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Solar Energy

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Abstract: *The source of energy in the core of the Sun is neutron repulsion, the same source of energy in cores of the uranium and plutonium atoms that destroyed Hiroshima and Nagasaki on 6 and 9 August 1945, respectively. The Sun is an ordinary star that produces and discards hydrogen generated by neutron-emission followed, in succession, by neutron-decay. This conclusion is based on precise measurements of meteorites, planets, the Moon and the Sun during the space age and on precise atomic rest mass data. It assumes that free neutrons decay spontaneously into hydrogen atoms and that solar energy arises from the conversion of nuclear rest mass (m) into solar energy (E).*

1. Introduction

I am grateful for the invitation to submit this review on neutron repulsion as the source of solar energy. The manuscript is based primarily on the work of two great scientists that participated on opposing sides of the Second World War and then died in 2001.

The astronomer, astrophysicist and cosmologist, Sir Fred Hoyle (1915-2001), led a radar development group for the British during WWII and later left unambiguous hints in his 1994 autobiography [1] of inexplicable, sudden changes in the foundations of these major fields of science in 1946.

The nuclear geochemist, Paul Kazuo Kuroda *aka* Kazuo Kuroda (1917-2001), was more circumvent in leaving hints in the description of his life as a graduate student and then as a faculty member at the Imperial University of Tokyo, studying radium, radon and other trace elements in hot springs and later extracting uranium from Manchurian euxenite ore for Japan during WWII [2].

Kuroda became my research mentor in 1960 and assigned this research project: *"The Origin of the Solar System and Its Elements."* This paper includes many of the research findings summarized in my biography, in progress [3]. After Kazuo Kuroda's death, BBC News reported [4] his widow returned secret atomic bomb plans missing from Japan for fifty-seven years (2002 - 1945 = 57 years).

The BBC News Report [4] of chaos in the handling of nuclear secrets in August 1945 and the earlier warning about possible annihilation of planet Earth by uncontrollable release of nuclear energy - in the last paragraph of Aston's 1922 Nobel Prize Lecture [5] - suggest that fear of nuclear annihilation may have influenced the decision to obscure the force of neutron repulsion in cores of heavy atoms and stars after WWII.

Hundreds of other scientists contributed to recognizance of neutron repulsion as the source of energy in cores of heavy atoms and stars and its release - suddenly in the case of atomic or stellar fission and/or more slowly in the case of nuclear reactors or stable stars. Many of these scientists were cited as references in the above papers [1-3, 5]. Special merit must go to Einstein's finding [6,7] that mass (m) is stored energy (E), to Chadwick's discovery of the neutron [8,9] and to F. W. Aston [5] for identifying isotopes, measuring their exact masses, and reporting a momentous promise and a dire warning to the public in the last paragraph of his 1922 Nobel lecture ***". . . the human race will have at its command powers beyond the dreams of scientific fiction; but the remote possibility must always be considered that the energy once liberated will be completely uncontrollable and by its intense violence detonate all neighbouring substances. In this event the whole of the hydrogen on the earth might be transformed at once and the success of the experiment published at large to the universe as a new star."***

The underlined part of Aston's lecture may have changed the course of world history by frightening world leaders into forbidding public knowledge of neutron repulsion after the chaotic closing days of WWII, when at least one copy of plans for building atomic bombs disappeared from government control for the next fifty-seven years [4].

2. Materials and Methods

The conclusions presented in this review are based on the best data available at the time the measurements were made. E.g., neutron repulsion was first recognized in 2000 in the atomic rest mass data published by the National Nuclear Data Center, Brookhaven National Laboratory [10]. Nine stages of mass-fractionation in the Sun were identified in precise isotope measurements at the Physikalisches Institut, Universität Bern [11] of solar-wind-implanted noble gases in lunar soils returned by the 1969 Apollo mission to the Moon. Most conclusions in this review come from Chapters 2 and 3 of my autobiography [3] and general information in chemistry and physics textbooks that was probably first published in reference books like the *CRC Hand-book of Chemistry and Physics* (First edition published in 1913) and the *Table of Isotopes* compiled at Ernest O. Lawrence Berkeley Laboratory. Paul Kazuo Kuroda supervised the author's PhD research. John Hamilton Reynolds supervised his introduction to stable isotope mass spectrometry and space physics.

3. Results and Discussion

Before reviewing experimental evidence the Sun made our elements, birthed the solar system, sustained the origin and evolution of life, and generates heat, light, solar neutrinos, solar-wind hydrogen and helium as waste products of the nuclear reactions triggered by neutron repulsion in the Sun 's pulsar core [12], a few words on nuclear forces, nuclear structure and nuclear decay may help readers see why *the ATTRACTIVE force of neutrons for protons is dominant in fusion of the light atoms*, but *the REPULSIVE force between neutrons becomes dominant in fission and/or neutron emission from cores heavy atoms, some planets, ordinary stars and galaxies*.

Three basic types of interactions between nucleons (neutrons and protons) [13-15] determine modes of nuclear decay and changes in nuclear structure. *Among light-weight nuclei*, the core consists of pairs of neutron-proton (n, p+) pairs with extra neutrons at the nuclear surface because:

1. The strongest nuclear force is the ATTRACTIVE force of neutrons for protons, and *visa versa*
2. The weakest nuclear force is the REPULSIVE force between neutrons
3. The intermediate nuclear force is the REPULSIVE force between protons.

Many of the abundant light-weight nuclei consist only of pairs of neutron-proton (n, p+) pairs: He-4, C-12, O-16, Ne-20, Mg-24, Si-28, S-32, Ar-36 and Ca-40.

The weakest and strongest nuclear forces are short-ranged, but the intermediate nuclear force includes the longer ranged REPULSIVE Coulomb force between the positive charges on each proton [13-15]. The REPULSIVE force between protons becomes competitive with the ATTRACTIVE force in neutron-proton pairs near 150 amu (atomic mass units) and *the nucleus rearranges into a core of neutrons somewhat more highly energized by neutron-repulsion* [14], *with pairs of neutron-proton (n, p+) pairs on the nuclear surface*.

Above ~150 amu, neutron-emission is replaced by alpha-emission, i.e., α-decay or He-4-emission is observed when the nuclear core contains 84 neutrons (in Nd-144, Pm-145 and Sm-146). But nuclear stability ceases when the nuclear core contains more than the 126 neutrons in Pb-208 and Bi-209.

