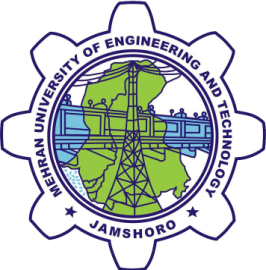
**MEHRAN UNIVERSITY OF ENGINEERING AND TECHNOLOGY,**

**JAMSHORO**

**Applied Physics**

**Assignment 02**

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# Q # 01:

## Discuss in detail the design procedure of modern regulated power supply?

# DC REGULATED POWER SUPPLY

# INTRODUCTION:

The linear voltage stabilizers with IC were the basis of the supply projects for many years now the time has come to modernize and replace them with analogous to much more efficient switching and equally easy to manage.

The linear voltage regulators are generally much more efficient and easier to use than equivalent circuits of voltage regulators realized with discrete components such as a zener diode and a resistor, or even transistors and operational amplifiers.

The most popular types of voltage regulators in a linear output are fixed and by far the series for positive output voltages and the 78XX series for negative output voltages 79XX These two types of complementary voltage regulators produce a precise voltage output and stable from about 5 volts until about 24 volts for the use in many electronic circuits.

A wide range of these voltage regulators adjustable fixing to three terminals, each with its own voltage regulation and current limitation of the embedded circuits. This allows us to create a whole series of different power outputs, both single or dual power supply, suitable for most of the circuits and electronic applications.

# METHODOLOGY AND PROCEDURE:

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from

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So

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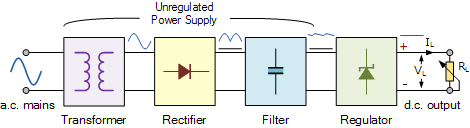
power

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this:







For definition, a switching mode power supply (SMPS) It is a type of power source that uses semiconductor switching techniques, rather than standard linear methods to provide the output voltage required. The basic scheme consists in a power switching stage and a control circuit. The power switching stage performs the circuits from the input voltage of the power conversion, Wine to its output voltage, Vout which includes the output filter.

## Circuit regulator transistor series

Here this simple emitter-follower regulator circuit consists of a single NPN transistor, and a DC bias voltage to set the output voltage required. Since an emitter follower circuit has a unitary voltage gain, applying a proper bias voltage to the base of the transistors, you get a stabilized output from the emitter terminal.

Given that a transistor provides current gain, the output load current will be much higher than the base current, even higher if you use a Darlington configuration.

The only condition is that the input voltage is sufficiently high to obtain the desired output voltage, the output voltage is controlled by the base voltage of the transistor.

In this example it comes 5,7 volts to produce an output of 5 volts to the load, additional 0.7V serve to compensate for the voltage drop between the terminals of the base and emitter. Then, based on the value of the base voltage, it is possible to obtain any value of the emitter output voltage.

The downside of this is that the series regulator transistor is continuously biased in its linear region, dissipates power in the form of heat as a result of its product VxI, since the entire load current must pass through the transistor, resulting in poor efficiency, wasted power and heat generation continues.

Furthermore, one of the disadvantages that the series voltage regulators have is that their nominal current of maximum continuous output is limited to a few amperes. So they are generally used in applications where low output power are required.

When you are prompted multiple output voltages or high currents, the normal practice is to use a switching regulator commonly known as *power supply* switching to convert the mains voltage to the power required in any other.

**power supplies switching**, O **SMPS**, They are becoming commonplace and replaced in most cases the traditional linear power as a way to reduce energy consumption, reduce the heat dissipation, as well as the size and weight.

Switching power supplies are now available in most PCs, power amplifiers, TV, DC motors, etc. Pretty much anything that requires highly efficient power because switching power supplies are becoming a mature technology.

The main advantage switching power supply is its greater efficiency, compared to standard linear regulators, and this is achieved by exploiting a transistor (or power MOSFET) including their status “ON” (full) and their status “OFF” ( cut-off), states that produce a lower power dissipation.

