

Karlsruhe Nuclide Chart – a tradition in progress for nuclear data

Zsolt Soti^{1,*}, Raymond Dreher², and Joseph Magill²

¹ European Commission, Joint Research Centre (JRC), PO Box 2340, 76125 Karlsruhe, Germany

² Nucleonica GmbH, Ludwig-Erhard-Allee 10, 76131 Karlsruhe, Germany

Received: 2 October 2023 / Received in final form: 18 April 2024 / Accepted: 14 May 2024

Abstract. The Karlsruhe Nuclide Chart is a well-known nuclear data collection used in education and research institutions worldwide. This paper summarises its content from 1958, with data on 1517 experimentally observed nuclides, to the latest 2022/23 edition with data on 4122 nuclides. The paper also provides an overview of the data content of the latest edition with emphasis on the data sources. The unique features of this nuclide chart are the compact presentation of the most essential and up-to-date nuclide data in small, 1.5×1.5 cm nuclide boxes and the availability in different printed formats. This compact data presentation allows the Chart to supplement educational and research materials in the last 65 years. In the past eleven years, the Chart's booklet has been extended by 100 simplified decay schemes for nuclides of particular interest to understand the decay processes in more detail.

1 Introduction

In addition to producing new knowledge, fundamental research also needs to organise and present this data. Nuclear scientists in Karlsruhe, Germany, started this task 65 years ago when they launched the first edition of the Karlsruhe Nuclide Chart (KNC). By then, the KNC had become a powerful and enduring tool impacting educational and research institutions worldwide.

In the middle of the last century, nuclear science found its place in the educational courses of colleges and universities. Countries opened research institutes, and scientists developed tools to support students and researchers. In this milieu, in 1956, the Karlsruhe Nuclide Chart began its long career to systematise the newly discovered nuclides [1] and the most important experimental data.

The IUPAC Gold Book [2] defines a nuclide as a species of atom characterised by its mass number, atomic number and nuclear energy state, provided that the mean lifetime in that state is long enough to be observable. Nuclide charts are tools for systematic knowledge presentation on nuclides. The nuclide charts present nuclide data in a two-dimensional coordinate system, based on the proton and neutron number of the atomic nucleus. Although there are a number of charts available worldwide, most of them are available only online. Online charts provide access to the full decay data sets (gamma, beta, alpha energies, etc. and emission probabilities). Printed charts, on the other hand, due to the limited space available for each nuclide box,

can only highlight the most important emissions i.e. the two or three most important gamma, beta, alpha energies, etc. In practice, the printed chart with such condensed information provides a fast and convenient overview of the most important emissions for a particular nuclide. The known online charts include the IAEA Live Chart of Nuclides [3], the NNDC NuDat3 [4], and the KAERI Table of Nuclides from South Korea [5]. All these nuclide charts have a user-friendly interface, which is easy to navigate. They provide very detailed information on selected nuclides through the use of multiple browser windows. The Karlsruhe Nuclide Chart also has an online version entitled the Karlsruhe Nuclide Chart Online (KNCO), integrated into the [nucleonica.com](https://www.nucleonica.com) scientific portal [6]. The registered users of this nuclear science portal can have access to the KNCO by paying a yearly licence fee to support the active and continuous management and hosting of the portal. To support nuclear education, a simplified school version, the KNCLight, has been developed [7]. The KNCO follows the principles of the printed KNC and provides the most important data for each nuclide in a concise way directly in nuclide boxes. The nuclide decay and radiation data in the online KNCO are updated continuously.

During the last eleven years, two other printed nuclide charts have become available. The JAEA Japanese nuclide chart had two editions in 2014 and 2018 [8]. This chart has compact nuclide boxes but without the most important radiation data. The Strasbourg Nuclide Chart was published in 2020 [9,10] and is available in a booklet format. The KNC is printed in several different formats: Fold-out Chart, Wall Chart, Auditorium Chart, etc. An

* e-mail: zsolt.soti@ec.europa.eu

Table 1. Most important modifications in each edition of KNC and the number of presented nuclides.

Edition	Year of publication	Number of nuclides (ground states and meta-stable states)	Most important development
1	1958	1517	The standard KNC colours used in the nuclide boxes are introduced.
2	1961	1587	Small coloured corner triangles indicate a decay mode with a branching ratio below or equal to 5%.
3	1968	1837	The explanatory booklet has been extended to four languages. The colour green is used to indicate spontaneous fission.
4	1974	2137	Gamma energies are given in keV. Short-lived nuclides have been added.
5	1981	2224	Double beta (2β), proton decay (p) and β delayed particle emissions (βp , βn ...) are included in the Chart.
6	1995	2684	A small purple triangle is introduced to indicate cluster emission (ce). The nuclide box shows the particular cluster(s) emitted e.g. C 12, O 20, etc.
7	2006	3658	The booklet is extended to include a historical overview and structure of the atom.
8	2012	3846	The booklet is extended to include a Reduced Decay Schemes section and new printed versions of the Chart are introduced (Auditorium Chart, Roll Chart and Nuclide Carpet). The new online version KNCO is available as of 2014.
9	2016	3993	New notation for isomeric transition (IT). The Reduced Decay Schemes section is extended to 46 schemes.
10	2018	4040	The Reduced Decay Schemes section is extended to 84 diagrams.
11	2022	4122	Thermal Neutron Chain Fission Yields and Cross Section data are actualized, and the Reduced Decay Schemes section extended to 100 schemes.

