SECTION II
ABSTRACTS AND/OR TITLES OF TALKS AT
AMERICAN PHYSICAL SOCIETY MEETINGS
AND
OTHER MEETINGS AND CONFERENCES
(JULY 1, 1982 TO JUNE 30, 1983)

Comparison of $4\pi$ Strengths Extracted from Møller Data with the Analogous Values from Gamow-Teller Data. B. A. Brown and B. N. WILDENHALL, Mich. State U. - Measured values of the isovector magnetic dipole moments and transition strengths in $\alpha$-particle models have been analyzed with shell-model wave functions. The results of these $4\pi$-based calculations are compared with those of the Shell-Mmodel calculations in the 30-200 MeV range. The agreement is found to be good.

[Supported by NSF grant PHY-80-17605]

Inelastic Electron Scattering and $\alpha$ + $\pi$ Transitions in $^{15}$Mg. B. A. Brown and B. N. WILDENHALL, Mich. State U. - The strong $4\pi$ transition between the ground state and the second $2^+$ state in $^{15}$Mg might constitute a practical case with which to study the momentum transfer dependence of spin excitation and the influence of excitation modes not explicitly considered in the conventional (neutrons, protons, $\alpha$, $\pi$, $\mu$) description of the $\pi$ giant resonance. We find that the best available shell-model wave function accounts for the observed $\pi$ data involving $\alpha$ + $\pi$ transitions in $^{16}$O with only $\pi$ accuracy. These wave functions yield quite different shapes for the second $2^+$ state in the lowest $\pi$ states of $^{15}$Mg. Hence, deviations from single-particle form factors are not significant evidence for unconventional excitation mechanisms.

[Supported by NSF grant PHY-80-17605]

Measurements of Gamow-Teller Strength for Double-$\Delta$ Decay of Neutrons in the $^{60}$Ni($^{14}$N,$^{14}$C) Reaction at 15 MeV. J. C. O'FLYNN, M. J. ACKERMAN, G. C. REYNOLDS, G. H. AUGUSTINE, R. A. BURBANK, B. N. WILDENHALL, Mich. State U. - Measurements of the lifetimes of the one- and two-neutron states in $^{60}$Ni have been made using the two-nucleon transfer reaction $^{60}$Ni($^{14}$N,$^{14}$C) at 15 MeV. The lifetime of the $2^-$ state at 307 keV was found to be 7.0 ns.

[Supported by NSF grant PHY-80-17605]

Probing the Nuclear Stratosphere, with Sub-Coulomb Heavy Ion Elastic Scattering. G. W. LINCH and W. J. LACRO, M.I.T. - Scattering of $^{40}$Ar ions at energies of 1.5 MeV$/\text{amu}$ by $^{12}$C, $^{16}$O, and $^{40}$Ar projectiles on the target nucleus $^{12}$C have been used to probe the heavy ion optical potential at distances greater than 15 fm. The influence of the imaginary potential in these sub-Coulomb energies is observed to be small and the onset of nuclear potential scattering is observed to be insensitive to the shape of the real part of the optical potential at large radii. The data will be compared to calculations using optical model potentials obtained by folding model techniques. Possible complications arising from dynamically induced nuclear deformations will be discussed.

[Work supported in part by the NSF.]

Energy and Angle Dependence of Fusion Fragments from the Reaction of $^{16}$O + $^{18}$O at 200 MeV. J. J. CRANK, H. W. L. RICHTER, M. I. STARK, and J. B. HILDEBRAND. Universiteit van Amsterdam, Nijmegen, The Netherlands. - The energy and angle dependence of fusion fragments from the $^{16}$O + $^{18}$O reaction at 200 MeV has been measured with the Cambridge tandem and with the 2 m magnetic spectrometer at the Argonne National Laboratory. The angular dependence is found to be highly peaked at forward angles. The energy dependence is also strongly forward peaked. The angular and energy dependences of the fusion fragments are similar to those of the Coulomb contribution to the fusion process.

[Supported in part by the NSF.]

