Positron-Decay of ^{54}Mn

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The decay of ^{54}Mn is well known to proceed by electron capture with a half-life of 312 days (Fig. 1). It is energetically possible for ^{54}Mn to decay to the ground state of ^{54}Fe by β^- decay or to the ground state of ^{54}Cr by β^+ via second forbidden decay modes. The branching fraction for β^- is about two orders of magnitude larger primarily because the available phase space is much bigger. These hindered decay modes are the primary means by which a fully ionized ^{54}Mn nucleus would decay. Such fully stripped ions are found in cosmic rays and abundances of ^{54}Mn relative to other Mn isotopes has recently been reported.[1] These relative abundances, combined with measured partial half-lives, provide a cosmic ray chronometer by which one can infer the cosmic-ray confinement time.

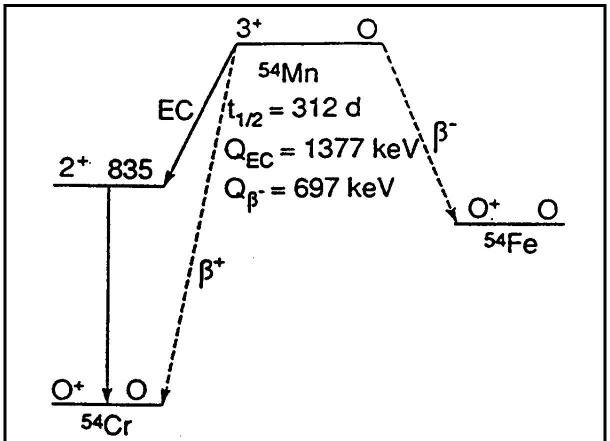

Fig. 1. The decay scheme of ^{54}Mn.

Previous efforts[1] have used the characteristic annihilation radiation from positrons as a signature for the β^+ decay. We have measured the β^+ decay branching ration using the APEX spectrometer[3] at Argonne. APEX is a three meter long solenoid which will be used to transport positrons to a charge particle detector surrounded by a segmented annihilation radiation detector. The method has high efficiency and allowing us to use an extremely intense radioactive source without suffer from the potentially large 835 keV gamma-ray background. We obtained 1.20±0.24(statistical)±0.09(systematic)x10^{-9} for the β^+ branching ratio. Using a shell model estimate for the relative matrix element for β^- to β^+ decay we obtain a partial lifetime of about 6 x10^{-5} years for beta decay. Our result suggests that the confinement times for Iron group elements is similar to that of lighter galactic ions. A paper describing this work has been accepted by the *Physical Review Letters*.

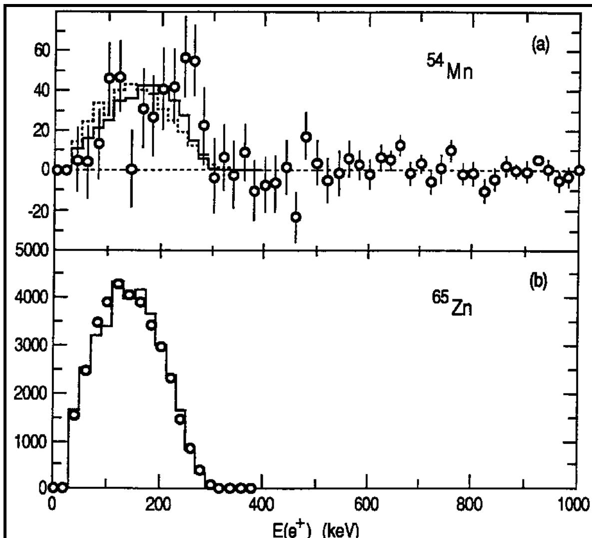

Fig. 1. Positron spectrum for ^{54}Mn and ^{65}Zn measured with the APEX spectrometer.

Footnotes and References

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