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AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

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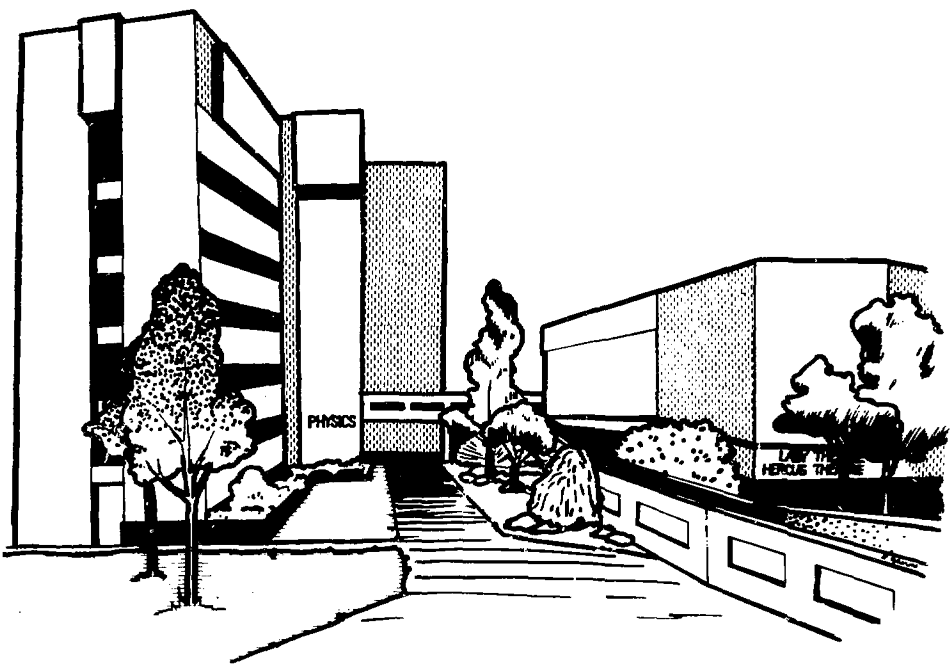
11th AINSE NUCLEAR PHYSICS CONFERENCE

3rd - 5th FEBRUARY 1986

School of Physics - Laby Theatre
UNIVERSITY OF MELBOURNE



CONFERENCE HANDBOOK

(Programme, Abstracts and General Information)

AUSTRALIAN INSTITUTE OF NUCLEAR SCIENCE AND ENGINEERING

11TH AINSE NUCLEAR PHYSICS CONFERENCE 1986

UNIVERSITY OF MELBOURNE

LABY THEATRE

Monday 3rd February, 1986

Sessions commence	10.15 a.m.
- conclude	6.00 p.m.
Conference Dinner - Pre-Dinner (Laby Foyer)	5.30-6.00 p.m.
- Buffet - Janet Clarke Hall Common Room	6.15 p.m.

Tuesday 4th February, 1986

Sessions commence	9.00 a.m.
- conclude	5.00 p.m.
Public Lecture - Laby Theatre	8.00 p.m.
"The Impact of Sixty Years of Quantum Mechanics"	

Wednesday 5th February, 1986

Sessions commence	9.00 a.m.
- conclude	4.10 p.m.

Conference President

Professor B.M. Spicer — University of Melbourne

Conference Committee

Prof. B.M. Spicer	University of Melbourne
Dr. J.W. Boldeman	Australian Atomic Energy Commission
Prof. H.H. Bolotin	University of Melbourne
Dr. T.R. Ophel	Australian National University
Assoc. Prof. L.S. Peak	University of Sydney
Dr. L.J. Tassie	Australian National University
Dr. D.D. Cohen	AINSE
Mr. E.A. Palmer	AINSE

