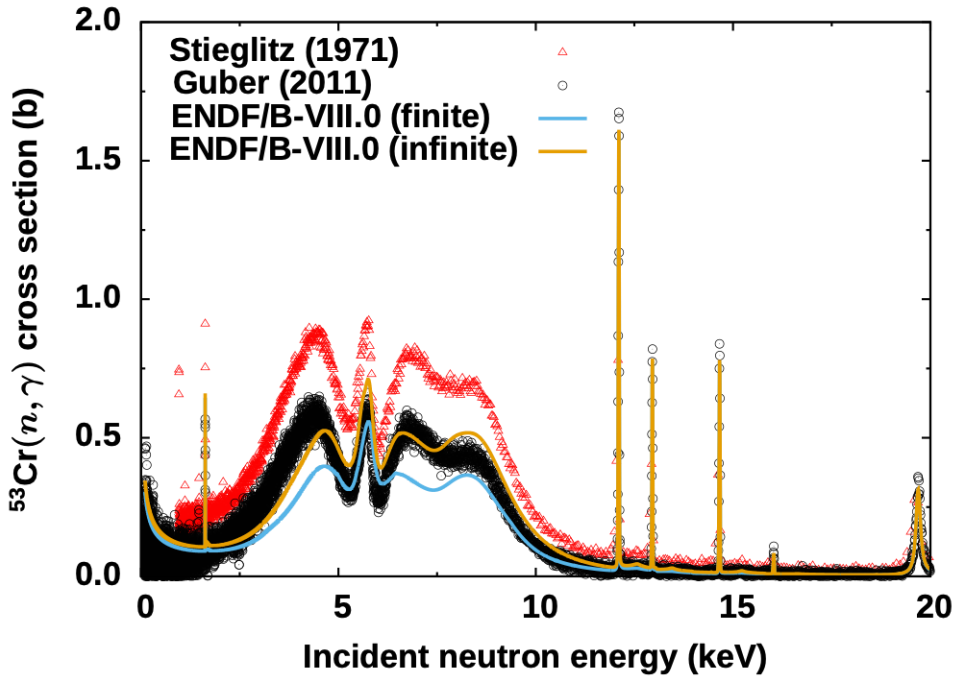
Legacy Data

Reproducing old work is expensive so how can we make old results useful?

An anecdote

- Cr alloyed in stainless steel, so it is EVERYWHERE
- NNDC led re-evaluation of stable Cr isotopes for ENDF/B library
- Clusters of resonances around 5-20 keV in most isotopes
- Outsized impact on neutron shielding

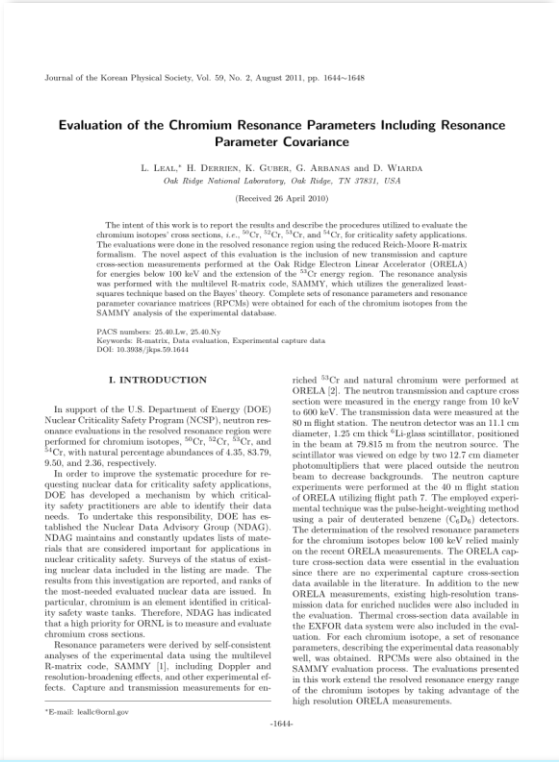


Who is right?

- ORELA (Guber (2011)) using modern analysis (fitted with full R-matrix, using well studied resolution function), digital DAQ experienced team from ORNL and properly reported uncertainties?
- RPI student Ph.D. project (Stieglitz (1971)), with no error bars?

Answer: the Ph.D. student was right

- Hinged on understanding multiple scattering correction in both experimental analyses
- Extensive GEANT and MCNP simulations
- Required deep dives into original literature
- Luckily original experimenters were still alive (especially Guber, who was co-author of evaluation!)



