The mechanism of autocatalytic synthesis of nuclei and CR-activators

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Abstract. The symmetric binuclear model of quasi-molecular states (QMS) is presented as a theoretical framework extending muonic catalysis concepts to cold nuclear fusion phenomena. This model proposes nuclear convergence through attraction to high-density negative charge configurations formed by bound electron (ee) pairs occupying toroidal orbitals in the internuclear region. These structural formations, designated as CRN activators (where N indicates (ee) pair multiplicity), function as catalytic centers for nuclear processes. Experimental validation includes mass spectrometry analysis of titanium isotopes revealing anomalous mass peaks consistent with model predictions. Extension to trinuclear QMS systems demonstrates enhanced CR4 activator formation during nickel synthesis from silicon and oxygen, with observed production rates doubling those of baseline CR2 activators. The analysis identifies cold nuclear fusion as a potential clean energy source with dual capability: direct energy generation and production of fissile materials for conventional nuclear power applications. These findings suggest significant implications for future energy systems combining fusion and fission technologies.

1 Introduction

It is well known that the advancement of human civilization has been driven primarily by progress in energy production. Furthermore, in the context of a growing global population and rising quality-of-life standards, the use of technologies that generate excessive waste or degrade the environment faces inherent limitations. Consequently, efforts to enhance existing energy production methods and develop novel technologies are both natural and necessary. Among these, renewable energy sources are particularly desirable.

In this regard, low-temperature nuclear fusion presents a highly relevant avenue for energy generation. It is worth emphasizing that muon-catalyzed fusion was discovered decades ago and remains a widely recognized example of cold nuclear fusion (see, e.g., [1, 2]). Notably, in conventional thermonuclear fusion, the absence of a negative charge necessitates extreme temperatures to overcome Coulomb repulsion between positively charged nuclei, requiring immense kinetic energy. In contrast, when a compact, high-mass negative charge is present in the internuclear region, nuclear convergence is driven primarily

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by electrostatic attraction to this charge. This physically intuitive concept forms the basis for extending the muon-catalyzed fusion mechanism [3].

Following the framework proposed in [3], it is logical to distinguish between two types of nuclear synthesis: (1) simple reactions that increment the charge number Z by one, and (2) reactions involving a substantial change in Z. The former can be explained, in our view, through the quasi-neutron concept, wherein a proton penetrates the Coulomb barrier via electron screening effects [3].

More complex low-temperature nuclear synthesis can be interpreted within the intermediate quasi-molecular state (IQMS) model, the schematic representation of which is provided in Fig. 1 (adapted from [3]).

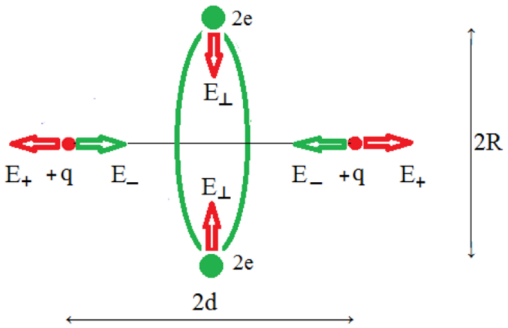

Fig. 1. Scheme of the simplest intermediate quasi-molecular state (IQMS) model: green circles correspond to bound electron (ee) - pairs, red ones to nuclei, arrows indicate the directions of the electric field strength.

In the symmetric binuclear model of the IQMS, nuclear convergence is driven by attraction to CR activators — massive, compact electron ee-pairs in a circular orbit, where electrons with opposite spins are bound via contact interaction [4]. Such pairs can form under conditions of electron flow [3], with permissible Coulomb barrier transparency coefficients achieved through electron tunneling at relative kinetic energies on the order of tens of electron volts. Notably, the critical nuclear proximity required for π^0 meson exchange to commence [3] is estimated at $\sim 10^{-11}$ m.

For a CR activator orbiting between two identical nuclei (each with charge q_+ and mass m_+), the negative charge q_- of the CR activator can be approximated — provided the orbital radius is sufficiently small — to satisfy the inequality:

$$| q_- | > q_+/4. \qquad (1)$$

The aim of this work is to demonstrate the exceptional simplicity, clarity, and constructiveness of the proposed approach to explaining cold nuclear fusion reactions.

2 Mass Spectra of Atoms Supporting the Existence of Massive (ee)-Pairs

Before discussing possible cold fusion reactions, it is pertinent to note that mass spectra measurements of various metals (most extensively titanium and tungsten) revealed atoms with anomalously high masses, $m + \Delta m$. Moreover, the mass excess Δm relative to the mass m of any stable isotope of the element consistently fell within the predicted interval [3]:

$$\Delta m \in (0.05 – 0.5) \text{ a.m.u.} \quad (2)$$

Figures 2 and 3 illustrate this effect using examples of titanium isotope and oxide mass spectra.