Conference Secretary

Mrs. Joan Watson — AINSE

C O N T E N T S

SUMMARY

Monday 3rd February, 1986 -	University of Melbourne
OPENING REMARKS	Professor B.M. Spicer (Uni. of Melbourne)
10.15 - 10.20	Conference President
SESSION I (Laby Theatre)	Chairman: Dr. E.G. Muirhead (Uni. of Melbourne)
10.20 - 12.20	
12.20 - 1.20	Lunch
SESSION II	Chairman: Prof.Sir Ernest Titterton (ANU)
1.20 - 3.00	
3.00 - 3.20	Afternoon Tea
SESSION III	Chairman: Prof. A.W. Thomas (Uni. of Adelaide)
3.20 - 5.00	
SESSION IV	POSTER SESSION A. Foyer - Laby Theatre
5.00 - 6.00	
CONFERENCE DINNER	
6.15 p.m.	Janet Clarke Hall Common Room
Tuesday 4th February, 1986	
SESSION V	Chairman: Dr. L.J. Tassie (ANU)
9.00 - 10.20	
10.20 - 10.40	Morning Tea
SESSION VI	Chairman: Prof. R. Delbourgo (Uni. of Tasmania)
10.40 - 12.20	
12.20 - 1.20	Lunch
SESSION VII	POSTER SESSION B. Foyer - Laby Theatre
1.20 - 2.00	
SESSION VIII	Chairman: Dr. J.K. Parry (AAEC)
2.00 - 3.00	
3.00 - 3.20	Afternoon Tea
SESSION IX	Chairman: Prof. C.A. Ramm (Uni. of Melbourne)
3.20 - 5.00	
PUBLIC LECTURE	Laby Theatre
8.00 p.m.	"The Impact of Sixty Years of Quantum Mechanics"
	Professor G.I. Opat - University of Melbourne
Wednesday 5th February, 1986	
SESSION X	Chairman: Dr. T.R. Ophel (ANU)
9.00 - 10.20	
10.20 - 10.40	Morning Tea
SESSION XI	Chairman: Prof.A.R. Poletti (Uni. of Auckland)
10.40 - 12.20	
12.20 - 1.00	Lunch
SESSION XII	Chairman: Professor S. Hinds (ANU)
1.00 - 2.40	
2.40 - 3.00	Afternoon Tea
SESSION XIII	Chairman: Prof.B.M. Spicer (Uni. of Melbourne)
3.00 - 4.00	
CLOSING DISCUSSIONS	Professor B.M. Spicer
4.00 - 4.10	Conference President

CONFERENCE SESSIONS

MONDAY 3RD FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
10.15 - 10.20		Opening Remarks - Prof.B.M. Spicer (Uni.of Melb.) Conference President.
SESSION I (Laby Theatre)		Chairman: Dr.E.G. Muirhead (Uni. of Melbourne).
10.20 - 11.00	1R Review	Magnetic Moments of Short-lived Excited Nuclear States. H.H. Bolotin (Uni. of Melbourne).
11.00 - 11.20	2	Hadron Models from QCD. C.D. Roberts, R.T. Cahill. (Flinders Uni.).
11.20 - 11.40	3	Microscopic Optical Potentials for Nucleon and Nucleus Scattering. L. Rikus (ANU).
11.40 - 12.00	4	Angular Distributions in the Maximum Alpha Yield for $^{18}O(p,\alpha_o)^{15}N$ Reaction at 846 keV. D.D. Cohen, A. Katsaros (AINSE), S. Frisken, (UNSW).
12.00 - 12.20	5	A Chiral Soliton Model of the Nucleon and Delta. M. Araki. (Flinders Uni.).
12.20 - 1.20		L U N C H
SESSION II		Chairman: Prof. Sir Ernest Titterton (ANU)
1.20 - 2.00	6R Review	Transport Theory for Nuclear Systems. M.K. Weigel (Uni. of Munich).
2.00 - 2.20	7	Inelastic Scattering to Unnatural Parity States in Light Nuclei using Elementary Probes. L. Berge, K. Amos. (Uni. of Melbourne).
2.20 - 2.40	8	How Good is the N=20 Shell Closure when Z<<N? II. Masses and Levels of ^{34}Si and ^{35}P. C.L. Woods, L.K. Fifield, P.V. Drumm, R.A.Bark. (ANU).
2.40 - 3.00	9	Renormalisation of g-Boson effects in the Interacting Boson Model. Chen, X.J.(Tsinghua Uni. Beijing, China), I. Morrison, K. Amos (Uni. of Melbourne).
3.00 - 3.20		A F T E R N O N T E A

