SECTION IV

ABSTRACTS OF PAPERS IN PRESS

(after June 30, 1976)

MSUCL-146
COO-1779-149

ODD-PARITY ROTATIONAL-BAND STRUCTURE IN ^{48}V

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and

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ABSTRACT:

An additional odd-parity rotational band in $^{48}_{23}V_{25}$, built on a 1099.1-keV state with $K^\pi = 4^-$, has been identified up to spin 8, and corrections are reported for the structure of the previously reported $K^\pi = 1^-$ band, now seen to spin 7. These bands can be interpreted as the singlet and triplet couplings, respectively, of the $\Omega^\pi[Nn_z\Lambda\Sigma] = 3/2^+[202\downarrow]$ proton and $5/2^-[312\uparrow]$ neutron orbitals.

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† Work supported in part by the U.S. National Science Foundation.

‡ Alfred P. Sloan Fellow, 1972-1976.

§ Work supported in part by the U.S. Atomic Energy Commission.

On the Existence of a Giant Monopole Resonance in ^{208}Pb and ^{197}Au*

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ABSTRACT

Evidence recently presented concerning possible EO giant resonance states in ^{208}Pb and ^{197}Au is discussed. It is shown that these states may be equally well of E2 character.

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*Supported by the National Science Foundation.

THE DECAY OF ^{63}Zn

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A Survey of the (^{3}He,^{7}Be) Reaction at 70 MeV*

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ABSTRACT

A study of the (^{3}He,^{7}Be) reaction has been undertaken using a 70 MeV ^{3}He beam. By surveying a wide range of target nuclides, namely ^{12,13}C, ^{16}O, ^{24,26}Mg, ^{40,42,44}Ca, ^{58,60,62,64}Ni, ^{90}Zr, ^{120,124}Sn, ^{144}Sm and ^{206}Pb, systematics of the α-clustering phenomenon were investigated. In addition, masses and energy levels of ^{60}Fe and ^{120}Cd were measured. The ^{7}Be particles were detected in a single wire proportional counter backed by a plastic scintillator in the focal plane of an Enge spectrometer to ensure adequate particle identification. Total energy resolution as small as 140 keV full width at half maximum was obtained, although in most cases the target thickness limited the energy resolution to larger values. Differential cross-sections as low as 20 nb/sr were measured. The finite range programs LOLA[11] and LOLITA[11] were used to calculate differential cross-sections for comparison to data, assuming the reaction to proceed by a direct α-transfer. The spectroscopic

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* Work supported by the National Science Foundation.

Migma Distribution Functions and Fusion Rates*

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ABSTRACT

Using a circular orbit model appropriate to a Migma fusion device, analytical expressions are obtained for the particle density and the colliding pair distribution functions in terms of a parameter which specifies the central ("core") density. Contrary to expectations, our distribution functions tend to favor colliding pairs with low relative velocities, and this tendency grows stronger as the central density increases. The reaction rate parameters for the d+d and d+^{3}He fusion reactions have been calculated for a wide range of deuteron energies, and our resultant values are not only significantly smaller than those found by Maglich, but are also generally smaller than those obtained from a comparable Maxwell distribution. We also find that the total pair density and the resultant fusion rate increase remarkably little with large increases in the central density, so that this basic Migma characteristic does not appear particularly advantageous for fusion production. Finally, the fusion time constant and power output from a deuteron Migma are estimated, with rather disappointing results.

Finite-range distorted-wave Born-approximation study of the (^{4}He,^{6}Li) reaction on ^{12}C, ^{24}Mg and ^{40}Ca

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Angular distributions have been obtained for the (α,^{6}Li) reaction at 46 MeV on targets of ^{12}C, ^{24}Mg and ^{40}Ca. A finite-range DWBA analysis is performed using shell model wave functions to describe the target and various cluster wave functions to describe ^{6}Li. Finite-range effects are evident in the predicted absolute magnitudes but not in the shapes of the angular distributions, which are poorly fit. Reasonable agreement between measured and predicted absolute cross sections is obtained if the product of the α-d wave function and potential for the ^{6}Li has no node away from the origin.

NUCLEAR REACTIONS: ^{12}C, ^{24}Mg, ^{40}Ca(α,^{6}Li), E=46 MeV; measured $\sigma(E_{Li},\theta)$: Finite-range DWBA analysis with microscopic wave functions

Work supported by the National Science Foundation.