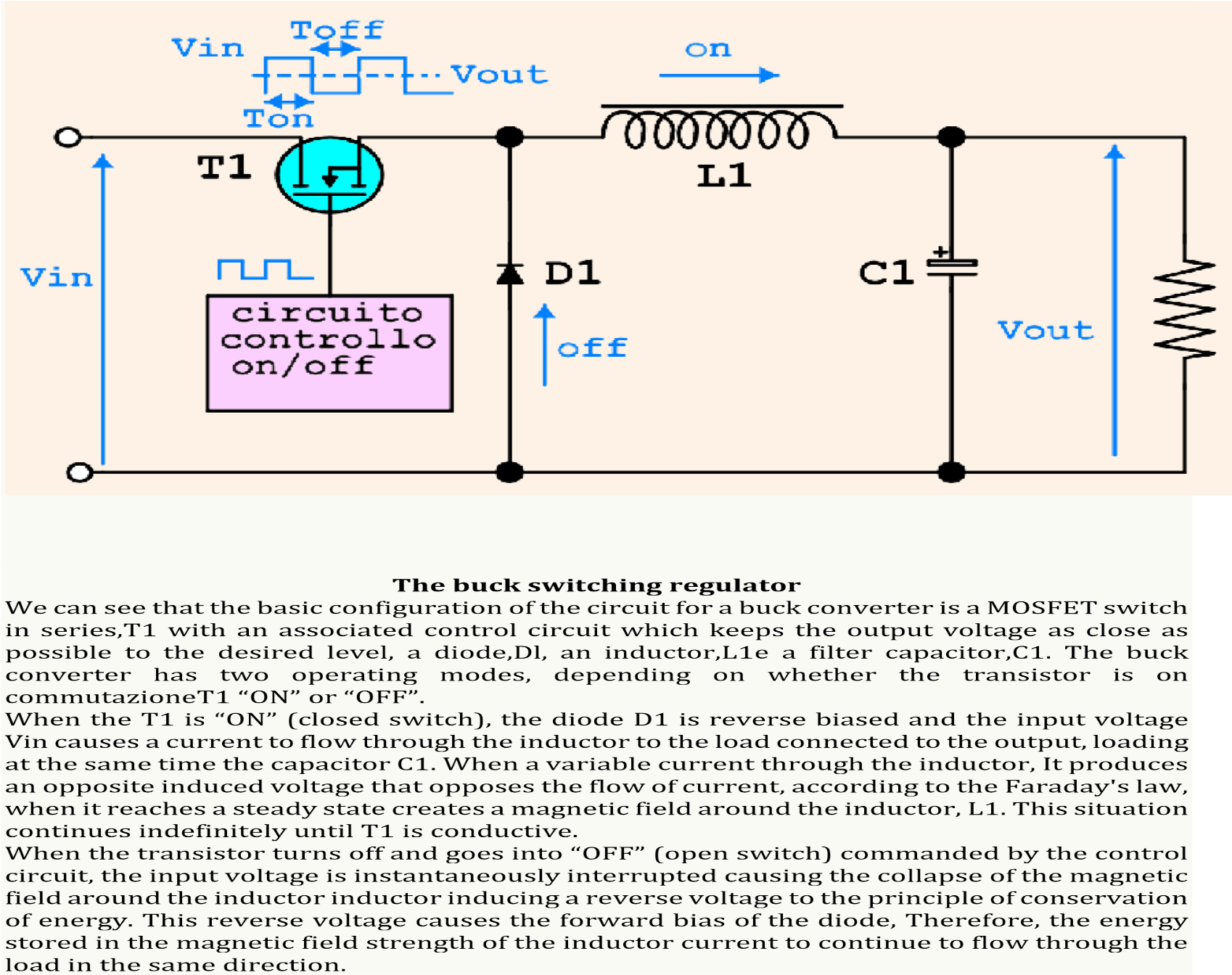
This means that when the switching transistor is completely “ON”, the voltage drop on it is at its minimum value and when the transistor is fully “OFF” there is no power dissipation. Then, the transistor behaves as an ideal switch.

Consequently, unlike linear regulators that provide only step-down voltage regulation, a switching power supply can provide step-down, step-up and negation of the input voltage using at least one of the three basic switch circuit topologies:*Buck*, *Boost* e *Buck-Boost*. The three types differ in the way in which the transistor, the inductor and the smoothing capacitor are connected inside the basic circuit.

## Feeder Buck

The **Buck regulator** It is designed to effectively reduce the DC voltage from a higher voltage to a lower without changing the polarity. In other words, the buck switching regulator is a step-down regulator circuit, thus for example a buck converter can convert +12 It was the +5 volt.

The buck switching regulator is a DC to DC converter and one of the easiest and most popular. The buck regulator switch uses a transistor in series or a power MOSFET or an IGBT as a main switching device as shown below, conventionally in the following schemes I will use a MOSFET as a switching element only because around the vast majority uses those but, the speech is equally true for BJT or IGBT.

Therefore, the inductor L1 returns the stored energy to the load by acting as a source and

providing power until all the energy stored is not returned to the circuit or until the switch (MOSFET) It closes again. At the same time discharging the capacitor contributes to the load. The combination of the inductor and the capacitor form an LC filter that attenuates any ripple created by the action of the switching transistor.

Therefore, when the solid-state switch is closed, power is supplied from power supply and when the switch is open, power is supplied from the inductor. Note that the current flowing through the inductor is always in the same direction, either directly or through it from the diode, but obviously at different times within the switching cycle.

Since the transistor switch is continuously closed and opened, the average value of the output voltage will then be dependent on the duty cycle D which is defined as the conduction time of the switch transistor during a whole switching cycle. If there is the supply voltage and timing “ON” e “OFF” for the switch are defined as: Ton e Toff, therefore the output voltage Vout is given as:



The duty cycle of the buck converters can also be defined as:



from here if we apply the previous formula we



So the greater the duty cycle D, the greater the power supply output voltage in switch mode. From this we can also see that the output voltage will always be lower than the input voltage because the work cycle, D can never achieve unity. The voltage regulation is obtained by varying the duty cycle and high switching speed, up to 200kHz, it is possible to use smaller components greatly reducing the size and weight in switch mode power supply, recently this limit has been largely overcome reaching Mhz for SMD assembly in which the coil must have a similar size to the other components.

With ideal components, or if the switching losses in the state “ON” were zero, the ideal buck converter may have efficiencies up to 100%.

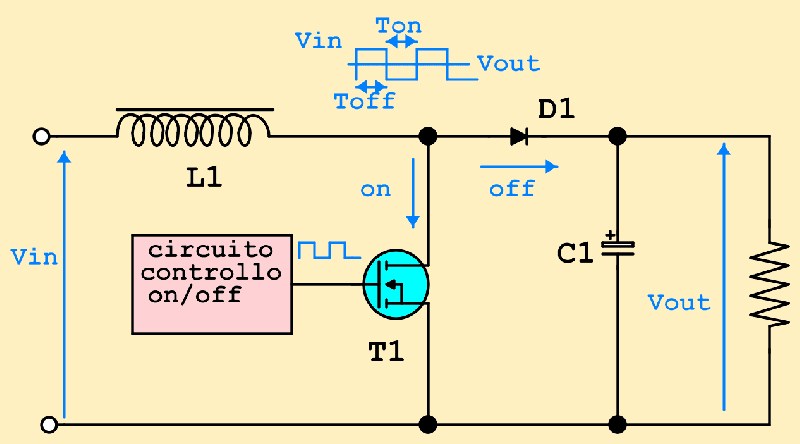
In addition to the controller **step-down buck** for the basic design of a switching power supply, There is another configuration, namely **step-up** O **Boost** Converter.

