Data Evaluation and Extrapolation using R-matrix

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Nearly all stable nuclei reactions have at least a single measurement, and many that are critically important for the modeling of energy generation and nucleosynthesis have been studied several times. This wealth of data is both a blessing and a curse. On the one hand, by combining the results of many different measurements, which have been made in independent ways, one can hope that systematic uncertainties can be drastically reduced. This works well in cases where measurements agree. However, if one finds that the different measurements are in disagreement, this leads to quite a mess.

For reaction cross sections that fall into the category of the resolved resonance region, a very useful tool is phenomenological R-matrix [1]. It has been commonly applied over a wide range of nuclear physics. The reaction framework contains some powerful physical constraints, but does not contain much information on the underlying nuclear physics. Instead, individual levels are added to the calculation based on the resonances that are observed in the experimental data. One very useful aspect of R-matrix is that it provides a very useful framework that greatly facilitates the comparison of different sets. A good example would be two sets of differential cross section measurements that were measured at different angles.

A long standing problem for R-matrix analyses, is that a standard parameter convention has never been completely established. This has lead to much confusion, since key information needed to reproduce R-matrix results has often been omitted from publications. The lack of standardization has made this vary valuable analysis tool hard to access and has lead to unnecessary confusion.

In this talk I will report on a new effort by the International Atomic Energy Agency to establish a set of conventions for R-matrix evaluations of charged particle induced reactions and uncertainty estimation [2]. A consultant group has been formed, drawing on R-matrix practitioners with different backgrounds from a wide range of applications. The group is now engaged in a series of benchmarking calculations for different R-matrix codes. Once complete, guidelines will be established for R-matrix analyses that will greatly facilitate the communication of R-matrix results across multiple disciplines and establish evaluation methodology standards.

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References

[1] Lane and Thomas, Rev. Mod Phys. **30** (1958) 257.

[2] Leeb, Dimitriou, and Thompson, INDC(NDS)-0726 (2016)