Proton Decay of the Isobaric Analogs of the Ground States of ^{207}Pb and ^{208}Pb*

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ABSTRACT

Proton spectra have been observed in coincidence with neutrons produced in p+ ^{207,208}Pb reactions at 25 MeV. When gated by neutrons produced in exciting IAS, the usual $\tilde{p}$ groups representing proton decay of IAS to low-lying states of ^{206,207}Pb appear at 10-12 MeV. When gated by lower-energy neutrons, there are no $\tilde{p}$ groups at 10-12 MeV; rather, a single broad peak, presumably arising from evaporation, appears in this region of the proton spectrum. To this evaporation peak is attributed the anomalous situation in which the IAS formation cross section via (p,n) has appeared to be exceeded by its partial decay cross section via proton emission. Anomalously large IAS widths previously inferred from proton singles spectra are also attributed to the decay protons being superimposed upon this background evaporation peak. Our coincidence proton spectrum from ^{207}Pb(p,n$\tilde{p}$)^{206}Pb reveals a narrower width, in agreement with ^{206}Pb+p resonance data and with ^{207}Pb(p,n) neutron spectra.

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* Supported by the National Science Foundation and the Office of Naval Research.

Monopole Excitation in the Giant Resonance Region of ^{208}Pb[+]

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ABSTRACT

Inelastic scattering of 45 MeV protons and 70 MeV ^{3}He-particles has been used to study the giant resonance region of ^{208}Pb. The giant resonance is found to be highly structured with states of different multipolarities, such as dipole, quadrupole and octupole. A monopole state is found at 9.11 MeV which exhausts about 13% of the monopole sum rule strength.

[+]Work supported by the National Science Foundation.

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The pathway of nitrogen metabolism after fixation of ^{13}N-labeled nitrogen gas by the cyanobacterium, Anabaena cylindrica*

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Methods have been developed for identifying the pathway of assimilation of N_2-derived nitrogen. The products of fixation of ^{13}N-labeled nitrogen gas (^{13}N-N_2), and the distribution of ^{13}N within glutamine, were determined after short periods of labeling (ca. 1 to 120 s) and also in pulse-chase experiments. Ammonia, the amide nitrogen of glutamine, and the α-amino nitrogen of glutamate, in that order, were the first observed products of fixation of N_2 by the cyanobacterium (blue-green alga), Anabaena cylindrica. This sequence of the formation of nitrogenous products was confirmed by the use of inhibitors. The presence of 1 mM methionine sulfoximine permitted continued formation of $^{13}NH_3$, while virtually preventing ^{13}N-labeling of amino acids. In the presence of 1 mM azaserine, glutamine was labeled, but not other amino acids. Our observations demonstrate unequivocally that N_2-derived nitrogen fixed by this organism is metabolized initially by the glutamine synthetase/glutamate synthase pathway.

*Research supported in part by the U.S. National Science Foundation.

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March 1976

Comparison of Measured Neutron Spectra with Predictions of an Intranuclear-Cascade Model*

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Neutron spectra resulting from bombardment of targets of ^{48}Ca, ^{90}Zr, ^{120}Sn, and ^{208}Pb with 45 MeV protons have been measured at many angles between 0° and 160°. Intranuclear-cascade, Monte-Carlo calculations predict too many high-energy neutrons in the forward direction and too few neutrons, particularly high-energy neutrons, at angles greater than $\sim 45^{\circ}$. Beyond 90° the underprediction is by factors of 10 to 100. For angle-integrated spectra, however, there is reasonable agreement between theory and experiment.

[NUCLEAR REACTIONS ^{48}Ca, ^{90}Zr, ^{120}Sn, ^{208}Pb (p,nx); E = 45 MeV; measured $\sigma(E_n,\theta)$ and $\int d\Omega\sigma(E_n,\theta)$; enriched targets. Intranuclear-cascade model.]

*Work supported by the National Science Foundation, the Office of Naval Research, and the Energy Research and Development Administration

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A Coupled-Channel Born Approximation Analysis of $^{22}Ne(p,t)^{20}Ne$ and $^{24}Mg(p,t)^{22}Mg$ using Shell-Model Wavefunctions*

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ABSTRACT

Coupled-channel Born approximation calculations for the reactions $^{22}Ne(p,t)^{20}Ne$ and $^{24}Mg(p,t)^{22}Mg$ to the 0^+, 2^+, and 4^+ members of the ground-state rotational bands have been carried out. The two-nucleon transfer spectroscopic amplitudes were determined from shell-model wavefunctions, the calculation of inelastic excitations was based on the collective model, and the reaction space was limited to the first 0^+, 2^+, and 4^+ states in each nucleus. The measured cross sections in the case of $^{22}Ne(p,t)$ are reasonably well described by this model. However, significant deviations were observed between the calculated cross sections and the experimental data for the $^{24}Mg(p,t)$ transitions to the 2^+ and 4^+ states. These discrepancies are possibly attributable to multistep processes involving higher-lying states in ^{24}Mg not included in the reaction space. The effects on the calculations of other possible inadequacies of the reaction model and uncertainties in the parameters of this model are discussed.