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Evaluation of the Chromium Resonance Parameters Including Resonance Parameter Covariance

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The intent of this work is to report the results and describe the procedures utilized to evaluate the chromium isotopes' cross sections, *i.e.*, ^{50}Cr, ^{52}Cr, ^{53}Cr, and ^{54}Cr, for criticality safety applications. The evaluations were done in the resolved resonance region using the reduced Reich-Moore R-matrix formalism. The novel aspect of this evaluation is the inclusion of new transmission and capture cross-section measurements performed at the Oak Ridge Electron Linear Accelerator (ORELA) for energies below 100 keV and the extension of the ^{53}Cr energy region. The resonance analysis was performed with the multilevel R-matrix code, SAMMY, which utilizes the generalized least-squares technique based on the Bayes' theory. Complete sets of resonance parameters and resonance parameter covariance matrices (RPCMs) were obtained for each of the chromium isotopes from the SAMMY analysis of the experimental database.

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Keywords: R-matrix, Data evaluation, Experimental capture data
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I. INTRODUCTION

In support of the U.S. Department of Energy (DOE) Nuclear Criticality Safety Program (NCSP), neutron resonance evaluations in the resolved resonance region were performed for chromium isotopes, ^{50}Cr, ^{52}Cr, ^{53}Cr, and ^{54}Cr, with natural percentage abundances of 4.35, 83.79, 9.50, and 2.36, respectively.

In order to improve the systematic procedure for requesting nuclear data for criticality safety applications, DOE has developed a mechanism by which criticality safety practitioners are able to identify their data needs. To undertake this responsibility, DOE has established the Nuclear Data Advisory Group (NDAG). NDAG maintains and constantly updates lists of materials that are considered important for applications in nuclear criticality safety. Surveys of the status of existing nuclear data included in the listing are made. The results from this investigation are reported, and ranks of the most-needed evaluated nuclear data are issued. In particular, chromium is an element identified in criticality safety waste tanks. Therefore, NDAG has indicated that a high priority for ORNL is to measure and evaluate chromium cross sections.

Resonance parameters were derived by self-consistent analyses of the experimental data using the multilevel R-matrix code, SAMMY [1], including Doppler and resolution-broadening effects, and other experimental effects. Capture and transmission measurements for enriched ^{53}Cr and natural chromium were performed at ORELA [2]. The neutron transmission and capture cross section were measured in the energy range from 10 keV to 600 keV. The transmission data were measured at the 80 m flight station. The neutron detector was an 11.1 cm diameter, 1.25 cm thick ^{6}Li-glass scintillator, positioned in the beam at 79.815 m from the neutron source. The scintillator was viewed on edge by two 12.7 cm diameter photomultipliers that were placed outside the neutron beam to decrease backgrounds. The neutron capture experiments were performed at the 40 m flight station of ORELA utilizing flight path 7. The employed experimental technique was the pulse-height-weighting method using a pair of deuterated benzene (C_6D_6) detectors. The determination of the resolved resonance parameters for the chromium isotopes below 100 keV relied mainly on the recent ORELA measurements. The ORELA capture cross-section data were essential in the evaluation since there are no experimental capture cross-section data available in the literature. In addition to the new ORELA measurements, existing high-resolution transmission data for enriched nuclides were also included in the evaluation. Thermal cross-section data available in the EXFOR data system were also included in the evaluation. For each chromium isotope, a set of resonance parameters, describing the experimental data reasonably well, was obtained. RPCMs were also obtained in the SAMMY evaluation process. The evaluations presented in this work extend the resolved resonance energy range of the chromium isotopes by taking advantage of the high resolution ORELA measurements.

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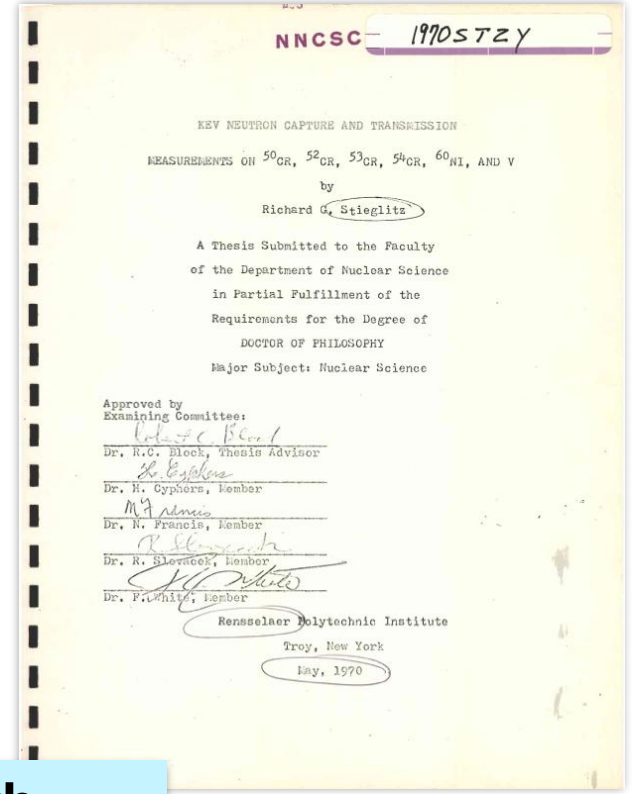

