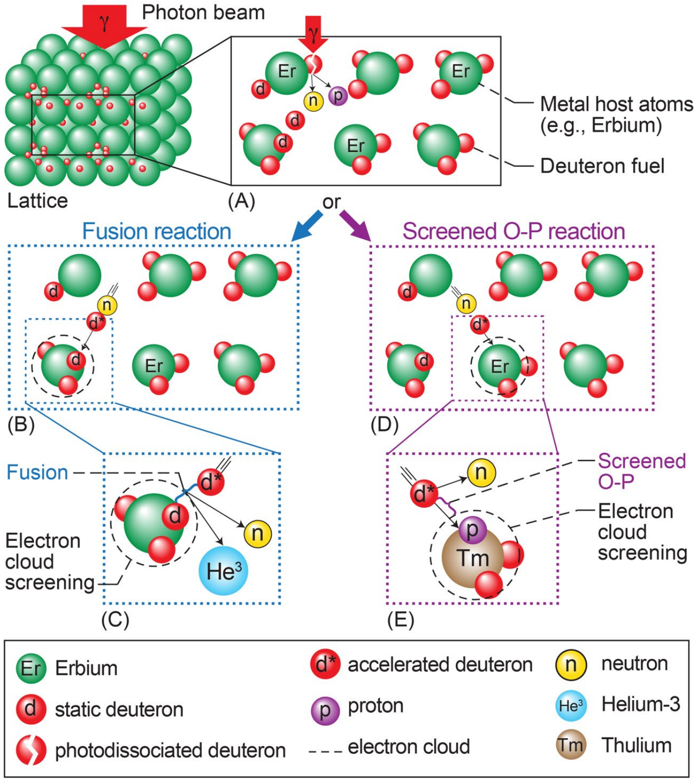
NASA Detects Lattice Confinement Fusion

In pursuit of a new energy source for deep-space missions, NASA revealed a means of triggering nuclear fusion. The results are published in the Elsevier journal, *Physical Review C*. The theoretical paper, “Nuclear fusion reactions in deuterated metals,” describes the mechanisms, and the companion paper, “Novel nuclear reactions observed in bremsstrahlung-irradiated deuterated metals,” presents experimental results.

Nuclear reactions are triggered between deuterium nuclei—or more specifically, deuterons—that are confined in a metal lattice as fuel held at ambient temperature. A deuteron is composed of a proton and neutron. In the current research, nuclear reactions are triggered in titanium or erbium metal lattices loaded with the hydrogen isotope deuterium—at densities approaching 10^{23} ions/cm^3. Such high fuel densities are greater than those available in current magnetic confinement (tokomak) fusion reactors, which have densities of only 10^{14} ions/cm^3. Also, previous deuterium (and tritium, another isotope of hydrogen) fusion research with tokamaks has relied upon temperatures 10 times the center of the Sun, yet the NASA method accomplishes the same in the loaded metal lattice. While the deuterium-loaded metal lattice may initially be at room temperature, the new method creates an environment where individual atoms achieve equivalent fusion-level kinetic energies.

An electron accelerator produces 2.9-MeV high-energy photons that photodissociate deuterons, splitting them into their respective protons and neutrons as shown in part (A) of the figure below. A reaction cascade begins when these energetic protons “p” and neutrons “n” collide with static deuterons “d” in the lattice, which boosts their energy to fusion levels, as represented by “d*” in the figure. The lattice atoms’ negative electrons “screen” and reduce the repulsion between the positively charged deuteron ions, further increasing nuclear reaction rates.



Part (A) in the figure shows a lattice of erbium loaded with deuterium atoms (i.e., erbium deuteride), which exist here as deuterons. Upon irradiation with a photon beam, a deuteron dissociates, and the neutron and proton are ejected. The neutron collides with a deuteron, accelerating it as an energetic “d*” as seen in (B) and (D). The “d*” induces either screened fusion (C) or screened Oppenheimer-Phillips (O-P) stripping reactions (E). In (C), the energetic “d*” collides with a static deuteron “d” in the lattice, and they fuse together. This fusion reaction releases either a neutron and helium-3 (shown) or a proton and tritium. These fusion products may also react in subsequent nuclear reactions, releasing more energy. In (E), a proton is stripped from an energetic “d*” and is captured by an erbium (Er) atom, which is then converted to a different element, thulium (Tm). If the neutron instead is captured by Er, a new isotope of Er is formed (not shown). All of these nuclear reactions produce useful energy. Turning off the electron accelerator safely stops the reactions.

Further development of the process is required to increase the efficiency of these lattice-confined nuclear reactions. Their applications range from terrestrial or long-duration space power to space propulsion to the production of radioisotopes, such as the most common medical isotope, Tc^{99m}.

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