explanatory booklet accompanies all the KNC print versions. One of the unique features of the KNC is the section on Reduced Decay Schemes in the booklet, which makes the KNC an easy-to-use reference for recent nuclear research. Finally, in 2023, Chinese scientists reported the development of a nuclide chart which, however, is available in Chinese only [11].

2 Progress in nuclear science during the past 65 years

In the following paragraphs, we summarise the evolution of the Karlsruhe Nuclide Chart's content. Table 1 summarises the most important developments and the number of nuclides presented in the different editions.

Seelmann-Eggebert and Pfennig, at the Institute of the Radiochemistry in Karlsruhe, created the first edition of the Karlsruhe Nuclide Chart in 1958 [12]. Since then, ten additional editions (in total 11 editions) have monitored progress in experimental research on nuclide properties and the discovery of new nuclides. Pfennig was, until the 9th edition in 2015, actively involved in updating the Chart [13]. The KNC shows only experimentally observed nuclides. The horizontal axis represents the number of neutrons (N), and the vertical axis the number of protons (Z) in the nucleus. These two numbers define a position in the coordinate system. In this position, the nuclide box shows the symbol of the chemical element, the isotope, the mass number of the nuclide, the half-life

for the unstable and the natural abundance in atom per cent for stable nuclides.

The modes of radioactive decay and the most important emitted radiations are also shown in the nuclide boxes (Fig. 1). Each new edition is used to present newly discovered nuclides and updated data measured since the previous edition. The first edition of KNC in 1958 listed 1517 different nuclides of 102 chemical elements known at the time. The latest edition provides data for 4122 nuclides of 118 known chemical elements. Figure 2 shows the evolution of the number of presented nuclides in different editions.

The 1st edition in 1958 was available as a DIN A0 wall chart and a collection of DIN A4 paper sheets for desktop use. It showed basic nuclear data such as half-lives, decay modes, particle energies, and most probable gamma energies. Already this edition used most of the colours now standard in the KNC: black for stable nuclide, red for β^+ or electron capture (ec) decay, blue for β^- decay, and white for isomeric transition [14]. Figure 3 shows the original Karlsruhe Nuclide Chart from 1958.

As of the first edition, a diagonally divided box denotes two competitive decay modes (Fig. 4a). Following the first edition's success a second edition was published in 1961. To extend the didactic use of the colours, small coloured corner triangles were introduced to indicate decay modes with small branching ratios. The small triangle indicates a decay mode with a branching ratio below or equal to 5% (Fig. 4b). The second edition presented information on 103 chemical elements, and 70 new unstable nuclides were added to the Chart. The third edition was

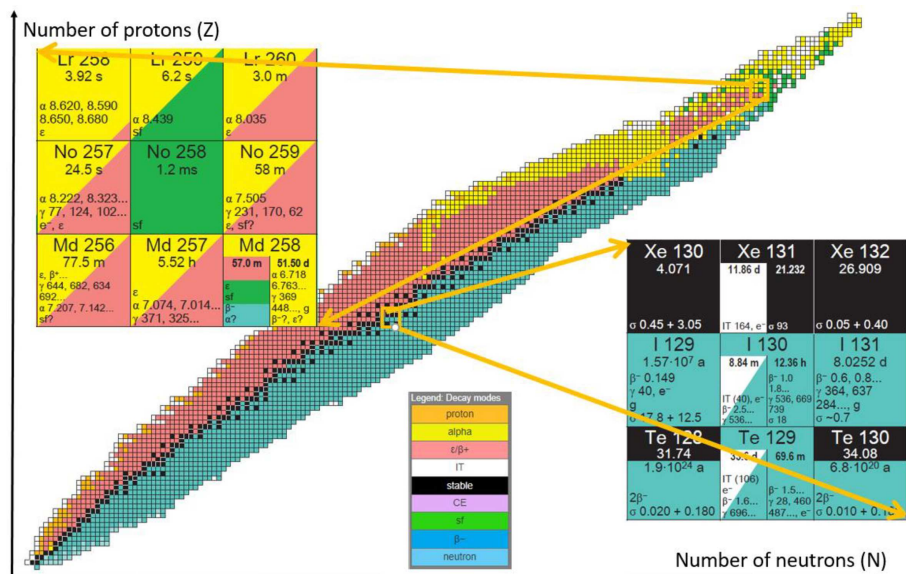


Fig. 1. The Karlsruhe Nuclide Chart in the neutron-proton (N, Z) coordinate system. The coloured boxes represent nuclides. Stable nuclides (black boxes) show the natural abundance, whereas the coloured boxes show the half-life of unstable nuclides. Boxes with a black header and an additional colour represent the primordial nuclides.

