POCKET ENCYCLOPEDIA
of
ATOMIC ENERGY

Edited by

Frank Gaynor

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PREFACE

MAN has succeeded in tapping the energy of the atomic nucleus, and is now working toward an efficient harnessing of this energy, and is eagerly looking forward to a new "Atomic Age."

This very expression "atomic age" calls for a brief comment. While the energy released from the *nucleus* of the atom is customarily referred to in popular parlance as "atomic" energy, and the layman has become accustomed to calling the bomb utilizing this energy "atomic" bomb, it is necessary to state emphatically and unambiguously that this use of the word "atomic" is a misnomer and a scientific inaccuracy. If there is at all such a thing as "atomic energy," it would be the energy contained in or released by the atom as a whole—it would be more or less a synonym for "chemical energy," the energy yielded by the extra-nuclear electrons within the atom. The energy which is released in the fission of an atomic *nucleus* is *nuclear* energy, and the bombs which flattened Hiroshima and Nagasaki were *nuclear* energy bombs. It may be right to call this energy *intra-atomic* (i.e. the energy present *within* the atom), but the expression "atomic" energy is scientifically meaningless and, even worse, misleading. However, this adjective is being so universally used by the general public that even scientific authors are compelled to use it—under protest—when writing for other than strictly scientific audiences.

The purpose of this book is to present a comprehensive collection of brief definitions and explanations of the terms

and expressions of this new field of science to the layman with a good average education, and to the student with a fair working knowledge of physics and at least a nodding acquaintance with higher mathematics.

It is not a textbook. It is merely a sort of tourist's guide in the new and strange realm of the Atom. It is not an accurate detail map of this strange land, not meant to describe every hill and vale, every boulder, every obscure path of the terrain. It is intended to furnish the stranger on a brief excursion in this unknown land with a general bird's eye view, merely to point out to him the most outstanding landmarks and the main highways which will lead him to his goal—a general understanding of the atom, its nucleus, its energy, and their relationship to human life and progress.

This book lays no claim to completeness. Completeness is impossible, anyway, for any dictionary, glossary or encyclopedia in this field. Atomics—nucleonics—is a living, growing, lusty infant science, which strides with seven-league boots on its way toward maturity. New discoveries are being made almost every day, and even an encyclopedia which could be claimed to be absolutely complete at the date of its printing may turn out to be more or less out of date by the time it reaches the bookstores. Let us cite just one example—the artificial radioisotopes. Artificial radioactivity was unknown before 1934. Six years after its discovery, J. J. Livingwood and G. T. Seaborg published a list of 332 artificially produced radioisotopes (*Rev. Mod. Phys.*, 12, 30/1940); the table published by G. T. Seaborg in 1944 (*Rev. Mod. Phys.*, 16, 1/1944) listed 425; today, the number of known radioisotopes is around 700. By the time this book is on the market, many more may have been discovered, and so may have been new sub-atomic particles and nuclear processes and reactions now unknown. The author and the publishers

can state in good conscience only that this book mentions the most important facts now known about the atom, its nucleus and its energy, but no one can foretell what additional facts will be known by the time this book reaches the reader.

Thumbnail biographical sketches of outstanding personages in this new field of science, too, have been included, to acquaint the reader with his guides to the new age in mankind's history.

Another supplementary feature of the book is that it lists the German equivalents of a great many of the topics mentioned, for the purpose of enabling those with a working knowledge of German to read German publications on the subject. Not all expressions treated in this book are given in German, for there are many for which there are no equivalent standard, universally accepted terms in German, at least the author has been unable to find any term which he could with certainty consider to be such, in all the German publications consulted. However, this listing of German words is merely a secondary feature of this book, which is not meant to be an English-German dictionary of atomics. That may come later. . . .

Dr. Samuel Johnson said: "Every author may aspire to praise; the lexicographer may only hope to escape reproach." The author and the publishers feel that this book has every reason to hope to escape reproach, but they sincerely invite suggestions and constructive comments.

