum transitions, as well as nuclear reactions of type A (a, bcd) B and reversed processes B (bcd, a) A, here A – a target-nucleus, a – bombarding particles; b, c, d – emitted particles and B– remained nuclei in the forward process).

For electromagnetic and strong (nuclear) interactions, the probabilities of forward and reversed processes are equal because of the reversibility principle; namely, the reversal

symmetry of motion and the principle of detailed equilibrium for microprocesses are clearly the consequences of the process reversal law.

The applications of reversible processes as the thermonuclear reactions of atomic nuclei, consisting in the interactions of two particles at supra high temperatues, are just bind-blowing. Chains of thermonuclear reactions, the proto-proton cycle or the carbon cycle, account for the solar energy and many other stars. When in an uncontrolled state, we have the destructive force of thermonuclear bombs and the last of all human wars.

But when the thermonuclear reactions under controlled conditions, the nuclear fusion, like the laser intiated, could be the source of practically unlimited green and renewable energy.

The thermal forces, processes, effects and applications

The interrelationships between heat and energy, temperature and work, their convertibility and the mechanical work involved are all under thermal processes, force and effects, and studied by thermodynamics, a fundamental part of all the physical science. Its three laws of thermodynamic are the law of conservation of energy, the law of equilibrium, or dicreasing entropy, or an irreversible process, and the law of absolute zero. It is widely believed that an irreversible process towards a stable condition of equilibrium of sliding to a state of maximum entropy (or disorder) could be one of the most universal regulators of all natural activities. Seemingly only after reversible processes

tending to a state of minimum entropy (order, highest orderness of energy). If the entropic regression from order to disorder is about chaotic disruptions of structure and organization, then its inverse, the entropic progression from disorder to order is about creative disruptions of structure and organization.

Its key concept, temperature, is an interrelationship of heat and energy. Thermodynamic forces are coming from heat and work interactions. The maximum work can be done if only the work producing process is completely reversible. For the fuels found in natures, like uranium or the fossill fuels of oil, gas or coal, it is required reversible nuclear reactions or reversible chemical reactions, respectively.

Thermodynamic processes can be carried out reversibly or irreversibly. Reversibility refers to performing a reaction continuously at equilibrium. A reversible process is a process whose direction can be "reversed" by inducing infinitesimal changes to some property of the system via its surroundings, without increasing entropy. Throughout the entire reversible process, the physical system is in an thermodynamic equilibrium with its surroundings.

In an ideal thermodynamically reversible process, the energy from work performed would be maximized, and that from heat would be minimized.

The thermodynamic reversibility is changes of a system's states made spontaneously or by interacting with other systems reversed to its initial state without leaving any net effects in the

systems involved.

The thermal processes embrace all the temperature changes to physical bodies (convection, cooling, heating), flow of heat, thermal conductivity, as well as the effects of thermal equilibrium radiation.

The reversal law involves thermodynamic systems in stable equilibrium states, as in classical thermodynamics, open physical systems in nonequilibrium states of nonequilibrium thermodynamics, or modern thermodynamics of dissipative systems. The nonequilibrium thermodynamics together with statistical thermodynamics studies a class of open thermodynamic systems, exchanging energy and matter with its environment, so intiating thermodynamic processes and phenomena, as thermoelectrical, galvanomagnetic, and thermogalvanomagnetic, in both directions, direct and reverse.

It is covered by the phenomenlogical equation: $\mathbf{J_i} = \sum_k L_{ik} \mathbf{X_k}$, the Onsager theorem and the Le Chatelier principle. For small fluctuations or deviations from the thermodynamic equilibrium, the equation describes the following processes.

The direct processes, when the thermodynamic force $\mathbf{X_k}$ is causing the same kind of thermodynamic flow $\mathbf{J_k}$, as a temperature gradient – heat flow. The cross-processes, where the thermodynamic force $\mathbf{X_k}$ is causing different kind of thermodynamic flow $\mathbf{J_i}$, as a temperature gradient – material flow in multicomponent systems, like as thermodiffusion, which

must run in both directtions, foreward and backward, having special names.

Last, not least, the reversibility principle governs a reversible chemical reaction in which no net change happens in the amount of reactantsand products. In such chemical equilibrium, the two opposing reactions go in both directions at equal rates, or velocities, varying with the temparature and pressure, as to the Le Chatelier principle.

There are a lot of thermal devices based on thermal effects involving heat and work interactions.

The electrical forces, processes, effects and applications

One of the basic physical forces is Coulomb force of interaction, attraction or repulsion of objects and particles due to their electric charge. Coulomb's Law is determining the electrostatic force as varied as an inverse square law directed in the radial direction, independent of the mass of the charged objects and liable the force superposition principle. Coulomb's law reminding a gravitational force is another good case of the symmetrical force-relationship. Later the concept of the electric field was constructef useful for determining the electrostatic force on an electric charge at any point in space.

Electromotive force is responsible for generating the electricity flow from one point to another, or an electric current as the time rate of change of electric charge.

The electrical processes cover all the effects of the dielectric

polarization of the material media and current electricity.

The magnetic forces, processes, effects and applications

Other basic physical forces is the Lorentz force of magnetism existing between two electric currents. Lorentz's Law describes the force on a charge moving in a magnetic field. It has the same mathematical form as Coulomb's Law except that like currents attract and unlike currents repel. Like the electric field, the magnetic field can be used to determine the magnetic force on an electric current at any point in space. The magnetic field exerts a force on all magnets, as the Earth's magnetic field causes compass magnets to become oriented by the magnetic force pulling on the needle.

The magnetomotive forces are producing a magnetic flux.

The magnetic processes include the effects of magnetization of solids, gases, atoms, molecules by an external magnetic field and also the phenomena binding changings of physical quantities characterizing magnetic phenomena in different physical media.

As a sample, we can mention the effect "Giant Magnetoresistance" as a sample of a huge magnetic inertia of magnetic resistence and the necessity of its converse effects.

The electromagnetic forces, processes, effects and applications

The forcible interrelations between electricity and magnetism result in a unified electromagnetic force acting on a charge.

This complex force-relationship can be written as a sum of the electrostatic force (due to the electric field) and the magnetic force (due to the magnetic field).

The mutual interactions of the electric and magnetic fields are producing a "self-generating" electromagnetic field freely propagating in space with the speed of light and transporting electromagnetic energy, radiation, as waves, and exerting so called pondermotive forces. Formally it is described by the Maxwell's Equations including the sources of the fields as being stationary and moving charges, and the interactions of the fields themselves, unifying a number of different insights and theories into a set of 20 scalar equations, which were later reformulated into 4 vector equations by Heaviside and Gibbs.

When the electromagnetic theory was combined with optics, it led to a full description of the electromagnetic spectrum, from radio waves to gamma rays.

While reconciling electromagnetic theory with the photoelectric effect and the nonexistence of the ultraviolet catastrophe, a new theory of electromagnetism was developed using quantum mechanics. This modification to electromagnetic theory resulted in quantum electrodynamics (QED) describing all electromagnetic phenomena as being mediated by wave–particles known as photons. The photons are the fundamental exchange particle accounting for all interactions relating to electromagnetism including the electromagnetic force.

The electromagnetic processes are coming from the mutual

interactions of electric and magnetic fields.

The electromagnetic induction is another strong case of the reversal principle and convertibility laws. A changing magnetic field caused by a varying current in a conductor induces an electromotove force, a voltage, which is inversly causing the current and a magnetic field, thus creating a forceful interrelationship.

The electromagnetic processes include all the effects of electromagnetic waves such as interactions and scatterings (including visible optical, X-rays and – rays bands) or the quantum field effects. Such effects are described by the nonlinear theory of fields.

Again, the electromagnetic theory of light is due to the Maxwell's ingenious conjecture: "if changing magnetic fields, then changing electric fields might create magnetic fields". The Reversibility Theory is replacing "might" with "must".

The mechanothermal and thermomechanical forces, processes, effects and applications

The mechanothermal and thermomechanical processes comprise all thermodynamic effects,

thermokinetic effects,

effects of thermal expansion in solids, gases and liquids,

thermomechanical effects in superflowing liquids (He II), and so on.

The thermoelectric and electrothermal forces, processes, effects and applications

The thermoelectric and electrothermal forces are caused by thermoelectricity and by difference of temperature.

The thermoelectric and electrothermal processes have to do with electricity generated by differences in temperature and vice versa.

They are involving such physical effects as thermoelectric and electrocaloric effects in solid conductors (Seebeck effect, Peltier effect, Thomson effect, and so on), as the direct Seebeck effect of generation of an electrical current in a circuit by the heat flow and the converse Peltier physical effect of generation of a heat flow by the current flow, as in refrigeration, and the Kelvin's effect involving the reversible generation of heat while a current flows in a conductor with a temperature gradient. It took almost 30 years to discover these interrelated effects and more then 130 years for useful applications, as thermoelectric devices, generators, thermocouples, coolers, etc.

Thermoelectric devices are defined as a sort of devices converting heat directly into elictricity or conversly transforming electrical energy into thermal power for heating or cooling. Based on thermoelectric and electrothermal effects, they work on interactions between the flow of heat and electricity through solid bodies.

The electro-magnetic and magneto-electric forces,

processes, effects and applications

The electro-magnetic and magneto-electric processes cover
the law of Bio-Savare-Laplace,
magneto-electric effects in antiferromagnetics,
the law of electro-magnetic induction (in conducting circuits), etc.

The magneto-electromagnetic and electromagnetic-magnetic forces, processes, effects and applications

The magneto-electromagnetic and electromagnetic-magnetic processes include Faraday effect, Cotton-Mouton effect in liquids, solids, gases and plasma, Seeman effect in atoms (the main effect in magnetooptics which study an influence of constant magnetic fields on the optical properties of physical systems or objects).

Inverse Faraday effect, inverse effect of Cotton-Mouton and inverse Seeman's effect in the same objects (liquids, solids, gases and plasma) fall under these processes as well.

Magneto-optic effects are when the presence of a quasistatic magnetic field is changing the way how an electromagnetic wave propagates through a medium. In a material, called gyrotropic or gyromagnetic, left– and right-rotating elliptical polarizations can propagate at different speeds, leading to a number of important phenomena.

When light is transmitted through a layer of magneto-optic material, the result is called the Faraday effect: the light's plane

of polarization can be rotated.