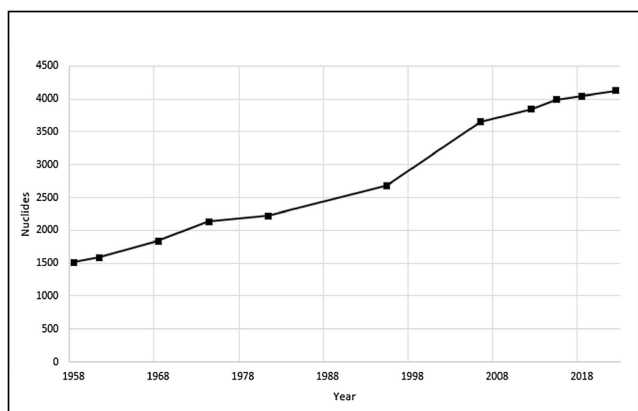


Fig. 2. The total number of nuclides, both ground state and metastable, listed in the Karlsruhe Nuclide Chart from 1958 to 2022.

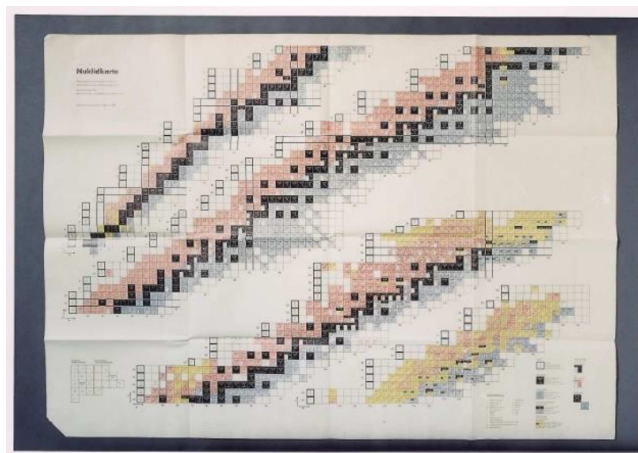


Fig. 3. The original Karlsruhe Nuclide Chart from 1958. (Credit: Magill, J. and Galy, J. (2005) Radioactivity Radionuclides Radiation. Springer Verlag, Berlin).

published in 1968. Due to its international use, the booklet section “Explanation of the Chart of the Nuclides” was extended to English, German, French, and Spanish. The colour green was introduced to indicate spontaneous fission (Fig. 4c), atomic masses were given based on C12, and instead of DIN A4 sheets, the desktop version was printed as a fold-out Chart.

The widespread use of Ge detectors made more accurate gamma measurements possible. Therefore, starting with the fourth edition in 1974, gamma energies are listed in keV. The improved experimental techniques allowed the detection of short-lived nuclides. This indicated that in the fourth edition, around 300 new nuclides were added to the Chart. The Chart then contained more than 2100 ground and metastable states. In the fifth edition in 1981, double β^- -decay ($2\beta^-$, Fig. 5a) and proton decay (p , orange

colour, Fig. 5b) were introduced. β^- -delayed particle emissions and fission from an excited state were designated by βp , βn , $\beta 2n$, $\beta \alpha$, $\beta 2\alpha$, βsf , etc. The growing popularity of the KNC resulted in the addition of the Chart as a supplement to several school textbooks books. The 5th edition was added to the following books: Ch. Petresch “Atom-og Kernfysik”, 1982, “Studienbrief Atom und Kernphysik”, 1987, “Lexikon der Physik”, vol. 3, Moscow, 1989 und K. H. Lieser, “Einführung in die Kernchemie”, 3rd edition 1991.

More than ten years after the publication of the 5th edition, the authors prepared a new 6th edition in 1995, which was reprinted in 1998. More than half of all nuclide boxes required revision and four new chemical elements

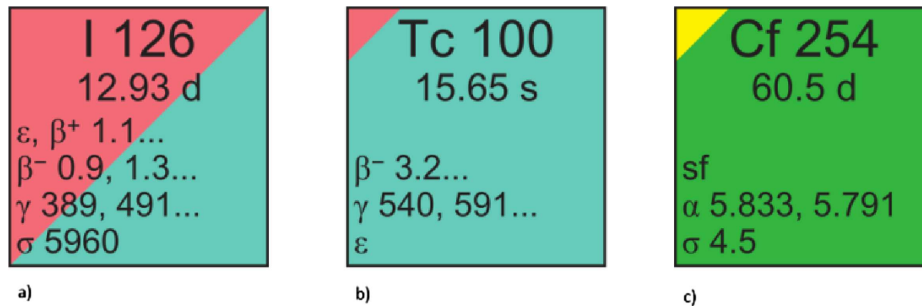


Fig. 4. When a nuclide has more than one decay mode, coloured triangles give rough indications of the branching ratios of each mode. (a) The large triangles, introduced in the first edition, in the left 1126 box, indicate branching ratios above 5%. The decay modes are listed in the order of decreasing branching ratios. (b) The small triangle, introduced in the second edition, in the nuclide box (Tc 100) indicates a branching ratio below and/or equal to 5%. (c) The green colour was introduced in the third edition to indicate spontaneous fission (Cf 254).