## Power boost

The **Boost switching regulator** is another type of power supply circuit in switch mode. It has the same components as the previous buck converter, but this time in different positions. The boost converter is designed to increase the DC voltage from a lower to a higher voltage, or increases the supply voltage, thereby increasing the available voltage across the output terminals without changing the polarity. In other words, the boost switching regulator is a

step-up regulator circuit, thus for example a boost converter can convert the voltage to be +5 It was the +12 volt.

We have seen earlier that the buck switching regulator using a switching transistor in series within its basic design. The difference with the design of *boost regulator* It is that it uses a switching transistor connected in parallel to control the output voltage from the sheet feeder in switch mode. Since the switch is effectively connected in parallel with the output, the energy passes through the inductor to the load only when the transistor is in “OFF” (open switch) as shown.



## The regulator switching boost

In the circuit *Boost Converter,* when the switch is in the "ON", the energy supply, Wine passes through the inductor and the transistor and feeding back. Consequently nothing passes the exit because the transistor switch creates a short circuit to the output. This increases the current flowing through the inductor as it has a shorter path to return to power. Meantime, the diode D1 inversely polarized because its anode is connected to ground through the switch while the cathode is at the voltage level at the output while the capacitor begins to discharge through the load.

When the transistor is off, the input power is now connected to the output through the inductor and diode connected in series. When the inductor field decreases, the energy stored in the inductor is induced thrust output from Vin, through the diode directly biased. The result of all this is that the reverse voltage induced by the inductor L1 is added to the supply voltage by increasing the total output voltage that becomes Vout = Vin + VL.

The current from the smoothing capacitor, C1 that was used to power the load when the switch was closed, is now provided to the input it from the condenser through the diode. So the current supplied to the capacitor is the diode current, that will always be ON or OFF since the diode is continuously switched between the state direct and the inverse value by the transistor switching actions. Then, the smoothing capacitor must be large enough to produce an output adjust and filter these peaks.

Since the induced voltage across the inductor L1 is negative, it is added to the source voltage, Wine, forcing the inductor current in the load. The output voltage of the boost converters is given by:

As with the previous buck converter, the output voltage from the boost converter depends on the input voltage and the duty cycle. Therefore, controlling the work cycle, You are obtained by the output regulation. Furthermore, this equation does not depend from the inductor value, ment from the load current or the output capacitor.

We have seen above that the basic operation of a switching power supply circuit may use a non-isolated buck configuration, or a boost configuration depending on whether you require a step-down output voltage (buck) o step-up (boost).

But we can also combine these two basic switching topologies in a single switching regulator circuit does not isolanto called, (coincidentally), with a huge stretch of the imagination, *BuckBoost Converter*.

## Buck-boost power supply

The **Buck-Boost switching regulator** It is a combination of the buck converter and the boost converter which produces an inverted output voltage (negative) which may be greater or less than the input voltage according to the work cycle. The buck-boost converter is a boost converter circuit variant in which the inverter converter delivers only to load only the energy stored by the inductor L1.

Below is the power supply circuit in buck-boost mode.

## The regulator switching buck boost

When the switch T1 is turned on (closed), the voltage across the inductor is equal to the supply voltage so that the inductor store energy input it from. No current is supplied to the load connected at its output because the diode, D1 is reverse biased. When the transistor is off (open), the diode becomes forward biased and the energy previously stored in the inductor is transferred to the load.

In other words, when the switch is on “ON”, the energy in the inductor is delivered from the supply and nothing is output.

When the switch is “OFF”, the inductor voltage is reversed and then the inductor itself becomes a source of energy, then the energy stored previously in the inductor is switched output (through the diode), nothing comes directly from the input source. Therefore, the voltage supplied to the load when the switching transistor is “OFF” It is equal to the induced voltage of the inductor.

The result is that the amplitude of the output voltage inverted can be greater than or less than or equal to the input voltage according to the work cycle. Eg, a buck-boost converter can convert from 5 It was the 12 volt (step-up) Oh yes 12 It was the 5 volt (step-down). In the buck-boost switching regulators the Vout is given as:

So the buck-boost regulator has this name because the output voltage that may be higher (as one of boost power stage) or less (as a buck power stage) of the input voltage. However, the output voltage has opposite polarity to the input voltage.

## Switch Mode Riepilogo

The modern switching power supply, o SMPS, it uses solid state switches to convert a DC input voltage is not regulated in a DC regulated output voltage at different voltage levels. The power supply of DC voltage can be a real input from a battery or a solar panel, or a rectified DC voltage from an AC power supply using a diode bridge together with some additional capacitive filters.

The main advantage of this is that the energy efficiency of the controller can be quite high because the transistor is fully turned on and conductor (full) or completely off (break).

There are different types of converter DC to DC available, the most commonly used three switching power supply topologies are known as *Buck*, *Boost* e *Buck-Boost*. All three of these topologies are not isolated, ie their input and output voltages share a common ground line. The adjustment of the output voltage is obtained by controlling the percentage of time in which the switching transistor is in the state “ON” out of the total ON time / OFF. This ratio is called the duty cycle and varying the duty cycle, D can be controlled by the amplitude of the output voltage Vout.

The use of a single inductor and diode and solid state switches with fast switching able to operate at switching frequencies in the order of kilohertz can greatly reduce the size and weight feeder. However, if it is required the isolation between the input and output terminals, it is necessary to include a first converter transformer.

The buck converter is designed to convert electrical energy from a starting voltage to a lower. The buck converter operates with a switching transistor connected in series. Since the duty cycle, D <1 , the buck output voltage is always lower than the input voltage.

The boost converter is designed to convert electrical energy from a starting voltage to a higher. The boost converter operates with a switching transistor connected in parallel which determines a direct current path between Vin and Vout through the inductor L1 and the diode D1. This means that there is no protection against output short-circuit.

By varying the duty cycle, (D) a boost converter, the output voltage can be controlled and with D <1, the DC output from boost converter is greater than the input voltage Vin as a result of self-induced voltage of the inductors.