FRANK GAYNOR

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LIST OF ILLUSTRATIONS
CHARTS AND TABLES

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A

A. (1) The symbol for the element *argon* (q.v.). (2) The symbol for *mass number* (q.v.) or the combined total of the number of protons and neutrons. (3) An abbreviation for *Angstrom unit* (q.v.).

Å. An abbreviation for *Angstrom unit* (q.v.).

α. The symbol used to designate *alpha particle* or *alpha ray* (q.v.). For terms beginning with α, see entries listed under *alpha*.

A-bomb. See *atomic bomb*.

abampere. The electromagnetic unit of current in the C-G-S system. 1 abampere is defined as the current which produces a magnetic intensity of 2π oersteds at the center of a circuit in a one-turn circular conductor of a radius of 1 cm. in a vacuum. 1 abampere=10 absolute amperes.

abcoulomb. The electromagnetic unit of quantity of electricity in the C-G-S system. 1 abcoulomb is defined as the quantity of electricity which passes any given point of an electric circuit in one second when the current is 1 abampere. 1 abcoulomb=10 coulombs.

abfarad. The electromagnetic unit of capacitance in the C-G-S system. 1 abfarad represents the capacitance of a condenser when a charge of 1 abcoulomb produces a difference of potential of 1 abfarad between terminals. 1 abfarad=10^9 farads.

abhenry. The electromagnetic unit of inductance in the C-G-S system. 1 abhenry represents the inductance in a circuit in which a current changing at the rate of 1 abampere per second produces an electromotive force of 1 abvolt. 1 abhenry=10^{-9} henry.

abmho. The electromagnetic unit of conductance in the C-G-S system. 1 abmho represents the conductance of a conductor when with an unvarying difference of potential of 1 abvolt between its terminals, the current in the conductor is 1 abampere. 1 abmho=10^{-9} mho.

abohm. The electromagnetic unit of resistance in the C-G-S system. 1 abohm represents the resistance of a conductor when with an unvarying current of 1 abampere flowing through it, the difference of potential between the terminals is 1 abvolt. 1 abohm=10^{-9} ohm.

absolute atomic weight. See *atomic weight*.

absolute joule. A unit of energy or work. 1 absolute joule=10^7 ergs.

absolute temperature. Temperature according to a scale in which the lowest mark is the *absolute zero* (q.v.). To calculate temperatures according to the absolute scale, add 273·1 to the centigrade value or 459·8 to the Fahrenheit value. [G: *absolute Temperatur*]

absolute zero. The temperature at which all molecular motion ceases and bodies possess no heat at all, i.e. −273·1°C. or −459·8°F. [G: *absoluter Nullpunkt*]

absorption coefficient. The rate of the absorption of radiation by the substance traversed by it; a constant which is characteristic of the nature and energy of the radiation and of the material absorbing it. Symbol: μ (cf. *atomic absorption coefficient*.) [G: *Absorptionskoeffizient*]

absorption edge. The sharp edge of the x-ray absorption spectrum on

the side of longer wavelength. An absorption edge is assumed to appear in the spectrum when the incident energy has reached the magnitude just sufficient to lift that electron which absorbs it completely out of the atom. (Cf. *absorption limit.*) [G: *Absorptionsrand*]

absorption factor. A term used in connection with *radiation survey instruments* (q.v.) to denote the fraction of particles capable of penetrating the window of the counter and the air, and any other substance, between the radioactive sample and the counter. [G: *Absorptionsfaktor*]

absorption limit. The wavelength or frequency corresponding to an *absorption edge* (q.v.). [G: *Absorptionsgrenze*]

absorption spectrum. The spectrum of radiation which has passed through a selectively absorptive substance. [G: *Absorptionsspektrum*]

absorptivity. Absorptive power, expressed in terms of the magnitude of that portion of a radiant energy which is absorbed by the substance of the body upon which the radiation normally impinges. [G: *Absorptionsvermögen*]

abundance of isotopes. The proportion, expressed in percentages, of the various natural isotopes of an element in any given sample of the element in question. (Cf. *isotope, isotope table.*) [G: *relative Häufigkeit von Isotopen*]

abvolt. The electromagnetic unit of electromotive force in the C-G-S system. 1 abvolt represents the electromotive force in a circuit when with a flow of a current of 1 abampere, electric energy is converted to other kinds of energy at a rate of 1 erg per second. 1 abvolt can be defined also as a unit of potential difference, representing the difference of potential between two points when 1 erg of work is required to transfer 1 abcoulomb of positive electricity from the point of lower potential to the point of higher potential. 1 abvolt$=10^{-8}$ volt.

abwatt. A unit of power. 1 abwatt represents 1 abampere through a difference of potential of 1 abvolt, and equals 10^{-7} watt.