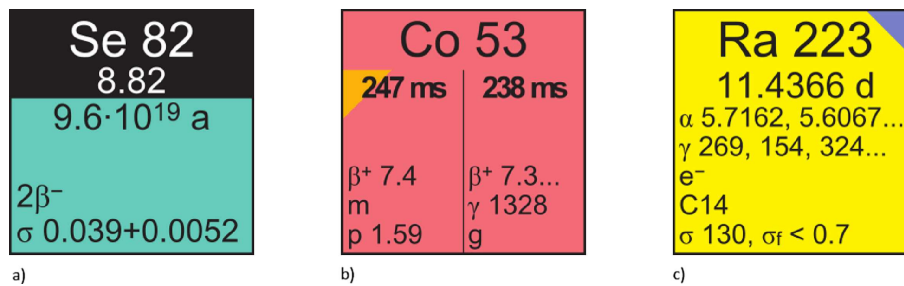


Fig. 5. (a) Double β^- -decay ($2\beta^-$) and (b) proton emission indicated by the small orange triangle first appeared in the 5th edition of the KNC. (c) Cluster emission indicated by the small violet triangle in Ra 223 was first introduced in the 6th edition.

with atomic numbers 108 to 111 were added. In this edition, cluster emission (CE), which involved the emission of clusters such as C 14 or O 20 from the nucleus, was introduced in purple (Fig. 5c). The 6th edition listed 2684 nuclides of 111 elements. To the reprint in 1998, element 112 was added, and 33 nuclides of transuranium elements were revised or added as new.

The 7th edition contained 2965 ground state nuclides and 693 isomers, including the new elements with atomic numbers 113–116 and 118. The booklet was extended with a historical overview of nuclear physics, describing the structure of the atom and with a brief introduction to radioactive decay. In 2011, through a license agreement with the EC Joint Research Centre, Nucleonica GmbH took over the hosting, software development and printing of the KNC. The JRC Karlsruhe, as the owner of the Chart, is responsible for the content development. During this collaboration, four new editions of the KNC have been published.

In 2012, to the 8th edition, 188 new nuclides were added, and data on 550 nuclides was updated. The new element names copernicium (Cn, element 112), flerovium (Fl, element 114) and livermorium (Lv, element 116) were introduced and element 117 was added. Several new print versions of the Chart became available: the Auditorium Chart, Roll Chart and Nuclide Carpet. The brochure was extended with the Reduced Decay Schemes section. In this new section, twenty decay schemes, such as those in Figure 6, helped users interpret the condensed data in the nuclide boxes. In January 2014 the new online version –

the Karlsruhe Nuclide Chart Online (KNCO) – became available in the Nucleonica nuclear science portal.

The most important change in the 9th edition, published in 2015, was the introduction of the new notation for isomeric transition (IT). Due to this notation, the gamma transitions from the parent metastable state can be distinguished from the cascade gammas emitted from excited states of the daughter nuclides. One example is shown in Figure 6, in the box and in the Reduced Decay Scheme of the Tc 99m.

The metastable state of Tc 99m, which has a half-life of 6.0072 h, has a very high probability of emitting conversion electrons leading to the excited level at 141 keV of Tc 99. The de-excitation of this level occurs due to 141 keV gamma emission, also with a very high probability of 89.8%. In the new notation, in the Tc 99m nuclide box, it can be seen that the most characteristic transition of Tc 99m is through cascade gamma emission at 141 keV, which is emitted from the excited level of Tc 99. The second isomeric transition of Tc 99m to the ground state of Tc 99 has a very low probability of 0.02%. Another low probable decay mode of the same nuclide is the β^- decay to the excited level of Ru 99, followed by a very weak gamma emission at 90 keV, in brackets.

Also in the 9th edition, ranges of atomic weights were introduced where available, to show the isotopic variability in natural materials (Fig. 7). 147 new nuclides were added to this edition, and data on 1496 nuclides was updated. The Reduced Decay Schemes section was extended from 20 to 46 schemes.