Author's PhD was devoted to discovering and systematizing the inverse magneto-optic effects, as inverse Faraday effects, generation of spontanous magnetic fields, in the nonlinear medium as thermonuclear plasma

(*Abdullaev A., Sov. J. Plasma Physics, 14, 214 (1988); (Abdullaev A., Frolov A., Inverse Faradey Effect in Relativistic Electron Plasma, JETF, 81, 917-932, 1981*)

The mechano-electromagnetic and electromagnetomotive forces, processes, effects and applications

The mechano-electromagnetic processes include all the quantum electrodynamic effects, like as

Compton effect and the inverse Compton effect,

Mossbauer effectnuclear -resonance.

In the framework of Quantum Electrodynamics, the process reversal law expressed by the equality between the probabilities of forward and reverse transitions.

For the classical mechano-electromagnetic processes, it is necessary to note the ponderomotive influence of light on a substance,

acousto-optical effects (e.g., soundluminescence of liquids),

dynamooptical effects in anisotropic media,

effects connected with charged particles emission transporting through matter (Cherenkov effect, friction and transition radiation),

external photoeffect, the effect of accelerating of charged particles (electrons) by intense electromagnetic fields – inverse Cherenkov effect , etc.

Pondermotive forces, as light pressure, are produced by powerful electromagnetic radiation.

The mechano-electric and electro-mechanical forces, processes, effects and applications

The mechano-electric processes (classical and quantum) and electro-mechanical processes include all the electrostriction's effects in solids (as piezoelectric effects in dielectrics, acoustoelectric effect in metals and semiconductors).

Dynamoelectric effects cover the focible relationships between mechanical force and electricity, while electrodynamic processes – the conversion of electrical energy into mechanical energy.

As the big applications are electrical motors and generators or dynamo machines, converting mechanical forces into electrical forces by the agency of electromagnetic induction..

In quantum physical limit, it is the quantum mechanical electrostatic Aaronov-Bohm effect, including inverse effect and so forth.

Piezoelectricity means electricity resulting from mechanical pressure or deformation, or the electric charge accumulated in solid materials (such as crystals, certain ceramics, and biological matter such as bone, DNA and various proteins) in reaction to

applied mechanical stress. It is discovered in 1880 by French physicists Jacques and Pierre Curie.

The piezoelectric effect is the electromechanical interaction between the mechanical and the electrical state in crystalline materials with no inversion symmetry, such as quartz, Rochelle salt, human bone, as well as engineered material, lithium niobate and lead zirconate titanate.

As a real process and effect, the piezoelectric effect is a reversible process: materials exhibiting the direct piezoelectric effect (the internal generation of electrical charge from an applied mechanical force) also exhibit the reverse piezoelectric effect (the internal generation of a mechanical strain from an applied electrical field).

The inverse piezoelectric effect refers to a deformation of these materials by an electric field, which causes tensile or compressive strains and stresses, depending upon the direction of the electric field, the direction of polarization in the material, and its connection to other structures.

Here is a sample addition of some areas of application of direct and converse piezoelectric effects and materials.

Actuators and Sensors, linear motors, rotary motors, and pumps, as well as load cells, pressure sensors, accelerometers, and gyroscopes.

Acoustics transducers to generate sound waves for miniature speakers in portable electronic devices, medical ultrasound devices, and SONAR transducers, such as the tonpilz transducer.

Acoustic waves generated by a tonpilz transducer with a piezo-stack actuator.

The direct piezoelectric effect allows piezoelectric materials for acoustic sensing in microphones, hydrophones, and acoustic-electric guitars. MEMS RF filters based on surface acoustic waves and bulk acoustic waves to convert electrical signals to elastic waves and then back to electrical signals; MEMS devices as micro-scale chemical and biological sensors, as quartz crystal microbalance. Microfluidics, inkjet printers use piezoelectric actuators, etc.

The same description could be performed for all physical processes, their effects, direct and inverse, and applications.

The mechano-magnetic forces, processes, effects and applications

The mechano-magnetic processes and magneto-mechanical processes contain all the magnetostriction effects (piezomagnetism) in ferromagnetics and antiferromagnetics, gyromagnetic effects in ferromagnetics (Einstein – de Haas effect, Barnet effect).

In quantum-mechanical limits, it is the magnetic effect of Aaronov-Bohm and the inverse to the magnetic effect of Aaronov-Bohm.

In the classical limit, there are magnetohydrodynamic effects in conducting liquids (turbulent dynamo-effects), gyromagnetic instabilities in plasma (Weibel effects), etc.

The thermomagnetic and magnetothermal forces, processes, effects and applications

The thermomagnetic and magnetothermal processes embrace the effects of changing of an object's temperature, or its internal energy induced by a change of its magnetic state (demagnetization or magnetization), especially well manifested in ferro-, ferri and antiferromagnetics (e.g., magnetocaloric effect).

Here it is also included the less known thermomagnetic effects in solids and plasma: when the change of a thermal state of matter brings about the change (generation) of a magnetic field.

The thermo-electromagnetic and electromagneto-thermal forces, processes, effects and applications

The thermo-electromagnetic and electromagneto-thermal processes include the effects of light scattering on the thermal fluctuations in gases, liquids, crystals, amorphous solids and high temperature plasma; thermal (electromagnetic) radiation, Joul heating of plasma by intense electromagnetic field, effects of thermal self-focusing of an electromagnetic beam in different physical media, etc.

The electro-electromagnetic and electromagneto-electrical forces, processes, effects and applications

The electro-electromagnetic and electromagneto-electrical

processes involve electrooptics studying the influence of a constant electric field on the optical properties of a substance and also the influence of light on media.

Here must be included

the Stark effect,

Kerr effect,

Pokels effect,

nonlinear optical effects such as electrostatic self-focusing of an electromagnetic beam, etc.,

electroluminescence in solids and gases,

the ventile photoeffect at the metal-semiconductor contact layer,

Damber effect in a semiconductor and recently found effects of electrostatic fields generation in plasma interacting with intense electromagnetic fields, and so on.

All in all, the total interconnection of physical phenomena, convertibility of all physical forces and reversibility of all physical effects, all is enabling to create revolutionary intelligent applications, like as Encyclopedic Knowledge Base in Physics for General AI systems.

(*А. Ш. Абдуллаев; База знаний энциклопедического искусственного интеллекта: Об исследовательском прототипе энциклопедической системы по физике, Москва, ВИНИТИ, 1989*).

Reversing Physical-Chemical Processes and Effects

Now adding chemical change to the above physical phenomena, we obtain a distributed network of heterogenous physico-chemical processes:

Mechanochemical processes;

QM-chemical processes;

Magnetochemical processes;

Electrochemical processes;

Thermochemical changes;

Radiation-chemical changes.

Each part of the disparate processes is capable to act as the cause and the effect of a forward process, as well as the cause and the effect of the converse process.

As an example, electrochemical phenomena consists of chemical changes of substances produced by electricity, while chemo-electrical processes represents the other way around. Then additionally to current electricity, static electricity, thermoelectricity, piezoelectric effect, photoelectricity and hydroelectricity we get galvanism, electricity produced by chemical action, as well as the converse chemo-electrical phenomena, when chemical reactions produce electrical fields.

Again, magnetochemistry is involved with the interrelationships of magnetic forces and chemical reactions.

For instance, such significant processes for all living systems as photochemical reactions, where chemical changes produced by radiation, infrared, visible, ultraviolet, fall into the causative couple of electromagnetic waves-chemical phenomena; both

photosynthesis and vision in living things come from the photochemical changes of substances.

In general, there are two complementary sciences: Physical Chemistry and Chemical Physics pertaining to the physical and chemical properties of matter.

All Nature is Reversible

Everything in the physical world is reversed, particles into anti-particles, matter into anti-matter, physical processes, effects, forces, interactions, reactions, all the known laws of physics, except the "weak interactions" between subatomic particles. The fundamental principles of Symmetry and Conservation have the ground in the Reversibility Principle as well.

The Reversibility Principle applies to all the Earth, both its physical or abiotic, nonliving and geophysical, and biotic, or living, parts of an integral complex of interdependent planetary systems, composing the ecosphere of the lithosphere, hydrosphere, atmosphere and biosphere of interacting living organisms.

The organic world of life sciences is a complement of the inorganic world of physical sciences. Biology, the science of living things and their vital processes, is dealing with all the physicochemical processes of life, at any level of organizations, molecules, cells, individuals, populations, biomes, biosphere, converting, processing or recycling the environmental nutrients

and energy.

Biological, or organic phenomena occurring in living organisms interacting with physical processes and chemical changes in both directions, forward and backward, like as:

bioelectricity and electro-organic phenomena, connecting electrical changes and biological processes,

thermogenesis and thermobiological phenomena, interrelating heat and organic actions.

All is subject to the Principle of Reversibility and Convertibility of Natural Processes, physical, chemical and biological:

biophysics and biochemistry,

molecular biology,

bioclimotology and bionomics or bioecology,

biofeedback and the natural circulation of energy and nutrients,

biochemical cycles of nature, gaseous and mineral, as the water cycle.

Real processes and actions, activities or operations works both forward and backward, without breaching a temporal consistency between the past, the present, and the future.

Postulated by the symmetric laws of nature, reverse processes can profoundly deepen all the established notions about the nature of forces.

Moreover, in understanding of the physical universe, a decisive role is to be played by a physical Theory of Everything

that aimed to unify all the fundamental forces involving the idea of convertibility and reversibility, along with symmetry and conservation, taking the physical processes and forces to be interrelared, acting backward as forward.

Today all the news are coming from the so-called reverse science and engineering. As it is said, a dog's biting a man is not news event, the real news is quite reverse and unexpected, a man's biting a dog. And it looks hardly to find a knowledge domain or practical sphere where the most innovational and ground-breaking ideas and strategies don't involve the reversing of conventional, normal, or primary order of things.

The **Reversibility Principle** enables creation of complex relational entity, the nonlinear circular process, a reciprocal natural relationship, or effective interaction of entities, operating as a mutual process, nonlinear system, or reflexive, self-referent entity, which is defined as a set (group, web, network, collection, or body) of changes (actions, activities, processes) that act on each other to form a single dynamic whole.

Such a reflexive, self-referent system of nature may include a great number of powerful loops, circles of causes, and networks of natural processes. But unlike the linear natural processes marked by linearity, irreversibility and equilibrium, the reciprocal and mutual processes and forcible natural interactions involve reversibility and convertibility, nonlinearity and disequilibrium, thus becoming the machinery driving the de facto universe as an ever-changing, dynamic and unstable but

scientifically predictable new smart world x.0.

