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INFORMAL TECHNICAL PROGRESS REPORT
AND BUDGET FOR INCREMENTAL FUNDING

SIGNATURE PAGE

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1982 March 25

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Informal Technical Progress Report
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Senior Investigator: Anthony Turkevich

Assisted by: John Warren*, H. Roland Heydegger**, Thanasis Economou, Karoline Wielgoz, Jerome J. LaRosa, Dale E. Boyce, and Debra Scatena-Wachel. Dr. George W. Reed, Jr. of the Chemistry Division of the Argonne National Laboratory continues to collaborate with us and to use some of our facilities.

ABSTRACT

The principal activities during the last year were related to LAMPF experiments, a newly initiated radiochemical search for Glashow particles, and the writing up of experimental work completed at FERMILAB studying the interaction of 400 MeV protons and 150 MeV pions with complex nuclei. Collaboration is proceeding with Los Alamos on heavy methanes as atmospheric tracers and in proposing a geological search for enhanced solar neutrinos in past geological times.

* Physics Department, Lakehead University, Canada

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1. Radiochemical Investigation of Δ^{++} Content of Complex Nuclei (LAMPF Expt. 603). Anthony Turkevich, John Warren¹, Dale Boyce, Thanasis Economou, and Debra Scatena-Wachel. In collaboration with S. Kaufman and E. Steinberg of Argonne National Laboratory, and B. Dropesky, LAMPF.

The presence of Δ^{++} in complex nuclei is being studied via the production of ^{88}Kr from ^{88}Sr assuming that the reaction proceeds by the mechanism:

where the (Δ^{++}) indicates the initial presence of the Δ^{++} in ^{88}Sr and (n) stands for the neutron in ^{88}Kr .

Neutrons of ~ 800 MeV at the Los Alamos Meson Facility (LAMPF) are being used, and a special ultra-low level technique for detecting ^{88}Kr has been developed.

A series of runs at LAMPF during the summer of 1981 has confirmed the formation of ^{88}Kr with a probability reflecting a cross section for the above process of $0.1 \mu\text{b}$. This would correspond to a Δ^{++} content in ^{88}Sr of only $\sim 0.01\%$ - much lower than ordinarily postulated.

During the winter, an experiment using 400 MeV protons at the Argonne National Laboratory IPNS has confirmed that the ^{88}Kr found at the LAMPF experiment is not due to secondary reactions or reactions with impurities in the target material.

This experiment searching for Δ^{++} in complex nuclei has been given high priority by the Program Advisory Committee at LAMPF. At present it is scheduled to receive runs this summer or fall with 500 and 650 MeV neutrons in order to establish the excitation energy for the process. A start will also be made on a radiochemical study of the double charge exchange process

using the same detection apparatus.

¹Physics Department, Lakehead University, Canada

2. Production of New Neutron Rich Radon Isotopes
(LAMPF Expt. 719). Anthony Turkevich, D. Scatena-Wachel
and John Warren¹.

ABSTRACT

The properties of neutron rich isotopes of the heaviest elements are important in defining the nuclear mass surface in this region and in predicting the detailed course of neutron capture processes in stars and nuclear explosions. It is proposed to produce and determine the half lives of ^{227}Rn and ^{228}Rn by 800 MeV proton irradiations of thick targets (~360 g) of ThO_2 . The expected cross sections are low (0.1-10 nb). The half-lives (30-100 sec) of the radons will be established by charged wire collection of daughter products.

A preliminary experiment is proposed that will use ^{226}Rn (360 sec) to establish the magnitudes of yields of such neutron rich species and to test the experimental technique.

This experiment was proposed to the Program Advisory Committee of LAMPF at the January 1982 meeting. In response to their reaction, more data is being developed to address questions about diffusion rates under the conditions of the experiment.

¹Physics Department, Lakehead University, Canada

3. Search for Glashow Particles, A. Turkevich, K. Wielgoz, D. Boyce and T. Economou.

Cahn & Glashow¹ have proposed that very heavy particles with integral negative charge might be stable and that a very small number might be left over from the millisecond time frame of the Big Bang. They suggest that such particles would interact with particles of ordinary matter only electromagnetically. Thus, at present, they would exist bound to the nuclei of heavy elements. Cahn & Glashow suggest several methods of searching for such atoms, ${}_{Z-1}({}^A\text{ZX}^-)$, which would have essentially the nuclear properties of A_Z but a very heavy mass (due to the X^-), and the chemistry of elements, $Z-1$.