[NUCLEAR REACTIONS: $^{22}Ne(p,t)$, E=39.8 MeV. $^{24}Mg(p,t)$, E=42.0 MeV; calculated $\sigma(\theta)$ using coupled-channel Born approximation and shell-model spectroscopic amplitudes.]

*Work supported by the National Science Foundation.

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Shell-Model Calculations for the Zinc Isotopes*

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ABSTRACT

Shell-model calculations for the zinc isotopes have been carried out with active particles distributed in the $1p_{3/2}$, $0f_{5/2}$ and $1p_{1/2}$ orbits outside a closed "^{56}Ni" core. The effective Hamiltonian used was one obtained by Koops and Glaudemans from a fit to Ni and Cu level energies. An average absolute deviation of 0.19 MeV between the calculated and experimental ground-state binding energies is obtained for the A=62-68 Zn isotopes. Good agreement is also found between most calculated and experimental excitation energies and spectroscopic factors for single-nucleon transfer for the low-lying levels in these nuclei. Experimentally known B(E2) values are generally well reproduced by the present model with effective charges of 1.0±0.1 and 1.6±0.2 for the neutron and proton, respectively. Magnetic dipole as well as Gamov-Teller transitions are not well accounted for by these calculations and seem to be sensitive to excitations of the ^{56}Ni core.

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** Fellow of the Niels Stensen Foundation, The Netherlands.

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A Measurement of Γ_{rad}/Γ for the 7.654 MeV State of ^{12}C and the Rate of the Stellar 3α Reaction*

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ABSTRACT

The branching ratio Γ_{rad}/Γ for the radiative de-excitation of the 7.654 MeV, 0^+ state in ^{12}C has been measured. Coincidences between α particles from $^{12}C(\alpha,\alpha')^{12}C(7.654\ MeV)$ and recoil ^{12}C ions at the proper energy and angle were the signature of radiative decay. Conservative techniques were used throughout to avoid the need for large corrections. A value of $\Gamma_{rad}/\Gamma = (3.87\pm0.25) \times 10^{-4}$ was obtained in good agreement with other recent results but substantially higher than the previously accepted value of $(2.9\pm0.3) \times 10^{-4}$. Available results are reviewed and a recommended value of Γ_{rad}/Γ is presented. The implication of this result for the rate of the 3α process in stellar helium burning is discussed and a recommended reaction rate is presented.

NUCLEAR STRUCTURE: ^{12}C, 7.654 MeV state; measured Γ_{rad}/Γ. Stellar helium burning.

*Research supported by the U.S. National Science Foundation.

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May 1976

Observation of Highly Neutron-rich ^{43}Cl and ^{59}Mn*

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ABSTRACT

We report the observation and mass measurement of ^{43}Cl and ^{59}Mn by the (^{3}He,^{8}B), 5-nucleon pickup reaction. Mass excess values of -23.14±0.06 for ^{43}Cl and -55.49±0.03 MeV for ^{59}Mn have been measured.

*Work supported by the U.S. National Science Foundation.

High-spin Multi-quasiparticle Yrast Traps in ^{176}Hf*

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ABSTRACT

We have identified several high-K 4- and 6-quasiparticle states between 2.5 and 5 MeV excitation in ^{176}Hf, which are well described by the collective model with axial symmetry. Isomers with $K^{\pi}=14^{-}$, 19^{+} and 22^{-} form traps at or near the yrast line. The yrast structure changes from the ground band to a $K^{\pi}=16^{+}$ band at I=16 and again to a $K^{\pi}=22^{-}$ state at I=22, providing the first demonstration that intrinsic excitations of a heavy deformed nucleus can become yrast.

*Supported by the U.S. National Science Foundation.

Anomalous Quenching of S=1 Two-Nucleon Transfer*

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ABSTRACT

Examination of the ground-state transitions of the (p,t) and (p,^{3}He) reactions on all T_z=1/2 nuclei from ^{21}Ne through ^{39}K reveals a systematic suppression of the S=1, T=0 component of the (p,^{3}He) transfer cross sections which is not explained in terms of current structure and reaction theories.

*Work supported by the U.S. National Science Foundation.

The Effective M1 Operator and Magnetic Moments of sd-Shell Nuclei*

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ABSTRACT

Analysis of experimental magnetic dipole moments of A=17-39 nuclei with shell-model wave functions shows that a constant-valued effective M1 operator which differs only slightly from the free-nucleon specifications suffices to explain all known data at a reasonable level of accuracy.

*Research supported in part by the U.S. National Science Foundation.

MSUCL-216
MSUNC-183

High-Spin Level Systematics in $^{177-182}$W: Yrast Band Anomaly in ^{180}W*

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Abstract

High-spin levels in $^{177-182}$W have been populated in (α,xnγ) reactions. Backbending-type behavior appears most prominently in ^{180}W. The role of $i_{13/2}$ neutrons and $h_{9/2}$ protons in the ^{180}W *yrast* behavior is examined. A strongly-coupled $K^{\pi} = 10^{+}$ band structure is identified in ^{182}W, the first seniority-two $i_{13/2}$ configuration to be characterized in a deformed nucleus.