Furthermore, it is assumed that the output smoothing capacitors in power supplies to **commutation** They are old enough, such as not to be discharged in the absence periods of energy supplied by the source with the switching, which translates into a constant output voltage.

With this I end this discussion on the types of switching power supplies with the hope of being able to persuade people to come to this type in the design of their works be it hobby or semi-professional. Basically once we understand how we can stop watching them with suspicion and fully experimented.

# LITERATURE REVIEW:

In paper (Shoewu, et. al., 2011) the author has designed and developed simple but efficient digitally controlled regulated power supply of a variable voltage ranging from 0v to 15v with a maximum output current of 5A. The approach employed here is generally an embedded system, designed around an intelligent microcontroller which is provided with a digitized reference voltage to control the input and the output liquid crystal display for the provision of greater precision, stability and accurate results. In paper (Adelakun, et. al., 2014) the design of the uninterrupted power supply (UPS) for personal computer (PC) for personal computer desktop workstations is carried out. Apart from its original functionality as a backup source of power, this design incorporates the unit within the system unit casing, thereby reducing the number of system components available. From the literature survey, the design and development of the power supply for the multiple power source is already developed, the only limitation with the existing work is to provide short circuit protection for the developed regulated power supply unit. This motivated us to design and develop the multiple source regulated DC power supply unit with short circuit protection.

## RESULTS AND DISCUSSION

The developed power supply is tested and the output of each section is measured. The summary of the results are hereby discussed as follows.

### **Testing and Measurement**

Tests were conducted on the developed power supply unit. These include short circuit test and earthing test. The output measurement was done using digital multimeter. In each segment, measurement of the output was made ten times and the average of the measured values was obtained.

### **Short Circuit Test**

Short circuit test conducted on the four sections of the power supply showed that the tripping circuit worked efficiently by tripping on the LED in each of the section specially designed to show short circuit.

# CONCLUSIONS

Power supply is used in most of the domestic and the laboratory equipment in order to power the smaller system or the devices. The developed multi-output power supply consists of four segmental outputs; Fixed DC 5 V output, variable DC output 0-15 V, regulated dual rectified DC output +12 V and – 12V. The variable DC output produced values ranging from

0-15V and regulated dual outputs produced ±12V and regulated DC will produce the 5V. Short circuit for the DC circuits while fuses were used to protect the AC circuit. Short circuit test and earthing test were carried out on the developed power supply unit. The output measurements showed that the developed power supply was effective and the measured values gave minimum variation from the nominal designed values. The developed system is cheap, robust and very useful for domestic application and laboratory experimental purposes.

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# Q: NO: 02

**Role of Physics in Daily Life**

# ABSTRACT

Physics extends well into your everyday life, describing the motion, forces and energy of ordinary experience. In actions such as walking, driving a car or using a phone, physics is at work. For everyday living, all the technologies you might take for granted exploit the rules of physics.An easy place to see physics in action is with a simple lever – most easily observed at a park. Levers come in three flavors, each with varying fulcrum locations. They serve to magnify force, lessening the effort needed to move an object on the opposing end. A simple “see-saw” at a park consists of a lever (the locations for sitting) and the fulcrum (placed in the middle). The two opposing forces counterbalance each other, creating a smooth ride through the air. At the same park you'll see a slide, a device that combines the stairs going up with the slide going down, both examples of inclined planes. The inclined plane eases the effort of climbing by spreading it over a longer distance. The smooth slide returns you gently to earth, slowing the influence of gravity just enough to make it fun. The transportation industry is no stranger to the manipulation of everyday physics. Cars and trains utilize the wheel, which provides a smooth, steady motion. Newton's laws of motion are at work as mechanical force and acceleration, action, reaction and inertia. Airplanes take it one step further, allowing lift as well as forward momentum. They manipulate physics – much like birds – by creating lift through wing shape as well as the wing’s angle – both of which serve to alter airflow. Physics is all relative. This theme resonates through Einstein’s special and general theories of relativity. Einstein's work is crucially important to GPS in your phone, for example. It takes radio signals from several satellites orbiting the Earth and calculates your location accurate to several centimeters. Because the speed and height of the satellites alters the signal very slightly, the smartphone adjusts the results using Einstein's theories. Without a helping hand from relativity, GPS would be far less accurate or useful. Even as you read this sentence, physics is at work. The eyes evolved in many species – through several examples of convergent evolution – harnessing the electromagnetic spectrum. The ears hear sounds which occur through the movement of air molecules. And the chemistry that drives all of biology depend on the physics of energy and molecules. Every day, for example, plants absorb sunlight, water and carbon dioxide, creating glucose and releasing oxygen as a byproduct.

# Literature Review

Out of the 54 analyzed articles, 20 proposed new didactical teaching strategies, and only five came from Brazilian periodicals. Thirteen of those 20 had been implemented and ten had been evaluated: three received both qualitative and quantitative evaluation, while the other seven underwent a qualitative analysis. The others were categorized as pertaining to articles stressing scientific dissemination. Following are presented articles proposing teaching didactical strategies, beginning with those that propose, implement, and qualitatively evaluate them.

Toigo (2006), as previously seen, after developing activities about biomechanics with elementary school students in their physical education classes, analyzed the students’ comments, which, by the way, helped their own learning since they could put into practice the theoretical knowledge they had constructed. Bravo and Rocha (2008) wrote their article based on a six-year longitudinal study (case study) with students enrolled in the three last years of elementary school and the three years of high school6. Their aim was to verify how students learn contents on vision and colors, and what ideas a group of students had about these topics as they progressed along their school years. The authors displayed the students’ major conceptions in relation to such topics. They carried out a painstaking analysis of the students’ answers in order to describe and characterize these students’ ways of knowing.