MONDAY 3RD FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION III		Chairman: Prof. A.W. Thomas (Uni. of Adelaide)
3.20 - 4.00	10R Review	The Role of Pions in Nuclei. I.R. Afnan. (Flinders Uni.).
4.00 - 4.20	11	How Good is the N=20 Shell Closure when Z<<N I. The Mass of ^{33}Al. L.K. Fifield. (ANU). R.C. Chapman et al (Uni. Manchester, UK). R.A. Cunningham et al (Daresbury Laboratory, UK)
4.20 - 4.40	12	The Anomalous Analyzing Power for one $^{11}B(\vec{d},n)^{12}C$ Reaction to the 2^+ State at 4.44 MeV. P.B. Foot, G.G. Shute, B.M. Spicer. (Uni. of Melbourne).
4.40 - 5.00	13	Transient Field Strengths for High Velocity ^{52}Cl Ions. A.E. Stuchbery. (ANU).
SESSION IV		POSTER SESSION A. - Foyer, Laby Theatre
5.00 - 6.00	14	Excitation Functions for $^{24}Mg(^{16}O,^{16}O')^{24}Mg^*$ $(0 \le E_x \le 8.4$ MeV) Scattering at Forward Angles. J. Nurzynski, D.F. Hebbard, T.R. Ophel, Y. Kondō, B.A. Robson (ANU), R. Smith (Dept. of Defence).
	15	A Phenomenological Nucleon-Nucleon Interaction. L. Berge, L. Petris. (Uni. of Melbourne).
	16	Linked Cluster Expansions for SU(3) Yang-Mills Theory. C.J. Hamer (ANU), A.C. Irving, T.E. Preece (Uni. of Liverpool).
	17	Applications of Octonion Algebra to Ten Dimensional Space-Time. A.J. Davies, G.C. Joshi. (Uni. of Melbourne).
	18	Electric Moments of Some Higher Excited States of ^{194,196,198}Pt. M.P. Fewell, G.J. Gyapong, R.H. Spear, A.M. Baxter, S.M. Burnett. (ANU).
	19	Calculation of the Energy Spectrum of Neutrons Released in Fission. R.L. Walsh. (AAEC)
	20	Microscopic Analyses of Antiproton Scattering in the Analytic Distorted Wave Approximation. F. Di Marzio, K.A. Amos. (Uni. of Melbourne).

MONDAY 3RD FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION IV (Cont'd)		POSTER SESSION A
5.00 - 6.00	21	Aharonov-Bohm Effects for Non-Abelian Gauge Fields. L.J. Tassie, R. Sundrum. (ANU).
	22	Cross Sections and Thermonuclear Reaction Rates of Alpha Particle Induced Reactions on ^{45}Sc. V.Y. Hansper, A.F. Scott, S.G. Tims, C.I.W. Tingwell, D.G. Sargood. (Uni. of Melbourne).
	23	Elastic Scattering of ^{152}Eu and ^{154}EU Gamma Rays. R.B. Taylor, P. Teansomprasong, I.B. Whittingham. (James Cook Uni.)
	24	Platinum-196 as A U(5) Nucleus. M.P.Fewell. (ANU)
	25	Dynamically Selected Vacuum Field Configuration in Massless QED[1]. C.D. Roberts, R.T. Cahill. (Flinders Uni.).
	26	Parity Violation from Susy Vertex Corrections in Deep Inelastic Scattering. L. Hollenberg, B.H.J. McKellar. (Uni. of Melbourne).
	27	Measurement of the Chiral Condensate in Lattice QCD. C.J. Burden (ANU). I.M. Barbour, (Uni. of Glasgow).
	28	Topological Effects in Neutron Optics. A.G. Klein, G.I. Opat, A. Cimmino. (Uni. of Melbourne).
	29	Sub-Barrier Fusion of the Oxygen Isotopes. J. Thomas, Y.T. Chen, (California Institute of Technology), S. Hinds (ANU).
	30	Cosmic Rays with Energies Greater than 10 EeV. M.M. Winn, J. Ulrichs, L.S. Peak, C.B.A.McCusker L. Horton (Uni. of Sydney).
	31	The $^{58}Ni(\vec{d}, {}^{3}He)^{57}Co$ Reaction at 80 MeV. S.M. Banks, B.M. Spicer, G.G. Shute, (Uni. of Melbourne), K. Reiner, G.J. Wagner (Uni. Tübingen, Germany), H. Nann, E. Stephenson (Indiana Uni. USA).

