New Neutron Capture and Total Cross Section Measurements on ^{88}Sr

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An improved measurement of the ^{88}Sr(n,γ) cross section is important to nuclear astrophysics for at least three reasons: (i) This very small cross section acts as a bottleneck during *s*-process nucleosynthesis; hence, it is crucial that it be known accurately so that the relative contributions of the various nucleosynthesis processes in the complicated A ≈ 100 region can be disentangled. (ii) It has been shown that the Rb/Sr ratio in stars can be used to extract the neutron density during the *s* process. However, previous ^{88}Sr(n,γ) measurements did not extend to low enough energies, so the neutron density extracted is based mainly on extrapolations from previous data. (iii) Non-solar ratios for isotopes of strontium observed in SiC grains in certain meteorites potentially provide stringent tests of *s*-process models. However, more accurate measurements of the ^{88}Sr(n,γ) cross section across the entire range of temperatures used in current *s*-process models are needed to more fully exploit the opportunities offered by the new meteorite data.

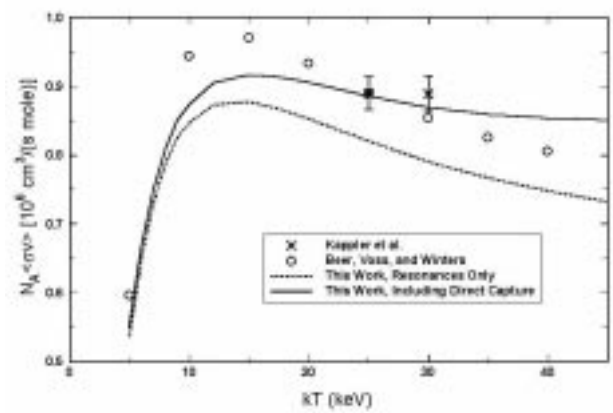

Figure 1: The ^{88}Sr(n,γ) reaction rate versus temperature.

We have made new and improved measurements[4] of the neutron capture and total cross sections for ^{88}Sr at ORELA. Improvements over previous measurements include a wider incident neutron energy range, the use of metallic rather than carbonate samples, better background subtraction, reduced sensitivity to sample-dependent backgrounds, and better pulse-height weighting functions.

Previously, a resonance at 2.78 keV was reported in the ^{88}Sr(n,γ) and total cross sections[5]. If this resonance is included, then the ^{88}Sr(n,γ) astrophysical reaction rate is increased by up to 70% over the rate used in most previous nucleosynthesis calculations. There is no sign of this resonance in our data, so if it exists it is much too small to have any significant impact on the astrophysical reaction rate.

We fitted our data using an R-matrix code to obtain the parameters of 101 resonances between 100 eV and 350 keV. As shown in figure 1, the reaction rate calculated from our resonance parameters is significantly smaller than both a recent high-precision activation measurement[6], and the rate[7] used in most previous nucleosynthesis calculations. We calculated the ^{88}Sr(n,γ) direct capture cross section using the known scattering length and spins, parities, and spectroscopic factors of levels in ^{89}Sr. When this small but significant direct capture component is added to our resonance reaction rate, there is good agreement with the activation measurement (which, due to the measurement technique includes both the resonance and direct capture components, but only at a single temperature). However, our results indicate that the evaluated rate[7] used in most previous nucleosynthesis calculations is about 8% too high in the kT = 6-8 keV region where most of the neutron exposure occurs in current *s*-process models. We currently are exploring the implications of this lower reaction rate.

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