Debru (2001) in his article focused on the history of Helmholtz’s discovery, in the 1850s, of the speed of nervous impulse/momentum in frogs and of its consequences in human physiology. Helmholtz’s conceptions of temporal space had applications both in psychology and physiology. Two main outcomes of those studies were his conclusions that neither environmental stimuli reached the brain simultaneously nor information sent by the brain could get immediately processed into actions. Nye (2000) proceeded to summarize Linus Pauling’s works because of his relevant contributions to biology, physics, and chemistry, which could describe him as an interdisciplinary researcher. An example of that was his discovery in quantum physics of energy resonance for which Pauling found much broader application in chemistry. Nye uses 89 bibliographic references, most of them papers written by Pauling himself.

Mosini (2000) centered on the history of resonance starting from the emergence of that theory with interpretations of Pauling and Wheland up to its modern application to medicine, more specifically in Nuclear Magnetic Resonance equipments.

Domenech and Navarro (2005) analyzed information available from the Spanish press in the period of 1943-1970 concerning medical equipments. According to the authors, the publications found in the periodic contributed to establish in Spain, an identity, reinforcing the self-sufficient, important information after the Spanish civil war. This is due to port war there were many pestilences, epidemics, so the means of communication showed investments on health area, helped the government to remain with in control.

Netto (2009) presented a historical perspective of the Ansonica Brasileira de Física Médica (Brazilian Association of Medical Physics) and its contribution to the development of medical physics in Brazil. Silva (2011) mentioned differences and similarities between medical physics in Brazil and in other countries, such as the United States and Germany, in which medical physicists were recognized as pivotal professionals quite differently from what occurs in Brazil. It was just recently, in 2011, that the medical physicist became a professional accredited with the International Professional Classification. The author also gave some details on the 18th edition of the International Conference on Medical Physics that first happened in Brazil in 2011.

# Methodology

Initially, there was a search in the previously mentioned periodicals for articles that had a connection with physics applied to medicine. Then it could be noticed that just one of those articles had a theoretical framework while all of them lacked an epistemological basis. Out of the totality of articles , there were just nine produced by professionals of the science teaching area, while the remaining ones came from the “hard sciences” area, what can somewhat justify this lack. The next step was to categorize these articles in agreement with the parameters proposed by Greca and Moreira (2001) adapting them to the issue presented in this article because the categories proposed by those authors were applied to Quantum Mechanics. They divided the articles they had found into three groups that were adapted to fit the present article objective:

Investigações em Ensino de Ciências – V20(1), pp. 60-78, 2015 !63!1) Students’ conceptions about physics applied to medicine; 2) Appraisal/evaluation of introductory courses of physics applied to medicine; 3) New proposals of didactic strategies. Articles categorized here complying with the first and second groups are scarce here. In the third group there were proposals for the inclusion of specific topics, shift of focus, curricular changes, and inclusion of new technologies (especially of computational resources). Such proposals, out of which only a few of them had actually been implemented and undergone evaluation, referred to contents taught at elementary, high school, and college teaching. In this study articles were also categorized into five other sets: 1) Study of body fluids; 2) Radiations; 3) Historical approach; 4) Use of equipment’s that apply physics to medicine; 5) Influence of media. The proposals of new didactic strategies were dealt with considering whether they had, or not, been implemented; they had, or not, undergone an evaluation process (qualitative, quantitative or data triangulation); the articles had, or not, a theoretical, experimental character, or both. The organization of these articles into the groups proposed here, certainly, is just one way of categorizing them and, besides, some of the articles can be inserted into more than one category. It is necessary to point out that data presented here are those that the articles display, though some of them lack supplemental information to help the authors of this paper attain a more qualified analysis. It must be said that there has not been any reinterpretation of the students’ conceptions about the physical concepts the articles’ authors manifested in each article so that such concepts should correspond to their authors’ own conceptualizations. It seems important to clarify at this point that carrying out a critical analysis of the literature reviewed here has not been part of this article objectives.

# Results

The corpus of this article comprises 52 articles, out of which 22 focus on teaching and 28 aim at scientific dissemination, and consequently they were not organized according to teaching level. The authors, as we could identify them, are majorly ‘hard science’ researchers, while only a few carry out research on the teaching area. Just four articles in Brazilian journals and five in international ones were produced by teaching professionals. It might be for this reason that just one article presents a theoretical framework while not a single one has an epistemological background. Only 11 of the international periodicals talk about the use of new technologies, whereas the Brazilian ones not even mention it. A feature to be stressed here is the focus on theory most of these articles have, since only 14 of them comprise experimental activities. There are 20 articles that refer to radiations, 10 to heart functioning and cardiovascular system, and five approach the functioning of the respiratory system. Students’ conceptions linked to physics applied to medicine

There are four articles in Brazilian journals and three in international ones that report research aiming at perceiving the students’ prior conceptions about a given subject, The first one of them, “Ondas, Sonido y Audición: Ideas Previas de los Estudiantes en Ciancia Médicas”2, (Aiziczon , 2007) writes about the application of two questionnaires to medical students, in which the second one is more structured than the first one, and are directed at detecting what kinds of prior knowledge could hinder learning and what knowledge students already had could become subsumes to facilitate the learning of a given topic. Such findings were applied to develop activities that could improve the learning of physics in the health area by using the students’ identified prior knowledge and their interests in such topics. Aiziczon (ibid.) evidenced the following alternative conceptions in those medical students: • Not adequately discriminating between sound wave and acoustic perception; • Getting confused about sound as a wave or physical phenomenon, and sound as hearing; • Not differentiating wave from vibration, and vibration from sound; • Inadequately relating intensity to pain and intensity with the human ear frequency.

# Discussion

Although much progress has been made in high-energy, quantum, and astronomical physics, many everyday phenomena involving complexity, chaos, or turbulence are still poorly understood. Complex problems that seem like they could be solved by a clever application of dynamics and mechanics remain unsolved; examples include the formation of sandpiles, nodes in trickling water, the shape of water droplets, mechanisms of surface tension catastrophes, and self-sorting in shaken heterogeneous collections.