MONDAY 3RD FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION IV (Cont'd)		POSTER SESSION A.
5.00 - 6.00	32	Elastic and Inelastic Scattering of ^{16}O by ^{24}Mg at 90° C.M. P.V. Drumm (Daresbury, UK), D.F. Hebbard, J. Nurzynski, T.R. Ophel, B.A. Robson, R. Smith (ANU).
	33	Computer Simulation of "Neutron Ball"; The New Generation Spin Spectrometer. H. Yamada, B. Fabre. (Uni. of Melbourne).

CONFERENCE DINNER

6.15 p.m.	Janet Clarke Hall Common Room

TUESDAY 4TH FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION V		Chairman: Dr. L.J. Tassie (ANU)
9.00 - 9.40	34R Review	Recent Results from UA2. S.N. Tovey (Uni. of Melbourne)
9.40 - 10.00	35	Effects of Quadrupole Deformation in Scattering of 52 MeV Vector Polarized Deuterons from s-d Shell Nuclei. J. Nurzynski (ANU), T.Kihm, et al (Max-Planck-Institut für Kernphysik.W.Germany)
10.00 - 10.20	36	The $^{12}C(\gamma,n)$ Cross Section at 65^o and Energies from E_γ = 30 MeV to 100 MeV, using Tagged Photons. P.D. Harty (Uni. of Melbourne)
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10.40 - 11.20	37R Review	Super Symmetry in Nuclear and Particle Physics. P.D. Jarvis (Uni. of Tasmania)
11.20 - 11.40	38	The Pick-up Reaction $^{13}C(\vec{p},d)^{12}C$ Induced by 120 MeV Polarised Protons. P. Lewis. (Uni. of Melbourne)
11.40 - 12.00	39	Quadropole Moments of the First Excited States of $^{192,194,196,198}Pt$. G.J. Gyapong, R.H. Spear, M.T. Esat, M.P. Fewell, A.M. Baxter, S.M. Burnett (ANU).
12.00 - 12.20	40	Relativistic Fermions in Periodic Structures. B.H.J. McKellar (Uni. of Melbourne).
12.20 - 1.20		LUNCH

TUESDAY 4TH FEBRUARY, 1986 - University of Melbourne

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	42	The Quadrupole Moment of ^{136}Ba. P.J. Rothschild, A.M. Baxter, S.M. Burnett, M.P. Fewell, G.J. Gyapong, R.H. Spear, (ANU).
	43	L^2 Solution of the Schrödinger Equation with a Separable Potential. H.A. Slim, A.T. Stelbovics (Murdoch Uni.).
	44	Photodistintegration of ^{17}O Leading to Excited Residual States. G.V. O'Reilly, M.N. Thompson, (Uni. of Melbourne).
	45	Valence Configurations in ^{213}Rn. A.E. Stuchbery, G.D. Dracoulis, A.P. Byrne, R.A. Bark (ANU), A.R. Poletti (Uni. of Auckland).
	46	Cross Sections and Thermonuclear Reaction Rates for Alpha Particle Induced Reactions on ^{39}K and ^{41}K. A.F. Scott, V.Y. Hansper, S.G. Tims, C.I.W. Tingwell, D.G. Sargood. (Uni.of Melbourne)
	47	A Covariant Calculation of $\rho\rightarrow\pi\pi$ Decay in QCD using a $1/N_c$ Colour Expansion. J. Praschifka, C.D. Roberts, R.T.Cahill, (Flinders Uni.).
	48	Effects of Collective Excitations in the Elastic Scattering of Vector Polarized Deuterons. J. Nurzynski (ANU).
	49	Cross Sections and Thermonuclear Reaction Rates of Alpha Particle Induced Reactions on ^{59}Co. S.G. Tims, V.Y. Hansper, A.F. Scott, C.I.W. Tingwell, D.G. Sargood. (Uni. of Melbourne).
	50	Measurement of Time-of-Flight Around the Enge Spectrometer. W.N. Catford, C.L. Woods, N.A. Orr, L.K. Fifield. (ANU).
	51	Quasiparticle States in the IBA. S. Kuyucak (Uni. of Melbourne).

