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ScienceDirect

Procedia - Social and Behavioral Sciences 174 (2015) 10 – 16

Procedia
Social and Behavioral Sciences

INTE 2014

Approaching youngs to unified theories: the charm of string theories

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Abstract

In this paper a pedagogical introduction to some key concepts of the process of unification in modern physics is presented. Starting by the notions of space and time, so important in the history of the human thought and at philosophical level, the paper comes to the peculiar aspects of the current string theories, with indications for the teaching of this charming topics by primary school. Interesting considerations, emerging by the fascinating connections of these theories with topics such as the extra-dimensions, will be also done.

Peer-review under responsibility of the Sakarya University

Keywords: Pedagogy; Education; Space; Time; Geometry; Physics; Unification.

1. Introduction

Albert Einstein devoted the last thirty years of his life searching the so-called "unified field theory", i.e. the theory that was supposed to unify the laws of gravity and electromagnetism, in order to allow a complete description of natural phenomena. His plan failed, but in no case it could be successful, because at that time there were many gaps in knowledge relating to the physical world. When Einstein embarked on his attempt of unification, only three elementary particles (electron, proton and photon) were known and only two fundamental interactions, electromagnetism and gravitation; the weak and strong nuclear forces were not yet been discovered (Di Sia, 2000).

Currently the elementary particles are more than a hundred. The fundamental forces are today four and their unification has become one of the central objectives of the present scientific research. The methods of investigation

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Peer-review under responsibility of the Sakarya University
doi:10.1016/j.sbspro.2015.01.619

had a clear progress, but on fact the unification of gravity with the other three forces has not yet been satisfactorily realized. Physicists, however, believe that the right direction leading to the formulation of a final complete theory has been taken. Currently the two followed main ways are:

- the superstring theory;
- the quantum gravity (Rovelli, 2010).

In this work we will consider the first way.

2. Space, time and theory of relativity

Modern physics has born through two great revolutions: the quantum theory and the theory of relativity. The "special theory of relativity" appeared in 1905 in order to reconcile the apparent contradiction between the motion of material bodies and the propagation of electromagnetic phenomena. Its creator Albert Einstein replaced the concepts of "absolute space" and "absolute time" with the concept of "space-time". Space and time remain two different types of quantities and are treated differently in the equations of relativity, but their connection exists and have deep and fascinating consequences.

Einstein proved that time is "elastic"; the motion can determine the expansion or contraction of it. Each observer has its own time scale, which in general does not agree with those of others. The temporal variation increases for the value of the speed tending to the speed of light. In 1908, a few years before completing the "general theory of relativity", Einstein assumed that gravity would change the rhythm of watches. The time depends on the place where a person is located, the rhythm of a clock is slower on the Earth's surface than on a plane flying at high altitude, where gravity is weaker.

Even space is elastic as time. The absolute simultaneity of events loses all meaning. The presence of the mass, which creates gravitational field, determines the curvature; the variability of the curvature indicates the "euclideicity" of the geometrical structure of space-time. The German theorist Karl Schwarzschild formulated the modern concept of "black hole", used for understanding the key features of Einstein's theory. A black hole is a region of space where gravity is so intense that nothing, not even the light, escapes from it. So all external objects tend to fall toward the black hole (Einstein, 2013).

Considering the relationship between gravity and space-time, we can consider a black hole as surrounded by "layers of time", where the time moves at a different rhythm. These layers also exist on earth, even if the difference between the bottom of the oceans and the highest peaks of the mountains is too small to give macroscopic evidence of this phenomenon. However, experiments with atomic clocks have occurred in every detail that situation. The experiments verified that the layers of time around a massive body are real.

In general relativity, gravity is therefore "distorting" the geometry of space-time. The space is no longer "flat", but "curved". Where the force of gravity increases, time slows down and vice versa. In some stars the gravity is strong enough to lead to a significant slowing of time (Di Sia, 2014) (Fig. 1).

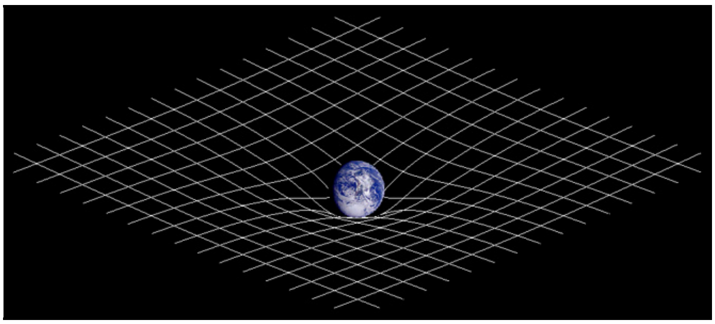

Fig. 1. A representation of the curvature of space-time due to the presence of a mass, represented in this case by the Earth.