Contribution ID: **11** Type: **Oral**

High-precision measurement of the inelastic neutron scattering cross section of 19F at GELINA

Fluorine is one of the most important materials in the molten salt reactor (MSR), one of the Generation IV reactor types. These designs use molten fluorides or chlorides as fuel mixtures or coolants. This type of reactor is under research and development in several countries worldwide, motivated by the fact that the MSRs have certain unique characteristics which offer a safer, more efficient and sustainable form of nuclear energy. Inelastic scattering is the main neutron energy-loss mechanism in a reactor; precise knowledge of the cross section over a large energy range is therefore very important. An experiment was performed at the GELINA neutron source of the European Commission's Joint Research Centre (JRC) in Geel, Belgium, to determine the gamma-ray production cross sections for 19F. The gamma rays were detected using the GAINS spectrometer, which consists of 12 high-purity germanium detectors. The neutron flux was monitored with a fission chamber containing 235U. The GAINS setup is located at GELINA flight path 3, 100-m measurement station, offering both an excellent neutron energy resolution in a time-of-flight measurement, and a relatively high neutron flux. Level cross sections and the total inelastic cross section are calculated from the measured gamma-production cross sections. Previous neutron inelastic scattering data on 19F suffer from poor neutron energy resolution and large gaps exist in the covered neutron energy range. The present experiment was the first one to measure the inelastic neutron scattering cross section of 19F with very good neutron energy resolution, low total experimental uncertainty (less than 5%), and over a large incident neutron energy range (from around 100 keV up to 15 MeV). As the lithium fluoride scattering sample also contained 7Li, the experiment allowed the re-measurement of the 7Li 478-keV gamma-ray production cross section. This transition is intended to be used as a standard gamma-production cross section in the future, but some discrepancies exist between previous data sets.

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