TUESDAY 4TH FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION VII (Cont'd)		POSTER SESSION B.
1.20 - 2.00	52	The Renormalised π-NN Coupling Constant in the Cloudy Bag Model. B.C. Pearce, I.R. Afnan, (Flinders Uni.).
	53	Cross Sections of Proton Induced Reactions on Some Isotopes of Nickel. C.I.W. Tingwell, V.Y. Hansper, A.F. Scott, M.E. Sevior, S.G.Tims, D.G. Sargood. (Uni. of Melbourne).
	54	High Spin States in $^{211,212,213}Fr$. A.P. Byrne, G.D. Dracoulis, C. Fahlander, H. Hübel, A.E. Stuchbery, J. Gerl, R.F. Davie, S.J. Poletti (ANU), A.R. Poletti (Uni. of Auckland).
	55	Partial Fusion Reaction Study with the Crystal Ball. H. Yamada (Uni. of Melbourne), D.G. Sarantites (Washington Uni.) J.H. Hamilton, C.F. Maguir (Vanderbilt Uni.) R.L. Robinson et al (Oak Ridge National Laboratory).
	56	Neutron Rich Nuclei Near the N=20 Shell Closure: Studies of ^{31}Al, ^{35}Si, $^{36,37}P$ and ^{39}S. W.N. Catford, L.K. Fifield, N.A. Orr, C.L.Woods, (ANU), P.V. Drumm (Daresbury Laboratory, UK).
	57	Direct Calculation of Neutron Damage from Activation Integrals. D.W. Lang (AAEC).
	58	Field Theory and Potential Approximations. B.H.J. McKellar, R.C. Warner (Uni. of Melbourne).
	59	Low-Lying States in Even Heavy-Transitional (W, OS,PT) Nuclei. A.E. Stuchbery (ANU).
	60	An Absolute Determination of the $^{9}Be(\gamma,p)$ Reaction Cross Section. D.J. McLean, D. Zubanov, M.N. Thompson. (Uni. of Melbourne)
	61	Radiative Decay of the Kaon Hydrogen Atom. Y.S. Zhong, A.W. Thomas (Uni. of Adelaide).
	62	The Colour-Dielectric Model as an Explanation of the Nolen-Schiffer Anomaly. A.G. Williams A.W. Thomas. (Uni. of Adelaide).
	63	The EMC Effect and the Smoking-Gun. R.P. Bickerstaff. (Uni. of Adelaide).

TUESDAY 4TH FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION VIII		Chairman: Dr. J.K. Parry (AAEC)
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2.40 - 3.00	65	Timescale of Fusion-Fission. D.J. Hinde, G.S. Foote, J.R. Leigh, J.O.Newton (ANU), R.J. Charity, (Lawrence Berkeley Lab.USA), S. Ogaza (Institute Nuclear Physics. Al Radzikowskiego, Poland), A. Chatterjee (Bhabha Atomic Res. Centre, Bombay).
3.00 - 3.20		A F T E R N O O N T E A
SESSION IX		Chairman: Prof. C.A. Ramm (Uni. of Melbourne)
3.20 - 4.00	66R Review	Potential Energy for Quarks. L. Heller (Los Alamos)
4.00 - 4.20	67	First Take Your High Spin Orbitals...and Then Construct ^{214}Rn. A.R. Poletti (Uni. of Auckland), G.D. Dracoulis, A.P. Byrne, A.E. Stuchbery, (ANU).
4.20 - 4.40	68	Unexpected Restrictions of a Quaternionic Quantum Field. C.G. Nash (Uni. of Melbourne).
4.40 - 5.00	69	Shape Coexistence in Very Neutron-Deficient PT Isotopes. G.D. Dracoulis, A.E. Stuchbery, A.P. Byrne, S.J. Poletti, J. Gerl, R.A. Bark, (ANU),A.R. Poletti, (Uni. of Auckland).

PUBLIC LECTURE - Laby Theatre

8.00 p.m. "The Impact of Sixty Years of Quantum Mechanics." Professor G.I. Opat. - University of Melbourne.