Excitation of $\pi^+$, $\Delta^-$, and $\Delta^+$ Resonances at 200 MeV. J. M. BONNELL, J. M. BONNER, G. C. REYNOLDS, G. H. AUGUSTINE, R. A. BURBANK, B. N. WILDENHALL, Mich. State U. - Measurements of the lifetimes of the one-neutron states in $^{60}$Ni have been made using the two-neutron transfer reaction $^{60}$Ni($^{14}$N,$^{14}$C) at 15 MeV. The lifetime of the $2^-$ state at 307 keV was found to be 7.0 ns.

[Supported by NSF Grant PHY 80-17605 and INT-8111097]

Composite Fragment Production in Intermediate Energy Heavy Ion Reactions.** B. V. JECAS, T. K. DIXON, C. H. HAMMOCK, M. C. SYMONDS, and T. A. SCOTT. National Superconducting Cyclotron Laboratory, M.S., and R. M. WILDETHAL, M.S., Nuclear Science Division, Argonne National Laboratory. Inclusive production cross-sections of isotopes of hydrogen, helium, lithium, beryllium, and boron have been measured for reactions of 50, 100, and 150 MeV/nucleon argon from the 184W beam with gold and calcium targets. The differential cross sections were measured using three solid state detector telescopes and are fitted with a moving source model to extract temperatures, source velocities and total cross sections in the intermediate rapidity region. The results are compared with values for light charged particles produced at bombarding energies from 2 to 100 MeV/nucleon. The temperature was found to drop dramatically with increasing projectile energy, while the d/p and t/p ratios remained nearly constant. The ratio of heavier nuclei to protons are added to investigate production of composites as a function of composite mass.

**National Science Foundation Grant No. Phy 80-17605.


Samou-Teller Lifetime Predictions for IC and H* M. S. CORBET, E. M. WILDETHAL, and B. A. HAMMOCK. National Superconducting Cyclotron Laboratory, M.S. The nuclear shell model was used to calculate the properties of light exotic nuclei, with particular interest focusing on lifetime predictions for such nuclei. Starting with the effective Hamiltonian of Rehfeld and Wildethal, which spans the model space (Op, Q^2, 0d, Lz), two necessary assumptions were made: (1) the generator of the parent-daughter combinations (1/2^+, 1/2^+), (3/2^-, 3/2^-), and (5/2^+, 5/2^+) in the Samou-Teller matrix elements were then computed and used to obtain the theoretical fi^A values for specific fi transitions. The prescription of Wilkinson and Wildethal was used to calculate the statistical factors and the associated partial half-lives. It was found that 13C has three candidates for its ground state, all lying within 570 keV of each other (3/2^+, 1/2^+, 5/2^-). Lifetime predictions varied depending upon which state was used as the ground state. Study of these nuclei is continuing.

**National Science Foundation Grant Phg 80-17605.

The NSCL-K-800 Magnet Spectrometer. A. ZELLER, J. A. NOLDA, K. BIRCHNO, C. H. HAMMOCK, and R. BLOßER. National Superconducting Cyclotron Laboratory. A progress report on the design and construction of large (K-800) magnet spectrometers. The magnet design of the NSCL phase II will be given. The optical design has been finalized by using the ray tracing program MOTHER. It is a vertical quadrant layout with a solid angle 20 msr, energy resolution 10s (800 MeV for 8 GeV **Ca beams), a calculated angular resolution S/Δα = 10,000, and angular resolution of 1°. Dispersion matching and kinematics effects are included in the ray tracing calculations. The magnetic components will utilize superconducting coils but will operate with iron dominated magnetic field on the outer coils, resulting cost will be significantly less, both initially and in operation, than if conventional copper coils were utilized. The mechanical problems associated with the construction of the superconducting dipole, including the coil bobbins and bobbin supports will be discussed. The dipole will also feature unique tapered gaps behind the pole tips and field shaping trim coils in the gap.

U.S. DOE Contract DE-AC02-80ER40579.