Thus, all the forces of nature are reversibly interrelated, tied together, or mutually dependent, reversing the order of action, position, time, and properties, including

gravity,
heat,
magnetism,
electricity,
electromagnetism,
radiation,
mechanical force,
nuclear force,
chemical force,
biological actions.

Why the Reversibility Law of Nature?

The Faraday's intuitive belief in the unity of the forces of nature, or that all the forces of nature are but manifestations of a single universal force and must be convertible one into another, made possible the classical electromagnetic field theory, the first foundation of modern physics.

This contradiction is explained by the empirical, test-and-error methodology of physical science: "physics has evolved and continues to evolve without any single strategy", while its ultimate goal to find a unified set of principles and laws governing force and energy, matter and change as motion

at micro-, meso– and macro-world (Physical Sciences, the Encyclopedia Britannica, Knowledge in Depth, 1994).

Considering all that, we proposed a unified conceptual framework of physical phenomena defined as the Reversibility Theory pivoting the Force-Relationship, Reversibility, Convertibility and Unity (of Forces of Nature) and enabling a unified theory of physical forces and processes, as well as one single strategy of physical science.

It is providing the description of diverse physical forces and energies, processes and phenomena and the prediction of actions of physical forces and effects in the most systematic and consistent ways without having to resort to pure accidents and assumptions and guesses, and without considering the details of the courses of physical processes and systems.

The Principle of Reversibility combines all the key attribute of universal laws of nature: asserting the interdependence between varying quantities of physical properties; stating that physical events occur in an invariant order; enriching cause and effect relationships, and demonstrating a constant regularity in the relations or order of physical phenomena in the world, embracing the empirical regularities of numerous physical effects.

The reversibility properties of nature implies that everything in the physical world is converted and reversed, matter, energy, motion, and all physical phenomena (processes, effects, forces, interactions, reactions), from particles into anti-particles and matter into anti-matter, as quarks and leptons into antiquarks

and antileptons, to all the known and unknown laws of physics. The symmetry properties of nature and the conservation laws following from them might also have the ground in the Reversibility Principle of Nature, like as the symmetry of action and reaction forces.

If the reversibility properties of nature and the convertibility of energy and unity of the forces of nature had been formulated as a universal principle and basic laws since the very beginning of modern physics, we'd have different physical science, more logical and systematic, predictive and productive, more esthetic and attractive, smarter or more intelligent and machine-wise.

As known, the Nobel Prize in Physics has been awarded 109 times to 201 Nobel Laureates between 1901 and 2015, according to the Nobel Foundation. And the key achievements lie in the serendipitous and intuitive and ingenious discovering of empirical physical laws and effects, as the Lorentz-Zeeman effects, the Doppler effect, the Einstein's law of photoelectric effect, the Compton effect, the Cherenkov effect, the Mössbauer effect, or the Hall effects, within 100 years incrementally enriched with the discoveries of subatomic entities, symmetry principles, conservation laws and increasingly generalizing force fields theories.

Above all, the Reversibility Law of Nature implies that if there is a physical effect in nature, there must be its inverse, converse or reversed action, otherwise it is not a real effect. The electromagnetic theory of light is all due to the Faraday's

ingenious conjecture: “if changing magnetic fields create electric fields, then changing electric fields might create magnetic fields”, being mathematized by Maxwell.

Simply put, if there are
the Faraday effect,
the Lorentz-Zeeman effects,
the Doppler effect,
the Einstein’s photoelectric effect,
the Compton effect,
the Cherenkov effect,
the Mössbauer effect,
the Hall effects….,
there MUST be
Inverse Faraday effect,
Inverse Lorentz-Zeeman effects,
Inverse Doppler effect,
Inverse Einstein’s photoelectric effect,
Inverse Compton effect,
Inverse Cherenkov effect,
Inverse Mössbauer effect,
Inverse Hall effects,…, just by LAW, the Law of Reversibility of Forces and Convertibility of Effects.

The interconnection of physical phenomena, convertibility of all physical forces, and reversibility of all physical entities and effects, all is enabling to create revolutionary intelligent applications, like as Encyclopedic Knowledge Base in Physics

for General AI. (*А. Ш. Абдуллаев; База знаний энциклопедического искусственного интеллекта: Об исследовательском прототипе энциклопедической системы по физике, Москва, ВИНИТИ, 1989*).

MOST FUTURE TECHNOLOGIES AND INNOVATIVE APPLICATIONS WILL BE THE ENGINEERING PRODUCTS OF NATURAL SCIENCE XXI AND PHYSICS X.0 COMING FROM THE GENERAL REVERSIBILITY MECHANISM.

Technology X.0: Smart and Green Technologies: Reversible Machines and Universal Transformers

If science is the systematic study of the world, technology is generally viewed as the systematic study of techniques for changing the world, the human environment, by making and doing things, from simple machines to sophisticated technical innovations to complex machinery, as cars or airplanes.

Up to date to the universe of machinery consists of four major groups, as in:

physical machines;

instrumentation;

computing machines;

telecommunication systems.

All sorts of traditional machines and instrumentation come under the notion of devices capable to convert physical force and energy in any of its form, either mechanical, thermal, electrical, magnetic, nuclear, and chemical energy into mechanical energy,

mechanical forces and motions, or vice versa.

Commonly, physical machines are understood as devices having an input, an output and a mechanism effecting force and motion-modifying functions, linear motion to rotary motion or vice versa.

The special class of technological machines, prime movers, has as the input the force, power and energy from a natural force, moving water, air currents, mineral resources of heat, coal, gas, oil, uranium, etc., to transform it into mechanical forces. Nuclear reactors and internal-combustion engines as well as windmills, water-wheels, turbines and steam engines are all prime movers.

In general, for the physical machines, the five key groups are traditionally distinguished:

simple devices/ machine elements (the lever, wedge, wheel and axle, incline plane, pulley, and screw);

prime movers (eg, windmills, turbines, engines, fission reactors, or fusion reactors);

generators (eg, thermal, electric, hydraulic or pneumatic);

motors (eg, thermal, electric, hydraulic or pneumatic);

operators (eg, appliances and conveying machines).

The instrumentation equipment in turn involves measuring of all kinds of natural phenomena. Among the equipment are the instruments measuring and monitoring physical and chemical properties of a substance, as well as the biomedical instruments, like the X-ray machines, the CAT and NMR scanners.

A second category is sensors, devices detecting any energy

change to turn it into a measurable or recorded signal. The controls consist of valves, governors, switches, motors, gears, levers, pulleys, power screws, power chain drivers, and other like mechanisms.

The transducers underlie all measuring, analytic, monitoring, and controlling tools and instrumentation, and they are classified according to the form of energy to be transformed. The transducer contain a transforming element by which converts any kind of input energy into output energy, mechanical, thermal, magnetic, electric, nuclear, gravitational, or chemical. Or, the transducers produce output signal, as voltage, current, displacement, resistance, temperature, force when subjected to a stimulus – radiation, heat, sound, strain, vibration, pressure, acceleration, voltage, and force.

The class of computers as a group of discrete state electronic devices falls within the physical systems able to receive, store, transform, and modify information in all its forms (raw data, data structures, expertise, and knowledge) and formats (text, video, voice, graphics), as well as to control machinery.

The telecommunication systems are devices and techniques to transmit information in the form of voice frequencies, telegraph messages, television programs, or digital data via wire, radio, space satellite, or computer networks, like the Internet.

But the pinnacle of the energy transforming devices looks to be a complex mechanical system integrating machines of all major categories as one functional unit. It is technically feasible

because the direction of energy transformation in all the main energy conversion devices and systems comes to be reversible: any machine can have energy flow in either direction.

For instance, for thermoelectric devices, it is physically lawful to convert thermal power to electric power and vice versa. Or another near example, in electromechanical machines, mechanical energy may be converted into electrical energy realized in electrical generators as well as electrical energy into mechanical power implemented in electric motors. Or, it might be chemo-mechanical systems, such cars and jet engine airplanes, transforming the explosive effect of gasoline to power the wheels rotation or to provide a thrust by the reaction force of a powerful jet of heated gas.

The biggest issue of Technology 1.0, with its machinery, techniques and mechanisms, design and inefficiency, is that they are not in any ways smart or intelligent, but waste-making technologies. Such technology is conducive for most ecological problems, as the wastes and products of technical processes are polluting the environment and violating the natural balance of natural forces of regeneration and reversibility.

Technology X.0 is without polluting the ocean with radioactive waste of nuclear plants or the atmosphere by combustion products of transportation systems and industrial plants, like controlled thermonuclear fusion systems or electro-mechanical transportation.

It is about a new class of machines, Reversible Machines,

preserving a healthy environmental balance, with the optimal design and efficiency for converting natural forces of gravitation, heat, electromagnetism, chemical and nuclear reactions, or quantum gravity.

Of all sorts and types of machines, the most desired are reversible intelligent mechanisms capable of optimal closed-loop conversion, transfer, positioning and processing of materials, energy and information of any of various forms, as well as possessing the locomotion of any types: aquatic, fossorial, terrestrial, aerial, and space.

For, it appears the final cause of machine technology is to create universal machines both guided by feedback control mechanisms and capable to intelligently behave in a changing world: to map (perceive) environments, to have plans (beliefs), to reason (think) thoughts, solve problems, experience emotions, and achieve goals of any complexity.

The idea of a universal transformer has long been served for the engineers as the technological Holy Grail or the ideal model of machines. The universal transducers or reversible machines, as dynamo-electric machines or MHD machines, essentially revolve around the reversibility law. For a basic aspect of reversible automata is the rule that *the force (energy) conversion direction runs backwards, turns the other way round, transforming mechanical energy into electrical energy, as well as electrical power into mechanical motion*.

Through the reverse input function system, the universal

automaton becomes a self-governing and self-operating force/ energy/ information converting machine, regulating its behavior in different real circumstances by controlling its outputs in conformity to a set of standard programmed values stored in it, such as AI computing programs. Then, generally, the universal operator will involve all four categories of machines integrating them as one unit:

- reversible machines as power and motion source;
- transducers as the sensing instruments, controlling mechanisms, and actuating devices;
- the AI based reversible computers as the decision element storing all the basic world knowledge and activating the control system;
- the Future Internet of Everything as a worldwide digital network resource (Abdoullaev, A. (2008). The Knowledge Society Applications: The RRR Language Machines. IGI Global; http://www.igi-global.com/bookstore/chapter.aspx?titleid=28319).