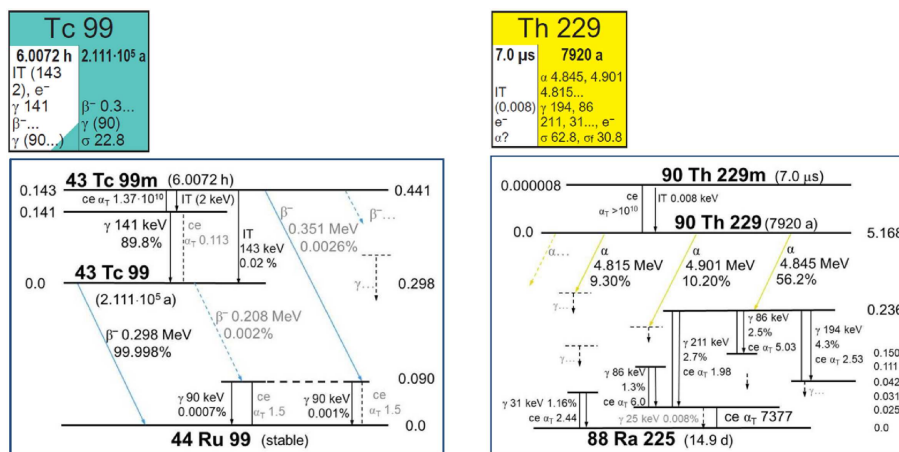


Fig. 6. The Reduced Decay Schemes (shown below the nuclide boxes) aid the user in interpreting the highly condensed information. The schemes concentrate on the data given in nuclide boxes and show how the most important transition branches can be deduced from the concise box content. Edition 8 in 2012 presents twenty schemes. Later, the section was extended, so there are currently around 100 Reduced Decay Schemes in edition 11.

8 O	O 12	O 13	O 14	O 15	O 16	O 17	O 18
Oxygen [15.99903; 15.99977]	580 keV 7.9·10 ⁻²² s	8.58 ms	70.619 s	122.24 s	99.757	0.038	0.205
σ 0.00029	2p β ⁺ ?	β ⁺ 16.7... β ^p 1.44, 6.44... γ(4439*, 3500...)	β ⁺ 1.8, 4.1... γ 2313...	β ⁺ 1.732 no γ	σ 0.00019	σ 0.000540 σ _{n,α} 0.257	σ 0.00016

Fig. 7. From the 9th edition in 2015, the element boxes show a range of atomic weights to show the natural isotopic variability. The source of this data is the actual IUPAC Table of Isotopic Abundances.

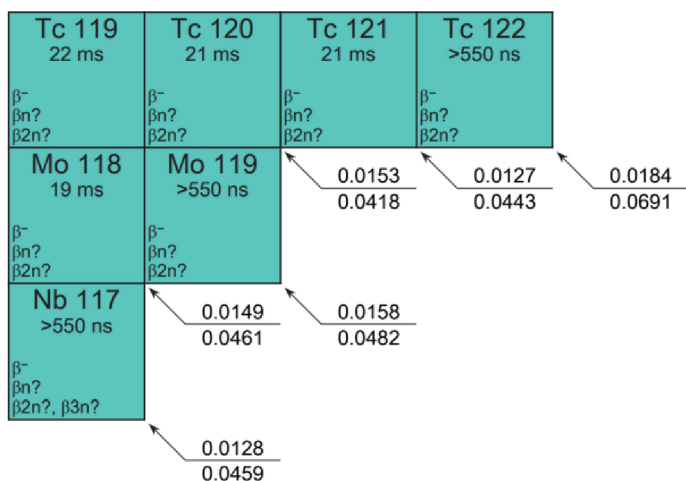


Fig. 8. The thermal neutron mass chain fission yields are updated in each new edition. The yields are shown on the right side of an isobaric line for U 235 (above) and Pu 239 (below) the arrowed line. In the last editions, the data source was the latest JEFF Fission Product Yield Evaluation.

In the 10th edition of 2018, 696 nuclides, six-element boxes, and 24 mass chain fission yields were updated. (Mass chain thermal fission yields are given for U 235 and Pu 239 Fig. 8). The names nihonium (Nh, element 113), moscovium (Mc, element 115), tennessine (Ts, element 117) and oganesson (Og, element 118) were introduced.

The complementary booklet had 72 pages and contained 84 Reduced Decay Schemes, a table of modified nuclides, a Difference Chart like one for the latest edition shown in Figure 9, a list of the most important physical constants and a periodic table of the elements.

The latest 11th Edition of the Nuclide Chart was published in 2022 with 4122 experimentally observed ground states and isomers. New data was presented on 82 nuclides, together with updated data on 953 nuclides (Fig. 9). All thermal neutron fission chain yields for U 235 and Pu 239 have been updated using the latest values from the JEFF 3.3 data file [15]. The thermal neutron cross sections in the nuclide boxes have also been actualized based on the sixth Edition of the Atlas of Neutron Resonance in 2018 [16]. The Reduced Decay Schemes section contains 100 diagrams of the most important nuclides. More details about the data content of this last edition can be found in the following section.

