Change of electron capture nuclear decay rate in different media and under compression

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Abstract: The study of electron capture nuclear decay rate in different media and under compression is interesting and has implications in many areas. It was known for a long time that the electron capture decay rate of ^{7}Be was slightly different for different ^{7}Be compounds. Recently relatively larger effects (~1%) were seen by comparing the decay rates of ^{7}Be implanted in a medium of high electron affinity. These results have implications for the calculation of ^{8}B solar neutrino flux.

The possibility of increasing the electron capture nuclear decay rate by compressing a radioactive atom has implications in earth science, astrophysics and many other areas. It was observed earlier by compressing ^{7}BeO and more recently by compressing $^{7}Be(OH)_2$ gel that the electron capture decay rate increased by ~0.6% and ~1% respectively under ~300 kbar pressure. The eigenstate energies of an atom increase under spatial confinement and this effect might also increase the electron density of the orbital electrons at the nucleus thus increasing the decay rate of an electron capturing radioactive nucleus. In a recent experiment, we implanted ^{109}In and ^{110}Sn in Au lattice (lattice parameter ~4 Angstrom) and Pb lattice (lattice parameter ~5 Angstrom) and observed that the orbital electron capture rates of ^{109}In and ^{110}Sn increased by (1.00±0.17)% and (0.48±0.25)% respectively when implanted in the small Au lattice versus large Pb lattice. These results have been qualitatively understood because of the higher compression experienced by the large radioactive atoms due to the spatial confinement in the smaller Au lattice. All these results and their possible applications would be discussed.