Beta-decay of proton-rich nucleus ^{23}Al and astrophysical consequences

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The results of a beta-decay study motivated by a nuclear astrophysics problem are presented. For the first time pure samples of ^{23}Al were separated with the MARS separator of Texas A&M University. Off-beam beta and beta-gamma coincidence measurements were made using a fast tape-transport system, beta and gamma-ray detectors. The experiment allowed us to measure beta branching ratios and logft values for transitions to 14 final states in ^{23}Mg and from them to determine unambigously the spin and parity of ^{23}Al ground state as J^{π}=5/2^{+} (see figure). We discuss how this excludes the large increases in the radiative proton capture cross section for the reaction ^{22}Mg(p,γ)^{23}Al at astrophysical energies which were implied by claims that the spin and parity is J^{π}=1/2^{+} [1]. The lifetime of ^{23}Al was measured with better accuracy and the logft for the Fermi transition to its isobaric analog state in ^{23}Mg is also determined for the first time. A doublet consisting of the IAS and a state 16 keV below it (figure) are observed for the first time well separated in the same experiment, and we solve a number of inconsistencies existing in the literature, excluding strong isospin mixing and allowing a new determination of their resonance strength. Both states are resonances in the ^{22}Na(p,γ)^{23}Mg reaction at energies important in novae. The radiative proton capture on ^{22}Na and ^{22}Mg are considered candidates to explain the absence in spectra taken with space-based gamma-ray telescopes of gamma-rays from the decay of long-lived ^{22}Na formed in ONe novae explosions [3,4]. These captures would divert some of the flux from the A=22 into the A=23 mass chain.

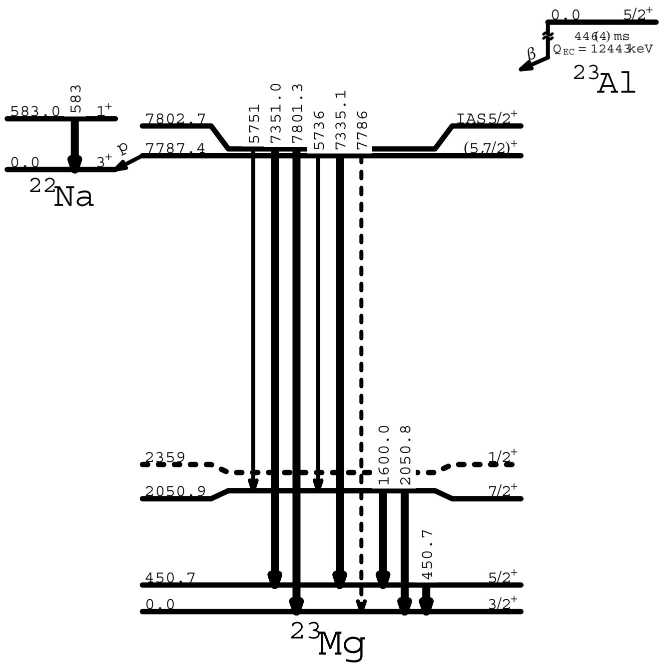

Figure 1: *Partial decay scheme of ^{23}Al. Only levels with relevance for the nuclear astrophysics problems are shown.*

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