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12

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Radioactivity inside our home

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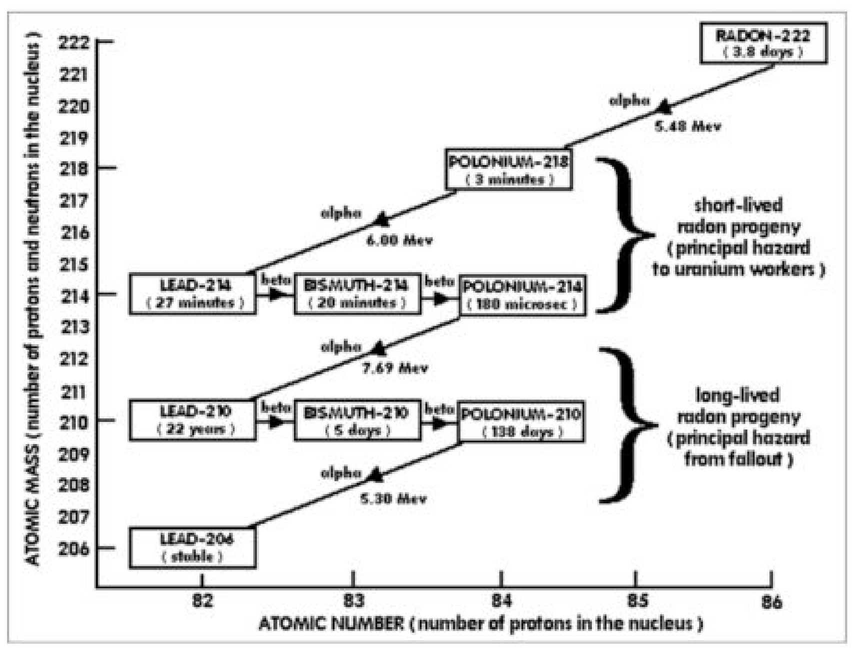
AMERICAN essayist Ralph Waldo Emerson wrote, "As soon as there is life, there is danger." Every day of our lives we face many dangers, some obvious, some hidden. One such hidden danger pervasive in every nook and cranny of our home is the carcinogenic radiation from radon.

We live on a planet that is literally bathed in radiation - from high energy gamma rays to low energy radio waves. Some of it comes from outer space in the form of cosmic rays, others from diagnostic X-rays, mammograms, CAT scans, radiation therapies, rocks, soil, smoke detectors, etc. These are known as background radiation. Apart from background radiation (~160 millirem/year), largest dose of radiation we receive (~200 millirem/year) comes from exposure to the ubiquitous radon gas. To put this in perspective, the average dose from a chest X-ray is 10 millirem.

Radon is a radioactive nucleus. The process by which an unstable nucleus spontaneously decays by emitting one or more particles with an accompanying radiation is called radioactivity. The time taken for half of the nuclei in a sample to decay into a more stable nucleus is called the half-life. It takes ten half-lives to reduce the intensity of radiation to approximately one-thousandth (1/2 raised to the power 10) of the original intensity, at which point the nucleus is considered safe.

Radon is everywhere - in the rocks, soil, water, and air. It is continuously produced in a chain of radioactive decay of uranium-238, thorium-232, and radium-226 atoms that are found abundantly in the Earth's crust. Radon has several radioactive isotopes. An isotope is the same nucleus with different number of neutrons. For example, radon-220 with 86 protons and 134 neutrons is an isotope of radon-222 with 136 neutrons. Of greater concern to us is radon-222 with a half-life of 3.8 days. It



has sufficient time (380 days) to diffuse through permeable soil and enter homes through cracks and crevices in the foundation and other openings. Radon dissolves easily in water. Hence, traces can be found in drinking water as well.

The radioactive decay chain of radon-222 is rather long. It starts with polonium-218 followed by isotopes of lead, bismuth, polonium, and ends with stable lead-206. At every step of the decay process, alpha (helium nucleus) or beta (electron) particles are emitted. One of the decay products, polonium-210, is so lethal it was used by KGB in 2006 to kill Alexander Litvinenko, a Russian political émigré in the U.K.

Radon is colorless, tasteless, odorless, and chemically inert. Because of its inertness the radon we breathe is not dangerous. However, it is the decay products that are dangerous. The various nuclei produced in the decay process of the inhaled radon lodge in the lining of the lungs and cause somatic effects, such as damage of the cells. The alpha particles and lead, in particular, strike sensitive lung tissue causing damage that can lead to lung cancer. For smokers, the effect is synergistic and will cause death in the extreme. Other effects may include cataracts, leukemia, gastrointestinal problems, and stomach cancer. It is estimated that life expectancy of a person exposed to at least 300 millirem of radiation a year decreases by about 15 days per exposure.

