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## Karlsruhe nuclide chart online

### Nuclide chart karlsruhe.

The Karlsruhe Nuclide Chart provides essential nuclear data for scientists and students, encompassing 4,122 experimentally observed ground states and isomers, as well as up-to-date atomic weights, isotopic abundances, and cross sections. This comprehensive chart offers structured information on radionuclides' half-lives, decay modes, and emitted radiation energies. Its impact extends beyond traditional physical sciences to life and earth sciences, showcasing its value in education and training for nuclear sciences. Accessible through the Nucleonica website, with a fee required for online access, this chart serves as a vital resource for researchers and students alike. The International Year of the Periodic Table: Understanding Isotopes and Nuclides The United Nations has recognized 2019 as the International Year of the Periodic Table, highlighting its significance in linking cultural, economic, and political aspects of global society through a common language. First introduced by Dmitry Mendeleev in 1869, the periodic table features 118 elements, with variants differing in neutron number classified as isotopes. The study of isotope properties and behavior has had a profound impact on our understanding of the universe, enabling applications such as powering spacecraft and developing climate change models. Today, over 4000 nuclides (extended forms of the periodic table) are known, providing a wealth of information for research and development. The Karlsruhe Nuclide Chart, shown in Figure 1, uses a coordinate system to represent atomic nuclei with varying numbers of neutrons (N) and protons (Z). Each horizontal line on the chart corresponds to a chemical element's isotopes. The colored boxes contain information about each nuclide, including its name, mass number (N + Z), half-life or abundance, decay modes, and radiations. Boxes divided into sections represent isomers, while those undivided represent the ground state of a nuclide. If an isomer decays quickly, only longer-lived ones are shown. The chart's central section displays stable nuclides in black boxes, while unstable ones have colors representing their decay modes: \* Blue:  $\beta^-$  decay (excess neutrons) \* Red: electron capture or  $\beta^+$  decay (excess protons) \* Yellow: alpha decay \* Light blue: neutron decay \* Light brown: proton decay \* Green: spontaneous fission \* Violet: cluster decay or emission \* White: isomeric transition Multiple decay modes for a single nuclide are represented by differently sized triangles. Primordial nuclides, still present on Earth due to their long half-lives, have both abundance and experimental data in the chart's black upper section. The lower section displays their decay mode and half-life. The chart highlights important features of each nuclide, making it a valuable resource for understanding nuclear properties. The IUPAC has announced the names of four new chemical elements: nihonium (Nh), moscovium (Mc), tennessine (Ts), and oganesson (Og). These elements were proposed by various research institutions, including RIKEN Nishina Center for Accelerator-Based Science, Joint Institute for Nuclear Research, Dubna, Oak Ridge National Laboratory, Vanderbilt University, and Lawrence Livermore National Laboratory. Oganesson was named in recognition of Prof. Yuri Oganessian's contributions to the field. The new edition of the Karlsruhe Nuclide Chart includes updated decay data on 4040 experimentally observed nuclides, with 649 updates from previous editions. The update procedure is described in detail, and 47 new nuclides were added, not found in the previous edition. Due to limited space, only key nuclear data can be inserted into the nuclide boxes, and reduced decay schemes have been developed to simplify the understanding of the condensed form used in the chart. More than 80 such decay schemes are included in the accompanying booklet, providing a better interpretation of the inserted data. The nuclide box displays detailed information about Cs-134, including its ground state and metastable state. The ground state has a half-life of 2.0652 years and decays by  $\beta^-$  emissions, while the metastable state has a half-life of 2.912 hours and undergoes isomeric transition (IT). The nuclide box shows the decay scheme with dotted lines indicating low emission probability radiation energies. It also displays the beta particle endpoint energy, which corresponds to several  $\beta^-$  particles with different endpoint energies. The Karlsruhe Nuclide Chart's (KNC) database relies on several key sources for its decay data, including the Nuclear Data Sheets (NDS), Evaluated Nuclear Structure Data File (ENSDF), and NUBASE2016. For creating detailed decay schemes, the most recent data from these sources are utilized. Additionally, the creation and maintenance of scientific references for each added or updated nuclide is a crucial process. Recently discovered nuclides are identified through periodic evaluations of original papers published in scientific journals such as Physical Review C, Nature, and Radiochimica Acta. Since 2006, over 660 new ground state and isomer nuclides have been discovered and incorporated into the KNC's database. Regular updates of radioactive decay data for existing nuclides are achieved by incorporating evaluated decay data from NDS publications, which are based on ENSDF evaluations. This process involves