WEDNESDAY 5TH FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION X		Chairman: Dr. T.R. Ophel (ANU)
9.00 - 9.40	70R Review	Can We Measure Fission Barriers? J.R. Leigh (ANU).
9.40 - 10.00	71	Analytic Calculation of Feynman Integrals in Axial Gauge Using Recurrent Relations. H.A. Slim (Murdoch Uni.)
10.00 - 10.20	72	Quasiparticles and IBA Mappings. L.D. Wood, I. Morrison (Uni. of Melbourne).
10.20 - 10.40		M O R N I N G T E A
SESSION XI		Chairman: Prof. A.R. Poletti (Uni. of Auckland)
10.40 - 11.00	73	The "NEUGAT" System - Experiments on Composition using Simultaneous Neutron & Gamma Transmission in Solids. C.M. Bartle, (Uni. of Auckland).
11.00 - 11.20	74	Angular Momentum Distribution of the Compound Nucleus. Y. Kondō, B.A. Robson, J.J.M. Bokhorst, D.J. Hinde, J.R. Leigh (ANU)
11.20 - 11.40	75	Small Angle Compton Scattering of ^{152}Eu and ^{154}Eu Gamma Rays. J. Dow, G.C. Hicks, R.B. Taylor, I.B. Whittingham (James Cook Uni.).
11.40 - 12.00	76	Magnetic Moments of Excited States in the Transitional Nuclei ^{150}Sm and ^{152}Sm. A.P. Byrne, H.H. Bolotin, C.E. Doran, P.K.Weng, (Uni. of Melbourne), A.E. Stuchbery (ANU).
12.00 - 12.20	77	Isospin Mixing in the 1^-, 6.88 MeV Level of ^{10}B. F.C. Barker (ANU)
12.20 - 1.00		L U N C H

WEDNESDAY 5TH FEBRUARY, 1986 - University of Melbourne

TIME	PAPER NO.	
SESSION XII		Chairman: Professor S. Hinds (ANU)
1.00 - 1.40	78R Review	The Fly's Eye A Scintillating View of the Cosmos. P.R. Gerhardy. (Uni. of Sydney).
1.40 - 2.00	79	Neutron Fission of ^{230}Th. J.W. Boldeman, R.L. Walsh (AAEC).
2.00 - 2.20	80	Kaon Contribution to the Nucleon Structure Function. A.I. Signal.(Uni. of Adelaide).
2.20 - 2.40	81	Transfer Contribution to Elastic $^{16}O + ^{20}Ne$ Scattering and Parity-Dependent Interactions. Y. Kondo, B.A. Robson, (ANU). R. Smith (Dept. of Defence) H.H. Wolter (Uni. München)
2.40 - 3.00		A F T E R N O O N T E A
SESSION XIII		Chairman: Prof. B.M. Spicer (Uni. of Melbourne)
3.00 - 3.20	82	The University of Sydney Underground Physics Program. L.S. Peak, A.M. Bakick. (Uni. of Sydney).
3.20 - 4.00	83R Review	Astrophysical Importance of Nuclear Reaction Rate Measurements. D.G. Sargood. (Uni. of Melbourne).
CLOSING DISCUSSIONS		
4.00 - 4.10		Professor B.M. Spicer Conference President

ABSTRACTS

MAGNETIC MOMENTS OF SHORT-LIVED EXCITED NUCLEAR STATES

by

H. H. Bolotin

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University of Melbourne
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Australia

Abstract

Recent development of experimental methods and techniques that have successfully exploited the extremely large (kilo-Tesla) transient hyperfine magnetic fields manifest at the nuclei of ions which rapidly traverse polarized ferromagnetic media, together with the availability energetic heavy-ion beams, have greatly enlarged the domain of those excited nuclear states whose gyromagnetic ratios (magnetic moments) have become accessible to measurement.

Over the last few years, empirical determinations of the gyromagnetic ratios (g-factors) of individual short-lived ($\tau \geq 1$ psec) excited nuclear states by these means have been shown to be singularly sensitive probes of the underlying nuclear structure characteristics of these levels and have provided the foundation upon which recent, particularly incisive, critical assessments of applicable nuclear models have been based.

This paper outlines the thin-foil transient field methods and techniques employed in measurements of the g-factors of individual, psec-lifetime, excited nuclear states; presents recent results of such experimental studies of levels in the transitional W-Os-Pt isotopes and other selected nuclides of interest; compares these findings with expectations and predictions of applicable theoretical models, and highlights salient aspects of these assessments.

HADRON MODELS FROM QCD

by

C.D. Roberts and R.T. Cahill

School of Physical Sciences,
Flinders University of S.A.,
Bedford Park, 5042.

Abstract

In Ref.1 we employed the Euclidean Functional Integral formalism to obtain a representation of the generating functional of Quantum Chromodynamics (QCD) in terms of a set of hermitian bilocal fields. This result was obtained using a $1/N_c$ expansion of the generating functional of connected gluon Green's functions.