Liquid Gas Phase Instability in Nuclear Systems. N. M. KRISTENSON. The architecture of the liquid gas phase instability in nuclear systems. The phase diagram of a model system involving heavy ion induced reactions yielding temperatures less than 20 MeV differ markedly from similar data at higher temperatures with regard to the cross section for a production. The single phase gas model predicts the mass distribution resulting from the decay of an intermediate rapidity source for 240 MeV/sym. Such modifications of the source are due to temperature effects. Enhanced a production could originate from a liquid-gas instability but it is also possible to modify the single phase gas model to reproduce the light ion cross sections by inclusion of binding energy effects of the a particle. Entropy considerations lead to a strong attenuation of heavier fragments. Questions arise regarding the possibility of preformation of particles, due to a clustering in the particles of a cluster model, which survives the collision and enhances the a cross section. Both considerations indicate that measurements of larger fragment masses are necessary to study the influence of the liquid-gas phase instability. The predicted consequences of which may be relevant to phase instabilities conjectured to occur at higher densities.

**National Science Foundation Grant PHY-80-17605.

A Mass Separator for Heavy Ions of 20 MeV/A and above. E. GÖRÖGHÁZY, S. BRICKER, M. S. CORBET, C. H. HAMMOCK, and J. A. NOLDA. National Superconducting Cyclotron Laboratory. A reaction-product mass separator (RPS) has been designed and constructed for use at the NSCL. It is primarily intended to directly separate (by a/m) the products of heavy ion fragmentation reactions, which will normally be at energies per nucleon from 100 to 1000 MeV. The mass-separated secondary beam can also be produced by the new 3.6 MeV source on the solid angle of 1 msr, an energy acceptance range of about 1/3 of the resolving power (a/m) of about 200, and can be positioned at scattering angles of 0° to 10°. The optical configuration is QWQDQ, where Q represents a 3.5 m long Wien filter previously used as a monochromator for the LBL Betatron, and the quadrupoles and magnetic dipole were also existing devices. Optical properties of the RPS, i.e., mass line shapes, band pass, etc., have been calculated using the ray tracing program TRACER and MOTHER.

U.S. DOE Contract DE-AC02-80ER10579.
Measurement of Half-Lives of Exotic Nuclei Produced in Fragmentation Reactions, L. E. HARTWOOD and D. P. WESTFALL, National Superconducting Cyclotron Laboratory, MSU, M. J. WILDENTHAL and T. D. BELL, Lawrence Berkeley Laboratory. A 300 MeV "Be beam impinging on a 1 g/cm² target was used to produce exotic neutron-rich nuclei. A 10 MeV slow neutron spectrometer analyzed the nuclei, the mass and charge of each fragment nucleus was determined with an eight-element, position-sensitive counter telescope. When a nucleus stopped in the telescope, the beam was cycled, and 8 decays were monitored. Elements ranging from Na to Ar were observed. Excluded half-lives will be presented.

National Science Foundation Grant No. Phy 80-17605.

Is the "Shell Closure" at Z=66 (A=82) Pseudo-Gapffectively? HANS G. W. KRUSE and K. E. WILDENTHAL, Michigan State U. We have performed shell-model calculations for the W=82 nucleus from 252 to 266 with a single model basis space and an empirically derived Hamiltonian. The observed energy level spectra are in general well described up to excitation energies of about 2 MeV in off-shell systems, and up to about 3 MeV in even-even systems. High-spin states at higher excitation energies are also well produced. The principal systematic discrepancy between theory and experiment is the inability to lower the energies of the first occurring 3 states to their observed values. The calculated spectrum for 133Cd as well as the spectra for 133Eu, 133Th, and 133Dy all agree well with the respective experimental spectra. The high spin ground state as well as the excited states of 133Cd contain 4p-3h orbits of particle-hole excitations. A similar situation is expected for the other nuclei and states of the nucleus.

Supported by NSF grant no. PHY-80-17605.