We have initiated a search for such particles using a different approach from any suggested by Cahn & Glashow. (This approach was developed in consultation with N. Sugarman.) We have obtained (courtesy of Dr. Gray of Batelle Northwest) samples of graphite that have been exposed to fast neutron fluences of $\sim 2 \times 10^{22}$ n cm⁻². If (${}^{14}\text{NX}^-$) particles exist, they would have followed the chemistry of carbon and might be present in graphite. Under neutron irradiation, they should undergo the reaction:

The product, ${}_5({}^{14}\text{CX}^-)$, should follow the chemistry of boron, and be a β^- emitted with a half life of ~ 15 years. Since normal boron has no long lived radioactive nuclei, this can be a sensitive test for the presence of (${}^{14}\text{NX}^-$) particles in the original graphite.

Boron from a 2 gm sample of graphite has been isolated, purified and is being measured for radioactivity in a low level beta counter. We expect to get an additional 20 grams of such graphite and should be able to detect the presence of (${}^{14}\text{NX}^-$) at the 10^{-13} level.

¹R. N. Cahn and S. L. Glashow, "Chemical Signatures for Super-heavy Elementary Particles", Science 213, p. 607 (1981).

A collaboration is being initiated with A. Fried-
mand and S. Fried of the Chemistry Division of the
Argonne National Laboratory on other, possibly more
sensitive, searches for Glashow-type particles.

4. Collaboration with Los Alamos National Laboratory,
Anthony Turkevich.

A. Turkevich continues to spend summers as a
Fellow of the Los Alamos National Laboratory working
on problems of Laboratory programmatic and scientific
interest. Among the latter is a continuing collabora-
tion in planning new continental scale atmospheric
experiments using heavy methanes. A new collaboration
has been started in proposing an experiment to detect
solar neutrino induced events in molybdenum. This would
take advantage of large scale molybdenum mining in
Colorado and is directed toward detecting higher rates
of neutrino emission by the sun in the past than are
being detected at present by the Davis chlorine experiment.

5. A published paper by H. R. Heydegger.
"Terrestrial, Meteoritic, and Lunar Titanium Isotopic
Ratios Revaluated: Evidence for Correlated Variations",
H. R. Heydegger^{1,2,3}, J. J. Foster², and W. Compston²,
Earth and Planetary Science Letters (accepted for publica-
tion February 1982).
6. The work summarized here is by G. W. Reed, Jr. (and S.
Jovanovic) of the Argonne National Laboratory. Facilities
at Fermi Institute were used in part to accomplish the work.
Work was supported by NASA and by DOE.

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²Research School of Earth Sciences, Australian National Univer-
sity, Canberra, A.C.T. 2600 Australia.

³Enrico Fermi Institute, University of Chicago, Chicago, IL

Published work:

- S. Jovanovic and G. W. Reed, Jr., "Aspects of the history of 66095 based on trace elements in clasts and whole rock", Proc. Lunar Planet. Sci. 12B, 295-304 (1981).
- G. W. Reed, Jr. and S. Jovanovic, "The significance of Cl/P₂O₅ ratios from lunar samples - A response", Proc. Lunar Planet. Sci. 12B, 333-336 (1981).
- S. Jovanovic and G. W. Reed, Jr., "Element mobilities related to alteration of granite from an IDHP core," (Abstract), EOS 62, 389 (1981).
- S. Jovanovic & G. W. Reed, Jr., "Noble metal sites in Allende - chemical evidence," (Abstract), Meteoritics 62, 334 (1981).
- S. Jovanovic & G. W. Reed, Jr., "Mobility of non-gaseous volatiles in the lunar regolite: 12027 drive tube measurements," (Extended abstract), Lunar Planet. Sci. XII, 522-524 (1981).
- S. Jovanovic & G. W. Reed, Jr., "Chlorine and Phosphorous-bearing phases in lunar samples: The significance of Cl/P₂O₅ ratios: A response" (Extended abstract), Lunar Planet. Sci. XII, 516-518 (1981).
- S. Jovanovic and G. W. Reed, Jr., "Insights regarding rusty rock 66095 based on trace element studies: The VAPOR consortium," (Extended abstract), Lunar Planet. Sci. XII, 516-518 (1981).

A manuscript entitled "Noble metal sites in Allende-chemical evidence" has been prepared for submission for publication.

Work in progress: A manuscript entitled "Phosphates in the lunar crust" will be submitted for publication by May 1982.

A manuscript is being written on the mobilities of trace, minor and major elements in two suites of fresh and weathered granite rocks.