MASTERF I N A L R E P O R T

Energetic Neutron Spectrometry

Grant No.: DOE DE-AC02-76EV02231

Dates: January 1, 1978 - December 31, 1980

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INCLUSIVE NEUTRON PRODUCTION BY 337 MeV/A NEON IONS
ON CARBON, ALUMINUM, COPPER, AND URANIUM

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A dissertation submitted to the
Kent State University Graduate College
in partial fulfillment of the requirements
for the degree of Doctor of Philosophy

by

Robert A. Cecil

December, 1981

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ACKNOWLEDGMENTS

This work was supported in part by the U.S. National Science Foundation, the U.S. Department of Energy, and the National Aeronautics and Space Administration. I am grateful to Gary Westfall for providing a copy of the firestreak computer code, and to S. Nagamiya for proton cross sections prior to publication. I acknowledge useful conversations with M. Gyulassy regarding final-state coulomb effects and K. Crebbin regarding Bevalac beam energy calibrations.

I would like to thank my advisor Bryon Anderson for his patience and insight as to what the really important things are, and I would like to thank my co-advisor Richard Madey for his constant attention to the details so necessary for consistent success. I am especially grateful to Alan Baldwin, without whose technical experience these measurements might not have been made. Lastly, I would like to thank my wife, Jeri Hoffman, for her support, assistance and encouragement throughout these measurements.

Reprints, etc Removed

CECIL, ROBERT A., Ph.D., December, 1981

PHYSICS

INCLUSIVE NEUTRON PRODUCTION BY 337 MeV/A NEON IONS ON CARBON, ALUMINUM, COPPER, AND URANIUM (112 pp.)

Directors of Dissertation: Bryon D. Anderson and Richard Madey

Neutron spectra from high-energy heavy-ion reactions were measured and compared with the spectra calculated from theoretical models. The inclusive double-differential cross sections for neutron production above about 12 MeV were measured at angles of 30, 45, 60 and 90 degrees. The neutrons were produced by 337 MeV/A neon ions bombarding targets of C, Al, Cu and U. Three different energy regions can be distinguished in the neutron spectra: (1) a low-energy "evaporation" region, (2) a high-energy exponential tail reflecting the internal momentum distribution of the nucleons, and (3) an intermediate energy region reflecting quasi-free and pre-equilibrium processes. The intermediate-energy region becomes less pronounced with increasing angle and is almost non-existent at 90 degrees. This behavior is consistent with the interpretation that the intermediate-energy region consists mainly of scattering processes with a few direct collisions. The intermediate-energy region is relatively flat at the forward angles and merges into an exponential fall-off at wide angles. The 30-degree spectrum from the carbon target shows a broad peak around 150 MeV, which is interpreted as a signature of quasi-free nucleon-nucleon collisions. Although the neutron detection threshold is not low enough to see the evaporation peaks, there is evidence of evaporation tails. The evaporation yields apparent in our spectra

increase with the mass number of the target. The neutron spectra differ from the proton spectra reported for similar targets at 385 MeV/A and 393 MeV/A. The neutron-to-proton cross section ratios are fit well by an intranuclear-cascade model calculation, but poorly by a "firestreak" model calculation. The neutron-to-proton cross section ratios calculated from experimental measurements result in constraints which may help determine the validity of the assumptions underlying some theoretical models of relativistic heavy-ion reactions.