Spontaneous fission becomes a mode of decay with 142 neutrons in Th-232 [16], if not earlier, and spontaneous fission becomes the dominant mode of decay when the neutron-rich core contains 156 neutrons in Cf-254, Fm-256 and No-258.

3.1 Proof of Neutron Repulsion

Figure 1 (below) shows convincing evidence of neutron repulsion [12-15] in cores of neutron-rich atoms (left), proton repulsion in cores of proton-rich atoms (right), and neutron-proton attraction in the middle. The vertical scale on this figure is the mass (energy) per nucleon, **M/A =** f **+ 1**, where f is Aston's *"packing fraction."*

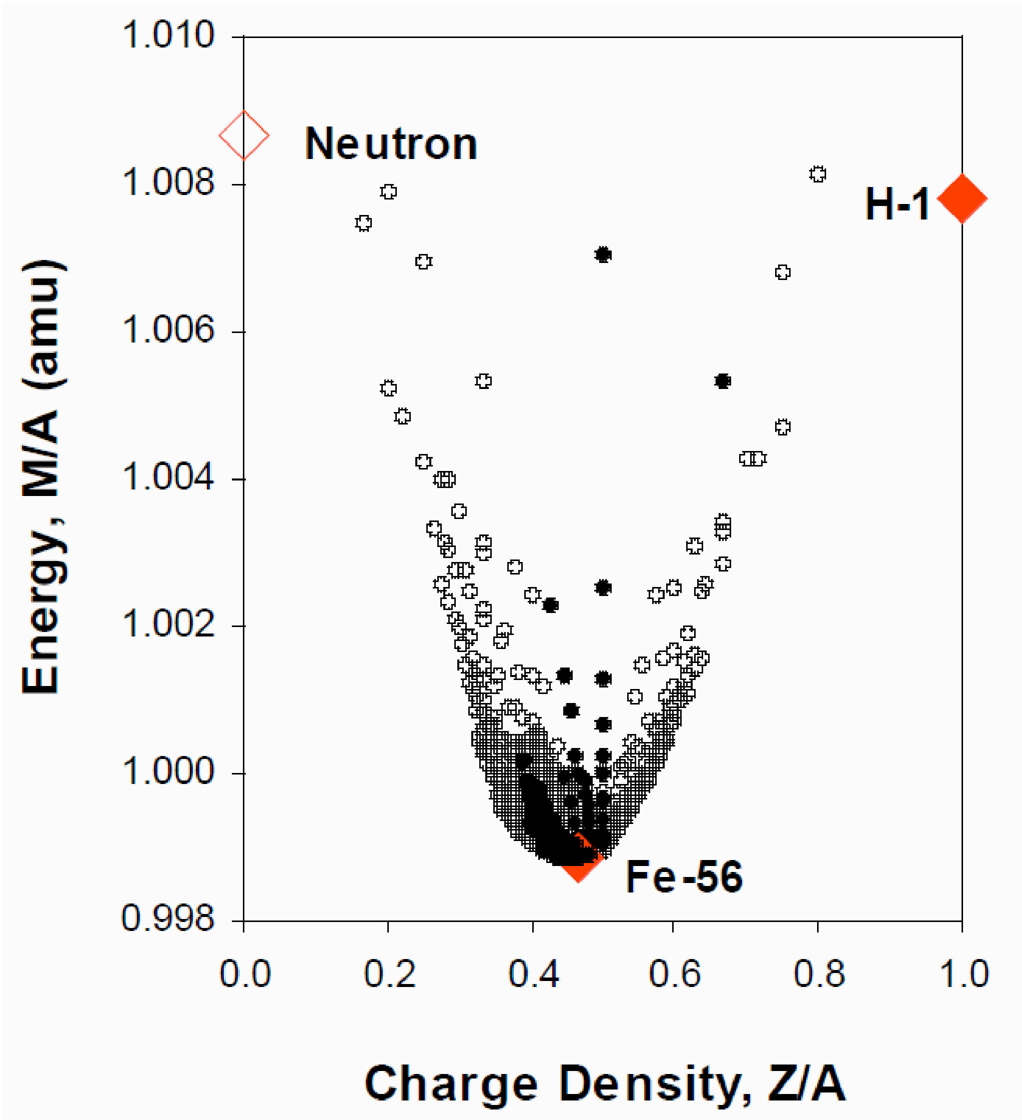


Figure 1a: Two forms of one fundamental particle shown by the **red** symbols on the left (**neutrons**) and right (hydrogen atoms, **H-1**) comprise every atom. The most stable atom, **Fe-56**, is also the most abundant atom in the Earth, in the Sun and in ordinary meteorites. On Earth H-1 is more stable than the neutron. At high pressure, H-1 atoms collapse into neutrons [17] and can be energized by neutron repulsion to energy levels above the top of the page [12].

The Cradle of the Nuclides

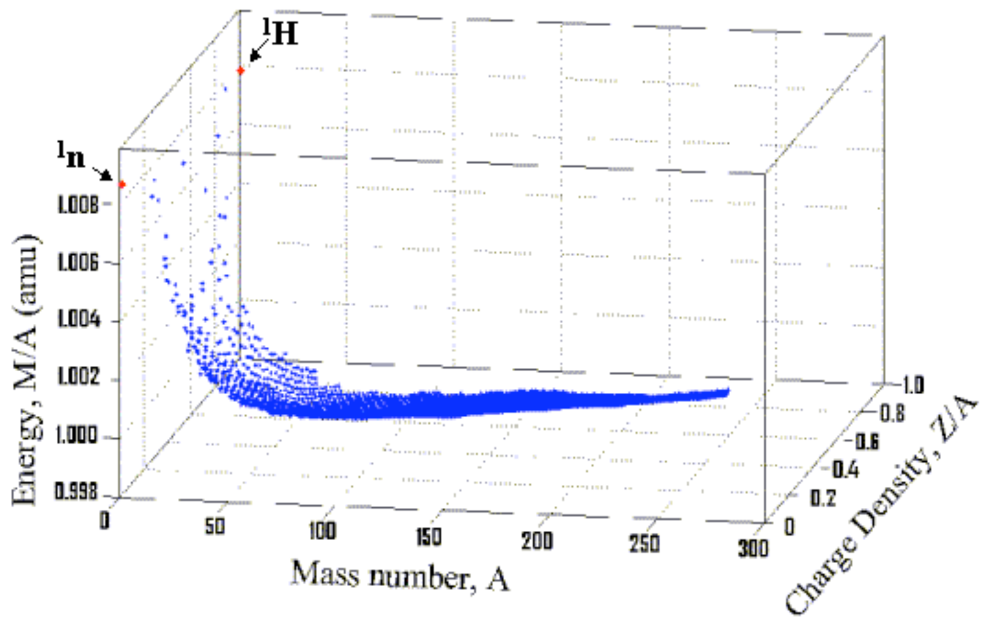


Figure 1b. Combinations of the two forms of one particle that comprise all of the atoms, neutrons (^{1}**n**) in the front and hydrogen atoms (^{1}**H**) in the back, are sorted above by mass number (A) on the horizontal axis and by charge density (Z/A) in the third dimension.