Radon is an ionizing radiation capable of ejecting one or more bound electrons from an atom or molecule. If the positively ionized atom or molecule is part of a biological system, severe consequences can result, such as changing of normal cells into cells that can in the end become cancerous. Cell mutations are of greatest long-term worry, because they may affect future generations by way of disrupting normal development of the fetus.

What is considered a safe level of radon gas? There is no safe level. Zero is perhaps the safest level. The concentration of radon reaches an uncomfortably high level in well-insulated homes during winter months. Furthermore, intensity of radiation from radon progeny is highest during the first few hours of radioactivity, when bismuth and polonium quickly decay into radioactive lead-210.

What can we do to mitigate the health related effects of radon? Honestly, not much except sealing cracks in the walls, floors or the concrete slab. A well-ventilated house will have lower level of radon concentration, but never zero level.

Just like the risk of an accident while driving a car, radiation from radon is another daily risk that we have to face. We have no choice but to breathe the air in our home; we have to live with radiation. So, why be fearful? When predictable, avoid radioactivity; when inevitable, accept and tame it.

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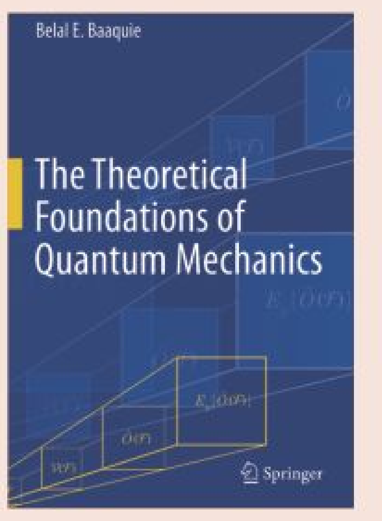
QUANTUM WORLD

The Theoretical Foundations of Quantum Mechanics



THE book, 'The Theoretical Foundations of Quantum Mechanics,' by **Belal E Baaquie,** introduces the Quantum Principle, which encodes the entire theoretical construction of quantum mechanics.

Explains the counter-intuitive construction of the nature of the mathematical techniques required to solve quantum mechanics equations.

Clarifies the implicit meaning of the symbols and operations of quantum mechanics and leads to a deeper understanding of its foundations.

A new theoretical framework based on the interplay of empirical and trans-empirical aspects of quantum mechanics is developed to explain the paradoxes of quantum mechanics.

All the discussions are carried out at a rigorous level employing the mathematics of quantum mechanics.

The Theoretical Foundations of Quantum Mechanics addresses fundamental issues that are not discussed in most books on quantum mechanics. This book focuses on analyzing the underlying principles of quantum mechanics and explaining the conceptual and theoretical underpinning of quantum mechanics. In particular, the concepts of quantum indeterminacy, quantum measurement and quantum superposition are analyzed to clarify the concepts that are implicit in the formulation of quantum mechanics.

The Schrodinger equation is never solved in the book. Rather, the discussion on the fundamentals of quantum mechanics is treated in a rigorous manner based on the mathematics of quantum mechanics. The new concept of the interplay of empirical and trans-empirical constructs in quantum mechanics is introduced to clarify the foundations of quantum mechanics and to explain the counter-intuitive construction of nature in quantum mechanics.

The Theoretical Foundations of Quantum Mechanics is aimed at the advanced undergraduate and assumes introductory knowledge of quantum mechanics. Its objective is to provide a solid foundation for the reader to reach a deeper understanding of the principles of quantum mechanics.

To get the book on the Net, visit: http://www.springer.com/physics/quantum+physics/book/978-1-4614-6223-1

TECTONIC

Solomon Islands quake

The quake hit Solomon Islands in the southwest Pacific Ocean. Dozens of smaller quakes have occurred in the area in the last month.

THE quake of magnitude 8 that hit Solomon Islands on February 6 originated 81 kilometers west of the town of Lata on Santa Cruz Island, at a depth of 28.7 kilometers beneath the seafloor, according to the U.S. Geological Survey. The temblor occurred either on or near the boundary between two plates of Earth's crust, where the northeast-moving Australian plate dives beneath the Pacific plate. Large earthquakes are common where such plate collisions occur.

The earthquake happened on a thrust fault, which means that one side of the fault pushes up during a quake. This upward movement of the seafloor displaced a huge volume of water, unleashing a tsunami that reached several islands in the region. At the Lata Wharf, the wave measured 91 centimeters above normal sea level, the Pacific Tsunami Warning Center reported.

Given the quake's size and depth, geophysicist Jessica Turner of the USGS Earthquake Information Center in Golden, Colo., was not surprised that a tsunami formed. "We usually see tsunamis beginning around magnitude 7 and with a shallow depth anything under 50 kilometers," she says.

