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PARTICLE ACCELERATORS

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INTRODUCTION

Humans have always been curious about the world around them, The sky in night with its bright celestial bodies have always fascinated humans since time immemorial. The regular repetition of day and night, the annual cycle of seasons, the eclipses, the tides, the volcanoes, the earthquakes, the rainbow, freezing of mountain peaks, blow of winds, flow of currents has been sources of wonders. The inquiring and imaginative human brain has been responded to wonder in different ways. Human endeavor led, in course of time, to modern science and technology.

Science is a systematic attempt to understand natural phenomena in as much detail and depth as possible. A scientific method interlink several steps :

Systematic Observations, Controlled experiments, Qualitative and Quantitative reasoning, Mathematical modeling, Prediction and Verification of theory. The interplay of theory and observation is the basis to the progress of science. Science is ever dynamic, There is no final theory in science and no unquestioned authority among scientists.

Basically, there are two domain of interests:

Microscopic and Macroscopic
Recently, the domain intermediate between the two is mesoscopic that deals with a few tens and hundreds of atoms and has emerged as an exciting field of research.

A ***particle*** is a minute fragment or quantity of matter. In the physical sciences, a ***particle*** is a small localized object to which can be ascribed several physical or chemical properties such as volume or mass.

PURPOSES

- To able to explain how different particle λ accelerators work.
- To be able to explain the role of magnetic fields in particle accelerators.
- How the magnetic force provides the centripetal force in particle accelerators.

Advancement in Science and Technology Research aims at providing a platform for researchers, engineers, scientists, and educators to publish their original research results, to exchange new ideas, to disseminate information in innovative designs, engineering experiences and technological skills. It is also the objective to promote engineering and technology education.

Science & technology has been continuously advancing with a fractional change in revolution and rotation of our earth in its orbit . Though human civilization has witnessed dramatic transformation in all walks of life but it is believed that invention of a circular 3 dimensional object WHEEL is the most important achievement that has been able to influence the society in the history of evolution of Homo-Sapiens Sapiens .Twentieth century is the main time span of advance stage in the field of science & technology .

Many newer areas are being explored by the scientists working round the clock around the world .Modern physics began in 1990 with Max Planck's discovery of the role of energy quantization in blackbody radiation, a

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revolutionary idea soon followed by Albert Einstein's equally revolutionary theory of the relativity and quantum theory of light. The theory of atom is then developed with emphasis on quantum mechanical notions.

Following are the recent advancements in science-

- Non-zero Ground State Energy
- EPR paradox, Hidden variables & Bell's inequality
- Low-dimensional Quantum Systems
- Theory of Alpha and Beta Decay
- Large Hadrons Collider

RUTHERFORD EXPERIMENT

The essential idea of Rutherford's theory is to consider the α-particle as a charged mass traveling according to the classical equations of motion in the Coulomb field of a nucleus. The dimensions of both the α-particle and nucleus are assumed to be small compared to atomic dimensions (10−5 of the atomic diameter). The nucleus was assumed to contain most of the atomic mass and a charge Ze. On this picture the Z electrons which make an atom neutral would not contribute much to the deflection of an impinging α-particle because of their small mass.

Other models had been proposed for atoms at this time (~1911) to account for features such as optical spectra.

One of these (Thomson's Model) pictured the atom as a continuous distribution of positive charge and mass with the electrons embedded throughout. This model predicts a very small amount of scattering at large angles compared to the Rutherford theory since the α-particles traversing this atom rarely see much charge concentrated in a large massFrom the results of the scattering experiment on gold foil Rutherford and Marsden drew the following conclusions.

1. Since most of alpha particles went straight through foil most of the space taken up by the atoms must be empty.
2. Since some of the positively charged alpha particleswere scattered back towards the emitter, they must have been repelled by a positive part of the atom (the nucleus).
3. Since the alpha particles were very fast moving, they have a relatively large momentum.

The positive nucleus of the gold atom must have a large massto be able to stop some of the alpha particlesfrom moving forward and then repel them back again.If the alpha particle goes straight towards the positive nucleus it is repelled back towards the emitter. This accounts for the scattering of the alpha particles from the gold foil.

Rutherford and Marsden's model ofthe structure of the atom has a small positivity charged nucleus which contains nearly all of the mass and electrons in shells which have almost no mass but take up most of the space. This is the model of atomic structure which we use today.

BOHR'S MODEL

Niels Bohr proposed the Bohr Model of the Atom in 1915. Because the Bohr Model is a modification of the earlier Rutherford Model, some people call Bohr's Model the Rutherford-Bohr Model. The modern model of the atom is based on quantum mechanics. The Bohr Model contains some errors, but it is important because it describes most of the accepted features of atomic theory without all of the high-level math of the modern version. Unlike earlier models, the Bohr Model explains the Rydberg formula for the spectral emission lines of atomic hydrogen.
The Bohr Model is a planetary model in which the negatively-charged electrons orbit a small, positively-charged nucleus similar to the planets orbiting the Sun (except that the orbits are not planar).

PARTICLE ACCELARATORS

They enable similarly charged particles to get close to each other - e.g. Rutherford blasted alpha particles at a thin piece of gold foil, in order to get the positively charged alpha particle near to the nucleus of a gold atom,

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high energies were needed to overcome the electrostatic force of repulsion. The more energy given to particles, the shorter their de Broglie wavelength ($\lambda = h/mv$), therefore the greater the detail that can be investigated using them as a probe e.g. – at the Stanford Linear Accelerator, electrons were accelerated to high energies and smashed into protons and neutrons revealing charge concentrated at three points – quarks. E = mc2 Colliding particles together, the energy is re-distributed producing new particles. The higher the collision energy the larger the mass of the particles that can be produced.

LARGE HEDRON COLLIDER

In sept 2008, LHC the biggest particle accelerator in the world had its inaugural run.It was momentous day for science, this was possibly the most complex scientific project ever undertaken by mankind. The accelerator will allow to explore the nature of matter at smallest possible scale.

The collider, which is designed for proton-proton collisions has two counter rotating beams. For protons, the collision energy is around 7TeV. This is achieved by accelerating the proton beams inside the LHC ring.

The LHC also hopes to shed some light on nature of dark matter and energy which is supposed to compromise the bulk of the universe according to currently fashionable cosmological theories.

Scientists hope that once the LHC is fully operational many of the mysteries of the universe at the largest and smallest levels will be solved.

CONCLUSION

Although the LHC couldn't achieve the accuracy level for which it was designed and experimented but it is a historic effort done by mankind on this planet. This will open avenues for more researches for generations to come.

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