Ac. The symbol for the element *actinium* (q.v.).

AcA, AcB, AcC, AcC′, AcD, AcU, AcX. The symbols for *actinium A, actinium B, actinium C, actinium C′, actinium D, actinium uranium* and *actinium X* (q.v.), respectively.

acceleration. The rate of change in velocity (either linear or angular) per unit time, customarily expressed in centimeter per second per second. [G: *Beschleunigung*]

accelerator of nuclear particles. Apparatus employed to increase the velocity of sub-atomic particles. (Cf. *betatron, cyclotron, linear accelerator, proton synchrotron, synchro-cyclotron, synchrotron.*) [G: *Elementarteilchen-Beschleunigungs-Apparat*]

actinic radiation. Radiation able to produce a chemical change. [G: *aktinische Strahlung*]

actinides. The elements with atomic numbers above 88, i.e. actinium, thorium, protactinium, uranium, neptunium, plutonium, americium and curium. (Recently the discovery of two new actinide elements, *berkelium* and *californium* (q.v.) has been announced.) According to Seaborg, these elements occupy one single place in the extended periodic table, in the same Group into which the *rare earth elements* ("lanthanides") are classified. The actinides and the rare earth elements show a striking similarity of extranuclear electron

structure and of properties dependent on the nature of this structure: in both these groups of elements, the outermost electron subshell of the atom is completed, and an inner electron subshell is filled with the increase of the atomic number in both groups, viz. the 4*f* subshell in the rare earth elements and the 5*f* subshell in the actinides. In analogy to the rare earth elements, the discovery of further actinide elements, up to atomic number 103, is expected, so as to make the actinide group, too, a group of 15 elements. (Cf. *electron structure of atoms, periodic table.*) [G: *Aktiniden*]

actinium (Ac). A rare radioactive element, first member of the actinium group of the extended periodic table, atomic number 89, atomic weight 227·05. Discovered by Debierne in 1899. Two natural actinium isotopes are known: Ac^{227}, which is a member of the uranium-actinium series, a product of the α-decay of protactinium, has a half-life of 13·5 years, changes into francium (Fr^{227}) and radioactinium; Ac^{228}, a member of the thorium series, as such called *mesothorium* 2 (q.v.). Artificially produced radioisotopes: Ac^{222}, Ac^{223}, Ac^{224}, Ac^{225} and Ac^{226}. Actinium is claimed to be safer than radium for many medical applications and to be approximately 150 times more active, weight for weight, than radium. (Cf. *electron structure of atoms, isotope table, elements, periodic table.*) [G: *Aktinium*]

actinium A (AcA). A radioactive isotope of polonium ($_{84}Po^{215}$), member of the uranium-actinium series, product of the α-decay of *actinon* (q.v.). Atomic number 84, mass number 215. An α-emitter with a half-life of 2×10^{-3} sec., it changes into *actinium B.* (Cf. *isotope table.*) [G: *Aktinium A*]

actinium B (AcB). A radioactive lead isotope ($_{82}Pb^{211}$), member of the uranium-actinium series, product of the α-decay of actinium A. Atomic number 82, mass number 211. A β-emitter, with a half-life of 36 minutes, it changes into actinium C. (Cf. *isotope table.*) [G: *Aktinium B*]

actinium C (AcC). A radioactive bismuth isotope ($_{83}Bi^{211}$), member of the uranium-actinium series, product of the β-decay of actinium B. Atomic number 83, mass number 211. An α- and β-emitter with a half-life of 2·16 minutes, it changes by β-emission (99·68%) into actinium C′ and by α-emission (0·32%) into actinium C″. (Cf. *isotope table.*) [G: *Aktinium* C]