These complex phenomena have received growing attention since the 1970s for several reasons, including the availability of modern mathematical methods and computers, which enabled complex systems to be modeled in new ways. Complex physics has become part of increasingly interdisciplinary research, as exemplified by the study of turbulence in aerodynamics and the observation of pattern formation in biological systems. In the 1932 Annual Review of Fluid Mechanics, Horace Lamb said:

I am an old man now, and when I die and go to heaven there are two matters on which I hope for enlightenment. One is quantum electrodynamics, and the other is the turbulent motion of fluids. And about the former I am rather optimistic.

# Conclusion

Physics is one of the oldest academic disciplines and, through its inclusion of astronomy, perhaps the oldest.[9] Over much of the past two millennia, physics, chemistry, biology, and certain branches of mathematics were a part of natural philosophy, but during the Scientific Revolution in the 17th century these natural sciences emerged as unique research endeavors in their own right. Physics intersects with many interdisciplinary areas of research, such as biophysics and quantum chemistry, and the boundaries of physics are not rigidly defined. New ideas in physics often explain the fundamental mechanisms studied by other sciences and suggest new avenues of research in academic disciplines such as mathematics and philosophy.

Advances in physics often enable advances in new technologies. For example, advances in the understanding of electromagnetism, solid-state physics, and nuclear physics led directly to the development of new products that have dramatically transformed modern-day society, such as television, computers, domestic appliances, and nuclear weapons advances in thermodynamics led to the development of industrialization; and advances in mechanics inspired the development of calculus.

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# Q: NO: 03

# Describe Modern physics; problems and solutions

# ABSTRACT

Some of the major unsolved problems in physics are theoretical, meaning that existing theories seem incapable of explaining a certain observed phenomenon or experimental result. The others are experimental, meaning that there is a difficulty in creating an experiment to test a proposed theory or investigate a phenomenon in greater detail. Can quantum mechanics and general relativity be realized as a fully consistent theory (perhaps as a quantum field theory)? [1] Is space-time fundamentally continuous or discrete? Would a consistent theory involve a force mediated by a hypothetical graviton, or be a product of a discrete structure of space-time itself (as in loop quantum gravity)? Are there deviations from the predictions of general relativity at very small or very large scales or in other extreme circumstances that flow from a quantum gravity theory? [2]

In general, there are some unanswered questions or complex concepts in modern physics. These issues are divided into two categories:

A: The questions that modern physics does not have answers for, and the physicists believe that it is due to the inability of theories.

B - Complex concepts that seem unrealistic, but physicists have admitted they do not know the problems of modern physics.

There are concepts and equations in physics (classical mechanics, relativity and quantum mechanics) that we can use to reach an understanding that is able to be experienced and by which we can review relativistic Newton's second law.

Using the revised relativistic Newton's second law, we can make it easier to express complex concepts in modern physics and respond to many unanswered questions in modern physics.

Modern physics; problems and solutions

2

Reconsidering the relativistic Newton's second law is a powerful tool that deepens our understanding of space-time and can be an important step in understanding the nature of interactions and unifying them easier.

Keyword: graviton, photon, relativity, blue shift, pair production, virtual photon, interactions, Zero point energy, Singularity

# LITERATURE REVIEW

The theory of quantum electrodynamics was born immediately following the formulation of quantum mechanics. In 1927 Dirac put Maxwell’s classical theory of electromagnetism together with Planck’s and Einstein’s ideas of quanta [1]. The following year he came up with his famous equation describing a relativistic electron [2], and with that all the ingredients for a quantum field theory of an electron interacting with photons (light quantum) were present. In two decisive papers in 1929 Heisenberg and Pauli [3, 4] developed a consistent theory of quantum electrodynamics. (For a detailed history of the development of quantum electrodynamics, see [17]. For scientific biographies of Julian Seymour Schwinger (1918–94) and Richard Feynman (1918–88), who solved the problems of QED?

# QUESTIONS AND COMPLEX CONCEPTS /METHADLOGY

In this paper are a lot of unanswered questions and complex concepts of which the most important parts have been propounded and at the end of each question the paper of solution is given here.

1-

Infinity in space-time: Assume that the observable universe would collapse due to gravity, is there any force that can counteract the gravity collapse in the universe? In other word, after the universe collapses, how and by which law (or force) will the universe expand again? A gravitational singularity or space-time singularity is a location where the quantities that are used to measure the gravitational field become infinite in a way that does not depend on the coordinate system. These quantities are the scalar invariant curvatures of space-time, which includes a measure of the density of matter. For the purposes of proving the Penrose– Hawking singularity theorems, a space-time with a singularity is defined to be one that contains geodesics that cannot be extended in a smooth manner. The end of such a geodesic is considered to be the singularity. This is a different definition, useful for proving theorems. The two most important types of space-time singularities are curvature singularities and conical singularities. Singularities can also be divided according to whether they are covered by an event horizon or not (naked singularities). According to general relativity, the initial state of the universe, at the beginning of the Big Bang, was a singularity. Both general relativity and quantum mechanics break down in describing the Big Bang. My question is, if the universe collapses, will it reach to infinite density and zero volume? Or is there a force that will counteract it? (For solution see [3]).

2-

Reviewing the special relativity postulates, always raises some questions like, “Does the constant speed of light (photon energy), result from a natural accident?” or “what is the difference between the characteristics of mass and energy while the speed rate of energy is fixed; the speed of matter can change and cannot reach the speed of light?”. Meanwhile when the physical and chemical processes occur, some amount of matter is converted into energy; what happens during this process that mass with non-constant speed is converted into energy with the constant speed? (For solution see [4]).

3-

According to the fundamental particle physics theories and energy issues in the production and decay of pairs of matter–antimatter are included in finding the common features between matter and energy which can be considered the constant velocity of photon as a property that can be transmitted from matter into energy and vice versa and also differences in the mass, structure of matter and its relation fields are explained by the relationship between length contraction (reduce in volume) and relativistic mass and relativistic Newton second law which show the mass variations (i.e., the infinite speed in classical mechanics is replaced by the infinite mass). Infinite mass is not observable (such as infinite velocity), how can we explain the limit of speed without infinite mass? (For solution see [4]).

