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NARODOWA STRATEGIA SPÓJNOŚCI

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Topics on modern physics

Three topics in modern physics.

Modern physics is a huge field and this section focuses on related subfields of modern physics including quantum mechanics, particle physics, and unification of the fundamental forces of nature.

1. Elementary particles and quantum field theory.

Physicists have long believed that nature has an underlying simplicity and that the number of fundamental forces can be reduced. Einstein spent most of his working life trying to interpret these forces as different aspects of a single superforce. He failed, but in the 1960s and 1970s, other physicists showed that the weak force and the electromagnetic force are different aspects of a single electroweak force. The quest for further reduction with the goal of unification continues today, at the very forefront of physics.

Grand Unification Theory, Called GUT, this is the most orthodox theory of unifying fundamental forces of nature. The current task at hand is to unify the strong, weak, and electromagnetic forces.

Supersymmetry Theory. These theories seek to unify all forces, including the gravitational force, with a single framework.

Superstring Theory. These theories interpret pointlike particles, such as electrons, as being unimaginable tiny, closed loops. Interestingly enough, this theory proposes the idea that the universe may not consist of only four dimensions as Einstein saw it, but instead ten dimensions. http://library.thinkquest.org/3471/index.html

2. Nuclear physics

For nuclei heavier than nickel-62 the binding energy per nucleon decreases with the mass number. It is therefore possible for energy to be released if a heavy nucleus breaks apart into two lighter ones. This splitting of atoms is known as nuclear fission.

The process of alpha decay may be thought of as a special type of spontaneous nuclear fission. This process produces a highly asymmetrical fission because the four particles which make up the alpha particle are especially tightly bound to each other, making production of this nucleus in fission particularly likely.

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For certain of the heaviest nuclei which produce neutrons on fission, and which also easily absorb neutrons to initiate fission, a self-igniting type of neutron-initiated fission can be obtained, in a so-called chain reaction. (Chain reactions were known in chemistry before physics, and in fact many familiar processes like fires and chemical explosions are chemical chain reactions.)

The fission or "nuclear" chain-reaction, using fission-produced neutrons, is the source of energy for nuclear power plants and fission type nuclear bombs. According to the theory, as the Universe cooled after the big bang it eventually became possible for particles as we know them to exist. The most common particles created in the big bang which are still easily observable to us today were protons (hydrogen) and electrons (in equal numbers). Some heavier elements were created as the protons collided with each other, but most of the heavy elements we see today were created inside of stars during a series of fusion stages, such as the proton-proton chain, the CNO cycle and the triple-alpha process. Progressively heavier elements are created during the evolution of a star. Since the binding energy per nucleon peaks around iron, energy is only released in fusion processes occurring below this point. Since the creation of heavier nuclei by fusion costs energy, nature resorts to the process of neutron capture. Neutrons (due to their lack of charge) are readily absorbed by a nucleus.

When two low mass nuclei come into very close contact with each other it is possible for the strong force to fuse the two together It takes a great deal of energy to push the nuclei close enough together for the strong or nuclear forces to have an effect, so the process of nuclear fusion can only take place at very high temperatures or high pressures. Once the nuclei are close enough together the strong force overcomes their electromagnetic repulsion and squishes them into a new nucleus. A very large amount of energy is released when light nuclei fuse together because the binding energy per nucleon increases with mass number up until nickel-62. Stars like our sun are powered by the fusion of four protons into a helium nucleus, two positrons, and two neutrinos

Nuclear magnetic resonance. Chemistry applications.

3. Nonlinear physics. Second harmonics generation. Brillouin scattering.

Solitons.

"Solitons", Springer-Verlag, Berlin and New York, 1980, (Topics in Current Physics, 17).

http://www.ma.hw.ac.uk/solitons/

Solitons are very stable solitary waves in a solution of those equations.

As the term "soliton" suggests, these solitary waves behave like "particles".

When they are located mutually far apart, each of them is approximately a traveling wave with constant shape and velocity. As two such solitary waves get closer, they gradually deform and finally merge into a single wave packet; this wave packet, however, soon splits into two solitary waves with the same shape and velocity before "collision".

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Data	Dzień tygodnia	Godzina	Sala
18.11.2010	Czwartek	16-19	LUWR (Chemia A)
25.11.2010	Czwartek	16-19	360 GG
02.12.2010	Czwartek	16-19	360 GG
09.12.2010	Czwartek	16-19	LUWR (Chemia A)
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