Here we review this procedure and discuss other aspects of this work which are of critical importance in the derivation of hadron models from QCD. The vacuum structure of QCD as revealed in this formulation is one such aspect. We discuss briefly the dynamically selected vacuum field configuration which is a class of degenerate field configurations related to each other by a $U_L(N_f)\times U_R(N_f)$ transformation[1,2]. This vacuum degeneracy plays an important role in the understanding of QCD based hadron phenomenology.

We employ a local field fluctuation ansatz[1] to obtain a generalised effective local bosonised action for QCD. From this we derive, as particular examples, the Skyrme-Witten topological soliton model of hadrons and also the Wess-Zumino five pseudoscalar interaction term. Most hadron phenomenology currently of interest is contained in this effective local action[3] and this suggests that the correct picture of hadrons may only emerge from the combination of what are currently considered to be competing models.

It is of importance to note that, because of the underlying bilocal structure in our approach, there are no free parameters in the phenomenological models that we derive once the necessary scale parameter of QCD has been set.

We interpret the local field fluctuations as meson fields and so, with this perspective, the generalised action would seem also to contain much of the physics of the mesons. We have studied many meson properties from this point of view with much success; for example, we obtain good agreement with experiment for the $\rho\to\pi\pi$ coupling[4].

References

1. R.T.Cahill and C.D.Roberts, Phys.Rev.D32,2419(1985).
2. C.D.Roberts and R.T.Cahill, FIAS-R-164.
3. R.T.Cahill, C.D.Roberts and J.P.Opie, FIAS-R-158.
4. J.Praschifka, C.D.Roberts and R.T.Cahill, FIAS-R-166.

MICROSCOPIC OPTICAL POTENTIALS FOR NUCLEON AND NUCLEUS SCATTERING

by

L. Rikus

Department of Theoretical Physics
Research School of Physical Sciences
Australian National University
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Australia

Abstract

In recent years there has been a great deal of interest in intermediate energy nucleon-nucleus scattering. Perhaps the most important entity required for any theoretical analysis of scattering data is the effective interaction for N N scattering with one nucleon in the fermi sea. This interaction not only acts as the driving transition operator to inelastic channels but also when summed over all target nucleons provides either the optical potential which totally describes elastic scattering or the self-consistent nuclear field which determines the structure of the target nucleus. One of the most successful effective interactions currently in use is the Hamburg interaction[1]. This is derived from the Paris[2] free N N potential by solving the Brueckner-Bethe-Goldstone equation for the t-matrix in nuclear matter and using Siemens prescription[3] to generate a local effective interaction which reproduces averaged nuclear matter t-matrix elements. Microscopic optical model potentials (MOMPs) are calculated by folding the complex energy and density dependent interaction with the matter density distribution of the target nucleus and localizing the knockon exchange terms using a simple local momentum approximation. The resulting MOMP comprises of both real and imaginary central and spin-orbit potentials and can be used in standard reaction codes to generate differential cross sections and polarizations for direct comparison with experimental data. Note that THERE ARE NO FREE PARAMETERS! The agreement with experiment is extremely good in most cases considered so far for the energy range 180 MeV to 400 MeV.

The effective interaction and the corresponding MOMPs have also been calculated for $\bar{N}$-nucleus scattering using the same methods with reasonable results. The extension of the nuclear matter approach to the heavy ion case is relatively straightforward but the calculation of the MOMP is complicated by the need to include collective excitations and the difficulty of including full antisymmetrization.

[1] L.Rikus, K.Nakano, and H.V.von Geramb, Nucl.Phys. A414 (1984)413-455. H.V.von Geramb, in The interaction between medium energy nucleons in nuclei 1982, ed. H.O.Meyer (AIP, 1983).
[2] M.Lacombe et al. Phys. Rev. C21 (1980) 861.
[3] P.J.Siemens, Nucl. Phys. A147 (1970) 225.

ANGULAR DISTRIBUTIONS IN THE MAXIMUM ALPHA YIELD FOR $^{18}O(p,\alpha_o)^{15}N$ REACTION AT 846 keV

D. D. Cohen[1], A. Katsaros[1] and S. Frisken[2]

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Abstract

One of the elements of interest in the metabolic rates of biological systems is oxygen. Oxygen has only short-lived radioactive isotopes and tracing is usually carried out with one of the stable iostopes, ^{18}O (0.204%) or ^{17}O (0.037%), using an appropriate ion beam induced nuclear reaction.