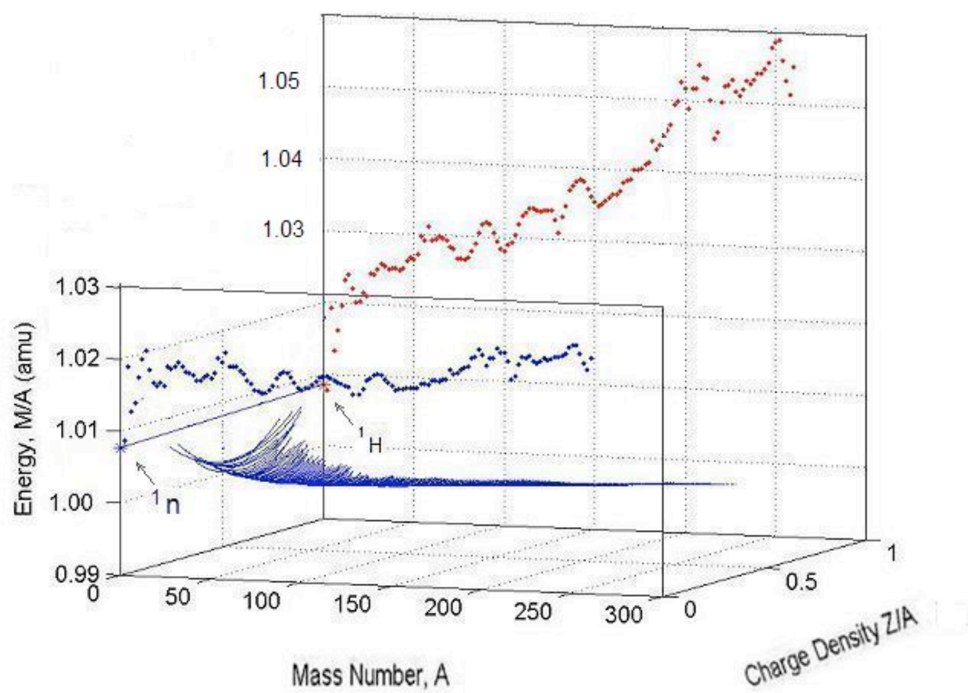


Figure 1c. Parabolas defined by mass data points reveal neutron repulsion at Z/A = 0 (**o**) on the front panel (nuclei made of neutrons only), proton repulsion at Z/A = 1.0 (**o**) on a back panel (nuclei made of protons only), and differences from Coulomb repulsion [15].

3.2 Proof of Local Element Synthesis

Figure 2 (below) shows evidence the solar system's elements were produced here and then formed solids before isotopes and elements from different regions of the supernova completely mixed. Figures 2a,b,c,d,e,f are all from papers published in 1972 [18], 1975/77/79/80 [19/20/21/22], 1993 [23], 1994 [24] and 1997 [25].

