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Plutonium as a metaphor for human relationships.

They say Plutonium is an unnatural substance. It's not. Here on earth its found in such microscopic quantities it's called man-made whenever we speak of it. Plutonium has a half life of just 24 thousand years compared to 4 billion years for Uranium 238. Out there, however, it's made whenever a star explodes and independent fragments of atom nuclei are fuzed together. It is created in the last act of a stellar super-nova. An act that may only take a second to complete before the entire star explodes. Such stars are visible as the brightest star in the sky and some have been visible during the day for a month or so.

On earth its made in an atomic reactor where Uranium 238 is bombarded by neutrons. Fission reactions occur when a neutron strikes material that is "fissionable," which is to say Uranium 233, 235, 238 and Plutonium. Thorium 232 can be used as well but the critical mass is measured in tons and still requires an external source of neutrons to get going. Thorium can't be used in bombs. When this fissionable material explodes after being hit with a neutron, it splits into fragments and releases a bunch of free neutrons. For a chain reaction to start the number of free neutrons released must be more than the number starting the reaction.

For our purposes, that of creating Plutonium, Uranium 238 is placed in a nuclear reactor where it absorbs a neutron to become U239. U239 is very unstable and almost immediately spits out an electron and an anti-neutrino to become neptunium 239 which is even more unstable, so it too spits out an electron and an anti-neutrino to become Plutonium 239 which is relatively stable.

Now for the magic: Critical mass. If you take a chunk of Uranium 235 it will spontaneously fissure, spitting out neutrons in the process. If the neutrons can escape without creating more than one neutron then the mass won't go boom. It might get hot, and it might spit out enough radiation to kill you but it won't go boom. As you increase the mass a larger and larger percentage of neutrons will be absorbed and create atomic fissures. It's a mass to surface ratio problem. At some point the number of neutrons being produced and absorbed begins to accelerate, that is the point of critical mass for a solid sphere of material. Change the shape and you change the critical mass. For Uranium 235 it's about 110 lbs. A six inch sphere. If you bring two subcritical pieces of Uranium together fast enough you get a bang. Bring them together slowly and you get a fizzle, the parts will melt and vaporize without going bang. The Hiroshima bomb used a gun to shoot a chunk of U235 into a second chunk. The combined chunks of U235 were super-critical and a bang resulted.

Plutonium 239 is a little different. For one it's more stable than Uranium 235 but it requires a lot less material to reach a critical mass, about 35 lbs. or a 4 inch sphere. Plutonium also doesn't spontaneously fissure as often as Uranium 235 does so it's possible to form hollow supercritical spheres of Plutonium without it going boom. There is a fly in the ointment, however. It's Plutonium 240. Plutonium 239 absorbs neutrons faster than U238 so unless the timing is right during the production of Plutonium, it can get contaminated with enough Pu240 to make a close to critical

mass very unstable. It might not go boom but it will make a mess with a radioactive fizzle - a "dirty bomb."

Creating a Plutonium bomb requires a lot of finesse and external help. For one, you have to start with a hollow ball of Plutonium that is super-critical when compressed into a solid ball. That hollow ball of Plutonium is compressed (or imploded) by surrounding the sphere with conventional explosives. The trick, and it isn't easy, apparently, is to time the explosives so that the sphere compresses evenly. A mis-formed chunk of Pu239 won't go boom. Still, getting a chain reaction started requires an external source of neutrons because Pu239 doesn't spontaneously fissure at a rate sufficient to make it explode even when it is lightly contaminated with Pu240. To make Plutonium go boom it needs an external source of extra neutrons as well as a "tamper" of U238 to reflect Neutrons back at the imploding sphere. It's hard to set off a Plutonium atomic bomb.

The sphere of Plutonium is called the "pit.". Inside the pit in early bombs was an "urchin" consisting of a sheet of Polonium 210 which emits alpha particles (a high speed Helium nucleus) and a sheet of Beryllium which absorbs alpha particles and emits neutrons. The two sheets were separated until crushed, along with the hollow Plutonium sphere. When everything comes together in a perfectly uniform ball the Plutonium becomes supercritical, the Beryllium and Polonium are merged and start producing enough neutrons to set the Plutonium off. The results are a big boom.

In more modern Plutonium bombs the urchin is replaced by a neutron gun consisting of a small particle accelerator that shoots neutrons at the imploding pit. Cupids arrow.

No wonder relationships are so … complex.