### 33 Atomic Nucleus and Radioactivity

Conceptual Physics Instructor's Manual, 12th Edition

33.1 X-rays and Radioactivity
33.2 Alpha, Beta, and Gamma Rays
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 Units of Radiation
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33.5 Radioactive Half-Life
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 Natural Transmutation
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33.8 Radiometric Dating
 Food Irradiation

Photo openers show two instructors with different radiation counters: Stan Micklavzina with a Geiger counter, and Roger Rassool with a scintillation counter. The impressive photo in the center is the world famous hot springs in Pamukkale, Turkey. I took a dip in these springs in 1995 and found them most intriguing. Like hot springs all around the world, their source of energy is primarily radioactive decay in Earth's interior. The 4th photo is of Leilah McCarthy of CCSF lecturing on radioactive half-life.

The personality profile for this chapter is Marie Curie. Most appropriate!

The chapter begins with X-rays and presents a relatively extensive treatment of radioactivity and its applications. Formulas for decay reactions are illustrated with supporting sketches that enable better comprehension. The background for this material goes back to Chapter 11. This chapter is a prerequisite to Chapter 34.

Ask your students if they want to produce X-rays. To do so, simply unroll a roll of Scotch tape! This creates electrostatic charges that jump across the gap between the tape and the roll, which can produce X-rays. That's if the process is done in a vacuum. In air, the electrons are too slow to produce them. But try unrolling tape in a completely dark room and you'll notice a faint glow.

The energy of gamma-ray photons is more than 100 kilo-electron-volts (keV), which is some 100,000 times more than a photon of visible light. All photons emitted by atomic nuclei are classified as gamma rays, even the rare ones of less than 100 keV. The sunlight we enjoy began as energetic gamma rays in the Sun's core and degraded into visible light during its passage through overlaying layers of gas. If watching stars on a calm night seems a tranquil experience, gamma rays betray the true violence of the universe!

In the text it is stated that a couple of round-trip flights across country exposes one to as much radiation one receives in a normal chest X-ray. More specifically, a dose of 2 millirems is typically received in flying across the United States in a jet. This is the same dose received annually from those old luminous did wristwatches. Cosmic radiation at sea level imparts 45 millirems annually, and radiation from the Earth's crust imparts about 80 millirems. Living in a concrete or brick house makes this figure slightly higher, for these materials contain more radioactive material than wood. The human body contains small amounts of carbon-14, potassium-40, and traces of uranium and thorium daughter products, which give an annual dose of 25 millirems. So the total natural background radiation annually is about 150 millirems. This makes up about 56% of the radiation the average person encounters, the rest being mainly medical and dental X-rays.

Before being retired, the former high-flying British-French SST, the Concorde, was equipped with radiation detectors that signaled the pilots when a level of 10 millirems per hour was reached (during a

# **Conceptual Physics Atomic Nucleus And Radioactivity Exercises**

**Minjie Lin** 

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