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Indirect (n,gamma)91,92Zr Cross Section Measurements for the s-Process

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The playground for the nucleosynthesis is found in the interior of stars
and/or in extreme cosmic events. The major contributors to creating heavier elements are the neutron capture processes.
The key question for these processes is whether the nuclear system after neutron absorption will keep the neutron and emitting gamma rays to dissipate the energy, or will it eject the neutron or other particles/fragments and thereby producing other elements? For the s-process, this question is important at the so-called branch points, where the beta-decay rate is comparable with the (n,gamma) rate.
Nuclear level densities (NLDs) and gamma-ray strength functions (gammaSFs) are essential quantities in the determination of the (n,gamma) rates.
At the Oslo cyclotron laboratory, we have used the 92Zr(p,p gamma)92Zr and 92Zrp,d gamma)91Zr reactions to extract NLDs and gammaSFs using the Oslo method.
These 91,92Zr gammaSF data, combined with photonuclear cross sections, cover the whole energy range from E_gamma~1.5MeV up to the giant dipole resonance at E_gamma~17MeV.
The wide-range gammaSF data display structures at E_gamma~9.5MeV, compatible with a superposition of the spin-flip M1 resonance and a pygmy E1 resonance. Furthermore, the gammaSF shows a minimum at E_gamma~2-3 MeV and an increase at lower gamma-ray energies, known as….
The experimentally constrained NLDs and gammaSFs are shown to reproduce known (n,gamma) and Maxwellian-averaged cross sections for 91,92Zr using the reaction code, thus serving as a benchmark for this indirect method of estimating (n,gamma) cross sections for Zr isotopes.

References
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