actinium C′ (AcC′). A radioactive polonium isotope ($_{84}Po^{211}$), member of the uranium-actinium series, product of the β-decay of actinium C. Atomic number 84, mass number 211. An α-emitter with a half-life of 5×10^{-3} sec., it changes into the stable lead isotope actinium D. (Cf. *isotope table.*) [G: *Aktinium C′*]

actinium C″ (AcC″). A radioactive thallium isotope ($_{81}Tl^{207}$), member of the uranium-actinium series, product of the α-decay of actinium C. Atomic number 81, mass number 207. A β-emitter with a half-life of 4·76 minutes, it changes into the stable lead isotope actinium D. (Cf. *isotope table.*) [G: *Aktinium C″*]

actinium D (AcD). The stable lead isotope ($_{82}Pb^{207}$) which is the end product of the uranium-actinium series, produced by the α-decay of actinium C′ and by the β-decay of actinium C″. Atomic number 82, atomic weight 207, natural abundance 22·6%. [G: *Aktinium D*]

actinium emanation. See *actinon*.

actinium group. See *actinides*.

actinium K (AcK). The radioactive francium isotope ($_{87}Fr^{223}$), (Cf. *francium, isotope table.*) [G: *Aktinium K*]

actinium series. See *uranium-actinium series.*

actinium uranium (AcU). The natural radioactive uranium isotope $_{92}U^{235}$, parent of the uranium-actinium series. Atomic number 92, mass number 235, an α-emitter with a half-life of $7{\cdot}1 \times 10^8$ years, it changes into uranium Y. (Cf. *isotope table.*) [G: *Aktinouran*]

actinium X (AcX). A radioactive radium isotope ($_{88}Ra^{223}$), member of the uranium-actinium series, product of the α-decay of radioactinium. Atomic number 88, mass number 223. An α-emitter with a half-life of 11·2 days, it changes into actinon. (Cf. *isotope table.*) [G: *Aktinium X*]

actinometer. An instrument for measuring the actinic effects of light or other electromagnetic radiation. The term is applied also to the instrument for measuring the direct heating power of the rays of the sun. [G: *Aktinometer*]

actinon (An). A gaseous radioactive element, isotopic with radon ($_{86}Rn^{219}$), product of the α-decay of actinium X. Atomic number 86, atomic weight 219. Also called *actinium emanation.* It is an α-emitter with a half-life of 3·92 sec., changes into actinium A. (Cf. *isotope table.*) [G: *Aktinon, Aktinium-Emanation*]

activation energy. The energy required to start off a nuclear transmutation process. [G: *Aktivations-Energie*]

activity. (1) The magnitude or rate of the intensity of a radioactive emission in terms of its observable effects. (2) An excited state of a gaseous substance due to ionization. (3) In chemistry: a concentration of free ions. [G: *Aktivität*]

adiabatic. A term used in thermodynamics referring to a change in a system without loss or gain of heat. [G: *adiabatisch*]

adiabatic curve. A curve or graph showing the relation between pressure and volume in substances having or assumed to have the property of adiabatic expansion and contraction. [G: *Adiabate*]

adiabatic process. A process in which no exchange of heat occurs between the substance and its environment. [G: *adiabatischer Vorgang*]

AEC. The abbreviation for (United States) *Atomic Energy Commission* (q.v.).

affinity. Chemical potential; the tendency or ability of atoms to unite in molecules. [G: *Affinität*]

afterglow. The luminosity persisting in a rarefied gas after the passage through it of an electrodeless discharge. [G: *Nachglühen, Nachleuchten*]

Ag. The symbol for the element *silver* (q.v.).

Al. The symbol for the element *aluminum* (q.v.).

alabamine (Ab). The name formerly used for the element *astatine* (q.v.). [G: *Alabamin*]

Alamogordo Air Base. An air base in New Mexico, about 120 miles south-east of Albuquerque where the first man-made nuclear explosion was achieved on July 16, 1945.