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The CIELO Collaboration: Neutron Reactions on ^{1}H, ^{16}O, ^{56}Fe, ^{235,238}U, and ^{239}Pu

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CIELO (Collaborative International Evaluated Library Organization) provides a new working paradigm to facilitate evaluated nuclear reaction data advances. It brings together experts from across the international nuclear reaction data community to identify and document discrepancies among existing evaluated data libraries, measured data, and model calculation interpretations, and aims to make progress in reconciling these discrepancies to create more accurate ENDF-formatted files. The focus will initially be on a small number of the highest-priority isotopes, namely ^{1}H, ^{16}O, ^{56}Fe, ^{235,238}U, and ^{239}Pu. This paper identifies discrepancies between various evaluations of the highest priority isotopes, and was commissioned by the OECD's Nuclear Energy Agency WPEC (Working Party on International Nuclear Data Evaluation Co-operation) during a meeting held in May 2012. The evaluated data for these materials in the existing nuclear data libraries — ENDF/B-VII.1, JEFF-3.1, JENDL-4.0, CENDL-3.1, ROSFOND, IRDFF 1.0 — are reviewed, discrepancies are identified, and some integral properties are given. The paper summarizes a program of nuclear science and computational work needed to create the new CIELO nuclear data evaluations.

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CONTENTS

I. INTRODUCTION

Outstanding progress has been made around the world in nuclear reaction and decay data evaluation. The quality of the main evaluated data libraries, such as ENDF/B-VII.1 [1], JEFF-3.1 [2, 3], JENDL-4.0 [4], BROND/ROSFOND [5], and CENDL-3.1 [6], is high, and for the most part the libraries perform well in neutronics simulations for fission and fusion energy applications (though covariance data that represent uncertainties are less advanced). However, our current understanding is insufficient in many essential areas, some user needs remain inadequately addressed, and a new working paradigm is needed to expedite future evaluated nuclear reaction data advances. We see this as being facilitated by (a) pooling expertise from across the world through creation of collaborative teams, and (b) using new computational techniques for optimization, sensitivity analyses, and uncertainty quantification (UQ). Stronger international collaborations will provide a new framework for nuclear data evaluation, and will help establish the highest fidelity general purpose nuclear database for all nuclear science communities around the world.

It is recognized that for many important applications, for example nuclear criticality calculations, the existing evaluated data perform well in transport simulations owing, in part, to compensating errors in the databases. Different cross section libraries may predict almost the same $k_{\rm eff}$ for benchmark experiments, but for very different reasons at a microscopic level [7, 8]. Such errors must be minimized since simulation predictions away from calibration points (corresponding to the benchmark experiments) can rapidly become erroneous if the underlying physical data used in a simulation are incorrect. Also, cross sections for transmutation reactions, including fission, capture, and $(n, 2n)$, are inadequately known for certain applications. And in many cases scattering cross sections — elastic and inelastic, and secondary neutron energy and angular distributions — are inadequately known for transport calculations.

In this paper we suggest that a new paradigm is needed to more rapidly advance our understanding for the evaluation of nuclear reaction cross sections. Closer international cooperation is needed, where the world's experts for various capabilities are brought together to solve the problems and to provide peer review on proposed solutions. We suggest the name for this collaborative ef-