4-

This may probably seem an unusual question in physics however; taking it into consideration may lead us to solve some of the problems in this science. As every physicist knows, in quantum mechanics and relativity, it has been accepted that field and mass-energy are two separable items. In general relativity, gravity is replaced by space-time, therefore it is is not a fundamental force. Quantum mechanics is a very good set of mathematical models that show how many elementary forces work, but it does not explain how they work. What is the main obstacle in the way of uniting the four forces and all of the elementary particles? We do not know how a charged particle produces an electric field or virtual photons in quantum mechanics. And many other unanswered questions. Maybe thinking about this seems useless or maybe it can be a step in order to find a theory of super-symmetry. Is it possible for force, energy and mass to convert to each other? If not, why? If so, how? (For solution see [5]).

5-

Late nineteenth century physics was faced with a crisis in the speed of light and energy. Quantum characteristic of radiation was proposed by Max Planck and during the past century his theory was developed and it reached to the quantum mechanics and elementary particles models. Einstein proposed the speed of light by special relativity theory. In this theory the speed of light in inertial frame of reference is constant “c”, and also it is the limit rate of speed. On the other hand, visible light is a radiation which is the small part of electromagnetic spectrum. The question is: On the constancy of the speed of light: a nature law or a natural accident! (For solution see [4]).

6-

The Einstein field equations or Einstein equation are not a dynamical equations that describe how matter and energy change the geometry of space-time, this curved geometry being interpreted as the gravitational field of the matter source. Einstein tried to propound geometrical structures of space by mathematical equations. So, he used non-Euclidian geometry. There are three considerable notes on Einstein’s equations;

# DISCUSSIONS

1-

Einstein Field Equations do not come from the equivalence principle directly. These equations are simply equations that are suitable for general relativity.

2-

There is a physical explanation for the path of light in a gravitational field. Although explaining the frames of reference is a physical concept, there is not any explanation of how gravitational field affects photons in general relativity. Then how can we explain this phenomenon by quantum mechanics?

3-

Space-time is a continuous quantity in general relativity. But the changing of photon frequency and production of energy are quantized. That gravitational blue shift (or red shift) is a special case of gravitational field that affects the photon. My question is therefore: how can we explain the gravitational blue shift according to the relationship between photon energy and its frequency? (For solution see [6]).

7-

The important concept in relationship between 'mass' and energy is c, regarding the phenomena of creation and decay of electron-positron pair, why do the related photons move at constant speed, but we could change the speed of matter and antimatter? What is the unique characteristic of matter which is convertible to photons that move with constant speed c (speed of light)? The idea that object/particle could not travel at superluminal speeds, originates from the structure of matter and the mechanism of interaction between field and mass; that with presenting a postulate we could generalize the constancy of speed from energy to mass. By gravitational blue shift, the energy of photon and consequently its frequency will increase. What is the mechanism of increasing in the photon energy that causes increase in its frequency? Are there more results than before in the energy-mass equivalence equation? (For solution see [7]).

8-

All our theories today seem to imply that the universe should contain a tremendous concentration of energy, even in the emptiest regions of space. The gravitational effects of this so-called vacuum energy would have either quickly curled up the universe long ago or expanded it too much greater size. The Standard Model cannot help us understand this puzzle, called the cosmological constant problem [8].

9-

The expansion of the universe was long believed to be slowing down because of the mutual gravitational attraction of all the matter in the universe. We now know that the expansions accelerating and that whatever causes the acceleration (dubbed “dark energy”) cannot be Standard Model physics. [8]

10-

There is very good evidence that in the first fraction of a second of the big bang the universe went through a stage of extremely rapid expansion called inflation. The fields responsible for inflation cannot be Standard Model ones. [8]

11-

The Standard Model cannot include gravity, because it does not have the same structure as the other three forces. In expressing these mysteries, when I say the Standard Model cannot explain a given phenomenon, I do not mean that the theory has not yet explained it but might do so one day. The Standard Model is a highly constrained theory, and it cannot ever explain the phenomena listed above. [8]

12-

Richard Feynman once quipped that "Time is what happens when nothing else does." But Julian Barbour disagrees: if nothing happened, if nothing changed, then time would stop. For time is nothing but change. It is change that we perceive occurring all around us, not time. Put simply, time does not exist. [9] Efforts to understand time below the Planck scale have led to an exceedingly strange juncture in physics. The problem, in brief, is that time may not exist at the most fundamental level of physical reality. If so, then what is time? And why is it so obviously and tyrannically omnipresent in our own experience? (For solution see [10]).

“The meaning of time has become terribly problematic in contemporary physics,” says Simon Saunders, “The situation is so uncomfortable that by far the best thing to do is declare oneself an agnostic.” [11] The question is, what is the physical nature of time? Which physical beings are not subject to the passage of time? (For solution see [10]).

13-

In quantum electrodynamics (QED) a charged particle emits exchange force particles continuously. This process has no effect on the properties of a charged particle such as its mass and charge. How is it explainable? If a charged particle as a generator has an output known as a virtual photon, what will be its input? (For solution see [5]).

14-

Zero-point energy, also called quantum vacuum zero-point energy, is the lowest possible energy that a quantum mechanical physical system may have; it is the energy of its ground state. All quantum mechanical systems undergo fluctuations even in their ground state and have an associated zero-point energy, a consequence of their wave-like nature. The uncertainty principle requires every physical system to have a zero-point energy greater than the minimum of its classical potential well. This results in motion even at absolute zero. For example, liquid helium does not freeze under atmospheric pressure at any temperature because of its zero-point energy. If the zero point energy in space (vacuum) exists, how we can describe it without using the uncertainty principle? (For solution see [5]).