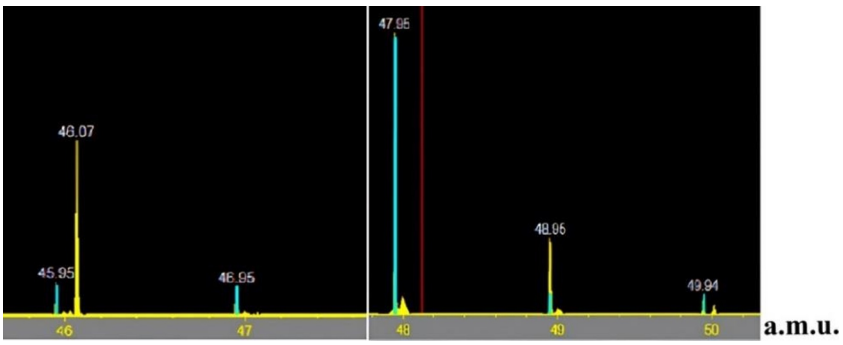

Fig. 2. Mass spectra of titanium isotopes at higher mass resolution. The "peaks" (especially for the main isotope Ti - 48) corresponding to atoms with increased masses are clearly visible.

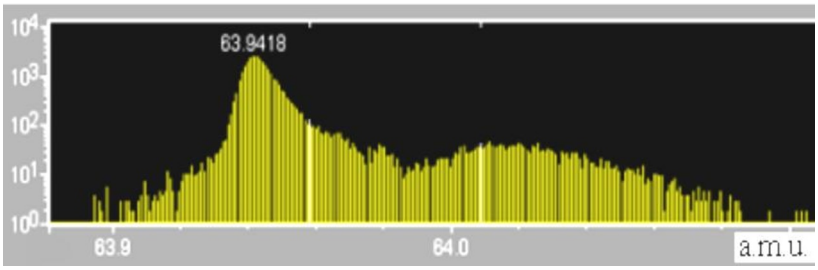

Fig. 3. Mass spectrum of TiO oxide for the titanium-48 isotope at high mass resolution in logarithmic coordinates.

The existence of atoms with anomalously high masses is interpreted as a consequence of massive (ee)-pairs entering atomic electron shells (where (ee)-pairs occupy deep near-nuclear orbits).

3 Example Reactions Involving CR Activators with Two (ee)-Pairs

When condition (1) is satisfied, nontrivial synthesis via nuclear fusion yields a nucleus ${}_zX^A$ with mass number $A = 2A_{1,2}$, where $A_1 = A_2$ are the mass numbers of the fusing nuclei. Regarding charge numbers, the exothermicity condition for massive nuclear fusion necessitates the capture of one or several massive (ee)-pairs [3].

For instance, as proposed in [3], synthesizing tin from iron requires the capture of one (ee)-pair and the participation of a CR activator containing—in accordance with (1)—at least seven (ee)-pairs. Notably, experiments with electric discharges in distilled water (without electrode material involvement) have reported the formation of dozens of elements, up to lead and bismuth, including iron and tin, with particularly high yields of carbon, silicon, and iron [5].

Since oxygen is the sole massive element initially present in water, the synthesis of silicon's primary isotope likely occurs via:

$$_6C^{12}+_8O^{16} + \mathrm{CR} \rightarrow _{14}Si^{28} + \mathrm{CR}, \quad (3)$$

$$_8O^{16}+_8O^{16} + \mathrm{CR} \rightarrow _{14}Si^{28} + _2He^4 + \mathrm{CR}. \quad (4)$$

Notably, as reported in [3], the formation of carbon mediated by (ee)-pairs may result either from oxygen nucleus decay or from a fusion reaction involving four helium nuclei produced by merging three oxygen nuclei. According to condition (1), only one CR-activator containing two (ee)-pairs is required to facilitate reactions (3) and (4). When representing the CR-activator with a green ring symbol, reaction (3) corresponds to the scheme shown in Figure 4.

Fig. 4. Scheme of action of the CR-activator in the synthesis of silicon.

It is evident that in the proposed scheme, the CR-activator is released unchanged after silicon synthesis.

4 Possibility of CR-Activator Synthesis with Increasing (ee)-Pair Numbers

The extensive list of synthesized elements in [5] suggests that, alongside CR-activators containing a small number of (ee)-pairs, there may exist an efficient mechanism for forming CR-activators with larger numbers of (ee)-pairs.

Let us denote CRN for a CR-activator containing N (ee)-pairs. We demonstrate that during nuclear synthesis in the presence of CR2-activators, the formation of CR4-activators may occur. Similar to how positive charges converge due to attraction to CR-activators, the convergence of CR2-activators can naturally be attributed to their attraction to the positive charge between them.

As an example, consider the synthesis of a $_{28}Ni^{60}$ nucleus according to the reaction:

$$_8O^{16} + _{14}Si^{28} + _8O^{16} + (ee) \rightarrow _{28}Ni^{60} \quad (5)$$

where we assume the participation of two CR2-activators simultaneously localized on both sides of the silicon nucleus between the oxygen nuclei. This cold fusion model resembles the atomic arrangement in silicon dioxide (O=Si=O).