Technology X.0 deals with interdisciplinary physico-technical sciences, emerging technologies, sophisticated technical innovations and complex cyber-physical ecosystems, as Future Internet of Everything, Encyclopedic AI, Universal Transformers, Intelligent Industry, or Technological Human Settlements of the Future, like as Intelligent Nations or Smart Green Cities.

Technology X.0 is about an intelligently expanding human

environment and big quest to explore the depths of an infinitely wonderful physical universe.

The Prospects of Emerging Technologies

The emerging technologies should be in line with the philosophy of New Physics and Technology X.0.

The most advanced technologies and breakthrough innovations and revolutionary applications are to reversibly convert natural forces, chemical, thermal, electrical, magnetic, electromagnetic, nuclear, gravitational and mechanical, in a closed loop, with zero-waste of energy.

The level of development of future technology and social communities is the capacity to control the forces of nature as according to **the Great Schema of Forces**:

Prime Force (ToE)::

Quantum Gravity Forces (Space Curvature, Standard Model of Cosmology; Electronuclear Force (GUT, Standard Model of Particle Physics)::

Strong Interaction (SU (3); Electroweak Interaction (SU(2) x U(1))::

Weak Interaction and Electromagnetism U(1em)::

Magnetism and Electricity::

Non-Fundamental Forces (contact forces, elasticity, viscosity, friction, pressure, etc.)::

normal force,

friction,

tension,

elastic forces,

continuum mechanics forces of pressure,

drag and stress,

fictitious forces coming from non-inertial reference frames,

the centrifugal force,

the Coriolis force,

general relativity gravity.

Accordingly, the top intelligent civilizations have extraordinary power of harnessing the Quantum Gravity Force, as in the hypothetical "Haven City of God" simulated by the NASA image on the book title page.

The future technological sciences, emerging technologies and technology x.0 advancement are presented in the SUPPLEMENT 1.

References: S&T XXI Monographic Series

Azamat Sh. Abdoullaev, SCIENCE AND TECHNOLOGY XXI: Physics X.0 & Technology X.0; EIS Encyclopedic Intelligence Systems; EU, Russia, 2016; ISBN set 978-9963-2202-1-2; ISBN 978-9963-2202-2-9

Azamat Sh. Abdoullaev, SCIENCE AND TECHNOLOGY XXI: Disrupting Modern Science, Technology and Engineering; EIS Encyclopedic Intelligence Systems; EU, Russia, 2016; ISBN set 978-9963-2202-1-2; ISBN 978-9963-2202-3-6

Azamat Sh. Abdoullaev, SCIENCE AND TECHNOLOGY XXI: The World, Global Knowledge Base and Encyclopedic AI;

EIS Encyclopedic Intelligence Systems; EU, Russia, 2016; ISBN set 978-9963-2202-1-2; ISBN 978-9963-2202-4-3

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Azamat Sh. Abdoullaev, SCIENCE AND TECHNOLOGY XXI: Russia at the Threshold of New Reality: Project RUSSIA XXI; EIS Encyclopedic Intelligence Systems; EU, Russia, 2016; ISBN 978-5-600-01518-0 (in Russian)

Supplement 1. New Technological Word

Biotechnology,
Nanotechnology,
Information Technology,
Cognitive Science,
Robotics and AI,
Computing and Communications,

Display Technology,
Electronics,
Robotics and Applied Mechanics,
Energy Systems,
Materials Science,
Manufacturing,
Space Technologies and Transportation

Future Technologies by Sectors: At Different Development Stages and Application Fields

Agriculture:

Agricultural robot,
Closed ecological systems,
Genetically modified food,
In vitro meat,
Kitchen meat incubator,
Vertical farming or Urban Agriculture

Sustainable Agriculture:

Genetic industries of renewable natural resources of agriculture, livestock, forestry, fishing, and natural processes

Biomedical:

Artificial uterus,
Body implants,
Prosthesis,
Cryonics,
Expressive augmentation,
Genetic engineering,

Hibernation or suspended animation,
Life extension,
Strategies for Engineered Negligible Senescence,
Oncolytic Virus,
Personalized medicine,
NG Genomics, full genome sequencing,
Synthetic biology,
Synthetic genomics,
Regenerative medicine,
Robotic surgery,
Tricorder,
Tissue engineering,
Virotherapy,
Vitrification or cryoprotectant

Displays:

3D displays,
Holography (Holographic display, Computer-generated holography),
Organic light-emitting transistor,
Screenless display (Virtual retinal display, Bionic contact lens),
EyeTap, etc.

Electronics:

Digital scent technology,
Electronic nose,
E-textiles,

Flexible electronics,
Memristor,
Spintronics,
Thermal copper pillar bump

Energy:

Renewable Energy Technologies,
Innovative Energy Storage,
Generation and Transfer

IT, Computing and Telecommunications:

Encyclopedic Intelligence
Ambient intelligence,
Artificial brain,
Artificial intelligence,
Atomtronics,
Augmented Reality,
Cybermethodology,
Virtual Reality;
Mobile Internet and Wireless Web,
Knowledge Work Automation,
the Internet of Things or M2M Internet,
Cloud Technology,
Advanced Robotics,
I-World Digital Platform: Smart World Applications (Intelligent Territories, Regions, Cities, Communities)

Manufacturing:

Additive Manufacturing or 3D/4D Printing,

Claytronics,
Molecular manufacturing,
Molecular assembler,
Materials science:
Advanced Materials,
Aerogel,
Cloak of invisibility,
Conductive Polymers,
Femtotechnology,
Picotechnology,
Graphene,
High-temperature superconductivity,
High-temperature superfluidity,
Metamaterials,
Multi-function structures,
Nanomaterials: carbon nanotubes, Programmable matter, Quantum dots, Silicene
Military:
Smart Weaponry,
Arms,
Weapons Systems,
Implements of War, or Munition,
Intelligent Defence Systems
Neuroscience:
Artificial brain,
Brain-computer interface,

Brain-reading,
Neuroinformatics,
Electroencephalography,
Neuroprosthetics (Visual prosthesis, brain implant, exocortex, retinal implant)

Space:

Asteroid mining,
Moon mining,
Domed city,
Inflatable space habitat,
Hypertelescope,
Force field,
Miniaturized satellite,
Alcubierre drive,
Propellant depot,
Reusable launch system,
Solar sail,
Space elevator,
Spaceplane,
Nuclear Launch Cannon,
High Altitude Platforms,
Orion Nuclear Starship,
Float to Orbit, etc.

Robotics:

Molecular nanotechnology,
nanorobotics,

Powered exoskeleton,
Self-reconfiguring modular robot,
Swarm robotics,
Unmanned vehicle

Transport:

Alternative fuel vehicle,
Autonomous Vehicles,
Vehicular communication systems (Artificial Passenger, Dedicated short-range communications, Intelligent transportation system),
Flexible wings (X-53 Active Aeroelastic Wing, Adaptive Compliant Wing),
Fluidic flight controls,
Flying car,
Hovertrain,
Ground effect train,
Maglev train,
Vactrain,
Hyperloop technology,
Pod Cars,
Jetpack,
Space Transportation Technologies,
Anti-gravity,
Other: Advanced Oil and Gas Exploration and Recovery, etc.
FUTURE ENERGY

Airborne wind turbine
Artificial photosynthesis
Biofuels
Concentrated solar power
Energy harvesting
Fusion power
Generation IV reactor
Grid energy storage
Home fuel cell
Hydrogen economy
LED lamp
Lithium-air battery
Molten salt reactor, Nantenna
Smart grid
Solar roadway
Space-based solar power
Wireless energy transfer
Vortex engine
GREEN ENERGY TECHNO-HUMAN COMMUNITIES, CITIES, STATES, REGIONS, AND CONTINENTS
FUTURE ICT TECHNOLOGIES
Ambient intelligence
Artificial brain
Artificial intelligence
Atomtronics
Augmented Reality

Brain-computer interface

Brain-reading, Neuroinformatics, Mind Uploading

Cybermethodology

Cyber Security (Network Security, Security Operations, Data Security, Access and Identity Control, Endpoint Security, Application Security)

Emerging memory technologies T-RAM, Z-RAM, TTRAM, CBRAM, SONOS, RRAM, Racetrack memory, NRAM, Millipede memory

Fourth-generation optical discs (3D optical data storage, Holographic data storage)

4G cellular communication (Mobile broadband, mobile TV, Interactive TV, 3D-TV, holographic cameras)

5G mobile communication (mobile smart cities)

General-purpose computing on graphics processing units

Machine augmented cognition, exocortices

Machine translation, Machine vision, Speech recognition

Mobile collaboration

Optical computing

Quantum computing, Quantum cryptography

Radio-frequency identification

Semantic Web or Web 3.0

Smart Mobile Internet and Wireless Web

Three-dimensional integrated circuit

Virtual Reality or Virtual World (3D Simulated Environment for Interaction and Personal Experience)

Immersive virtual reality (Virtusphere, 3rd Space Vest, haptic suit, immersive technology, simulated reality, holodeck)

Internet of Things, M2M Communications, Web of Things, Smart Web, Smart Cyberspace

INTERNET OF EVERYTHING, INTELLIGENT INTERNET; DIGITAL CITIES AND INTELLIGENT COMMUNITIES

FUTURE PHYSICAL WEAPON

Airborne laser (Advanced Tactical Laser, High Energy Liquid Laser Area Defense System)

Antimatter weapon

Caseless ammunition

Directed energy weapon

Electrolaser

Electromagnetic weapons

Electrothermal-chemical technology

Particle beam weapon

Plasma weapon

Pure fusion weapon

Sonic weapon

Stealth technology, Plasma stealth, Stealth aircraft, Radar-absorbent material

Vortex ring gun

Information or Cyber Warfare Weapons (Smart Cyber Security Systems and Tools)

SMART WEAPONRY, CYBER WARFARE AND

INTELLIGENT DEFENCE SYSTEMS

FUTURE SPACE

Asteroid mining

Moon mining

Domed city

Inflatable space habitat

Hypertelescope

Force field, Plasma window

Miniaturized satellite

Alcubierre drive

Propellant depot

Reusable launch system

Solar sail

Space elevator (Non-rocket spacelaunch, Orbital ring, Sky hook, Space fountain)

Spaceplane

Nuclear Launch Cannon

High Altitude Platforms, Aeroscraft

Orion Nuclear Starship

Float to Orbit

EXTRATERRESTRIAL SUSTAINABLE COMMUNITIES: Intelligent Domed Cities

http://www.slideshare.net/ashabook/smart-cosmos

http://www.slideshare.net/ashabook/space-platform

http://www.slideshare.net/ashabook/future-space

Future Technologies Advancement:
Agriculture,
Biomedical,
Electronics,
Energy,
ICT & Robotics,
Manufacturing,
Neuroscience,
Military,
Space,
Transport

Future Information, Future Knowledge, Science & Technology, and Future Intelligence

Future Web, Future Internet, Intelligent Internet, Smart WWW

Future Industry, Intelligent Integrated Industry

Future Government, Intelligent Global Government

Future Cities, Smart Green Urban Communities

Future Nations

Future Superpower

Post-Singularity World:
Scientific, Technological,
Social,
Economic,
Political,
Ecological Singularities

http://www.slideshare.net/ashabook/creating-the-future-tomorrows-world

Supplement 2. All Nobel Prizes in Physics

The Nobel Prize in Physics has been awarded 109 times to 201 Nobel Laureates between 1901 and 2015.

