Teaching the History of Nuclear Science with the CPEP Wallchart

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Contemporary Physics Education Project
Nuclear Science in High School

• At Creighton we have done multiple 5 hr. mini-courses in nuclear science with high school students, gifted junior high students and boy scouts.

• High school students (and gifted junior high students) outperform university astronomy students in nuclear physics problem solving.

The History of Nuclear Science

- Particles and Waves
- Nuclei
- Building-up and Breaking-down Nuclei
- Fission and Fusion
- Nuclear Thermodynamics
Particles and Waves

- X-Rays
- Cathode Rays
- Cosmic Rays
- Alpha Rays
- Beta Rays
- Gamma Rays
Nuclei

- Structure
- Chart of the Nuclides
Building Up and Breaking Down Nuclei

- Identifying the Super-heavy Nuclei from Decay Chains
- Nuclear Decay Applications

Radioactive Dating

Naturally occurring radioactive isotopes such as $^{14}$C are used to date objects that were once living, such as wood. For example, from a study of artifacts found at the site, scientists determined that Stonehenge was built nearly 4,000 years ago.

Space Exploration

Sojourner used alpha particles to identify chemical elements present in Martian rocks. On Earth, nuclear reactions are used in many areas from criminal investigations to art authentication.

Smoke Detectors

Many smoke detectors use a small amount of the alpha emitter $^{222}$Rn to ionize the air. Smoke entering the detector reduces the current and sets off the alarm.

Nuclear Medicine

Radioactive isotopes such as $^{99m}$Tc, $^{67}$Co, and $^{18}$F are commonly used in the diagnosis and treatment of disease. Positron emitters such as $^{18}$F are used in Positron Emission Tomography (PET) to generate images of brain activity.
Fission and Fusion

- **Nuclear Power**

  Nuclear Reactors
  
  Nuclear reactors use the fusion of $^{235}_{92}$U or $^{239}_{92}$Pu nuclei to produce electric power. Reactors and most other nuclear applications generate radioactive waste; disposal of this waste is a subject of current research.

- **Light and Neutrinos from the Sun**

  - The Solar Neutrino Problem
Nuclear Thermodynamics

- Phase Diagram
- Particles of the Big Bang
  - kinetic energy vs. binding energy
Heavy Ion Physics Probing Nuclear Thermodynamics

• Phases of Atomic Matter
  – solid
  – liquid
  – gas
  – plasma of constituents

• Phases of Nuclear Matter
  – liquid drop model
  – hadron gas
  – quark-gluon plasma

Nearest neighbor forces govern the binding
The Little Bang at CERN and Brookhaven
www.cpepweb.org

Free Teachers Guide Available at http://www.lbl.gov/abc/wallchart/guide.html