3 The compact data set in the nuclide boxes

The Karlsruhe Nuclide Chart is a colour-coded map with colours corresponding to the nuclide decay modes. Black boxes for nuclides such as Xe 130 and Xe 132 imply stable nuclides, as shown in Figure 1. Partially black boxes, such as for Te 128 and Te 130 boxes, also in Figure 1, indicate primordial nuclides. Primordial nuclides are unstable, but because of their very long half-life, e.g. 6.8×10^{20} years for Te 130, they are still present in terrestrial matter.

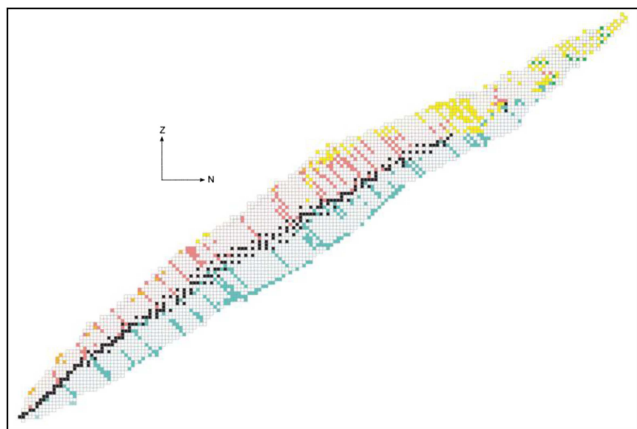


Fig. 9. The Difference Chart highlights new and modified nuclides in the latest 11th edition 2022.

The nuclide boxes, such as Te 130, also show the natural abundance and the half-life. The yellow colour denotes alpha decay (α) such as for Lr 258 in Figure 1, blue the beta minus (β^-), e.g. I 129 and red the electron capture (ϵ) or beta plus decays (β^+), e.g. Md 256 in Figure 1. The white nuclide boxes indicate metastable states of the atoms, which decay to the ground state, e.g. Xe 131m. The green colour denotes spontaneous fission (*sf*) (No 258), purple cluster emissions, light blue neutron decay (*n*), and orange proton decay (*p*). Other exotic decay modes, like double beta decay or beta decay with delayed neutrons, are also given in the nuclide boxes. If experiments showed several branches of competing decay modes for a nuclide, the nuclide box has several different colours, as shown in the I 130m and Te 129 boxes in Figure 1. Large triangles indicate the decay mode has a branching ratio of more than 5%, whereas the small triangles denote a branching ratio equal to or less than 5%. The coloured nuclide boxes, corresponding to the radionuclides, list the energies of alpha particles, protons and neutrons and the end-point energies of β particles. In the case of β^- and β^+ energies, the first value associates the emission with the highest probability and the second the highest endpoint emission energy. The dots imply additional emissions. Following the particle emissions, the most important gamma energies, responsible for the de-excitation of the nucleus, are shown.

Each horizontal row of nuclide boxes with a fixed number of protons corresponds to the experimentally determined isotopes of a chemical element. The first box in the row is the element box and gives information on standard atomic weight and the thermal neutron cross sections of that element in barn as is shown in Figure 7. The thermal neutron cross sections are in the nuclide boxes if they are available for a specific nuclide. The nuclides with the same mass number are called isobars. On the right bottom end of the tilted isobar lines, one can find the thermal neutron fission chain yields for U 235 and Pu 239, as shown in Figure 8. More details on the KNC's data structure have been described elsewhere [1].

The Chart's booklet, in addition to the explanation in four languages: English, German, French and Spanish,

contains data on fission (shape) isomers and the properties of chemical elements. It gives a short historical overview of nuclear science and explanations of the nuclear decay modes. A Reduced Decay Schemes section supports interpreting the concise content of nuclide boxes for 100 nuclides. Figure 6 shows the decay schemes for Tc 99, Tc 99m and Th 229, Th 229m, with reference to the data in the nuclide boxes. A Difference Chart (Fig. 9) shows the new nuclides and nuclides updated since the previous edition.