The Nobel Prize in Physics 2016

The 2016 Nobel Prize in Physics has not been awarded yet. It will be announced on Tuesday 4 October, 11:45 a.m. CET at the earliest.

The Nobel Prize in Physics 2015

Takaaki Kajita and **Arthur B. McDonald**

"for the discovery of neutrino oscillations, which shows that neutrinos have mass"

The Nobel Prize in Physics 2014

Isamu Akasaki, **Hiroshi Amano** and **Shuji Nakamura**

"for the invention of efficient blue light-emitting diodes which has enabled bright and energy-saving white light sources"

The Nobel Prize in Physics 2013

François Englert and **Peter W. Higgs**

"for the theoretical discovery of a mechanism that contributes to our understanding of the origin of mass of subatomic particles, and which recently was confirmed through the discovery of the predicted fundamental particle, by the ATLAS and CMS experiments at CERN's Large Hadron Collider"

The Nobel Prize in Physics 2012

Serge Haroche and **David J. Wineland**

"for ground-breaking experimental methods that enable measuring and manipulation of individual quantum systems"

The Nobel Prize in Physics 2011

Saul Perlmutter, **Brian P. Schmidt** and **Adam G. Riess**

"for the discovery of the accelerating expansion of the Universe through observations of distant supernovae"

The Nobel Prize in Physics 2010

Andre Geim and **Konstantin Novoselov**

"for groundbreaking experiments regarding the two-dimensional material graphene"

The Nobel Prize in Physics 2009

Charles Kuen Kao

"for groundbreaking achievements concerning the transmission of light in fibers for optical communication"

Willard S. Boyle and **George E. Smith**

"for the invention of an imaging semiconductor circuit – the CCD sensor"

The Nobel Prize in Physics 2008

Yoichiro Nambu

"for the discovery of the mechanism of spontaneous broken symmetry in subatomic physics"

Makoto Kobayashi and **Toshihide Maskawa**

"for the discovery of the origin of the broken symmetry which predicts the existence of at least three families of quarks in nature"

The Nobel Prize in Physics 2007

Albert Fert and **Peter Grünberg**

"for the discovery of Giant Magnetoresistance"

The Nobel Prize in Physics 2006

John C. Mather and **George F. Smoot**

"for their discovery of the blackbody form and anisotropy of the cosmic microwave background radiation"

The Nobel Prize in Physics 2005

Roy J. Glauber

"for his contribution to the quantum theory of optical coherence"

John L. Hall and **Theodor W. Hänsch**

"for their contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique"

The Nobel Prize in Physics 2004

David J. Gross, **H. David Politzer** and **Frank Wilczek**

"for the discovery of asymptotic freedom in the theory of the

strong interaction"

The Nobel Prize in Physics 2003

Alexei A. Abrikosov, **Vitaly L. Ginzburg** and **Anthony J. Leggett**

"for pioneering contributions to the theory of superconductors and superfluids"

The Nobel Prize in Physics 2002

Raymond Davis Jr. and **Masatoshi Koshiba**

"for pioneering contributions to astrophysics, in particular for the detection of cosmic neutrinos"

Riccardo Giacconi

"for pioneering contributions to astrophysics, which have led to the discovery of cosmic X-ray sources"

The Nobel Prize in Physics 2001

Eric A. Cornell, **Wolfgang Ketterle** and **Carl E. Wieman**

"for the achievement of Bose-Einstein condensation in dilute gases of alkali atoms, and for early fundamental studies of the properties of the condensates"

The Nobel Prize in Physics 2000

"for basic work on information and communication technology"

Zhores I. Alferov and **Herbert Kroemer**

"for developing semiconductor heterostructures used in high-speed– and opto-electronics"

Jack S. Kilby

"for his part in the invention of the integrated circuit"

The Nobel Prize in Physics 1999

Gerardus 't Hooft and **Martinus J.G. Veltman**

"for elucidating the quantum structure of electroweak interactions in physics"

The Nobel Prize in Physics 1998

Robert B. Laughlin, **Horst L. Störmer** and **Daniel C. Tsui**

"for their discovery of a new form of quantum fluid with fractionally charged excitations"

The Nobel Prize in Physics 1997

Steven Chu, **Claude Cohen-Tannoudji** and **William D. Phillips**

"for development of methods to cool and trap atoms with laser light"

The Nobel Prize in Physics 1996

David M. Lee, **Douglas D. Osheroff** and **Robert C. Richardson**

"for their discovery of superfluidity in helium-3"

The Nobel Prize in Physics 1995

"for pioneering experimental contributions to lepton physics"

Martin L. Perl

"for the discovery of the tau lepton"

Frederick Reines

"for the detection of the neutrino"

The Nobel Prize in Physics 1994

"for pioneering contributions to the development of neutron scattering techniques for studies of condensed matter"

Bertram N. Brockhouse

"for the development of neutron spectroscopy"

Clifford G. Shull

"for the development of the neutron diffraction technique"

The Nobel Prize in Physics 1993

Russell A. Hulse and **Joseph H. Taylor Jr.**

"for the discovery of a new type of pulsar, a discovery that has opened up new possibilities for the study of gravitation"

The Nobel Prize in Physics 1992

Georges Charpak

"for his invention and development of particle detectors, in particular the multiwire proportional chamber"

The Nobel Prize in Physics 1991

Pierre-Gilles de Gennes

"for discovering that methods developed for studying order phenomena in simple systems can be generalized to more complex forms of matter, in particular to liquid crystals and polymers"

The Nobel Prize in Physics 1990

Jerome I. Friedman, **Henry W. Kendall** and **Richard E. Taylor**

"for their pioneering investigations concerning deep inelastic scattering of electrons on protons and bound neutrons, which have been of essential importance for the development of the quark model in particle physics"

The Nobel Prize in Physics 1989

Norman F. Ramsey

"for the invention of the separated oscillatory fields method and its use in the hydrogen maser and other atomic clocks"

Hans G. Dehmelt and **Wolfgang Paul**

"for the development of the ion trap technique"

The Nobel Prize in Physics 1988

Leon M. Lederman, **Melvin Schwartz** and **Jack Steinberger**

"for the neutrino beam method and the demonstration of the doublet structure of the leptons through the discovery of the muon neutrino"

The Nobel Prize in Physics 1987

J. Georg Bednorz and **K. Alexander Müller**

"for their important break-through in the discovery of superconductivity in ceramic materials"

The Nobel Prize in Physics 1986

Ernst Ruska

"for his fundamental work in electron optics, and for the design of the first electron microscope"

Gerd Binnig and **Heinrich Rohrer**

"for their design of the scanning tunneling microscope"

The Nobel Prize in Physics 1985

Klaus von Klitzing

"for the discovery of the quantized Hall effect"

The Nobel Prize in Physics 1984

Carlo Rubbia and **Simon van der Meer**

"for their decisive contributions to the large project, which led to the discovery of the field particles W and Z, communicators of weak interaction"

The Nobel Prize in Physics 1983

Subramanyan Chandrasekhar

"for his theoretical studies of the physical processes of importance to the structure and evolution of the stars"

William Alfred Fowler

"for his theoretical and experimental studies of the nuclear reactions of importance in the formation of the chemical elements in the universe"

The Nobel Prize in Physics 1982

Kenneth G. Wilson

"for his theory for critical phenomena in connection with phase transitions"

The Nobel Prize in Physics 1981

Nicolaas Bloembergen and **Arthur Leonard Schawlow**

"for their contribution to the development of laser spectroscopy"

Kai M. Siegbahn

"for his contribution to the development of high-resolution electron spectroscopy"

The Nobel Prize in Physics 1980

James Watson Cronin and **Val Logsdon Fitch**

"for the discovery of violations of fundamental symmetry principles in the decay of neutral K-mesons"

The Nobel Prize in Physics 1979

Sheldon Lee Glashow, **Abdus Salam** and **Steven Weinberg**

"for their contributions to the theory of the unified weak and electromagnetic interaction between elementary particles, including, inter alia, the prediction of the weak neutral current"

The Nobel Prize in Physics 1978

Pyotr Leonidovich Kapitsa

"for his basic inventions and discoveries in the area of low-temperature physics"

Arno Allan Penzias and **Robert Woodrow Wilson**

"for their discovery of cosmic microwave background radiation"

The Nobel Prize in Physics 1977

Philip Warren Anderson, **Sir Nevill Francis Mott** and **John Hasbrouck van Vleck**

"for their fundamental theoretical investigations of the electronic structure of magnetic and disordered systems"

The Nobel Prize in Physics 1976

Burton Richter and **Samuel Chao Chung Ting**

"for their pioneering work in the discovery of a heavy elementary particle of a new kind"

The Nobel Prize in Physics 1975

Aage Niels Bohr, **Ben Roy Mottelson** and **Leo James Rainwater**

"for the discovery of the connection between collective motion and particle motion in atomic nuclei and the development

of the theory of the structure of the atomic nucleus based on this connection"

The Nobel Prize in Physics 1974

Sir Martin Ryle and **Antony Hewish**

"for their pioneering research in radio astrophysics: Ryle for his observations and inventions, in particular of the aperture synthesis technique, and Hewish for his decisive role in the discovery of pulsars"

The Nobel Prize in Physics 1973

Leo Esaki and **Ivar Giaever**

"for their experimental discoveries regarding tunneling phenomena in semiconductors and superconductors, respectively"

