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THE (p,d) REACTION ON 2s-1d SHELL NUCLEI*

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ABSTRACT

An investigation of the (p,d) reaction on $N=Z$ nuclei in the 2s-1d shell has been made to obtain spectroscopic information and to study the $\ell_n = 2$ J-dependence for the (p,d) reaction. The experiments were performed with ^{24}Mg , ^{28}Si , ^{32}S , ^{36}Ar , and ^{40}Ca as target nuclei, and virtually all of the 2s-1d shell hole strength was observed. Deuteron angular distributions for strongly excited levels in ^{23}Mg , ^{28}Si , ^{31}S , ^{35}Ar , and ^{39}Ca were measured for laboratory angles from 10° to 155° , and spectroscopic factors were obtained using DWBA calculations. The J-dependence for the pickup of an $\ell_n = 2$ neutron appears mostly in the forward angles of the angular distributions and seems to follow systematic trends through the 2s-1d shell, thus suggesting spin assignments for levels in ^{31}S , ^{35}Ar , and ^{39}Ca . Appreciable configuration mixing is found to exist in the ground state wave functions of all the nuclei investigated. Of particular interest are the $\ell_n = 1$ levels excited in the $^{24}\text{Mg}(p,d)^{23}\text{Mg}$ and $^{28}\text{Si}(p,d)^{27}\text{Si}$ reactions, which could arise

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from the removal of either 1p or 2p shell neutrons. The ground states of ^{36}Ar and ^{40}Ca are observed to contain appreciable mixing with the $f_{7/2}$ shell, and evidence exists for a small $[2p]^2$ admixture in the ^{40}Ca ground state. The level orders of the residual nuclei and the DWBA spectroscopic factors are discussed in terms of the strong coupling rotational model and Nilsson model wave functions. Evidence for strong rotational band mixing is apparent in many cases.

Submitted to the Annals of Physics, June 1968

Orbit Properties of the
Isochronous Cyclotron Ring with Radial Sectors*

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ABSTRACT

The isochronous cyclotron considered here consists of a ring of radial magnet sectors separated by straight sections. The general features of such cyclotrons are discussed, and a complete analysis is presented of their orbit properties using the hard-edge approximation. This analysis proceeds through the transfer matrix technique, which is simplified by the symmetry of the magnet structure; the only complication arises from the inconsistency of the magnetic field index resulting from the isochronism condition. Computed orbit properties are presented and discussed for a wide variety of possible geometries; these properties include the extreme values of the beam widths, as well as the focusing frequencies, as a function of the energy. Problems associated with certain resonances are also considered. The results indicate that isochronous cyclotrons of this type should be quite capable of producing proton beams at energies up to about 500 MeV.

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Submitted to Nuclear Instruments and Methods, March 1968

REMOTE CONTROLLED SLITS FOR THE MSU CYCLOTRON
EXTERNAL BEAM SYSTEM*

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Abstract: Circuitry and mechanical design are described for the remotely-operated water-cooled slit jaws on the MSU Cyclotron external beam line. The displacement of the slit jaw from the center of the beam line is automatically set to the reading of the fifteen-turn Helipot on the console of the cyclotron. The setting accuracy and reproducibility is ± 0.05 mm.

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Submitted to the Fall Joint Computer Conference, May 1968

JANUS: A Flexible Approach to Realtime Timesharing*

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ABSTRACT

JANUS is an operating system developed for the SDS Sigma-7 Computer at Michigan State University Cyclotron Laboratory. It was designed to permit random start/stop operation of an open-ended set of realtime processes. To implement this, a time-sharing vehicle was constructed, which also permits extensive background computation between interrupts. By making the system extremely modular, it is possible to operate with a 3k-word resident and to timeshare "monitors" created from a library of mastermode routines. An important by-product of the swap optimization is an automatic segmenting algorithm permitting problem-solving programs of up to 128k-words to be run without modification in a much smaller memory.

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High Resolution Gamma-Ray Spectroscopic Studies of
The Decays of 2.6-Hour Nd^{141g} and 60-Second Nd^{141m}

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ABSTRACT

Gamma rays emitted in the decays of 2.6-Hour Nd^{141g} and 60-Second Nd^{141m} have been investigated with Ge(Li) and NaI(Tl) detectors. Following the decay of Nd^{141g} gamma-rays with the following energies (and relative intensities) have been observed: 145.4 (30.0), 981.3 (3.0), 1126.8 (≈ 100), 1147.1 (38.2), 1292.8 (61.2), 1298.7 (16.3), 1434.6 (3.0), 1579.9 (0.74), 1607.9 (2.3), and 1657.2 keV (0.12). On the basis of coincidence and anticoincidence experiments, energy sums, and relative intensities, states were placed in Pr^{141} at 0, 145.4, 1126.8, 1292.5, 1298.4, 1580.0, 1607.9, and 1657.2 keV. An upper limit of 0.1% of the intensity of the Nd^{141m} 756.5-keV isomeric transition gamma-ray was placed on the intensity of any other gamma-ray between 130 and 2600 keV following direct transitions from the $11/2\text{-Nd}^{141m}$ to high spin states of Pr^{141} . Limits are placed on the spins of Pr^{141} states on the basis of $\log ft$ values and relative photon intensities, and the structures of the states are discussed in terms of current nuclear models.

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Submitted to IEEE Transactions, April 1968

Use of a Sigma-7 Computer in a Nuclear
Physics Laboratory*

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ABSTRACT: Advanced features of the Scientific Data Systems Sigma-7 Computer are being used at the Michigan State University Cyclotron Laboratory to permit large scale off-line computations such as distorted wave Born approximation and large on-line jobs such as 16,000 channel pulse height analysis. Time sharing of on-line and off-line programs is also possible.