The simultaneous action of two CR2-activators corresponds to the model shown in Figure 5.

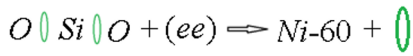

Fig. 5. Nickel synthesis in the symmetric three-nucleus cold fusion model through simultaneous action of two CR2-activators with formation of a CR4-activator.

In Figure 5, the two left rings represent CR2-activators, while the larger right ring represents a CR4-activator. Clearly, in this symmetric three-nucleus model, the two outer

oxygen nuclei move synchronously toward the central stationary silicon nucleus. In this connection, we make the following observations:

1. Capture of an (ee)-pair can occur through preliminary modification of a silicon atom, when a massive (ee)-pair localizes on a near-nuclear orbit. Using the notation *Si** for such a modified atom, we obtain Fig. 6 instead of Fig. 5.

Fig. 6. Nickel synthesis involving a modified Si* atom and simultaneous action of two CR2-activators.

2. If the (ee)-pair capture occurs during the merging of CR2 rings, then in the scheme shown in Fig. 7, the larger ring corresponds to a CR3-activator.

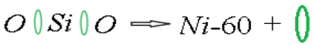

Fig. 7. Nickel synthesis with formation of a CR3-activator.

3. The merging of CR2-activators requires that the rotation of (ee)-pairs in both circular orbits occurs in the same direction (either clockwise or counterclockwise). When this condition is met, the magnetic interaction between dipole magnetic moments of the circular currents is attractive. If the directions of the circular currents are opposite, the magnetic interaction will prevent the merging of CR2-activators.

4. In principle, nickel synthesis is also possible through double action of a single CR2-activator (see Fig. 8):

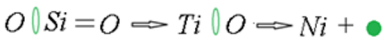

Fig. 8. Synthesis of Ni-60 through double action of a CR2-activator.

In Fig. 6, the unstable isotope Ti-44 (half-life 60 years) appears as an intermediate product. Moreover, this example demonstrates (ee)-pair capture leading to transition from CR2 to CR1 containing a single (ee)-pair.

5. We note that formation of CR2-activators from two (ee)-pairs is possible through tunneling, similar to (ee)-pair formation. The maintenance of compact stable sizes (smaller than the electron Compton wavelength) of CR2-activators can be achieved through magnetic dipole and contact interactions.

There is also a variant of CR2-activator synthesis within the three-nucleus cold fusion model:

$$ {}_2He^4 + (ee) + {}_2He^4 + (ee) + {}_2He^4 \rightarrow {}_6C^{12} + \mathrm{CR2} \qquad (5) $$

In symbolic form, reaction (5) is shown in Fig. 9.

Fig. 9. Carbon synthesis reaction from helium with formation of a CR2-activator.

6. According to condition (1), the appearance of a CR4-activator facilitates a two-fold expansion (compared to CR2) of the range of q+ charge values in fusion reactions of identical isotope pairs q+.

5 Conclusion

The analysis of nickel synthesis within the three-nucleus cold fusion model demonstrates that the fusion process can be accompanied by the synthesis of CR4-activators from a pair of CR2-activators. This conclusion can be readily generalized, revealing additional possibilities for interpreting nuclear fusion reactions as a relay-like autocatalytic process coupled with the synthesis of CRN-activators.

The inequality (1) can be extended to the asymmetric two-nucleus model. In this case, the simplest fusion reaction involving proton capture requires only a CR1-activator. Notably, compared to the quasi-neutron mechanism proposed in [3], the CR1-mediated process offers a significant advantage by dramatically increasing the probability of proton capture.

It seems natural that protons catalyze the processes of (ee)-pairs formation and, accordingly, CR1-activators, as well as the processes of formation of CR2-activators. In this connection, it becomes clear why electric discharges in water are so effective in the synthesis of nuclei [5].

It should be noted that after the publication of [6], the main efforts were directed at the simplest reactions of cold fusion (see, for example, [7-9]) during the saturation of metals with hydrogen isotopes.

All exothermic fusion reactions hold potential for energy production. For instance, a silicon synthesis reaction (similar to (3)) has already been demonstrated experimentally [10]. In [10], it is suggested that one of the fusing nuclei undergoes preliminary transformation, acquiring a negative charge, thereby eliminating the Coulomb barrier issue. While this interpretation is plausible, the authors emphasize [10] that in the presence of CR-activators, it is not the only viable mechanism.

Cold nuclear fusion reactions represent a highly promising avenue not only for synthesizing new nuclei but also as a clean and virtually inexhaustible energy source, destined to occupy a niche in the broader energy landscape. Interestingly, such reactions can even reproduce radioactive isotopes, potentially enabling energy production in fission-based power plants if the need arises.

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