*Research supported by the U. S. National Science Foundation and the U. S. Energy Research and Development Agency.

MSUCL-217
MSUNC-185

A He-Jet Chopper for Measuring Half-Lives of Short-Lived Nuclei*

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ABSTRACT

A He-jet chopper has been built to enable one to measure the half-lives of nuclear species from several seconds to as short as several tens of milliseconds. The chopper has been used to measure some of the mirror beta decays in the $f_{7/2}$ shell.

*Work supported in part by the U. S. National Science Foundation.

†Alfred P. Sloan Fellow, 1972-1976.

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Comparison of Realistic and Empirically Optimized Nuclear Hamiltonians*

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ABSTRACT

Empirically determined Hamiltonians for A=18-24 and A=32-38 nuclei exhibit average attractions between unlike active orbits which are only half as strong as those obtained when corresponding effective Hamiltonians are calculated from nucleon-nucleon parameters and corrected for core-polarization effects.

*Research supported in part by the U.S. National Science Foundation.

RESPONSE FUNCTIONS OF ORGANIC SCINTILLATORS TO HIGH ENERGY NEUTRONS

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ABSTRACT

Two cylindrical liquid scintillators of dimensions 5cm x 5cm and 12.5cm x 12.5cm, filled with NE213, were calibrated with high energy neutrons from E_n = 3 MeV to E_n = 75 MeV at the time-of-flight facility associated with the Michigan State University Cyclotron. Pulse shape discrimination was used on each detector to separate the protons and alphas produced by neutron interactions from the electrons produced by gamma rays. Response functions for monoenergetic neutrons from about 2 MeV to 75 MeV have been determined. These response functions are very different from the calculated response using the Monte Carlo method. The implications of these calibrations for measurements of high energy neutrons using liquid scintillators are discussed.

*Deceased

A Determination of the Mass and Some Energy Levels of the Nuclide ^{44}Ar*

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ABSTRACT

The mass and some energy levels of the nuclide ^{44}Ar have been determined from the $^{48}Ca(^{3}He,^{7}Be)^{44}Ar$ reaction. A comparison with theoretical values of the mass is made.

The lifetime of the nucleus ^{44}Ar has been reported [1,2] but until now its mass and energy levels were unknown. This letter reports a measurement of the mass of ^{44}Ar and the excitation energies of several of its excited states as determined from the $^{48}Ca(^{3}He,^{7}Be)^{44}Ar$ reaction at 70 MeV ^{3}He bombarding energy.

The ^{3}He beam was produced by the Michigan State University isochronous cyclotron. The reaction products were analyzed by an Enge split-pole magnetic spectograph [3]. Detection of ions in the focal plane of the spectrometer was accomplished by a system composed of a plastic scintillator photomultiplier unit behind a 25 cm single wire charge division gas proportional counter [4]. The counter measures both position along the focal plane and differential energy loss of an ion,

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*Work supported by the National Science Foundation.
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The Level Structure of ^{191}Pt from the Decay of 3.2 h ^{191}Au

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Abstract: Levels of ^{191}Pt populated in the decay of 3.2 h ^{191}Au have been investigated by γ-ray singles and comprehensive γ-γ coincidence measurements. A detailed ^{191}Au decay scheme, which differs radically from earlier versions, has been established. The ^{191}Au decay results are discussed with reference to those obtained in complementary (α,3nγ) studies of odd-A Pt nuclei and with particular emphasis on the locations and properties of low-spin members of the $\nu i_{13/2}$ level family in ^{191}Pt.

RADIOACTIVITY ^{191}Au [from ^{191}Ir(α,4n)]; measured E_γ, I_γ, γγ-coin; ^{191}Pt deduced levels, J, π, ICC. Enriched target, Ge(Li) detectors.

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[†††]Work supported by the U.S.ERDA and the NSF

Core Polarization and Coulomb Displacement Energies*

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ABSTRACT

The contribution of core polarization terms (other than the Auerbach-Kahana-Weneser (AKW) effect) to the Coulomb displacement energies of mirror nuclei near A=16 and A=40 is examined within the framework of a macroscopic collective model. The parameters of the model are adjusted to reproduce related experimental properties when possible. In the absence of relevant data an energy weighted sum rule (EWSR) is exploited. The total contribution of multipole excitations of the core ($L \leq 5$) reduces (increases) the discrepancy for particle (hole) states by ~2% of the value of the direct Coulomb term. The implications of this effect on the recently conjectured charge symmetry breaking terms are discussed.

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