Brian David Josephson

"for his theoretical predictions of the properties of a supercurrent through a tunnel barrier, in particular those phenomena which are generally known as the Josephson effects"

The Nobel Prize in Physics 1972

John Bardeen, **Leon Neil Cooper** and **John Robert Schrieffer**

"for their jointly developed theory of superconductivity, usually called the BCS-theory"

The Nobel Prize in Physics 1971

Dennis Gabor

"for his invention and development of the holographic method"

The Nobel Prize in Physics 1970

Hannes Olof Gösta Alfvén

"for fundamental work and discoveries in magnetohydrodynamics with fruitful applications in different parts of plasma physics"

Louis Eugène Félix Néel

"for fundamental work and discoveries concerning antiferromagnetism and ferrimagnetism which have led to important applications in solid state physics"

The Nobel Prize in Physics 1969

Murray Gell-Mann

"for his contributions and discoveries concerning the classification of elementary particles and their interactions"

The Nobel Prize in Physics 1968

Luis Walter Alvarez

"for his decisive contributions to elementary particle physics, in particular the discovery of a large number of resonance states, made possible through his development of the technique of using hydrogen bubble chamber and data analysis"

The Nobel Prize in Physics 1967

Hans Albrecht Bethe

"for his contributions to the theory of nuclear reactions, especially his discoveries concerning the energy production in stars"

The Nobel Prize in Physics 1966

Alfred Kastler

"for the discovery and development of optical methods for studying Hertzian resonances in atoms"

The Nobel Prize in Physics 1965

Sin-Itiro Tomonaga, **Julian Schwinger** and **Richard P. Feynman**

"for their fundamental work in quantum electrodynamics, with deep-ploughing consequences for the physics of elementary particles"

The Nobel Prize in Physics 1964

Charles Hard Townes, **Nicolay Gennadiyevich Basov** and **Aleksandr Mikhailovich Prokhorov**

"for fundamental work in the field of quantum electronics, which has led to the construction of oscillators and amplifiers based on the maser-laser principle"

The Nobel Prize in Physics 1963

Eugene Paul Wigner

"for his contributions to the theory of the atomic nucleus and the elementary particles, particularly through the discovery and application of fundamental symmetry principles"

Maria Goeppert Mayer and **J. Hans D. Jensen**

"for their discoveries concerning nuclear shell structure"

The Nobel Prize in Physics 1962

Lev Davidovich Landau

"for his pioneering theories for condensed matter, especially liquid helium"

The Nobel Prize in Physics 1961

Robert Hofstadter

"for his pioneering studies of electron scattering in atomic nuclei and for his thereby achieved discoveries concerning the structure of the nucleons"

Rudolf Ludwig Mössbauer

"for his researches concerning the resonance absorption of gamma radiation and his discovery in this connection of the effect which bears his name"

The Nobel Prize in Physics 1960

Donald Arthur Glaser

"for the invention of the bubble chamber"

The Nobel Prize in Physics 1959

Emilio Gino Segrè and **Owen Chamberlain**

"for their discovery of the antiproton"

The Nobel Prize in Physics 1958

Pavel Alekseyevich Cherenkov, **Il´ja Mikhailovich Frank** and **Igor Yevgenyevich Tamm**

"for the discovery and the interpretation of the Cherenkov effect"

The Nobel Prize in Physics 1957

Chen Ning Yang and **Tsung-Dao (T.D.) Lee**

"for their penetrating investigation of the so-called parity laws which has led to important discoveries regarding the elementary particles"

The Nobel Prize in Physics 1956

William Bradford Shockley, **John Bardeen** and **Walter**

Houser Brattain

"for their researches on semiconductors and their discovery of the transistor effect"

The Nobel Prize in Physics 1955

Willis Eugene Lamb

"for his discoveries concerning the fine structure of the hydrogen spectrum"

Polykarp Kusch

"for his precision determination of the magnetic moment of the electron"

The Nobel Prize in Physics 1954

Max Born

"for his fundamental research in quantum mechanics, especially for his statistical interpretation of the wavefunction"

Walther Bothe

"for the coincidence method and his discoveries made therewith"

The Nobel Prize in Physics 1953

Frits Zernike

"for his demonstration of the phase contrast method, especially for his invention of the phase contrast microscope"

The Nobel Prize in Physics 1952

Felix Bloch and **Edward Mills Purcell**

"for their development of new methods for nuclear magnetic precision measurements and discoveries in connection therewith"

The Nobel Prize in Physics 1951

Sir John Douglas Cockcroft and **Ernest Thomas Sinton Walton**

"for their pioneer work on the transmutation of atomic nuclei by artificially accelerated atomic particles"

The Nobel Prize in Physics 1950

Cecil Frank Powell

"for his development of the photographic method of studying nuclear processes and his discoveries regarding mesons made with this method"

The Nobel Prize in Physics 1949

Hideki Yukawa

"for his prediction of the existence of mesons on the basis of theoretical work on nuclear forces"

The Nobel Prize in Physics 1948

Patrick Maynard Stuart Blackett

"for his development of the Wilson cloud chamber method, and his discoveries therewith in the fields of nuclear physics and cosmic radiation"

The Nobel Prize in Physics 1947

Sir Edward Victor Appleton

"for his investigations of the physics of the upper atmosphere especially for the discovery of the so-called Appleton layer"

The Nobel Prize in Physics 1946

Percy Williams Bridgman

"for the invention of an apparatus to produce extremely high

pressures, and for the discoveries he made therewith in the field of high pressure physics"

The Nobel Prize in Physics 1945

Wolfgang Pauli

"for the discovery of the Exclusion Principle, also called the Pauli Principle"

The Nobel Prize in Physics 1944

Isidor Isaac Rabi

"for his resonance method for recording the magnetic properties of atomic nuclei"

The Nobel Prize in Physics 1943

Otto Stern

"for his contribution to the development of the molecular ray method and his discovery of the magnetic moment of the proton"

The Nobel Prize in Physics 1942

No Nobel Prize was awarded this year. The prize money was with 1/3 allocated to the Main Fund and with 2/3 to the Special Fund of this prize section.

The Nobel Prize in Physics 1941

No Nobel Prize was awarded this year. The prize money was with 1/3 allocated to the Main Fund and with 2/3 to the Special Fund of this prize section.

The Nobel Prize in Physics 1940

No Nobel Prize was awarded this year. The prize money was with 1/3 allocated to the Main Fund and with 2/3 to the Special Fund of this prize section.

The Nobel Prize in Physics 1939

Ernest Orlando Lawrence

"for the invention and development of the cyclotron and for results obtained with it, especially with regard to artificial radioactive elements"

The Nobel Prize in Physics 1938

Enrico Fermi

"for his demonstrations of the existence of new radioactive elements produced by neutron irradiation, and for his related discovery of nuclear reactions brought about by slow neutrons"

The Nobel Prize in Physics 1937

Clinton Joseph Davisson and **George Paget Thomson**

"for their experimental discovery of the diffraction of electrons by crystals"

The Nobel Prize in Physics 1936

Victor Franz Hess

"for his discovery of cosmic radiation"

Carl David Anderson

"for his discovery of the positron"

The Nobel Prize in Physics 1935

James Chadwick

"for the discovery of the neutron"

The Nobel Prize in Physics 1934

No Nobel Prize was awarded this year. The prize money was with 1/3 allocated to the Main Fund and with 2/3 to the Special Fund of this prize section.

The Nobel Prize in Physics 1933

Erwin Schrödinger and **Paul Adrien Maurice Dirac**

"for the discovery of new productive forms of atomic theory"

The Nobel Prize in Physics 1932

Werner Karl Heisenberg

"for the creation of quantum mechanics, the application of which has, inter alia, led to the discovery of the allotropic forms of hydrogen"

The Nobel Prize in Physics 1931

No Nobel Prize was awarded this year. The prize money was allocated to the Special Fund of this prize section.

The Nobel Prize in Physics 1930

Sir Chandrasekhara Venkata Raman

"for his work on the scattering of light and for the discovery of the effect named after him"

The Nobel Prize in Physics 1929

Prince Louis-Victor Pierre Raymond de Broglie

"for his discovery of the wave nature of electrons"

The Nobel Prize in Physics 1928

Owen Willans Richardson

"for his work on the thermionic phenomenon and especially for the discovery of the law named after him"

The Nobel Prize in Physics 1927

Arthur Holly Compton

"for his discovery of the effect named after him"

Charles Thomson Rees Wilson

"for his method of making the paths of electrically charged particles visible by condensation of vapour"

The Nobel Prize in Physics 1926

Jean Baptiste Perrin

"for his work on the discontinuous structure of matter, and especially for his discovery of sedimentation equilibrium"

The Nobel Prize in Physics 1925

James Franck and **Gustav Ludwig Hertz**

"for their discovery of the laws governing the impact of an electron upon an atom"

The Nobel Prize in Physics 1924

Karl Manne Georg Siegbahn

"for his discoveries and research in the field of X-ray spectroscopy"

The Nobel Prize in Physics 1923

Robert Andrews Millikan

"for his work on the elementary charge of electricity and on the photoelectric effect"

The Nobel Prize in Physics 1922

Niels Henrik David Bohr

"for his services in the investigation of the structure of atoms and of the radiation emanating from them"

The Nobel Prize in Physics 1921

Albert Einstein

"for his services to Theoretical Physics, and especially for his discovery of the law of the photoelectric effect"

The Nobel Prize in Physics 1920

Charles Edouard Guillaume

"in recognition of the service he has rendered to precision measurements in Physics by his discovery of anomalies in nickel steel alloys"

The Nobel Prize in Physics 1919

Johannes Stark

"for his discovery of the Doppler effect in canal rays and the splitting of spectral lines in electric fields"

The Nobel Prize in Physics 1918

Max Karl Ernst Ludwig Planck

"in recognition of the services he rendered to the advancement of Physics by his discovery of energy quanta"

The Nobel Prize in Physics 1917

Charles Glover Barkla

"for his discovery of the characteristic Röntgen radiation of the elements"

The Nobel Prize in Physics 1916

No Nobel Prize was awarded this year. The prize money was allocated to the Special Fund of this prize section.