updating half-life, branching ratios, particle, and photon emission energies and probabilities in the KNC. The creation and updating of reduced decay schemes involve displaying Q-values and energy levels in diagrams within the booklet. Data for these values are sourced from either NUBASE2016 or NDS, with priority given to the more recent source. In cases where data is incomplete, Nuclear Science References may be consulted for original literature. Lastly, maintaining scientific references for each nuclide is essential, especially when updating existing data. While references may not be included in printed versions, they are available online within the Karlsruhe Nuclide Chart Online platform. Given article text here The Q-value was checked as described above. Following the introduction of this procedure in 2011, around 2400 ground and isomeric states have been referenced in this manner. References for decay data for individual nuclides are available in the online version of the Karlsruhe Nuclide Chart. In this example for Am 241 note the data sources for half-life and decay modes/radiations are from different NDS evaluations. Isotopic abundances refer to the relative proportion of an isotope to its stable or primordial isotopes in terrestrial matter. These abundances are expressed in atom % and are given in the nuclide boxes for stable and primordial isotopes of a chemical element. Figure 6 shows an excerpt from the Karlsruhe Nuclide Chart showing stable (black) and unstable (red/blue) isotopes of oxygen. In the difference chart (Fig. 3), the black coloured boxes denote the nuclides with isotopic abundances modified in the latest edition. The element oxygen has 15 isotopes in the 10th edition of the Karlsruhe Nuclide Chart, with 9 shown in Figure 6. The three stable isotopes O 16, O 17 and O 18 are shown in black with natural isotopic abundances respectively: 99.757, 0.038 and 0.205 atom %. Figure 7 All cross sections are given in barn (10<sup>-24</sup> cm<sup>2</sup>) and refer to reactions with thermal neutrons with energy 0.0253 eV. The symbol  $\sigma$  without any index in the nuclide boxes refers to the (n,  $\gamma$ ) capture cross section. If two values are given, the first refers to the formation of the product nucleus in the metastable, the second to the formation in ground state. The symbols  $\sigma_{f, n, p, \alpha}$  and  $\sigma_{abs}$  refer to the fission, (n,p), (n,  $\alpha$ ) and absorption cross sections respectively. In Figure 6, values following the symbol  $\sigma$  in boxes O 16, O 17 and O 18 are the cross sections for (n,  $\gamma$ ) reactions for the formation of nuclides O 17, O 18 and O 19, respectively. The value on  $\alpha$  in the box O 17 is the cross section of the reaction for formation of carbon C 14 isotope. Standard atomic weights are given based on the assumption that the mass of the C 12 isotope equals 12 atomic mass units. For twelve elements H, Li, B, C, N, O, Mg, Si, S, Cl, Br and Tl, a range of atomic weights is given to reflect the isotopic variability in natural materials. The atomic weight data has been taken from atomic weights The Karlsruhe Nuclide Chart features various elements, including hydrogen, helium, and lithium, with their standard atomic weights and thermal neutron cross sections displayed in white boxes. Additionally, it showcases the chain yields for thermal neutron fission of U-235 and Pu-239 isotopes. The upper values represent U-235, while the lower values correspond to Pu-239. This information is sourced from the IAEA Handbook of Nuclear Safeguards (2008) [11] and the JEFF 3.1 Nuclear Data Library (2006) [12]. Moreover, physical constants and conversion factors are updated based on CODATA recommended values [13]. Furthermore, the booklet accompanying the chart provides important properties of chemical elements, including allotropic form, density, triple point, melting point, boiling point, and ionization potential. These data were taken from the latest editions of the CRC Handbook of Chemistry and Physics [9] except for densities of gaseous elements, which were published in a previous edition [14]. The booklet also includes a Periodic Table of the Elements based on the latest IUPAC data. The Karlsruhe Nuclide Chart can be used to investigate decay and nuclear reactions. For instance, it shows the location of daughter products following decay processes such as  $\alpha$ ,  $\beta^-$ ,  $\epsilon/\beta^+$ , n, and p decay. Users can obtain entire decay chains manually by applying these rules. An example is given for the decay of Th-232, where highlighted daughter products are shown. Moreover, the chart can be used to obtain activation and nuclear reaction products. This is demonstrated schematically in Figure 9b, which illustrates a target nuclide transforming into a reaction product through a process such as (n,  $\gamma$ ) reaction or capture reaction. The nuclear activation process involves gamma emission, resulting in a product with an extra neutron compared to the original target nuclide. This process can be tracked using a chart that outlines rules for building up activation products. For example, U-238 transforms into U-239 through (n,  $\gamma$ ) reactions, which then decays into Np-239 and further. The chart visualizes radioactive decay processes and nuclear reactions, allowing users to follow the transformation of nuclides. It also highlights specific decay chains, such as that of Th-232. The Karlsruhe Nuclide Chart is available in various printed formats