Residents of the Solomon Islands are no strangers to large earthquakes. In April 2007, a magnitude 8.1 quake rocked the country, striking about 700 kilometers northwest of the February 6 temblor. A magnitude 7.1 event struck in January 2010.

And in the month leading up to today's earthquake, seismometers recorded dozens of quakes in the region, seven with a magnitude of 6.0 or higher.

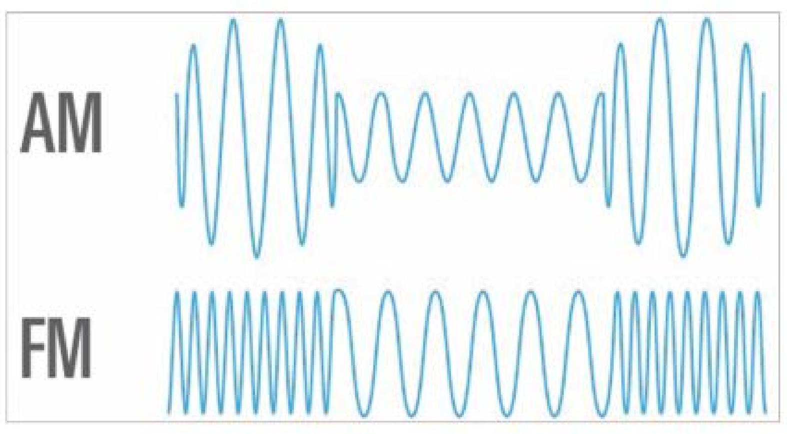
Source: **Science News**

RADIO REVISITED

Understanding radio broadcasting

NAVID AKBAR

FROM the Swadhin Bangla Betar Kendra to today's FM favorites, radio has occupied an important space in our national history. FM radio is our unfaltering companion during a jam-clogged city commute or a jukebox that plays our desired tracks. We all enjoy this marvelous gift of science, but not all of us know how it actually works.



In its most basic form, radio broadcast takes place in two ways: Amplitude Modulation (AM) and Frequency Modulation (FM). Historically, AM was invented first. In the backdrop of this development, communication was limited to one-to-one transfer of information over the telephone channel. AM enabled data transmission from one user to multiple listeners. It involves multiplying the signal frequency with a generated high frequency electromagnetic wave, called a carrier. The result is a modulated wave whose amplitude depends on the amplitude of the input signal. Reception of this AM wave can be done with a simple diode detector and low pass filter. Ease of use of this technology culminated in its rapid adoption by news and mass-media services, after first successful commercial demonstration back in 1906. Acronyms like MW (Medium Wave) or SW (Short Wave) refer to AM modes of propagation and span in frequency from 535 kHz to 1705 kHz.

However, some disadvantages of the AM soon became apparent. First, it was vastly affected by transmission channel noise, and second, it could not transmit high fidelity audio. AM radio has a limited audio range from 200Hz to 5 kHz, which limits its usefulness to speech mainly. To address these limitations, Edwin Armstrong proposed the concept of FM in 1935. Unfortunately, this genius engineer had to fight Radio Corporation of America during his later years regarding patent rights. Years of legal battle left him mentally tattered and culminated in a tragic suicide. He was later posthumously recognized as the originator of the FM radio, though.

A FM transmitter is similar to an AM, with the exception that here the frequency of the carrier wave is varied according to the instantaneous amplitude of the input signal. An FM receiver circuitry is quite complex, but can be accomplished in a number of different ways. The most popular scheme is the Phase-Locked Loop (PLL). In this method, a voltage-controlled frequency oscillator tracks the input FM wave frequency through continuous comparison of phase differences.

The advent of FM elevated radio broadcasting to a whole new level. Noise and voltage spikes due to lightning could now be eliminated completely at the receiver by amplitude limiting the output signal. Furthermore, Wide Band FM (WBFM) system can deliver broad dynamic music with a range from 30Hz to 15 kHz. Carrier of an FM can swivel from 88 MHz to 108 MHz in the VHF region.

Even with apparent drawbacks, AM modulation is still used worldwide by news channels and long-distance voice broadcasters. Short wavelength of an AM wave reflects back from the ionosphere and covers a longer area. Besides, it requires lesser bandwidth compared to FM, giving rise to higher spectral data efficiency. However, in the urban metropolitan context, FM has the especial ability to overcome obstancles. A high frequency wave undergoes lesser absorption when passing through obstacles such as building walls. FM is therefore better suited for city recipients.

So the next time we tune into Bangladesh Betar in MW or Radio Foorti in FM, we should not forget the sacrifices of unsung heroes like Armstrong that made this amazing technology possible.