The Nobel Prize in Physics 1915

Sir William Henry Bragg and **William Lawrence Bragg**

"for their services in the analysis of crystal structure by means of X-rays"

The Nobel Prize in Physics 1914

Max von Laue

"for his discovery of the diffraction of X-rays by crystals"

The Nobel Prize in Physics 1913

Heike Kamerlingh Onnes

"for his investigations on the properties of matter at low temperatures which led, inter alia, to the production of liquid helium"

The Nobel Prize in Physics 1912

Nils Gustaf Dalén

"for his invention of automatic regulators for use in conjunction with gas accumulators for illuminating lighthouses and buoys"

The Nobel Prize in Physics 1911

Wilhelm Wien

"for his discoveries regarding the laws governing the radiation of heat"

The Nobel Prize in Physics 1910

Johannes Diderik van der Waals

"for his work on the equation of state for gases and liquids"

The Nobel Prize in Physics 1909

Guglielmo Marconi and **Karl Ferdinand Braun**

"in recognition of their contributions to the development of wireless telegraphy"

The Nobel Prize in Physics 1908

Gabriel Lippmann

"for his method of reproducing colours photographically based on the phenomenon of interference"

The Nobel Prize in Physics 1907

Albert Abraham Michelson

"for his optical precision instruments and the spectroscopic and metrological investigations carried out with their aid"

The Nobel Prize in Physics 1906

Joseph John Thomson

"in recognition of the great merits of his theoretical and experimental investigations on the conduction of electricity by gases"

The Nobel Prize in Physics 1905

Philipp Eduard Anton von Lenard

"for his work on cathode rays"

The Nobel Prize in Physics 1904

Lord Rayleigh (John William Strutt)

"for his investigations of the densities of the most important gases and for his discovery of argon in connection with these studies"

The Nobel Prize in Physics 1903

Antoine Henri Becquerel

"in recognition of the extraordinary services he has rendered by his discovery of spontaneous radioactivity"

Pierre Curie and **Marie Curie, née Sklodowska**

"in recognition of the extraordinary services they have rendered by their joint researches on the radiation phenomena discovered by Professor Henri Becquerel"

The Nobel Prize in Physics 1902

Hendrik Antoon Lorentz and **Pieter Zeeman**

"in recognition of the extraordinary service they rendered by their researches into the influence of magnetism upon radiation phenomena"

The Nobel Prize in Physics 1901

Wilhelm Conrad Röntgen

"in recognition of the extraordinary services he has rendered by the discovery of the remarkable rays subsequently named after him"

https://www.nobelprize.org/nobel_prizes/physics/laureates/

Supplement 3. List of Natural Effects

A

Accordion effect (physics) (waves)

Acousto-optic effect (nonlinear optics) (waves)

Aharonov–Bohm effect (quantum mechanics)

Antenna effect (digital electronics) (electronic design automation)

Anti-greenhouse effect (atmospheric dynamics) (atmospheric science) (astronomy) (planetary atmospheres)

Askaryan effect (particle physics)

Asymmetric blade effect

Auger effect (atomic physics) (foundational quantum physics)

Aureole effect (atmospheric optical phenomena) (scientific terminology)

Autler–Townes effect (atomic, molecular, and optical physics)

(atomic physics) (quantum optics)

Autokinetic effect (vision)

B

Bank effect (marine propulsion) (nautical terms) (water)

Barkhausen effect (condensed matter) (magnetism)

Barnett effect (condensed matter) (magnetism)

Bauschinger effect (classical mechanics) (materials science)

Bernoulli effect (equations) (fluid dynamics) (wind power)

Biefeld–Brown effect (physical phenomena) (propulsion)

Black drop effect (astronomical transits)

Blazhko effect (astronomy)

Bridgman effect (electricity) (electromagnetism)

Brookings effect (atmospheric science) (Curry County, Oregon) (Oregon coast) (Oregon geography) (winds)

Butterfly effect (chaos theory) (physical phenomena) (stability theory)

C

Callendar effect (atmospheric science) (climate) (climate change)

Captodative effect (organic chemistry)

Capture effect (broadcast engineering) (radio) (radio communications/) (telecommunications) (wireless communications)

Cascade effect (spaceflight)

Casimir effect (quantum field theory) (physical phenomena)

Catapult effect (electromagnetism)

Cheerio effect (fluid mechanics) (physics)

Cherenkov effect (experimental particle physics) (fundamental physics concepts) (particle physics) (special relativity)

Chorus effect (audio effects) (audio engineering) (effects units) (sound recording)

Christiansen effect (optical filters)

Christofilos effect (particle physics)

Cis effect (inorganic chemistry)

Coandă effect (aerodynamics) (boundary layers) (physical phenomena)

Cocktail party effect (acoustical signal processing) (attention)

Common-ion effect (ions) (physical chemistry)

Compton effect (astrophysics) (atomic physics) (foundational quantum physics) (observational astronomy) (quantum electrodynamics) (X-rays)

Coriolis effect (atmospheric dynamics) (classical mechanics) (force) (physical phenomena) (urban legends)

Cotton effect (atomic, molecular, and optical physics) (polarization)

Cotton–Mouton effect (magnetism) (optics)

D

De Haas–van Alphen effect (condensed matter) (magnetism) (quantum physics)

(de Sitter effect: see) Geodetic effect (general relativity)

Debye–Falkenhagen effect

Dellinger effect (radio communications)

Dember effect (electrical phenomena) (physics)

Dole effect (climatology) (oxygen) (paleoclimatology) (photosynthesis)

Domino effect (physic) (politics)

Doppler effect (Doppler effects) (radio frequency propagation) (wave mechanics)

E

Early effect (transistors)

Edison effect (atomic physics) (electricity) (Thomas Edison) (vacuum tubes)

Efimov effect (physics)

Einstein effect (disambiguation), several different effects in physics

Einstein–de Haas effect (science)

Electro-optic effect (nonlinear optics)

Electrocaloric effect (cooling technology) (heat pumps)

Electron-cloud effect (particle accelerators) (physics)

Electroviscous effects (colloid chemistry) (surface chemistry)

EMC effect (particle physics)

Emerson effect (photosynthesis)

Eötvös effect (geodesy) (topography)

Espresso crema effect (earth phenomena) (geology)

Ettinghausen effect (condensed matter) (electrodynamics) (thermodynamics)

Evershed effect (physics) (solar phenomena)

Exciter (effect) (audio effects) (effects units)

F

Fahraeus–Lindquist effect (blood) (fluid dynamics) (molecular and cellular biology)

Faraday effect (magnetism) (optics)

Ferroelectric effect (condensed matter physics) (electrical phenomena)

Floating body effect (electronics) (semiconductors)

Forbush effect (cosmic rays) (solar phenomena)

Fractional quantum Hall effect (physics)

Franssen effect (acoustics) (sound perception)

Franz–Keldysh effect (condensed matter) (electronic engineering) (electronics) (optics) (optoelectronics)

Free surface effect (fluid mechanics)

Fujiwhara effect (tropical cyclone meteorology) (vortices)

G

Garshelis effect (electric and magnetic fields in matter) (magnetism) (physics)

Gauche effect (stereochemistry)

Generation effect (cognitive biases) (memory biases) (psychological theories)

Geodetic effect (general relativity)

Giant magnetoresistive effect (condensed matter physics) (electric and magnetic fields in matter) (quantum electronics) (spintronics)

Gibbons–Hawking effect (general relativity)

Gibbs–Donnan effect (biology) (physics)

Gibbs–Thomson effect (petrology) (thermodynamics)

Glasser effect (physics)

Goos–Hänchen effect (optical phenomena)

Greenhouse effect (atmosphere) (atmospheric radiation) (climate change feedbacks and causes) (climate forcing)

Ground effect (aircraft) (aerodynamics)

Gull effect (diodes) (microwave technology) (physics) (terahertz technology)

H

Haas effect (audio engineering) (sound) (speakers)

Hall effect (condensed matter physics) (electric and magnetic fields in matter)

Hanbury Brown and Twiss effect (quantum optics)

Hot chocolate effect (acoustics) (physics) (wave mechanics)

Hundredth monkey effect (behavioral science) (New Age) (urban legends)

Hydrophobic effect (chemical bonding) (supramolecular chemistry)

Hyperchromic effect (biochemistry)

Hypersonic effect (acoustics) (hearing) (psychology) (ultrasound)

I

Ideomotor effect

Imbert–Fedorov effect (optical phenomena)

Inductive effect (chemical bonding)

Inert pair effect (atomic physics) (inorganic chemistry) (quantum chemistry)

Inverse Doppler effect (Doppler effects) (wave mechanics)

Inverse Faraday effect (electric and magnetic fields in matter) (optical phenomena)

Inverse magnetostrictive effect The inverse magnetostrictive effect (also known as magnetoelastic effect or Villari effect) is the name given to the change of the [magnetic susceptibility] of a material when subjected to a mechanical stress.

inverse piezoelectric effect

J

Jahn–Teller effect (condensed matter physics) (inorganic chemistry) (organometallic chemistry) (quantum chemistry)

Johnsen–Rahbek effect (classical mechanics) (electrical engineering)

Joule–Thomson effect (thermodynamics)

Josephson effect (condensed matter physics) (sensors) (superconductivity)

Jupiter effect (astronomy) (science book)

K

Kapitsa–Dirac effect (physics)

Kautsky effect (fluorescence)

Kaye effect (fluid dynamics)

Kendall effect (telecommunications)

Kerr effect (nonlinear optics)

Keystone effect (technology)

Kinetic isotope effect (chemical kinetics) (physical organic chemistry)

Kirkendall effect (chemistry) (metallurgy)

Klein–Nishina effect (quantum field theory)

Knife-edge effect (radio frequency propagation)

Kohn effect (physics)

Kondo effect (condensed matter physics) (electric and magnetic fields in matter) (physical phenomena)

Kozai effect (astronomy) (celestial mechanics)

L

Lake effect (snow or ice weather phenomena)

Landau–Pomeranchuk–Migdal effect (high-energy physics)

Larsen effect (audio feedback)

Lazarus effect (particle detectors)

LCD memory effect (display technology)

Leidenfrost effect (physical phenomena)

Lenard effect (physics)

Lense–Thirring effect (effects of gravitation) (tests of general relativity)

Leveling effect (chemistry)

Liquid Sky (effect) (lasers) (stage lighting)

Little–Parks effect (condensed matter physics)

Lockin effect (physics)

Lotus effect (nanotechnology)

Luxemburg–Gorky effect (radio communication) (radio spectrum)

M

(Mach effect: see) Woodward effect (spacecraft propulsion)

Magnetic isotope effect (physics)

Magneto-optic effect (electric and magnetic fields in matter) (optical phenomena)