15-

In quantum mechanics, the concept of a point particle is complicated by the Heisenberg uncertainty principle, because even an elementary particle, with no internal structure, occupies a nonzero volume. There is nevertheless a distinction between elementary particles such as electrons, photon or quarks, which have no internal structure, versus composite particles such as protons, which do have internal structure. According to the quantum mechanics that photon is an unstructured particle, how can we explain the

Relationship between the photon energy and frequency, and also pair production and decay? (For solution see [12]).

16-

QED rests on the idea that charged particles (e.g., electrons and positrons) interact by emitting and absorbing photons, the particles of light that transmit electromagnetic forces. These photons are virtual; that is, they cannot be seen or detected in any way because their existence violates the conservation of energy and momentum. If the electromagnetic field is defined in terms of the force on a charged particle, then it is tempting to say that the field itself consists of photons which cause a force on a charged particle by being absorbed by it or simply colliding with it - as in the Photo-electric effect. The electric repulsion between two electrons could then be understood as follows: One electron emits a photon and recoils; the second electron absorbs the photon and acquires its momentum. Clearly the recoil of the first electron and the impact of the second electron with the photon drive the electrons away from each other. So much for repulsive forces. How can attraction be represented in this way? The uncertainty principle makes this possible. The attraction between an electron and a positron may be described as follows: the electron emits a photon with momentum directed away from the positron and thus recoils towards the positron. This entails a degree of definiteness in the momentum of the photon. There must be a corresponding uncertainty in its position - it could be on the other side of the positron so that it can hit it and knock it towards the electron. Is there a way to explain virtual photon (in fact interaction between charged particles) without using the uncertainly principle? (For solution see [5]).

17-

In physics, the graviton is a hypothetical elementary particle that mediates the force of gravitation in the framework of quantum field theory. If it exists, the graviton must be mass less (because the gravitational force has unlimited range) and must have a spin of 2. This is because the source of gravitation is the stress-energy tensor, a second-rank tensor, compared to electromagnetism, the source of which is the four-current, a first-rank tensor. Additionally, it can be shown that any mass less spin-2 field would be indistinguishable from gravitation, because a mass less spin-2 field must couple to (interact with) the stress-energy tensor in the same way that the gravitational field does. This result suggests that if a mass less spin-2 particle is discovered, it must be the graviton, so that the only experimental verification needed for the graviton may simply be the discovery of a mass less spin-2 particle. (For solution see [4]).

Gravitons are postulated because of the great success of quantum field theory (in particular, the Standard Model) at modeling the behavior of all other known forces of nature as being mediated by elementary particles: electromagnetism by the photon, the strong interaction by the gluons, and the weak interaction by the W and Z bosons. The hypothesis is that the gravitational interaction is likewise mediated by a – yet undiscovered – elementary particle, dubbed the graviton. In the classical limit, the theory would reduce to general relativity and conform to Newton's law of gravitation in the weak-field limit. However, attempts to extend the Standard Model with graviton has run into serious theoretical difficulties at high energies (processes with energies close to or above the Planck scale) because of infinities arising due to quantum effects (in technical terms, gravitation is non-renormalizable). Since classical general relativity and quantum mechanics are incompatible at such energies, from a theoretical point of view the present situation is not tenable. Some proposed models of quantum gravity attempt to address these issues, but these are speculative theories. As long as you think like the past, you will get the same results that you've already earned, Feynman said. Does a new definition of the graviton solve the problem of quantum gravity? (For solution see [5, 12]).

# RESULTS

Lagrangian that describes exactly the quantum motion of an electron in a constant background electromagnetic ﬁeld [5]. Among other processes, this represents the scattering of light by light, a phenomenon not directly yet observed, although present as an internal process in the well-tested theory of the anomalous magnetic moment of the electron. This scattering process can be represented pictorially by what we would now call a Feynman diagram, see Fig.1. Here the loop represents an electron, as a virtual particle, one that does not satisfy the ordinary balance between energy and momentum,

E^2 =/= m^2c^4 +p^2c^2

Thus, it can only propagate for a short distance and for a short period of time. Oppenheimer and many others struggled with the theory of quantum electrodynamics, but little progress was made until after the Second World War, when using techniques developed during the war experimentalists established that two predictions of the Dirac theory of the electron were invalid. One was that the 2s1/2 and 2p1/2 states of the hydrogen atom should be degenerate, that is, have equal energy; the non-degeneracy is called the Lamb shift, after it was conclusively established by Willis Lamb [6]. The second turned out to be a deviation from the Dirac g-factor of the electron, its anomalous magnetic moment, unexpectedly discovered by Nafe, Nelson, and Rabi [7], and by Kusch and Foley [8]. This set the stage for solving the theory, and in Schwinger’s words, showed that “electrodynamic effects were neither inﬁnite nor zero, but ﬁnite and small, and demanded understanding.” So after these results were announced at the Shelter Island conference in June 1947, theoretical developments rapidly followed. Based on discussions at the meeting, Bethe published a nonrelativistic calculation of the Lamb Shift [9]. By De- camber, Schwinger had a relativistic calculation of this effect (with some incorrect

# CONCLUSION

At the beginning of the 20th century, Newton’s second law was corrected considering the limit speed c and the relativistic mass. In this paper, through various arguments and investigation of some physical phenomena, it has been attempted to show the necessity of reviewing relativistic Newton’s second law. Today Physics literature faces numerous problems and questions that without considering the internal structure of the particles, they would remain unanswered. Moreover, the classical definition of energy that defines energy as the ability to do work, could not explain the interaction among the particle in high energies. The true understanding of physical entity of energy and the structure of photon, enable us to understand the structure of matter. Attention to photon structure and using new definitions for graviton, charged and exchange particles, will change our perspective on modern physics. It also provides us with a new tool to be able to overcome physics problems in a better way. This approach will show us how particles are formed and when physical symmetries are broken spontaneously. Moreover, one could explain the expansion of the universe better and more real through reviewing relativistic Newton’s second law.

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