TALENT Course 6: Theory for exploring nuclear reaction experiments

Outline project proposal

Project name: R-matrix analysis associated with the ^{60}Ni(p,γ) reaction
Researcher(s): Jelena Gajevic

Affiliation: Jozef Stefan Institute, Ljubljana, Slovenia

Supervisor(s): E. Simpson

Project outline and aims:

When two nuclei collide at energies far below the Coulomb barrier, the reaction rate is low, since the projectile has to tunnel through the huge potential barrier. Due to Coulomb repulsion, the cross section for charged - particle -induced nuclear reactions drops rapidly with decreasing beam energy [1], thus it becomes difficult to measure the cross section at low energies. It is known that the cross section increases at low energies when the interacting nuclei are not bare but surrounded with atomic electron clouds. As a result, the measured cross sections are enhanced compared to cross sections for bare nuclei. Experimental studies of various nuclear reactions in metallic environments have shown the expected cross sections enhancement at low energies. However, the enhancements in metallic targets were significantly larger than expected from adiabatic limit (see [2] and references therein) which is thought to provide the theoretical maximum for electron screening potential. One of the reactions in which large electron screening was recently observed is ^{60}Ni(p,γ) [3]. During studies of this reaction a large discrepancy in cross section at low energies obtained by two groups was noticed [4, 5]. In order to remove this discrepancy we intend to measure this cross section again, taking into account measured electron screening potential. The aim of this project is to fit the cross section data.

Methodology:

AZURE [6] will be used for R-matrix fit to the data. Since R-matrix has not been used for fitting of data concerning proton capture on intermediate mass nuclei it is not certain if this method is suitable for this reaction. In the case of unsuitability of this method to this reaction, data from the other suitable reaction will be selected in the agreement with supervisor.

Key references:

1. Claus E. Rolfs and William S. Rodney, *Cauldrons in the Cosmos*: Nuclear Astrophysics, University of Chicago Press, 1988.
2. K. U. Kettner et al., J. Phys. G **32**, 489 (2006).
3. J. Gajević et al,. Eur. Phys. J. A **49**,70 (2013).
4. G. A. Krivonosov et al., Izv. Akad. Nauk SSSR **41,** 2196 (1977).
5. C. I. W. Tingwell et al., Nucl. Phys. **A496** 127 (1989).
6. R. E. Azuma et al.,Phys. Rev. C, 81, 045805 (2010).