Magneto-optic Kerr effect (condensed matter physics) (electric and magnetic fields in matter) (optical phenomena)

magnetocaloric effect (physical phenomena) (electric and magnetic fields in matter) (thermodynamics)

Magnus effect (fluid dynamics)

Malmquist effect (astronomy)

Malter effect (physics)

Marangoni effect (fluid dynamics) (fluid mechanics) (physical phenomena)

McCollough effect (optical illusions)

McGurk effect (auditory illusions) (perception) (psychological theories)

Meissner effect (levitation) (magnetism) (superconductivity)

Meitner–Hupfeld effect (particle physics)

Memory effect (electric batteries)

Mesomeric effect (chemical bonding)

Microwave auditory effect (cognitive neuroscience) (espionage) (hearing) (human psychology) (less-lethal weapons) (mind control) (sound)

Mikheyev–Smirnov–Wolfenstein effect (particle physics)

Miller effect (electrical engineering) (electronics terms)

Misznay–Schardin effect (explosives)

Mössbauer effect (condensed matter physics) (nuclear physics) (physical phenomena)

Mpemba effect (phase changes) (physical paradoxes) (thermodynamics)

Mullins effect (rubber properties)

Multiple-effect humidification (drinking water) (water supply) (water treatment)

Munroe effect (explosive weapons) (explosives)

N

Nernst effect (electrodynamics) (thermodynamics)

Non-thermal microwave effect (chemical kinetics)

Nordtvedt effect (astronomy) (astrophysics) (effects of gravitation) (relativity) (theoretical physics)

Novaya Zemlya effect (arctic) (atmospheric optical phenomena) (atmospheric science) (Novaya Zemlya) (solar phenomena)

Nuclear Overhauser effect (chemical physics) (nuclear magnetic resonance) (physical chemistry) (spectroscopy)

Numerosity adaptation effect (cognitive science) (optical illusions) (perception)

O

Observer effect (physics) (physics)

Okorokov effect (physics)

Oligodynamic effect (biology and pharmacology of chemical elements)

Onnes effect (condensed matter physics) (fluid mechanics) (helium)

Opposition effect (astronomy) (optical phenomena) (observational astronomy) (radiometry) (scattering, absorption and radiative transfer [optics])

Ouzo effect (Colloidal chemistry) (Chemical mixtures) (Condensed matter physics) (Soft matter) (Fluid dynamics)

P

Paschen–Back effect (atomic physics) (atomic, molecular, and optical physics) (magnetism)

Pauli effect (experimental physics) (parapsychology) (psychokinesis)

Payne effect (rubber properties)

Pearson–Anson effect (electronics)

Peltier–Seebeck effect (thermoelectric effect) (electricity) (HVAC) (physical phenomena) (thermodynamics)

Petkau effect (radiobiology)

Phaser (effect) (audio effects) (effects units)

Photoacoustic Doppler effect (Doppler effects) (radar signal processing) (radio frequency propagation) (wave mechanics)

Photoelectric effect (Albert Einstein) (electrical phenomena) (foundational quantum physics)

Photorefractive effect (nonlinear optics)

Photothermal effect (particle physics) (photochemistry) (physics)

Physical effect (physics)

Piezoresistive effect (electrical phenomena)

Plasma effect (demo effects)

Pockels effect (cryptography) (nonlinear optics) (polarization)

Polar effect (physical organic chemistry)

Portevin–Le Chatelier effect (engineering) (materials science)

Poynting effect (gases)

Poynting–Robertson effect (celestial mechanics)

Precedence effect (acoustics) (sound perception)

Primakoff effect (particle physics)

Proximity effect (atomic physics) (nuclear physics) (physics)

Proximity effect (audio) (acoustics)

Proximity effect (electromagnetism) (electrical engineering)

Proximity effect (electron beam lithography) (condensed matter physics)

Proximity effect (superconductivity) (superconductivity)

Pulfrich effect (3D imaging) (optical illusions)

Purkinje effect (optical illusions) (perception) (vision)

Q

QMR effect (electric and magnetic fields in matter) (magnetism) (optics) (optical phenomena)

Quantum confined stark effect (quantum mechanics)

Quantum Hall effect (Hall effect) (condensed matter physics) (quantum electronics) (spintronics)

Quantum Zeno effect (quantum measurement)

R

Raman effect (physics)

Ramsauer–Townsend effect (physical phenomena) (scattering)

Rebound effect (conservation) (economics paradoxes) (energy) (energy conservation)

Relativistic Doppler effect (Doppler effects) (special relativity)

Renner–Teller effect (molecular physics)

Reverse Cerenkov effect (physics)

Reverse short-channel effect (transistors)

Rope trick effect (nuclear weapons)

Rossiter–McLaughlin effect (Doppler effects) (extrasolar planets) (spectroscopy) (star systems)

Rusty bolt effect (radio electronics)

S

Sabattier effect (solarization) (photographic processes) (science of photography)

Sachs–Wolfe effect (astronomy) (physical cosmology)

Sagnac effect (optics) (relativity)

Scharnhorst effect (quantum field theory)

Schottky effect (diodes)

Screen-door effect (display technology) (technology)

Seeliger effect (astronomy) (observational astronomy)

Shapiro effect (effects of gravitation)

Shielding effect (atomic, molecular, and optical physics) (atomic physics) (chemistry) (quantum chemistry)

Shower-curtain effect (fluid dynamics)

Shubnikov–de Haas effect (science)

Silk screen effect (technology)

Simpson's paradox aka Yule–Simpson effect (probability) (statistics)

Skin effect (electronics)

Smith–Purcell effect (physics) (quantum optics)

Sound effect (film techniques) (sound effects) (sound production) (special effects)

Spin Hall effect (condensed matter physics) (Hall effect) (physics) (spintronics)

Stark effect (atomic physics) (foundational quantum physics) (physical phenomena)

Stewart–Tolman effect (electrodynamics)

Sunyaev–Zel'dovich effect (physical cosmology) (radio astronomy)

T

Thermal flywheel effect (heat) (thermodynamics)

Thermal Hall effect (condensed matter) (Hall effect) (superconductivity)

Thorpe–Ingold effect (chemical kinetics) (organic chemistry)

Threshold effect (particle physics) (physics) (renormalization group)

Trans effect (coordination chemistry)

Transformer effect (electrodynamics)

Transverse flow effect (aerodynamics)

Trench effect (fire)

Triboelectric effect (electrical phenomena) (electricity)

Twisted nematic field effect (display technology) (liquid crystal displays) (liquid crystals)

Twomey effect (air pollution) (atmospheric radiation) (clouds, fog and precipitation)

Tyndall effect (physical phenomena) (scattering)

U

Umov effect (astronomy) (observational astronomy) (planetary science)

Unruh effect (quantum field theory) (thermodynamics)

Urban heat island effect (climate change feedbacks and causes) (climate forcing)

V

Vaporific effect (fire)

Venturi effect (fluid dynamics)

Voigt effect (magnetism) (optics)

Vroman effect (molecular and cellular biology)

W

Wagon-wheel effect (optical illusion)

Walker effect (illusions of self-motion) (spatial misconception)

Warburg effect (biochemistry) (oncology) (photosynthesis)

Weissenberg effect (physics)

Wien effect (electrochemistry)

Wigner effect (condensed matter physics) (nuclear

technology) (physical phenomena) (radiation effects)

Wilson effect (astronomy) (Sun)

Wilson–Bappu effect (physics)

Wolf effect (scattering) (spectroscopy)

Woodward effect (spacecraft propulsion)

Y

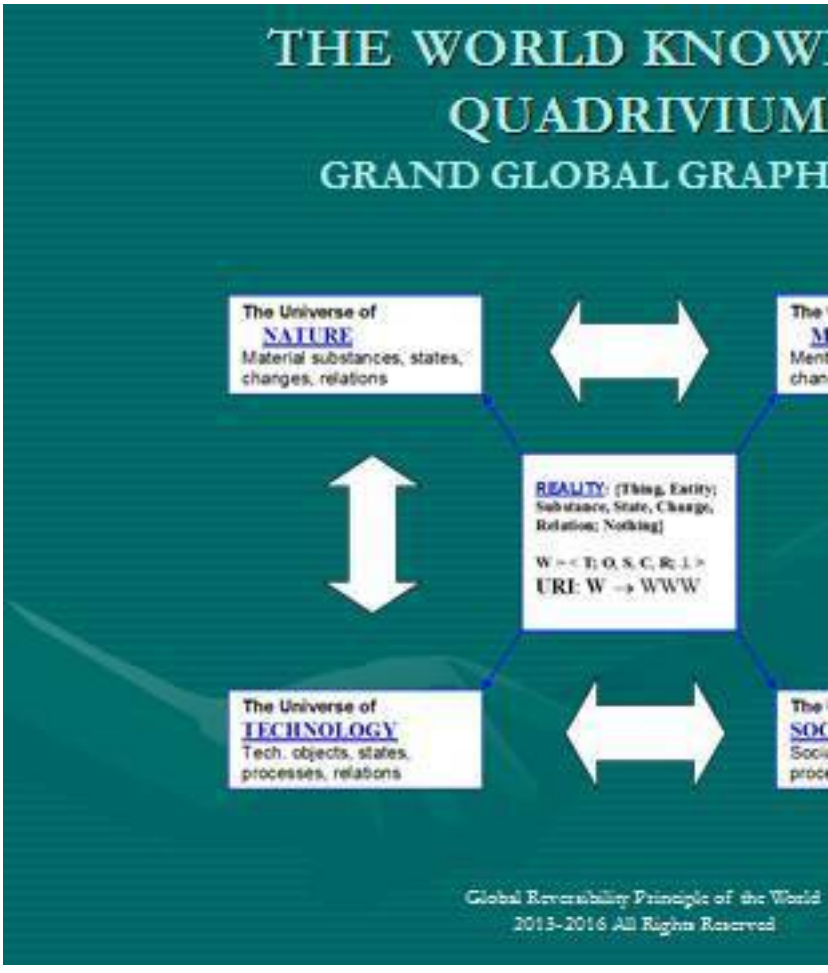
Yarkovsky effect (celestial mechanics)

Yarkovsky–O'Keefe–Radzievskii–Paddack effect (celestial mechanics)

Yule–Simpson effect (probability) (statistics)

Z

Zeeman effect (atomic physics) (foundational quantum physics) (magnetism) (physical phenomena) https://en.wikipedia.org/wiki/List_of_effects



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