Nuclear physicists thinking about astrophysics

Nuclear decay data evaluators Valery CHECHEV from the Khlopin Radium Institute (KRI), Saint Petersburg, Russia, and Xiaolong HUANG from the China Institute of Atomic Energy (CIAE), Beijing, China, in their research article published in *Applied Radiation and Isotopes 105(2015)114* are calling other scientists to expand the Decay Data Evaluation Project for evaluating and measuring many nuclear decay data of astrophysical interest.

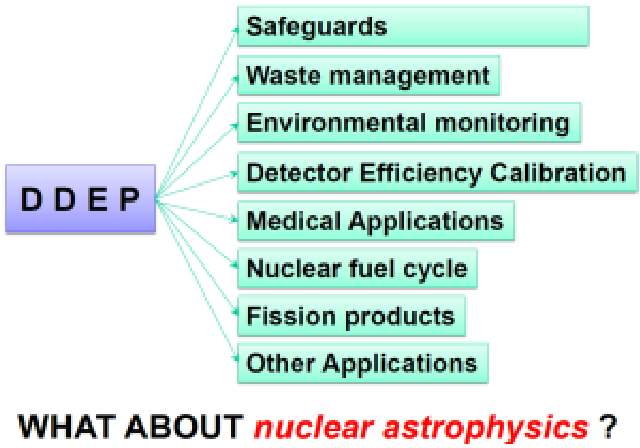

Fig. 1. Different applications of radionuclide decay data recommended by the DDEP cooperation.

What is “nuclear decay data” and “Decay Data Evaluation Project (DDEP)”? *Nuclear decay data* are the characteristics that define the behavior of disintegrated atoms called *radioactive nuclides*, or *radionuclides*. For example, the radionuclide half-life is an interval of time after which a half of decaying atoms remains, the emission energies and intensities are characteristics of different radiations (alpha-, beta-, gamma-) which accompany the radionuclide decay. The evaluators analyze all the available (published) measurement results for radionuclide characteristics and recommend for use their best values obtained by the special computational procedures. In 1995 the famous nuclear metrologist from the National Institute of Standards and Technology (NIST), USA, Richard Helmer initiated the creation of an international cooperation named *Decay Data Evaluation Project (DDEP).* This cooperation has aimed at the evaluations of decay characteristics for applied radionuclides such as medical isotopes, detector calibration standards, fission products, etc. (Fig. 1).

The aforementioned Russian and Chinese nuclear physicists thought why not to use the well-tested methods of the DDEP cooperation for nuclear astrophysics. Since the DDEP cooperation deals with radionuclides near the valley of nuclear stability, they pointed the three groups of such radionuclides of astrophysical interest and made the current updated evaluations for some decay characteristics.

The first of these groups includes long-lived radionuclides with half-lives more than hundred thousand years. Nuclear geochronology and cosmochronology using independence of the radioactive decay rate on the external conditions can determine an age of the objects which contain long-lived radioactive nuclides and/or their daughter products. For example, by determining the amount of accumulated decay products of uranium in meteorites, we can calculate the time duration of its decay and thus the age of meteorites and the Solar System. But for this we must know exactly what the half-life of uranium, i.e. the uranium half-life evaluated value and its uncertainty. This is a task for nuclear evaluators.

Xiaolong HUANG and Valery CHECHEV in Bucharest during the DDEP meeting held in the Hotel Capitol 12-14 May 2008.

Similarly the evaluated values of decay characteristics are required for the second group of radionuclides such as nickel-56 (half-life of 6 days), cobalt-57 (half-life of 272 days) and others. These radioactive isotopes are synthesized along with stable isotopes in stellar interiors and explosions of stars, and their decay generates gamma rays observed (or which can be observed) by orbital observatories. Stellar interiors are opaque but expanding explosive sites of nucleosynthesis such as novae and supernovae are gamma-ray transparent typically a few days to weeks after the explosion, thus allowing a direct gamma-ray view at the nucleosynthesis site. Therefore the accurate gamma-ray energy and intensity values for these radionuclides are important for astronomical observations.

The third group of radionuclides of astrophysical interest that was suggested for the decay data evaluations by Valery CHECHEV and Xiaolong HUANG relates to theoretical nuclear astrophysics, specifically to basic processes of stellar nucleosynthesis in which the chemical elements heavier than iron are produced. It includes the 30 more radionuclides near the valley of nuclear stability (Photo).

Publication

Decay data of radionuclides along the valley of nuclear stability for astrophysical applications.
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