*Supported by the National Science Foundation.

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Precise Energies of ^{40}Ca Levels*

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ABSTRACT

Energies of excited levels of ^{40}Ca have been measured with high precision using a Ge(Li) detector to observe γ -ray transitions. The present work, which resolves some discrepancies in the literature, yields $E_x = 3737.1 \pm 0.3$ keV for the lowest 3^- level and $E_x = 7658.9 \pm 0.5$ keV for the ^{40}Ca $T = 1$ analog of the ^{40}Sc ground state. Energies of a number of other levels of ^{40}Ca are also given.

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Spectral Averages in Transfer Reactions Involving
Targets with Single Active Shell

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ABSTRACT

We have presented the equations relating the energies of the spectroscopic-weighted averages of the spectra obtained in Equivalent Nucleon Transfer Reactions involving single-active-shell targets containing only neutrons in their active shell. For the sake of completeness we have also given the results for the case of Inequivalent Transfer; in this latter case there is no restriction on the neutron-proton composition of the target state.

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$^{203}\text{Pb}^m$ Decay and M4 Transition Probabilities
in Neutron-Deficient Lead Isotopes

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ABSTRACT

The decay of 6.1-sec $^{203}\text{Pb}^m$ has been examined with a high-resolution Ge(Li) spectrometer, and a 5.1-keV M2 transition was found to compete with the 825.2-keV M4 isomeric transition. The M4 transition probability, thus corrected, is now found to be consistent with those of the other M4's in the lead region.

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The States of ^{117}Sn

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Abstract: Gamma-rays emitted in the decay of 2.8-h ^{117}Sb have been investigated with 2.5 to 45 cm^3 Ge(Li) detectors. Gamma-rays of energies (and relative intensities) 158.5 (99.1), 553.1 (0.07), 846.2 (0.04), 861.7 (0.29), 1004.5 (0.22), 1020.6 (0.09), 1021.0 (0.10), 1287.6 (0.026), 1339.5 (0.009), 1420.1 (0.016), 1446.4 (0.051) and 1578.0 (0.018) keV have been observed. On the basis of energy sums, relative intensities and two-dimensional Ge(Li)-Ge(Li) coincidence experiments, excited states are placed at 0 ($1/2^+$), 158.5 ($3/2^+$), 711.7 ($7/2^+$), 1004.5 ($3/2^+$), 1020.2 ($5/2^+$), 1179 ($5/2^+$), 1446.4 ($3/2, 5/2^+$), 1498.0 ($5/2, 3/2^+$) and 1578.3 keV ($5/2, 3/2^+$). The spin assignments and limits have been made on the basis of log ft values and relative photon intensities from ^{117}Sb decay, aided in some cases by ^{117}In decay, and also from information gleaned from nuclear reactions data. The structures of the states are discussed in terms of current nuclear models, and the behaviour of these states is followed as a function of neutron number.

RADIOACTIVITY: ^{117}Sb [from $^{117}\text{Sn}(p,n)$ and $^{115}\text{In}(\alpha,2n)$] and ^{117}In [from $^{116}\text{Cd}(n,\gamma)$]; enriched Sn and Natural In and Cd targets; Ge(Li) detectors; measured E_γ , I_γ , $\gamma\gamma$ -coin; ^{117}Sn deduced levels, J, π .

E

M2 Isomerism in ^{83}Rb and High Resolution Spectroscopic
Investigations of the Decay of ^{83}Sr

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Abstract: The photon spectrum accompanying the electron capture decay of ^{83}Sr has been studied with a high resolution Ge(Li) spectrometer in singles and coincidence configurations. The positron and internal conversion electron spectra were investigated with the MSU "orange" and $\pi\sqrt{2}$ iron free electron spectrometers. Sixty transitions were identified. Excited states have been placed

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in ^{83}Rb at 5.0, 42.3, 295.2, 389.2, 423.5, 736.8, 804.8, 994.2, 1043.7, 1053.7, 1103.0, 1202.0, 1242.6, 1273.1, 1324.6, 1653.1, 1756.9, 1783.5, 1916.7, 1952.2, 2014.8, 2090.0, 2147.8, and 2179.3 keV. Internal conversion coefficients, log ft, and gamma ray branching have been used to place limits upon the spins and parities of the excited states. An isomeric M2 transition has been identified at 42.3 keV. The ground state spin and parity of ^{83}Sr have been shown to be $7/2^+$ which are the same as for all other known 45 neutron nuclei.

The Spin-Isospin Dependent Interaction from Inelastic
Proton Scattering on ${}^6\text{Li}^*$

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ABSTRACT

The differential cross-section for the inelastic scattering of protons leading to the ($J^\pi = 0^+$, $T = 1$) state of ${}^6\text{Li}$ at 3.56 MeV has been measured at $E_p = 24.4$ MeV. A real spin-isospin dependent interaction with a Yukawa shape, a strength of 12.7 MeV and a range of 1.0 fm fits the data well at small angles.

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IV. PhD Theses Completed

- (1) Lorenz A. Kull - "An Investigation of (p,d) Reaction in lp Shell Nuclei"
- (2) Raymond L. Kozub - "An Investigation of the (p,d) Reaction on $N = Z$ Nuclei in the 2s-1d Shell"
- (3) Robert C. Etherton - "Conversion-electron and gamma-ray experiments with the Decay of Bromine-82 and Strontium-83"

V. List of Personnel

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