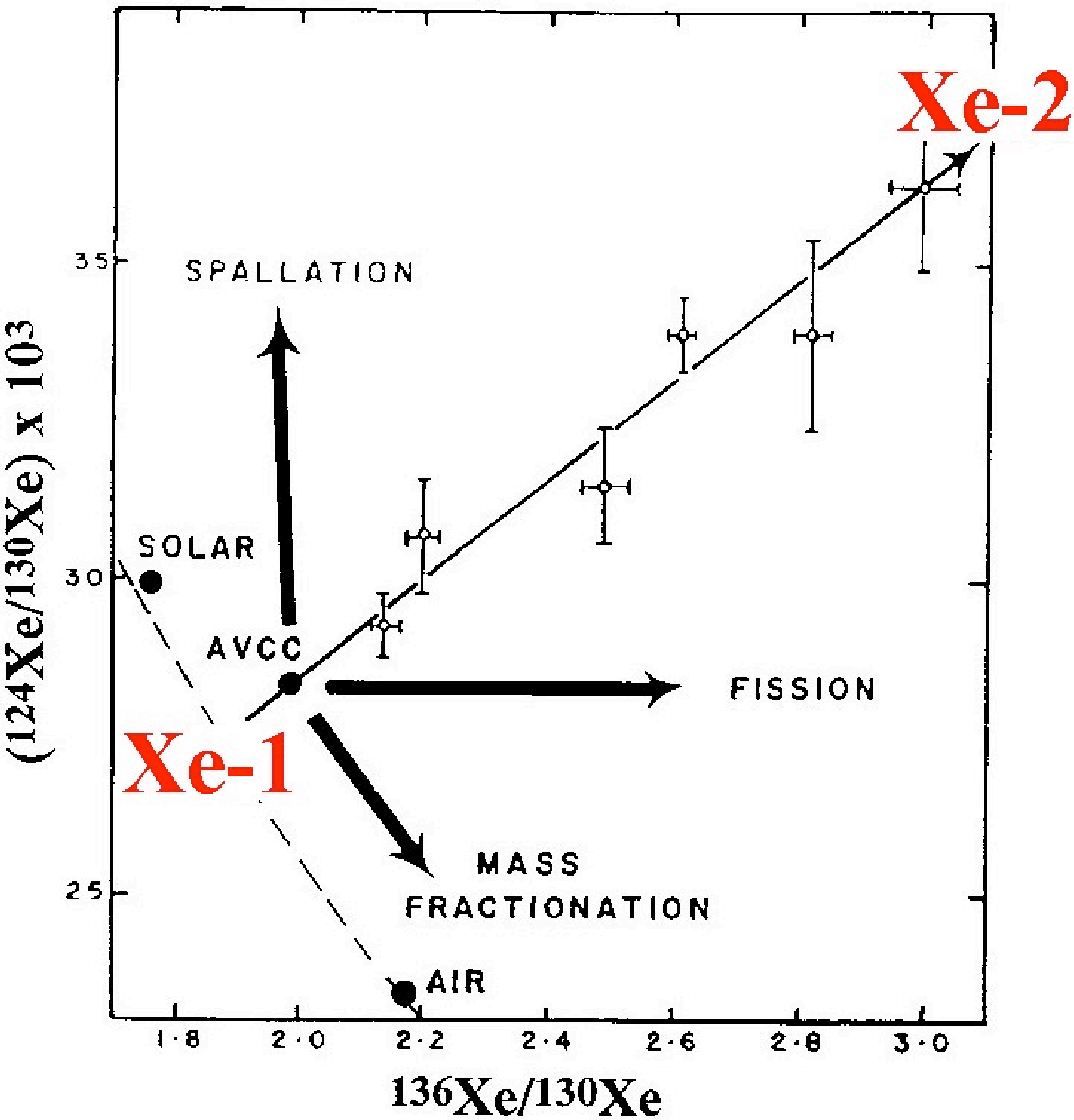


Figure 2a: "Normal" xenon, **Xe-1**, is dominant in the iron-rich, inner region of the solar system but mass fractionated (dashed line) in the Sun. "Strange" xenon, **Xe-2**, dominates the outer region of the solar system [26]. **Xe-1** is dominant in the Earth (**AIR**), the Sun (**SOLAR**), and in ordinary meteorites. At about 1000^{o} C [18], carbon-rich inclusions of average carbonaceous chondrites (**AVCC**) selectively released **Xe-2** that is enriched in ^{124}Xe from the p-process and in ^{136}Xe from the r-process of nucleosynthesis [27].

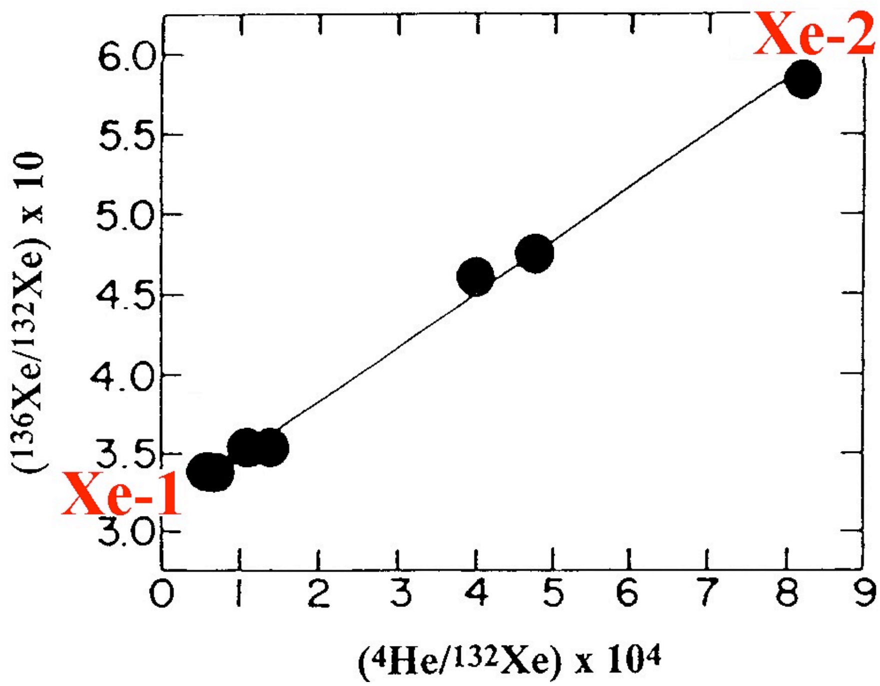


Figure 2b: Primordial helium (^{4}He) accompanies only "strange" xenon, **Xe-2**, in carbon-rich (diamond/graphite) mineral separates of the Allende [19] and other meteorites [22]. The Galileo probe later found "strange" xenon **Xe-2**, in Jupiter's He-rich atmosphere [26].

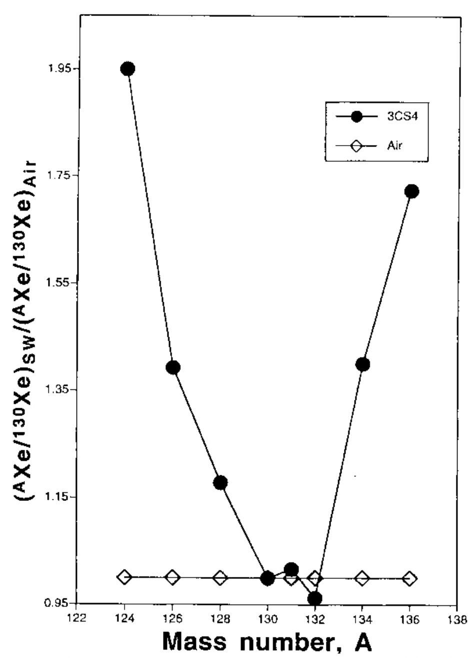


Figure 2c: "Strange" xenon, **Xe-2**, in Allende has excess light and heavy isotopes [19] from p- and r-processes of supernova nucleosynthesis [27]. The "complementary" component to "strange" xenon was identified in the Murchison meteorite in 1978 [28]. Both the "strange" and the "complementary" components of tellurium isotopes were identified in mineral separates of the Allende meteorite in 1979 [21].

