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Introduction of Nuclear Physics

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***Abstract:*— Every time you breathe you are taking in atoms. Oxygen atoms to be exact. These atoms react with the blood carried to every cell in your body for various reactions you need to surive. Like wise,every time you breathe out corbon di oxide atoms are released.**

Nuclear Physics

Nuclear physics is the field of physics that studies atomic nuclear and constitutents and interactions. Discovers in nuclear physics have led to applications in many fields.This includes nuclear power, Nuclear weapons, Nuclear Medicine and magnetic resonance imaging,

industrial and agricultural Isotopes, Ion implantion in material engineering and radiocarbon dating in geology and archaeology.

Particle physics evolved out of nucler physics and the two fields are thpically taught in close association. Nuclear astrophysics, The application of Nuclear physics to astrophysics, is crucial in explaining the inner workings of stars and the orgin of the chemical elements.

The Atoms

As you probably alredy known an atom is the building block of all matter. It has a nucleus with protons and neutrons and an electron could outside of the nuclease where electrons orbiting and moving.Depending on the element, the amount of electrons differs as well as the amounts of orbits surrounding the atom.

To help visualize the atom think of it like a ladder. The bottom of the ladder is called **Ground state** where all electrons would like to exist. It energy is absorbed it moveds to a new rung on the ladder or energy level called an **Excited state.** This state is away from the nucleas.As energy is released the electron can relax by moving to a new energy level or rung down the ladder.

Energy Level Application: Spedroscopy

Spectoscopy is an optional technique by which we can identify a material based on its emission spectrum. It is heavily used in Astronomy and remote sensing. Ther are too many sub categories to mention here but the one you are probably the most fanilier with are flame tests. So,basically you could look at light from any element of which the electrons emit photons. If you look at the light with a diffraction grating the lines will appear as sharp spectral lines occurring at specific wavelengths. This phenomenon allows us to analyze the atmospear of planets or galaxies simply by looking at the light being emitted from them.

Radio Activity And Notation

Before we begin to disscuss the specifics of radio active decay we need to be certain you understand the proper notation that is used.

An isotope is when you have the same element, yet it has a different Mass. This is a result of have extra neutrons. Since corbon is always going to be element 6,we can write carbon in terms of its mass instead.

Einstene-Energy/Mass Equivalence

IN 1995,Albert Einstene publishes a 2nd Majore Theory called the Energy-mass Equivalance in a paper called,`Does the inertia of a body depond on its energy content?'.

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Looking closely at Einsten`s equation we see that he postulated that mass held an enormous amount of energy within it self.we call this energy **Binding energy** or Rest mass energy as it is the energy that holds the atom together when it is at rest. The large amount of energy comes from the fact that the speed of light is squared.

Mass Defect

The nucleus of the atom is held together by a **Strong nuclear force.**The more stable the nucleus, the more energy needed to break it apart. Energy need to break the nucleas into protons and newtrons is called the **Binding energy.**Energy discovered that the **Mass of the separated particles** is greater than the mass of the intact stable Nucleus to begin with this difference in mass is called the **Mass defect.**

Positron Emission Tomography

Position emission tomography is a nuclear medicine imaging technique which produces a three-dimensional image or picture of functional proceses in the body.The system detects

pairs of gamma rays emitted indirectly by a position-emitting radio nuclide, which is introduced into the body on a biologically active molecule, Images of tracer concentration in three-dimensional space within the body are then reconstructed by computer analysis.

Alpha,Beta And Gamma Particles

An **alpha particle** is the nucleus of a helium atom consisting of two protons tightly bound.

Charge = +2e

Mass = 4.001506 U

A beta particle is simply an electron that has been expelled from the nucleus.

Charge = e

Mass = 0.00055U

A gamma ray has very high electromagnetic radiation carrying energy away from the nucleus.

Charge = zero

Mass = zero

The Half Life

The half-life of an isotope is the time in which one-half of its unstable nuclei will decay.

$$N=N_o(1/2)^n$$

Where n is number of half-lives. The same reasoning will apply to activity R or to amount of materials.In general, the following three equation can be applied to radioactivity.

1)Activity

$$R=R_0(1/2)^n$$

2)Mass Remaining

$$M=M_0(1/2)^n$$

3)Number of half-lives

$$n=1/T_{1/2}$$

Conservation On Laws

For any nuclear reaction, there are three are three conservation laws which must be obeyed.

Conservation of charge:

The total charge of a system can neither be increased nor decreased.

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Conservation of nucleons:

The total number of number of nucleons in a reaction must be unchanged.

Conservation of mass energy:

The total mass energy of a system must not change in a nuclear reaction.

Stable Vs Unstable Nuclides

Known nuclides-3760

Stable nuclides -269

Radio nuclides-3481

$T_{1/2}$> 1year : 144

Primordial:26

A radio nuclide is a atom that has an unstable nucleous.It will decay by emitting particles to reach a stable configuration.

Steller Nucleo Synthesis

Nuclei with masses A>60 are formed by neutron or proton capture which takes place in 2 different astrophysical environment.

Staad state buring nucleo synthesis:

S-process

Explosive nucleo synthesis:

r-process

rp-process

S-process: Neutron capture is on a slow rate compared to Beta-decay located near the valley of stability, takes place in red giants and the neutrons are provided by

$^{13}C(alpha,n)^{16}O$, $^{23}Ne(alpha,n)^{25}Mg$

R-process:

Neutron capture is on a fast rate compared to beta-decay needs high newton fluxes>$10^{20}/cm^3$. Probably takes place in supernovae.

BENIFITES OF PHYSICS FOR SOCIETY

1) ultra-sensitive technique of accelerator mass spectrometry plays an increasing role for environmental research,providing data for the study study of climate change,global air and water circulation patterns, stratospheric ozone depletion and monitoring of air and water quality.

2)Nuclear Techniques are of special intrest in medicine and bio-logy..Radio active isotopes produced byaccelerators or nuclear reactor are widely used for treatment and diagnosis and in biomedical research.

3)Accelator-driven transmulation of nuclear wastes, medical imaging and cancer theraphy.