The writer is a Senior Year Undergrad Student, Dept. of EEE, BUET.

MAGNETIC BEACON

Magnetism guides Salmon home

WHEN migrating, sockeye salmon typically swim up to 4,000 miles into the ocean and then, years later, navigate back to the upstream reaches of the rivers in which they were born to spawn their young. Scientists, the fishing community and lay people have long wondered how salmon find their way to their home rivers over such epic distances.

How do they do that?

A new study, published in this week's issue of Current Biology and partly funded by the National Science Foundation, suggests that salmon find their home rivers by sensing the rivers' unique magnetic signature.

As part of the study, the research team used data from more than 56 years of catches in salmon fisheries to identify the routes that salmon had taken from their most northerly destinations, which were probably near Alaska or the Aleutian Islands in the Pacific Ocean, to the mouth of their home river--the Fraser River in British Columbia, Canada. This data was compared to the intensity of Earth's magnetic field at pivotal locations in the salmon's migratory route.

Earth has a magnetic field that weakens with proximity to the equator and distance from the poles and gradually changes on a yearly basis. Therefore, the intensity of the magnetosphere in any particular location is unique and differs slightly from year to year.

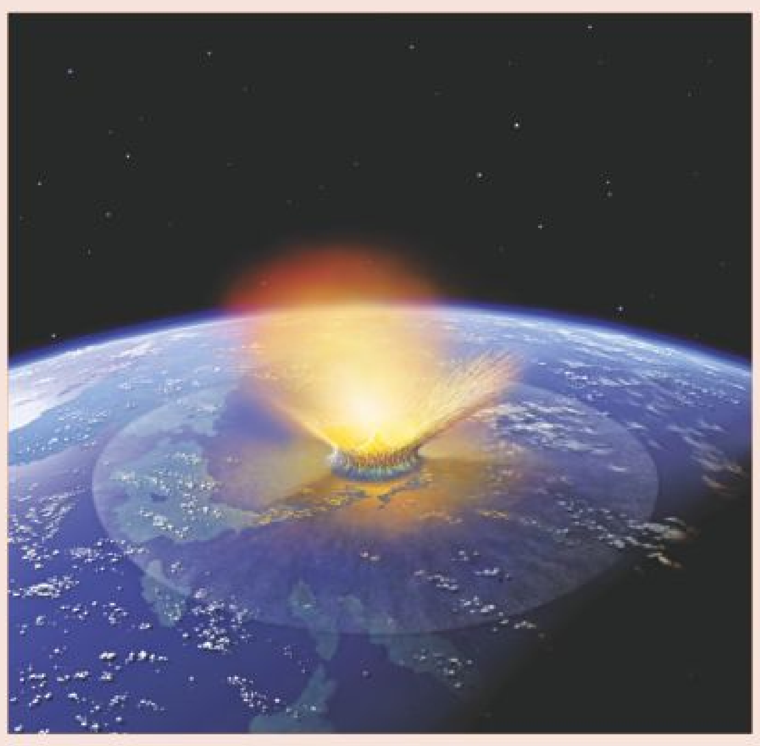
Because Vancouver Island is located directly in front of the Fraser River's mouth, it blocks direct access to the river's mouth from the Pacific Ocean.

Source: **Science Daily**

Sockeye salmon weigh on average 8 pounds, and may reach 3 feet in length.

GIANT KILLER

Artist's impression of a 6-mile-wide asteroid striking the Earth. Scientists now have fresh evidence that such a cosmic impact ended the age of dinosaurs near what is now the town of Chixculub in Mexico.



Asteroid that killed dinos

The idea that a cosmic impact ended the age of dinosaurs in what is now Mexico now has fresh new support, researchers say.

The most recent and most familiar mass extinction is the one that finished the reign of the dinosaurs the end-Cretaceous or Cretaceous-Tertiary extinction event, often known as K-T. The only survivors among the dinosaurs are the birds.

SOURCE: LIVE SCIENCE

DID YOU KNOW?

Who was 1st woman Nobel laureate?

Marie Sklodowska-Curie, often referred to asMarie Curie, (7 November 1867 4 July 1934) was the first Nobel Prize winner among women. She was a Polish physicist and chemist, working mainly in France, who is famous for her pioneering research on radioactivity. She was the only woman to get Nobel prize win in two fields, and the only person to win in multiple sciences. She was also the first female professor at the University of Paris (La Sorbonne), and in 1995 became the first woman to be entombed on her own merits in Paris'Panthéon.

Marie Curie

She was born Maria Salomea Skłodowska in Warsaw, in what was then the Kingdom of Poland. She studied at Warsaw's clandestine Floating University and began her practical scientific training in Warsaw.