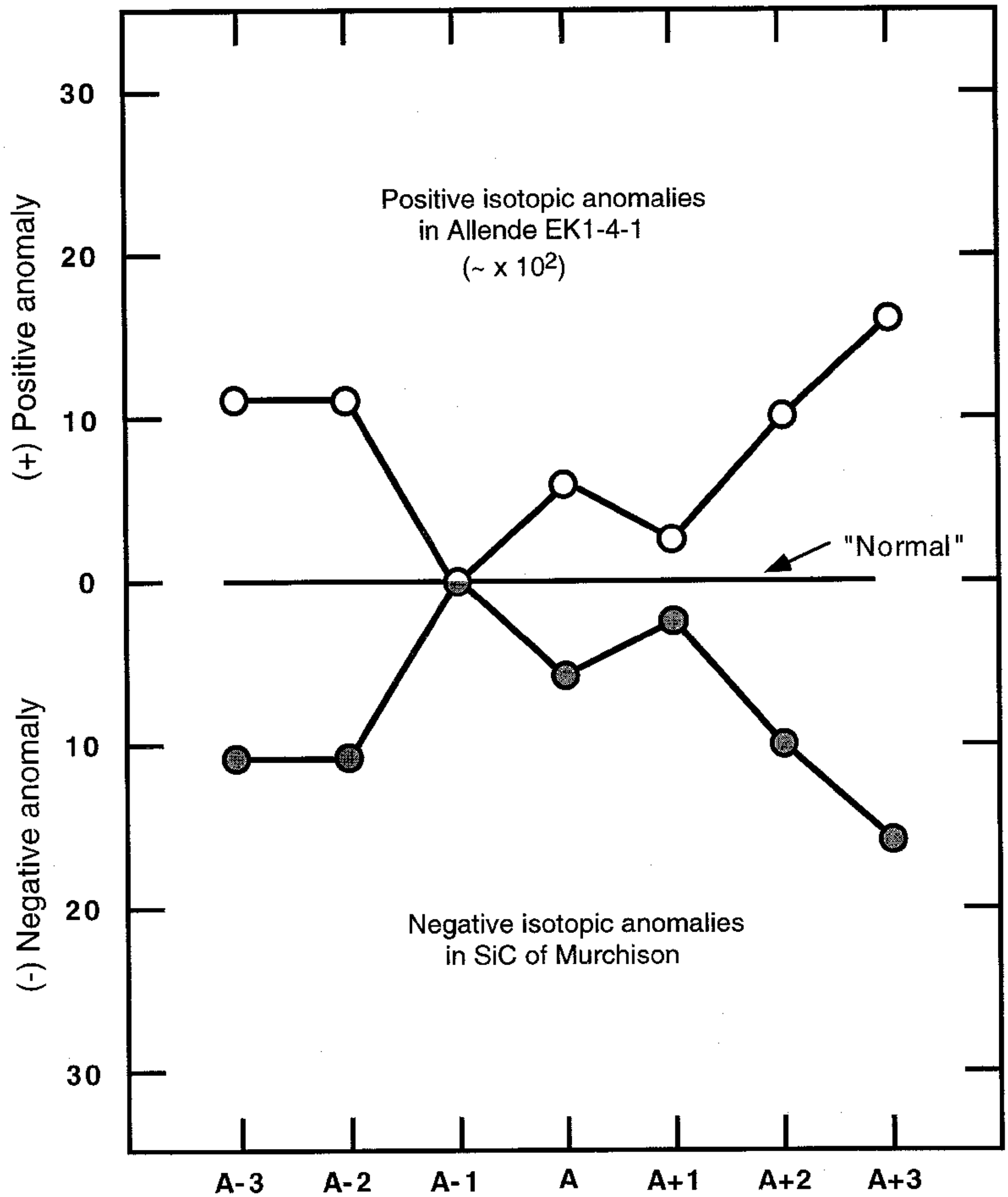


Figure 2d: In 1978 Srinivasan and Anders [28] found a "complementary" component to "strange" xenon, enriched in middle isotopes by the s-process of nucleosynthesis [27], in the Murchison meteorites. By 1993, "strange" and "complementary" isotopic anomalies had been found in the isotopes of xenon (element #54) [18, 28], tellurium (element #52) [21], barium (element #56), neodymium (element #60) and samarium (element #62) [23]. These two anomaly patterns are usually observed in refractory grains of diamond (C) and silicon carbide (SiC) that condensed early in the heterogeneous solar nebula [12, 20-23].

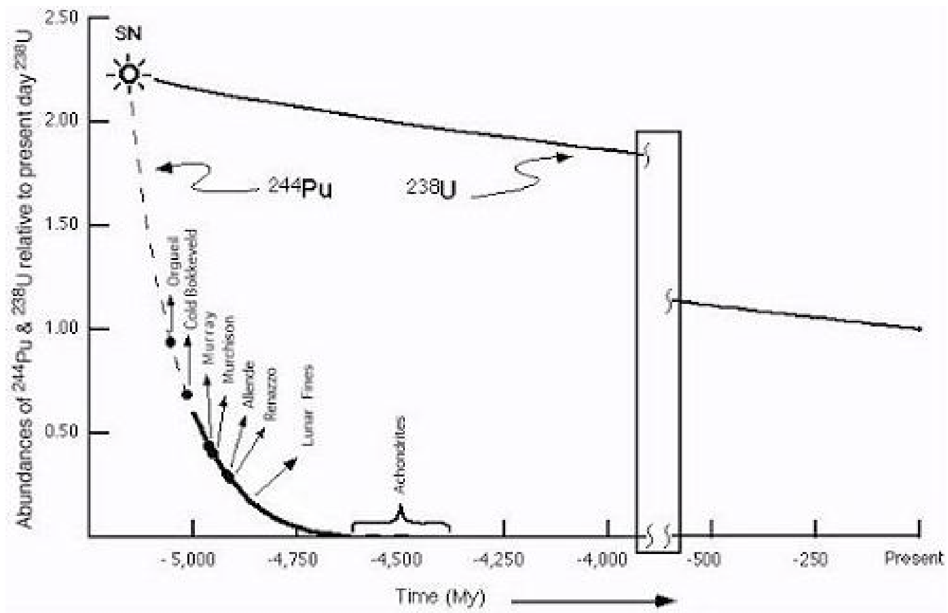


Figure 2e: Combined U/Pb and Pu/Xe age dating of primitive meteorites by Kuroda and Myers [24] show that the supernova exploded shortly before the oldest meteorites formed about five billion years (5 Ga or 5,000 My) ago.