4 Practical applications of the Karlsruhe Nuclide Chart

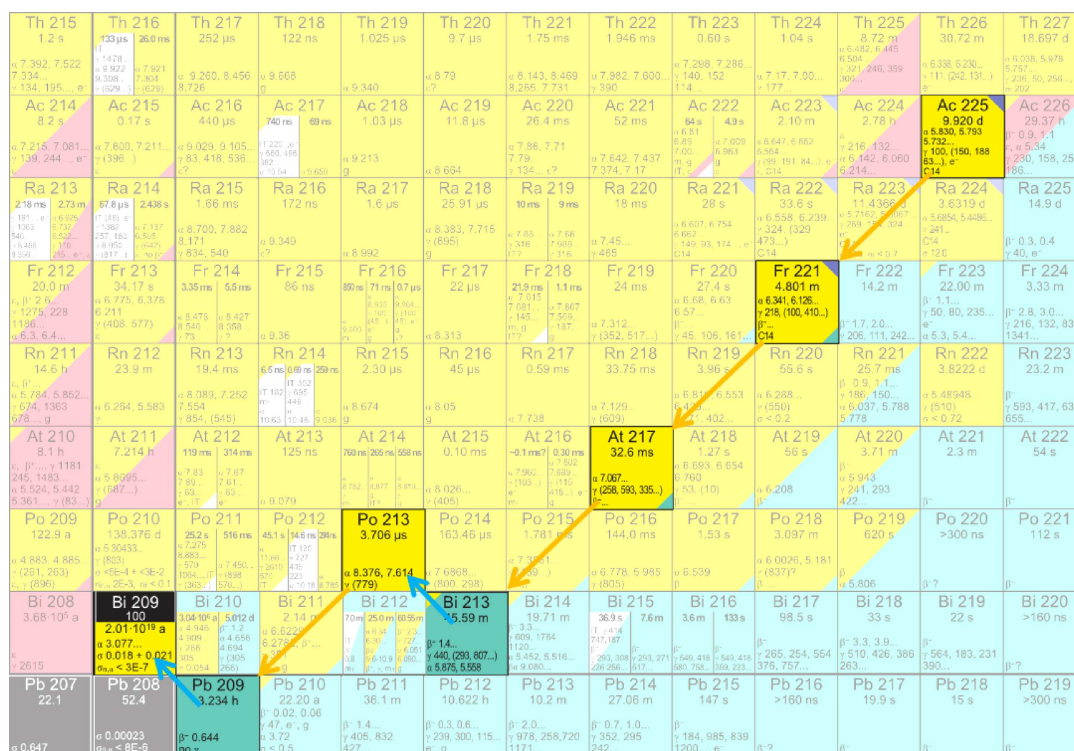
The Karlsruhe Nuclide Chart is available in scientific, educational and industrial organisations worldwide with giant versions of the chart on display in CERN, Paul Scherrer Institute, Technical Universities Delft and Munich, Urenco Group, etc. The decay chain of a nuclide can be obtained “manually” on the Chart by following simple rules. Figure 10 highlights the decay chain of Ac 225, a nuclide suitable for targeted alpha therapy [17]. From the radiation energies shown in the nuclide boxes, one can see that the decay chain has several alpha emissions between 5.8 and 8.4 MeV, shown in yellow boxes. There are only two beta-emitting nuclides in the chain (coloured in blue) and only one important gamma emission at 440 keV. Low emission probability gammas (shown in brackets) have emission probabilities below 1%. These are all properties of advantage in targeted alpha therapy.

Another exciting innovation is the thorium (Th 229) nuclear clock project [18]. The compact 1.5×1.5 cm box of Th 229 on the KNC (see Fig. 6) shows almost all the data necessary to find out how the clock can be produced. It can be seen that the Th 229m metastable state has a low-lying excitation energy at 8 eV. This unique feature makes it possible to excite the metastable state using laser radiation. The metastable level, however, has a short half-life of 7.0 μ s and decays rapidly through conversion electrons, e^- , also shown in the box. Moreover, the Th 229 ground state is identified as a long-lived alpha emitter, possessing a half-life of 7920 years, which indicates minimal radiological risk for transport and handling due to its low activity, also shown in the nuclide box.

Based on the project description [18], the key to extending the half-life of the metastable state lies in finding an appropriate mixed crystal structure in which the excitation energies of Th 229 electrons can be increased beyond 8 eV. With this half-life extension, the hurdle in the development of the nuclear clock can be overcome.

5 Use of the Nuclear Data Sheets (NDS) and other sources for nuclide data updates

Most of the updates in the KNC are based on the recent evaluations published in the Nuclear Data Sheets (NDS). The NDS evaluations are supported by the Evaluated Nuclear Structure Data Files (ENSDF) [19]. In Figure 9



(Difference Chart), the highlighted atomic masses are updated in the latest edition of KNC.

As an example, consider the decay of Tc 99 shown in Figure 6. Decay of the ground state Tc 99 is through β^- -emission and leads to the daughter Ru 99 which has the same mass number 99. Data updates for Tc 99 will therefore be found in the mass chain 99 evaluation. In the NDS, however, the beta and gamma emission data are associated with excited states of the daughter Ru 99 (as shown in the decay scheme in Fig. 6) and are to be found not in the Tc 99 data set but in the daughter Ru 99 data set. In the case of Tc 99m, the decay data is to be found in the Tc 99 data set (for the IT transition) and in the Ru 99 data set (for the β^- transition).

a mass number of 225, this data is not included in the mass number 229 evaluation, but in the mass number 225 evaluation. So for the Th 229 data update for the nuclide boxes shown in [Figure 6](#), data from the mass chains 229 and 225 need to be considered. In the case of Th 229m, the decay data is to be found in the Th 229 data set (for the IT transition).