A Universal Hamiltonian for Calculations in Complete (sd) Spaces, B. H. WILDENTHAL, Michigan State U. We have performed one-body plus two-body Hamiltonians for use in complete (sd) spaces. A new interaction region has been empirically formulated which has a good accounting of the intra- and shell energy level schemes for the sd region throughout the sd region. The essential difference between this new formulation and previous empirical 0d-shell effective interactions is that the two-body matrix elements incorporate a dependence in the form of a simple, uniform (1/R) dependence on the distance between the two nucleons. This feature has made it possible to construct a form that is dominantly dominated by d and s, and to construct a structure into the 1s-0d part. The new interaction appears, upon preliminary inspection, to preserve the best features of the earlier mass-independent empirical Hamiltonians and to eliminate many of their systematic residual deficiencies.

Supported by NSF grant PHY-80-17605.


Study of Higher Isospin Components of Gamow-Teller Strength in (np,α) Reactions, W. ANANTARAMAN, S. M. AUSTIN, G. M. CRAWLEY, A. H. BALDWIN, C. LEBE, R. HADDE, and J. W. WATSON, Kent State U., and C. C. FOSTER, Indiana U. We report results of an experiment to locate the (T=1), T and (T=0) components of the Gamow-Teller strength in (np,α) via the (np,α) reaction at a proton energy of 134 MeV. The experiments are interpreted in terms of (np,α) time-of-flight spectra of the Indiana University Cyclotron Facility with a flight path of 88 m and a resolution of ~0.05 MeV. All three isospin components for 83Cu and the (T=0) and (T=1) components for 83Cu were observed, with characteristic forward-peaked angular distributions. The identification of higher-lying T and (T=0) components was based upon detection of proton energies, which corresponded to the values expected from locations of their parent states seen in (p,n) measurements. A comparison of the relative intensities between the various components in both the (p,n) and (p,α) studies will be presented.

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American Physical Society Anmerat Meeting, October 1982 (Cont)

Inelastic Electron Scattering and $\gamma - $ to $\gamma$ transitions in $^{24}$Mg. R.A. BROEN and B.H. WILDERTHAL, Mich. State U.-The strong M1 transitions between the ground state and the second J$^+$ = 1 excited state in $^{24}$Mg might constitute a practical case with which to study the momentum transfer dependence of spin excitation and the influence of excitation modes not explicitly considered in the conventional (neutrons, protons, $\alpha$ = 0, $\alpha$ = 2) description of the M1 giant resonance. We find that the best available shell-model wave functions account for all the $\gamma - 0$ data involving $0^+ - 1$ transitions in $A = 24$ with good accuracy. These wave functions yield quite different shapes for the form factors of the lowest several $J^+$ states of $^{24}$Mg. Hence, deviations from single-particle form factors are not significant evidence for unconventional excitation mechanisms. In addition, the contributions of neighboring levels of higher spin are predicted to yield cross sections at larger momentum transfer which are comparable to those of the M1 excitation.

Supported by NSF grant PHY-80-17605.


Entry Line Measurements in Residues from $^{19}$O to $^{19}$Cl Fusion** E.L. S. REMINGTON, A. GALUSSKY, L. F. A. HASS, and J. KASAGI, MIP, State Univ.** F. P. FRASER, Univ. of Kansas I. P. DOELING, Jr., J. A. KOCH, R. RACISE, and L. GALUSSKY, Univ. of Notre Dame** -A series of experiments in heavy ion beam reactions at Notre Dame to locate the entry lines in the residues from the fusion of $^{19}$O with $^{17}$O at energy 100 MeV from 0$^+$ to 25 MeV. We report here on the spectra of neutrons emitted in reaching certain of these residues. Neutron detectors were placed at 0° and at five other angles, and a Ge(Li) detector was located at 120° to the 0° beam. Neutron-gamma ray coincident events were recorded on magnetic tape. The events were sorted to produce neutron time-of-flight spectra in coincidence with y-rays from known transitions in the residues. In the nuclei $^{20}$Al, $^{20}$Mg, and $^{20}$Ne there were nine such transitions in total. Measurement of the charged particle spectra leading to these nuclei is underway. Both neutron and charged particle data are needed to define the entrance energies.

*Support by grants from the NSF.