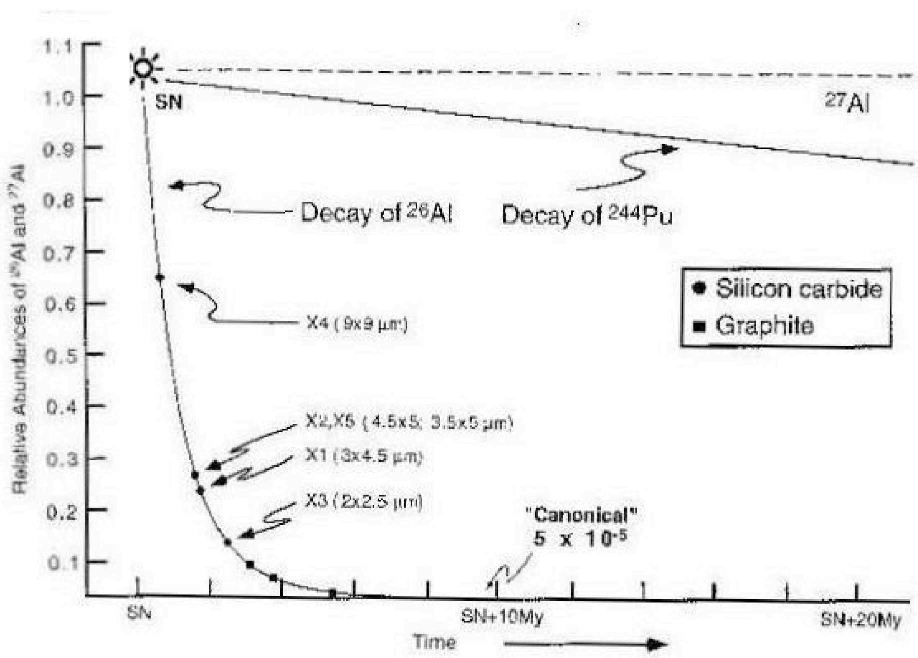


Figure 2f: ^{26}Al/^{26}Mg age dating of refractory meteorite inclusions of silicon carbide and graphite show that they formed within 1-10 My of the supernova with physical properties like those of "fall-out" particles from nuclear explosions [25]. The grains that formed first grew larger and trapped higher levels of radioactive ^{26}Al ($\mathbf{t}_{1/2}$ = 740,000 yr or 0.74 My).

3.3 Proof of Solar Mass Fractionation and the Iron-Rich Sun

Figure 3 (below) shows the results of _a few_ of the thousands of measurements that revealed _unequivocal evidence_ of mass-dependent fractionation in the Sun and its iron-rich interior. Ubiquitous evidence is even in publications of leading astronomers and astrophysicists. E.g., pages 153-154 of Sir Fred Hoyle autobiography [1] tell of abrupt, inexplicable changes in consensus opinions on composition and source of energy in the stars in 1946; Nobel Laureate William Fowler admitted in 1998 [29] that ***"we certainly do not understand the nuclear astrophysics which produced the oxygen and carbon in our bodies."*** Data from a well-known paper co-authored by these scientists, B2FH [27], are shown on the right in Figure 3a:

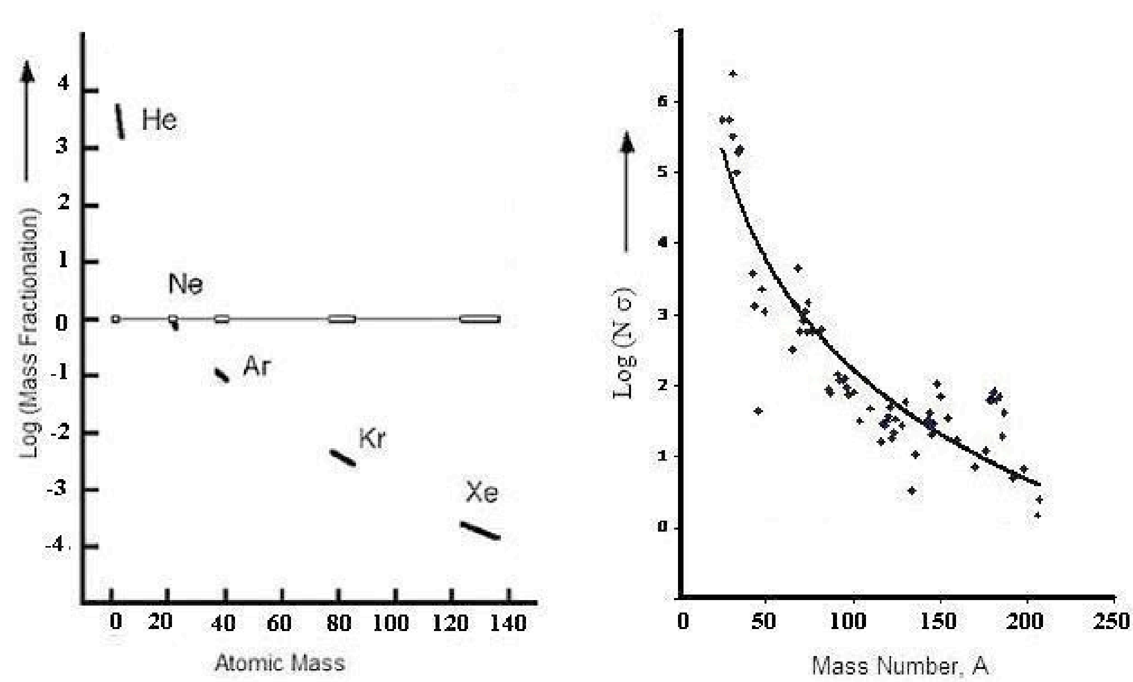


Figure 3a: Severe mass-fractionation in the Sun is obvious in the abundances of seventy-two (72) *s*-products in the photosphere (graph on the **right**) relative to the constant value of ⊆ ʃ that B2FH predicted for s-products [27]. Theses s-products span a mass range of 25-207 amu. This is based on values reported by B2FH [27] for neutron-capture cross-sections (ʃ). The graph (**right**) is from a paper in the 2005 Lunar and Planetary Science Conference [30]. Severe mass-fractionation of noble gas isotopes in the solar wind (**left**) was noted in 1983 [31]. Precise measurements of noble gas isotopes implanted in lunar soils and breccias from the solar wind [11] (filled bars) are mass fractionated relative to those in planetary noble gases [32-34] (open bars). Solar mass fractionation of isotopes is shown in the graph on the **left** across 22 isotopes, spanning a mass range of 3-136 amu (atomic mass units), and solar mass fractionation of s-products is shown in the graph on the **right** across 72 s-products spanning a mass range of 25-207 amu.

A common mass-fractionation of xenon and neon isotopes was identified earlier in the Sun and meteorites in 1970 [35]. The dashed line in **Figure 2a** shows mass-fractionated xenon isotopes first observed in primitive meteorites in 1972 [18]. It was not possible to recognize a common mass fractionation across all five noble gases in the Sun (See the graph of the **left** side of **Figure 3a**) before the discovery in 1975 [19] of "strange" isotope abundances in all three heavy noble gases; argon, krypton and xenon and the 1976 [36] discovery that noble gases in the Sun are a mixture of "strange" ones, from the outer region of solar system, with "normal" ones from the inner regions of the solar system [37].