Information on recently discovered nuclides is obtained from the Discovery of Nuclides project [23]. In the preparation period for the latest KNC 11th edition, 2018–2021,



Fig. 11. Blue arrows show some decay and radiation data that can be found in the mass evaluation $A = 186$. The red arrows indicate decays that need a deeper search to find the most recent data.

the RIKEN Nishina Center in Japan reported many new nuclides. In a series of five publications [24–27], the authors reported in total data on 51 newly discovered nuclides in the neutron-rich region of the nuclide chart.

The main data set in the KNC contains nuclide decay and radiation information. This data is updated as follows:

- each new NDS mass evaluation is checked for new or updated data on the nuclides.
- If a nuclide is not in the Chart, it is added.
- When a nuclide is in the Chart, the half-life and decay modes information is updated.
- In the case of a new metastable state decays only by isomeric transition (IT), it is added to the Chart if the half-life is above 1 s. There can be exceptions. If the nuclide is important for some reason, e.g. part of the decay chain, or it has an interesting application such as Th 229m mentioned above, it is also added to the Chart.
- For each decay mode, the particle emissions are updated. In the case of β emission, there are two end-point energies in the nuclide box, given in MeV. The first endpoint energy corresponds to the most probable emission; the second is the highest endpoint energy. If the highest energy also has the highest emission probability, only a single value is given. Dots indicate additional β emissions.

- Other particle emissions, e.g. α , proton and neutron, are ordered based on emission probabilities and are given in MeV.
- Finally, for all decay modes, the most important gamma emissions are updated and ordered according to their emission probability. Weak gamma emissions below 1% probability are given in brackets. The existence of conversion electrons is denoted by e^- . This emission is included only if it is more probable than the photon emission (conversion coefficient >1).

Additional non-decay information in the KNC includes chemical element data, isotopic abundancies, atomic weights, chain fission yields, thermal cross-sections and physical constants.

- The recent chemical element data is obtained from the CRC Handbook of Chemistry [28],
- isotopic abundancies and atomic weights from the evaluations of the CIAAW web portals [29],
- chain fission yields from the JEFF-3.3 data library [15],
- cross-section data from the sixth Edition of the Atlas of Neutron Resonance in 2018 [16],
- physical constants and conversion factors from the CODATA recommended values.

Currently, the Karlsruhe Nuclide Chart is published every three to four years. On average, there are around 700 to 800 modified nuclides in each new edition. The next edition is planned for 2025. In addition to providing print-based and online versions of the Karlsruhe Nuclide Chart for the end user, the KNCO program implements all features supporting the editors' work, from editing nuclide box contents to creating new nuclide boxes and elements to managing the Chart's versions. The program also allows for the creation of Charts and Chart excerpts in various layouts and formats. In addition, high-resolution vector graphic PDFs can be produced for printed charts, and the accompanying brochure, as well as EMF files suitable for Word documents and other standard formats like PNG, JPEG, SVG, etc.

The KNC online (KNCO) program is integrated into the nucleonica.com portal. The portal contains numerous additional apps such as data search for nuclides and radiations, decay calculations, dosimetry and shielding and gamma spectrometry.

6 Summary

This paper provides an overview of the history of the Karlsruhe Nuclide Chart over the past 65 years and details of the most recent 11th edition from 2022/2023.

The data presented in the Chart is used in health physics and radiation protection, nuclear and radiochemistry, and astrophysics. Beyond these more traditional areas, the data is used in nuclear medicine, environmental sciences, and biology where a knowledge of the behaviour of nuclides plays an important role. Although many nuclear data sources are available on the internet, the Karlsruhe Nuclide Chart provides a unique overview of current knowledge and is for many the preferred medium for ease of use, convenience and practicality in daily work.

The Chart owes its success to its compact but carefully selected content described in detail in this paper, its regular reference editions, its varied printed formats, and its recognisable aesthetic appearance. The Karlsruhe Nuclide Chart is a good example that in the world of artificial intelligence, online platforms and huge visualisation equipment, well-designed and carefully selected compact scientific data sets can have their place.

The Karlsruhe Nuclide Chart is supported and updated by the European Commission's Joint Research Centre in Karlsruhe. Maintenance, marketing and publication of the Chart is through a collaboration with Nucleonica GmbH (nucleonica.com). The Nucleonica portal also provides an online version of the Chart with many additional features.

Conflicts of interest

The authors declare that they have no competing interests to report.

Funding

The research did not receive any specific fundings.

Data availability statement

This article has no associated data generated and/or analysed.

Author contribution statement

Zsolt Soti is responsible for the data content of the Karlsruhe Nuclide Chart and for the figures and text of this paper. Joseph Magill is responsible for the publication of the Karlsruhe Nuclide Chart and the text of this paper. Raymond Dreher is responsible for the printing, data presentation and programming tasks in the Karlsruhe Nuclide Chart and for the figures and text of this paper.

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Cite this article as: Zsolt Soti, Raymond Dreher, Joseph Magill. Karlsruhe Nuclide Chart – a tradition in progress for nuclear data, EPJ Nuclear Sci. Technol. **10**, 7 (2024)