NNCSC 1970STZY

KEV NEUTRON CAPTURE AND TRANSMISSION

MEASUREMENTS ON ^{50}CR, ^{52}CR, ^{53}CR, ^{54}CR, ^{60}NI, AND V

by

Richard G. Stieglitz

A Thesis Submitted to the Faculty
of the Department of Nuclear Science
in Partial Fulfillment of the
Requirements for the Degree of
DOCTOR OF PHILOSOPHY
Major Subject: Nuclear Science

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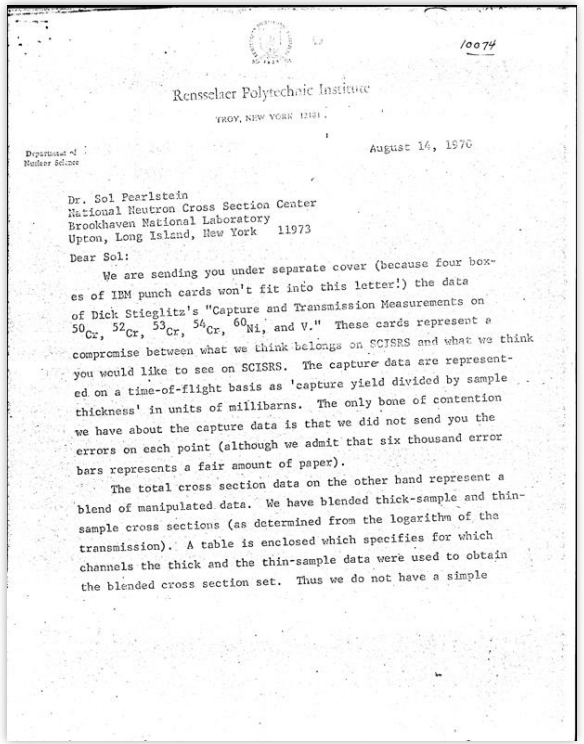
Rensselaer Polytechnic Institute
Troy, New York
May, 1970

We had to "rerun" both experiments on our cluster

About the missing uncertainties

- RPI had them. They had full covariances.
- The mean values of the data were shipped to BNL on punch cards (in four boxes)
- Sending the covariance would have meant the death of numerous trees



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Rensselaer Polytechnic Institute

TROY, NEW YORK 12181

Department of Nuclear Science

August 14, 1970

Dr. Sol Pearlstein
National Neutron Cross Section Center
Brookhaven National Laboratory
Upton, Long Island, New York 11973

Dear Sol:

We are sending you under separate cover (because four boxes of IBM punch cards won't fit into this letter!) the data of Dick Stieglitz's "Capture and Transmission Measurements on ^{50}Cr, ^{52}Cr, ^{53}Cr, ^{54}Cr, ^{60}Ni, and V." These cards represent a compromise between what we think belongs on SCISRS and what we think you would like to see on SCISRS. The capture data are represented on a time-of-flight basis as 'capture yield divided by sample thickness' in units of millibarns. The only bone of contention we have about the capture data is that we did not send you the errors on each point (although we admit that six thousand error bars represents a fair amount of paper).

The total cross section data on the other hand represent a blend of manipulated data. We have blended thick-sample and thin-sample cross sections (as determined from the logarithm of the transmission). A table is enclosed which specifies for which channels the thick and the thin-sample data were used to obtain the blended cross section set. Thus we do not have a simple

Although ARPANET was one year old at the time, there was no realistic way to predict what tools would be available in 50 years

You don’t know what the future user will need

- **You made a delicious cake, and I asked for the recipe**
  - You’d share it, right?
  - I’ll need the recipe to bake my own
  - I’ll need the recipe if I need modify it (dietary restrictions…)
  - I’d also appreciate a “heads up” for any gotchas (do not substitute baking soda for baking powder)

- **We’re asking for the same thing for your research**
  - ***Open Data means sharing the process, not just the data***
  - ***The Recipe***: Here’s a detailed, quantified, well-documented description of what was done
  - ***What I’ll need to modify it***: portable scripts that do the file assembly/analysis/whatever
  - ***Avoiding gotchas***: the container/virtual environment with all the evaluation and assembly codes, with corresponding inputs, so the user can re-run the research as you intended!

Legacy Data: Discussion

- Do we have adequate succession plans
- How do we capture institutional knowledge, i.e., technician logbooks, machine nuances, etc.
- Maintaining uncommon expertise
  - Lessons learned from ORELA
  - UTK