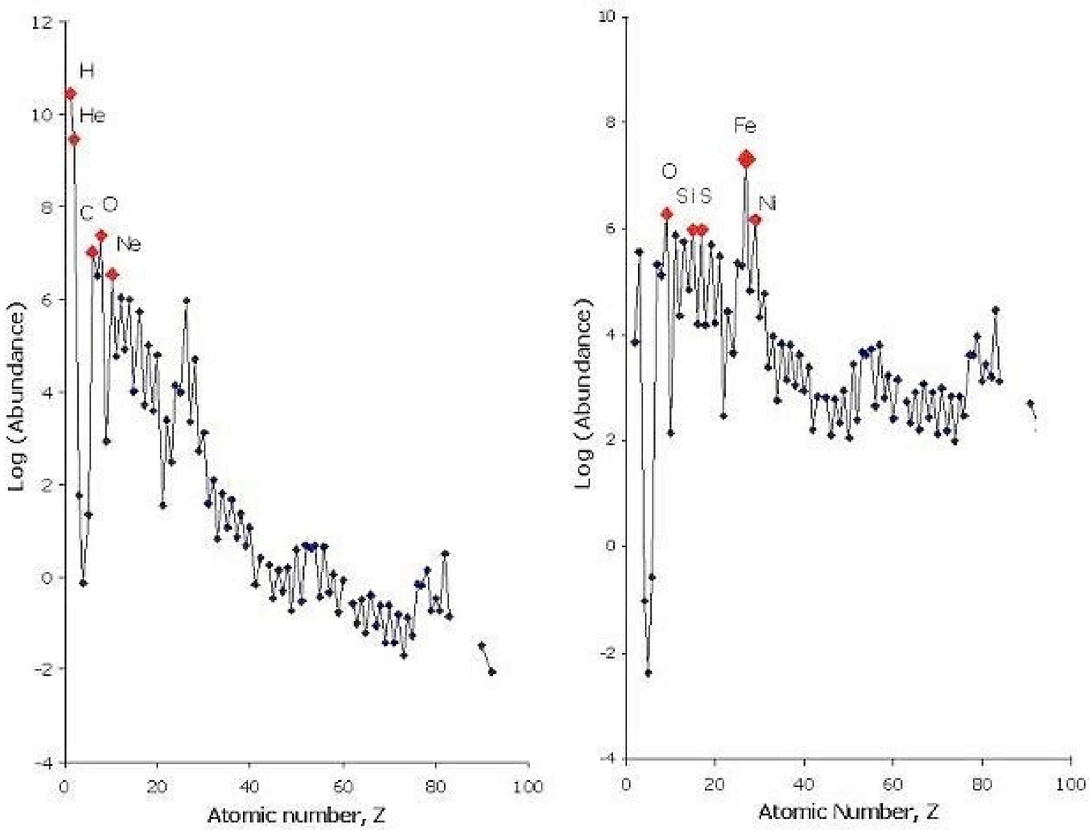


Figure 3b: The severely mass fractionated abundance pattern of elements at the top of the Sun [38] (**left**) becomes remarkably like the abundance pattern of elements on Earth and in ordinary meteorites [39] (**right**) - consisting mostly of Fe, O, Ni, Si and S - after correcting for the severe solar mass fractionation revealed by precise measurements [11] at the Universität Bern, Physikalisches Institut of isotopes implanted in lunar soil #bb18. Correcting for mass fractionation (**Figure 3a, right**) across the 72 s-products that B2FH [27] reported in the solar photosphere in 1957, yields the same five elements - Fe, O, Ni, Si and S - dominant in the interior of the Sun as were revealed by wet chemical analysis as the five most abundant elements in ordinary meteorites forty years earlier, in 1917 [39].

Over my entire research career, from the first meteorite I analyzed in 1964 [40] - a meteorite that fell near the University of Arkansas in 1934 [41] - until the present, precise measurements have revealed severe mass fractionation in the Sun. I.e., the Sun's internal composition is ***<u>not</u>*** represented by high abundances of light-weight elements (H and He) at the top of its atmosphere any more than Earth's internal composition is represented by the ocean waters and air that cover its surface.

My 1964 finding [40] was repeatedly confirmed by analyses of meteorites and the solar wind [42] but obscured by claims data points on the dashed fractionation line (below) are mixes of arbitrary types of primordial neon: Ne-A, -B, -C, Ne-*etc* [43].

