AMERICAN CHEMICAL SOCIETY DIVISION OF

NUCLEAR CHEMISTRY AND TECHNOLOGY

168th ACS National Meeting — E. P. Steinberg, Chairman

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MONDAY MORNING - SYMPOSIUM ON NUCLEAR CHEMISTRY AT THE NEW ACCELERATORS - S. B. Kaufman, Presiding

1. 300-GeV PROTONS - AN ASSESSMENT FOR NUCLEAR CHEMISTRY.* Ellis P. Steinberg, Chemistry Division, Argonne National Laboratory, Argonne, Illinois 60439.

Production cross sections for a broad variety of nuclides from 200- and 300-GeV proton bombardment of selected targets from C to U have been determined by a number of investigators in a collaborative program at the Fermi National Accelerator Laboratory. Many of these results were obtained by direct Ge(Li) γ-ray spectrometry of unseparated targets. Comparison with results of similar measurements at proton energies of 3-30 GeV show that within ~10% the spallation cross sections are independent of energy from ~10-300 GeV for targets of $A \lesssim 110$. For Au and U targets, the heavier products ($A \sim 150$) exhibit a somewhat lower formation cross section (~15%) at 300 GeV than at 10-30 GeV. Thick-target, thick-catcher integral recoil studies have been carried out for Al, Au, and U. An interesting energy dependence, with peaking of the forward-to-backward ratio for a number of products from Au and U has been observed around 3 GeV. The need for more differential data and the significance of further studies at the highest energies available will be discussed in terms of possible relativistic effects and the energy deposition and break-up mechanisms.

*Work performed under the auspices of the U. S. Atomic Energy Commission.

2. INTERACTION OF ^{238}U WITH 300- AND 11.5 GeV PROTONS: CROSS SECTIONS AND RECOIL PROPERTIES OF PRODUCTS IN THE A=100-140 MASS REGION. N. T. Porile, Y. W. Yu, and S. Biswas, Department of Chemistry, Purdue University, West Lafayette, Indiana 47907.

Formation cross-sections of some 30 Cd, Te, I, Cs, and Ba nuclides formed in the interaction of ^{238}U with 300- and 11.5- GeV protons have been measured. Thick-target recoil properties of many of these products were also determined. An analysis of approximately 50% of the data indicates that the values of $\sigma_{300}/\sigma_{11.5}$ are consistent with unity for products with A>130 and decrease with decreasing A below this mass number, a trend that is most notably exhibited by neutron deficient iodine nuclides. The values of $\sigma_{300}/\sigma_{11.5}$ thus range from 0.64±0.05 for ^{123}I to 1.02±0.05 for ^{133}I. The cross-section ratios of all the measured nuclides correlate poorly with the charge dispersion variable, Z_A-Z_{eff}, but instead show a systematic trend with A. The recoil ranges and F/B values are, within the limits of error, the same at both energies indicating that the energetics of fission and spallation, as well as the transition point between these mechanisms remains unchanged. Complete results will be presented.

3. STATUS REPORT ON THE INITIAL NUCLEAR CHEMISTRY EXPERIMENTS AT THE CLINTON P. ANDERSON MESON PHYSICS FACILITY (LAMPF)*. R. A. Williams and B. J. Dropesky, University of California, Los Alamos Scientific Laboratory, P. O. Box 1663, Los Alamos, New Mexico 87544.

The present nuclear chemistry program at LAMPF consists of 18 experiments which have been approved and granted beam time. Of the 66 participants on these experiments about a third are Los Alamos based while the remaining two thirds are from national laboratories and universities throughout the U. S. and Canada. Because of the variety of particle beams being delivered at LAMPF and the high intensities planned for these beams, a broad spectrum of nuclear chemistry experiments have been proposed. In addition to

muon capture processes, experiments utilizing the proton beams and [illegible]getic secondary neutrons produced at the main beam stop are also an important part of the program. The status of the half a dozen or so experiments that have commenced will be described and some of the preliminary results obtained will be presented.

*Work performed under the auspices of the U. S. Atomic Energy Commission.

4. SYSTEMATICS OF (x,x2p) REACTIONS FOR PRODUCTION OF NUCLEI "TWO PROTONS REMOVED FROM STABILITY."* R. Collé, W. B. Walters, and W. H. Zoller, Department of Chemistry, University of Maryland, College Park, Md. 20742 and W. R. Dodge, National Bureau of Standards, Washington, D.C. 20234

In recent years, considerable effort by a number of laboratories has been made in searching for new neutron-rich isotopes ("two protons removed from stability"). This work has lead to the discovery of ^{184}Hf, ^{206}Hg and ^{236}Th as well as intense searches for the still undiscovered ^{62}Fe, ^{186}Os and ^{190}W. Although (p,3p) and (γ,2p) reactions are usually employed, these neutron-rich nuclei can also be produced by (n,n'2p) reactions utilizing the fast neutron spectra accompanying the stopping of high energy proton beams in solid stops. We have undertaken a systematic study of these (x,x2p) reactions for incident protons, bremsstrahlung and fast neutrons because of the scarcity of production data for them. Radiochemically determined cross sections for production of (p,3pxn) products and integral atom yields for the neutron-induced and photonuclear reactions are reported for a wide range of target masses at selected incident beam energies (≤100-MeV). Systematics as a function of target mass and the relative distributions of neutron-deficient vs. neutron-rich products are discussed.

*Work performed under the auspices of the U.S. Atomic Energy Commission.

5. VERY HEAVY ION INDUCED REACTIONS (^{40}Ar, ^{63}Cu, ^{84}Kr) STUDIED AT ORSAY WITH ALICE ACCELERATOR.† F. Hanappe, C. Ngo, J. Peter, B. Tamain, J. Galin*, B. Gatty, D. Guerreau, J. Pouthas, X. Tarrago, Institut de Physique Nucleaire BP n°1, 91406 Orsay (France), B. Cauvin, J. Girard, H. Nifenecker, DPh N/MF CEN Saclay BP n°2, 91120 GIF/Yvette (France).

Two kinds of experiments with the heaviest ions accelerated by ALICE at Orsay are in progress.
1. The first kind is related to the formation of heavy compound nuclei ($Z \geq 101$) by different entrance channels involving the projectiles ^{40}Ar, ^{63}Cu, ^{84}Kr. Unlike what is observed with Ar, in Kr induced reactions the binary fission process following a complete fusion is found to be scarce. Instead of complete fusion, a new reaction mechanism appears which may be called "incomplete fusion" or "quasi fission".
2. In the second kind of experiments the quasi fission process already observed with Kr, is under study in Ar induced reactions. Coincidence experiments where both light and heavy fragments are identified simultaneously (with both ΔE-E and time-of-flight techniques) should allow to precise the mechanism involved in such reactions.

†Work performed under the auspices of the U. S. Atomic Energy Commission.

*On leave of absence from Orsay (France).

6. CALCULATION OF TOTAL NUCLEAR REACTION CROSS SECTIONS WITH HIGH-ENERGY HEAVY IONS. Paul J. Karol, Department of Chemistry, Carnegie-Mellon University, Pittsburgh, Pennsylvania 15213.

Calculations of total nuclear reaction cross sections for heavy projectiles (single or composite) with kinetic energies ≥ 150 MeV per nucleon will be presented. The method of calculation employed is based on the Fernbach, Serber and Taylor model (Phys. Rev. 75, 1352 [1949]) but modified to allow for tapered density distributions in both target and projectile. Very good agreement has been obtained for incident nucleons and pions where experimental data is available for comparison.