American Physical Society Baltimore Meeting, April 1983.

Nuclear Physics and the Solar Neutrino Problem**, SAM H. AUSTIN, Michigan State University, East Lansing, MI.-The solar neutrino problem is still with us. The observed flux of solar neutrinos is substantially smaller than that predicted by standard models of the sun and of neutrino propagation. Both the strength of the neutrino source in the sun and the efficiency of the neutrino detectors on the earth depend on the detailed properties of specific nuclear reactions and structure. One must then be confident the nuclear physics is understood before introducing more exotic explanatory mechanisms such as neutrino oscillations and strong time-dependent changes in solar activity. It also happens that nuclear studies are involved in the new experimental approaches aimed at pinpointing more precisely the cause of the solar neutrino discrepancy. The status of these nuclear (1) recent studies of nuclear reactions active in the sun and the net effect they produce on the predicted solar neutrino production rate, (2) measurements, via (p,n) reactions, of the matrix elements determining the efficiency of proposed solar neutrino detectors (e.g. $^{8}$B, $^{33}$Cl, $^{37}$Ar), and (3) measurements of nuclear matrix elements necessary for determination of neutrino masses and neutrinoless double beta decay.

*Research supported in part by NSF Grant No. PHY80-17605-05.

Single and Two Particle Inclusive Measurements of Non-Compound Light Particle Emission in Nucleus-Nucleus Collisions. W. LYNCH, Michigan State University, East Lansing, M1. - The attainment of statistical equilibrium is an important concept for intermediate energy nucleus-nucleus collisions. The systematic trends of the energy spectra and multiplicities obtained in one particle inclusive measurements over the incident energy range of E/A = 10-2000 MeV offer considerable support to theoretical models which incorporate statistical equilibrium as a central assumption. These thermal descriptions require that local thermal equilibrium is obtained within a subset of nucleons, an assumption which is a central ingredient of many current reaction theories. The interpretation of nucleon and composite particle inclusive spectra in terms of statistical equilibrium is not unique and other calculations employing quite different assumptions have been used to describe the singles data. More stringent tests of the assumptions of statistical emission can be provided by two particle inclusive data which test the generation of the observed correlations with calculations using both statistical and non-statistical calculations including final state interactions as the particles leave the statistical emission. Measurements of nucleon-nucleon correlations at small relative angles are sensitive to the special and unique fields and information about the number of nucleon participating in the emission process can be used to search for the correlations resulting from direct knockout reactions collective flow effects or from shadowing effects due to the surrounding cold nuclear matter.

Microscopic Calculations for the IBK Model Using the Generalized Seniority Scheme. K. SCHOTTER, KEK, High Energy Phys. - It was proposed by Otsuba et al. that there exists a direct relation between the generalized seniority scheme and the Interacting Boson Model. Using this relation it has been possible to calculate the microscopic structure of the bosons as a function of the number of nucleons from a calculation in the generalized seniority scheme. The IBK model parameters and can now be easily calculated. Furthermore, predictions can be made for g-factors and transition densities. Using the microscopic structure of the bosons also the concept of an effective number of bosons can be introduced.

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American Physical Society Baltimore Meeting, April 1983 (Cont.)

Man Asymmetry and Angular Momentum Alligations*, B.J. MORRISSET, Michigan State Univ., J.H. MOCKLER, L.G. SOBOJEK, B.J. PACHECO, J.J. MCCONALO and L.G. MORETTO, LBL, BERKELEY, CA—Projectile fragmentation and reaction coincidence events were obtained from the reaction of 340 MeV Ca on U at 16° and 90° at the LBL Super HILAC. The average values and functions of the angular momenta of the target-like products were determined by fitting the fission fragment angular distributions as a function of Q value (uranium only) and as a function of projectile fragment Q. The results show an increase in the inplane fission fragment angular anisotropy as the reaction fragments become more symmetric. This behavior is exactly opposite from that expected for statistical equilibrium among the degrees of freedom of two tangent spheres.