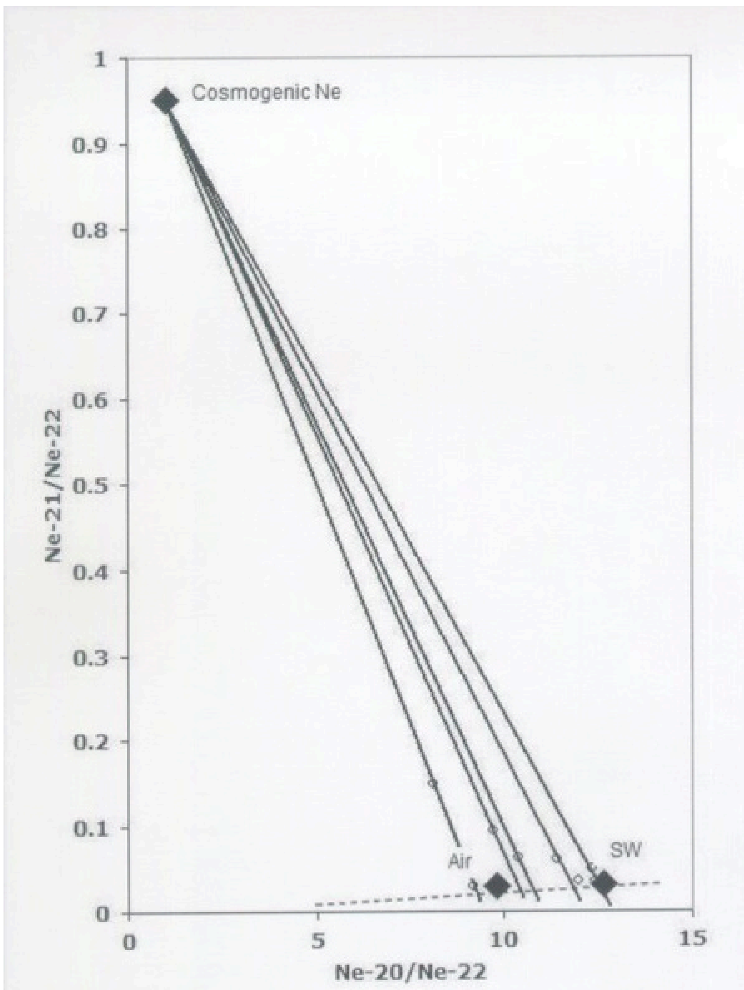
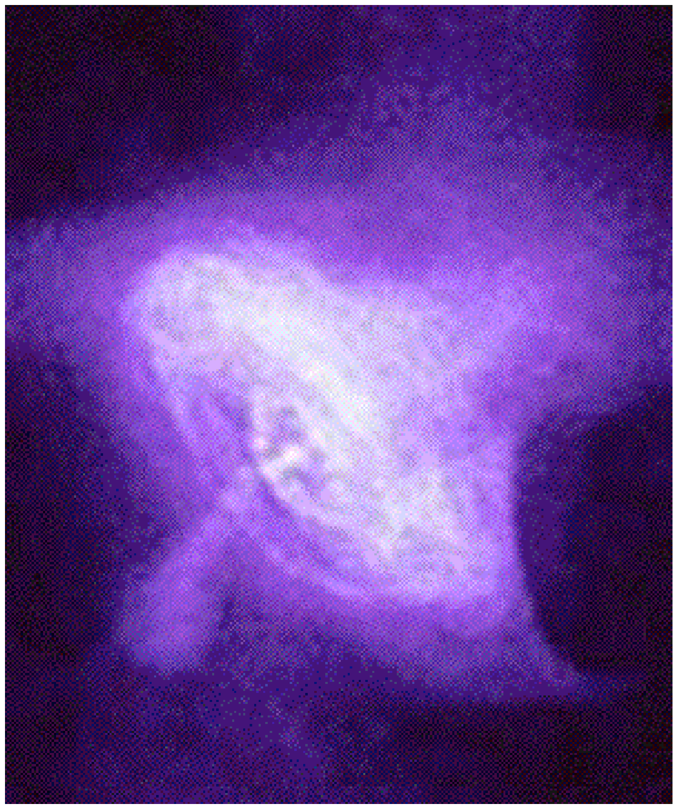


Figure 3c: Analysis of neon isotopes in dark regions of the Fayetteville meteorite in 1964 [40] revealed a.) Neon isotopes in the upper left corner of the graph generated by cosmic ray bombardment (**Cosmogenic Ne**); b.) Neon isotopes implanted from the solar wind (**SW**) in the lower right part of the graph; and c.) Mass-fractionated forms of SW neon along the dashed line that passes close to atmospheric neon (**AIR**) and extends on toward mono-isotopic Ne-22 (^{22}Ne or Ne-E) as the final end product of mass-fractionation [43].

4. Conclusions

The inescapable conclusion of all the experimental results shown in the preceding section, and independent studies of the Sun [44, 45] and interactions of atoms with the Sun [46-48], is that solar energy comes from the pulsar remnant of the super-nova that made our elements, birthed the solar system 5 Ga ago, and sustained the origin and evolution of life on Earth after ~3.5 Ga ago [49].



The Creator, Destroyer and Sustainer of every atom, life and world in the Solar System is a pulsar like the one above that birthed the Crab Nebula in 1054 AD [3, 50].

This conclusion confirms the validity of a.) Kuroda's insight standing in the ruins of Hiroshima in August 1945: *"I became overwhelmed by the power of nuclear energy. The sight before my eyes was just like the end of the world, but I also felt that the beginning of the world may have been just like this"* [reference 51, page 2], b.) Aston's earlier promise on 12 December 1922 that nuclear energy offers the human race *"powers beyond the dreams of scientific fiction"* [ref. 5, page 20], and c.) Max Planck's views on the essence of matter in 1944: *"There is no matter as such! All matter originates and exists only by virtue of a force which brings the particles of an atom to vibration and holds this most minute solar system of the atom together ... We must assume behind this force the existence of a conscious and intelligent Mind. This Mind is the matrix of all matter."* [52].

Solar energy is generated by a series of nuclear reactions [12] triggered by neutron repulsion in the Sun's pulsar core [44, 45]. This same energy source triggered the destruction of Hiroshima and Nagasaki from cores uranium and plutonium atoms sixty-nine years ago and the production of chemical elements in stars and in self-sustaining nuclear chain reactors that spontaneously burned on the surface of the Earth about two billion years ago [51], as Kuroda first explained in 1956 [53].

Having established that publicly-financed consensus science misrepresented solar energy after the Second World War [Chapter 2 of my auto-biography, reference 3, and reference 54], *e.g.-*

1. The internal composition of the Sun was changed from mostly iron (Fe) in 1945 to mostly hydrogen (H) in 1946 [1];
2. Aston's rigorously valid *nuclear packing fraction*, clearly showing evidence of neutron repulsion, was removed from text-books and replaced with von Weizsacker's *nuclear binding equation* that obscures neutron repulsion; and
3. Honesty, humility and open-minded willingness to learn from measurements and observations - marks of genius in scientists like Einstein, Aston, Planck and Kuroda - were replaced with the arrogance and closed-mindedness of post-1945 Standard Models of stars and nuclear energy -

What should society do now? ***Forgive those who deceived us for the past sixty-nine years for being human and move as quickly as possible to restore integrity to government science and to constitutional limits on governments.***

As noted in the conclusions on page 11 of my message to the US Congressional Space Science & Technology Committee on 17 July 2013 [50], the human race has been deprived of Aston's 1922 promises - ***"powers beyond the dreams of scientific fiction"*** [ref. 5, page 20] - for ninety-two years.

5. Acknowledgements

Kuroda never hinted what I would find when he made my research assignment in 1960, but the knowledge he had displayed in 1956 of the infinite multiple constant in natural, self-sustaining nuclear fission reactors on Earth [53] convinces me that Kuroda already knew in 1960 I would eventually discover neutron-repulsion in the Sun's pulsar core, if I remained faithful to basic principles of science.

This paper is dedicated to my research mentor, the late Professor Paul Kazuo Kuroda, and to all those who love eternal truths more than the temporary fame or fortune bestowed by mankind.

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