and an online edition through the Nucleonica portal. The latter offers additional features like colour coding, access to previous editions, and tools for scientific applications like decay calculations, dosimetry, and shielding. Users are directed to the Nucleonica portal for more intensive use of the data provided by the chart. The 10th edition of the Karlsruhe Nuclide Chart, celebrating its 60th anniversary since publication in 1958, has been released. This chart provides essential nuclear data for non-experts and features information on 4040 experimentally observed ground states and isomers, including half-lives, branching ratios, decay modes, and radiation energies. Since the previous edition in 2015, 649 nuclides have been updated, and 47 new ones identified. The chart includes the IUPAC names for elements 113 to 118. The paper discusses the structure of the nuclide boxes, how data can be related to decay schemes, and provides details on data sources, update procedures, and scientific references. It also explains how the Chart can be used to investigate decay chains and nuclear reactions. Additionally, the paper summarizes extra data provided with the chart, including isotopic abundances, thermal neutron cross sections, standard atomic weights, chain yields for thermal fission of U-235 and Pu-239, physical constants, and properties of chemical elements. The Karlsruhe Nuclide Chart is available in multiple languages and in various printed and online editions. A new evaluation of nuclear properties has been published in Chin. Phys. C 41, 030001 (2017), which updates previous studies on atomic weights and isotopic compositions. Several databases and publications have provided updated information on nuclear data, including the NSR database and Web Retrieval System (Nucle. Instrum. Methods Phys. Res. A 640, 213, 2011) and the CRC Handbook of Chemistry and Physics (97th Edition, 2016-2017). The International Atomic Energy Agency has published a report on handbook of nuclear data for safeguards; database extensions (IAEA Report INDC(NDS)-0534, 2008), which provides updated information on atomic weights and isotopic compositions. A new edition of the Karlsruhe Nuclide Chart (10th edition) has been released in EPJ Nuclear Sci. Technol. 5, 6 (2019), which includes 47 newly discovered nuclides and isomers. The chart also updates previous editions with new information on atomic weights and isotopic compositions. The CRC Handbook of Chemistry and Physics (95th Edition, 2014-2015) and other publications have provided updated information on fundamental physical constants, including the CODATA recommended values of the fundamental physical constants (J. Phys. Chem. Ref. Data 45, 043102, 2016). Overall, these updates provide a comprehensive and accurate picture of atomic weights and isotopic compositions for various elements, which is essential for nuclear science and technology applications. Note: I've condensed the text to focus on the main points, while trying to preserve the original meaning. Let me know if you'd like any further changes! Show isotopes of elements H, He and Li on a diagram. The boxes represent chemical elements with standard atomic weights and thermal neutron cross sections inside. Figures 8 to 10 illustrate mass chain fission yields, radioactive decay processes, activation processes, and nuclear reactions. These figures also show the highlighted decay chain of Th232. The Karlsruhe Nuclide Chart is a widely used table of nuclides that visually represents elements with their proton and neutron numbers. Each element is shown as a small square box containing its chemical symbol and nucleon number A. The chart categorizes radioactive decays by color, including stable (black), primordial radionuclides (partially black), and others like alpha decay (yellow) and beta minus decay (blue). It also includes information on half-lives, essential energies of emitted radiation, cross sections for nuclear reactions, standard atomic weights, and mole fraction abundances in natural isotope mixtures. The Karlsruhe Nuclide Chart was first printed in 1958 by Walter Seelmann-Eggebert and his assistant Gerda Pfennig (a predecessor institution of the later "Kern-Forschungszentrum Karlsruhe", nowadays Karlsruhe Institute of Technology) and appointed professor of radiochemistry at the Karlsruhe Technical University. Radiochemical isotope courses were held at the institute, and in the context of these teaching courses the Karlsruhe Nuclide Chart arose, which was intended to be a well-structured overview of the essential properties of the nuclides already known at that time. In the following decades, the Karlsruhe Nuclide Chart was published and revised several times. The scientific progress in the field of discovery/exploration of the nuclides and new chemical elements is also reflected in the individual editions of the chart. The chart has been published as a fold-out chart or as a wall chart, with different sizes available. Since 2014, an internet-based version "Karlsruhe Nuclide Chart Online (KNCO)" with regular updates is offered via the Nucleonica nuclear science internet portal. A simplified school version, the KNCLight, has also been developed to support nuclear education. The largest known version of the Karlsruhe Nuclide Chart is located in the Reactor Institute Delft, being 13 m  $\times$  19 m in size. The Karlsruhe Nuclide Chart is available in a large digital format, according to TU Delft. Wikipedia. Retrieved on January 31, 2024, from "