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Resonance-like Structures in heavy-ion collisions and the quasi-free scattering model, N. Krasznahorkay, J. TOPI, C.O. SCOTT, Michigan State Univ.—The recent experiments of Fura* at GSI have shown resonance-like structures in the energy spectra of outgoing projectile-like heavy nuclei produced in "Ca on "Ca at reactions at 264 MeV and 400 MeV, and at 4°C on "Ca at 950 MeV. These structures have been attributed to giant resonances at excitations of 200 MeV. We have developed an alternative interpretation in terms of quasi-free scattering of incoming heavy-ions with light particle clusters in the target. We obtain narrow bumps at the excitation energies, which correspond to the experimental observations after taking into account the Fermi motion of the light clusters in the target. We also discuss the incoming energy and as the scattering angle dependence of the quasi-free bumps within the model.

*Supported by NSF Grant No. PHY80-17605-05.

Relative Cross Sections for (p, 2p) Reactions Calculated with the "Hidden" Wave Functions: B.A. BROW, H. TOY, and W. SCHOLTEN, LBL. We have recently the (p, 2p) reaction on "Ca has been found to lead to many previously unknown states in "Ti which are presumably of high spin. We have calculated the relative cross sections for this reaction within the (p, 2p) shell model space with the various assumptions about the reaction mechanism. We also investigated the angular and Z dependence for this reaction expected within the (p, 2p) model and find for the total cross section 2F(2F) (2F) where F and 2 are for the target nuclei.

*Supported by NSF grant PHY-80-17605.


The W-32 isotones in the Generalized Seniority Scheme, D. SCHWARTZ and HANS D.W. KRUSE, UIC. WECC, State U.—A shell model calculation is compared in a calculation in a general shell model basis for the W-32 nuclei.

The shell model interaction is calculated in order to give the best reproduction of the energy and reaction data for ground states.

The calculation in the much more restricted (single interacting pair bases) compared to the shell model) generalized seniority basis shows a rather good reproduction of the reaction energies of the lower levels. Also electromagnetic properties will be compared.

*Supported by NSF grant PHY-80-17605.

Isotopic M. Transition Strength from the "(p, 2p) Reactions at T=1 300 MeV, N.J. DEVITO, C.C. POSTER, and C.D. GOODMAN, Indiana University, T.R. TADDEUCCI, Ohio University, SAM M. AUSTIN and ARAO GALONUKI, Michigan State University, U.C.P. BERG, jacket-Loma University—Differential cross sections have been measured for the reaction "(p, 2p) at 120 MeV covering the angular range 0-180°. Excitation to the isobaric analog of the lowest 1- T=1 state in "Ne is observed. This state exhibits a constructive interference of spin and orbital recoiling transition amplitudes. Additional T=1 and T=0 states are observed around 5.6 MeV excitation with spin and orbital reconciliation strength detected by the "(Ne, e'') measurement. These results are consistent with the constructive interference of the "Ne ion and the "Ne recoil transition in the 12C+12C collision.

"(Ne, e') measurement will be presented.

*Supported in part by the NSF.

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Design of the NSCL coupling Line*, D.H. Harouden, J.A. Wolk, Jr., R. Resmini, and M.C. Gullicks*, Mich. State U. - The design of the beamline to transfer the extracted beam from the NSCL kaon superconducting cyclotron to injection into the K500 superconducting cyclotron will be presented. This line is isochronous and has an intermediate anomalous double waist to facilitate tuning. The optics conceptual design will be presented as well as details of magnet design; all magnetic elements will be superconducting. RF pulse selectors and bunchers are included in the design. Planned optics diagnostic beams will be described.

Work supported by NSF grant #MF50-1705 and DOE grant #DEAC-02-80-ER-13579.

Three Phase R.F. Systems for Superconducting Cyclotrons, J. Riedel, Mich. State U. - The design of the RF system for NSCL's K500 superconducting cyclotron RF system was published in 1983. This paper will detail the significant modifications that had to be made to that design in order to achieve a reliable RF system that now works quite well. Of particular interest will be the problems associated with the use of the coupling capacitors and the 75 amp / cm moving short current density.