We were approached by the Zoology Department at the University of Western Australia to analyse ^{18}O enriched water samples taken from a variety of lizards. The 846 keV proton resonance in the $^{18}O(p,\alpha_o)^{15}N$ reaction was found to be adequate in terms of available machine energy and gave sufficient yield to detect background ^{18}O levels in just a few minutes of running time.

In this short paper we will discuss the cross section data and the angular distribution for this resonance. The resonance energy was found to be (846±3) keV. The FWHM was (47±3) keV with a peak cross section of (60±5) mbarn s^{-1} for a reaction angle of ψ = 40° and (41±6) mbarn s^{-1} for ψ = 90°. The reaction cross section was adequately fitted with a split Breit-Wigner function sitting on a mean d.c. level over the proton energy range 700 to 950 keV.

A CHIRAL SOLITON MODEL OF THE NUCLEON AND DELTA

by

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Abstract

The chiral soliton model is believed to be a good phenomenological model which incorporates most of the important properties of quantum chromodynamics. In the linear and non-linear chiral soliton models, only the hedgehog ansatz (which is spherical symmetric in quark spin-isospin space) for the pion, has been exploited. We will show, however, that one can also exploit a non-spherically symmetric, semi-classical, ansatz for the pion in these models. With the new ansatz, one is able to solve the equation of motion exactly in the linear model, and approximately in the non-linear model. The new ansatz also facilitates to solve the degeneracy of the nucleon and delta. We will discuss the relations among various types of chiral soliton models with respect to the boundary conditions on the pion. The roles of the vector mesons (especially ω-meson) and the gluon in a model will also be discussed.

TRANSPORT THEORY FOR NUCLEAR SYSTEMS

by

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Abstract

It is the ultimate object of a theory of many-body systems to give a complete account of their physical properties. For this purpose one needs very general kinetic theory, which gives, in principle, a microscopic insight into the general structure of (nuclear)non-equilibrium systems. However, these equations are intractable in most cases and must be simplified. The hierarchy of approximations - starting from the most general kinetic theory - is given and discussed. The guidelines used in nuclear physics for simplifying the complex equations are given by the following criteria:

1) the effects of "damping" and "dissipation", respectively, should be taken into account;
2) the (approximate) single-particle description should remain in the formulation;
3) it should be possible to obtain the approximations used in the past, as for instance: TDHF, VUU-equations, nuclear hydrodynamics etc.;
4) it should be possible to extract the structure of the equations for macroscopic variables (centre-of-mass coordinate of colliding nuclei etc.).

The essential quantity turns out to be the causal part of the effective single-particle potential. Its imaginary part determines the damping of the system.

INELASTIC SCATTERING TO UNNATURAL PARITY STATES IN LIGHT NUCLEI USING ELEMENTARY PROBES

by

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Abstract

The scattering of elementary probes (electrons, pions and protons) provide important tests of nuclear structure. The properties of each probe are such that they tend to elucidate different aspects of the states under consideration and are thus particularly interesting when used in combination.

Experimental results for all three probes exist for a number of unnatural parity states in light nuclei (e.g. the 4- states in O16 and the 6- states in Si28) which may be analysed using simple shell model transition densities. The results of these calculations will be discussed with reference to the shapes and absolute magnitudes of the cross-sections and the influence of isospin and configuration mixing will be considered.

HOW GOOD IS THE N=20 SHELL CLOSURE WHEN Z<<N? II. MASSES AND LEVELS OF ^{34}Si AND ^{35}P

by

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Abstract

The nuclei ^{31}Na and ^{32}Mg are strongly deformed, indicating that N=20 is not a good shell closure for very neutron-rich nuclei. Recent studies of the N=20 isotones ^{34}Si and ^{35}P at the ANU have assisted in determining the extent of this region of stable deformation.

The nuclei ^{34}Si and ^{35}P were produced via the $^{36}S(^{11}B,^{13}N)^{34}Si$ and $^{36}S(^{6}Li,^{7}Li)^{35}P$ reactions using targets of Ag_2S, enriched to 82.2% in the isotope ^{36}S. Ejectiles emitted at forward angles were momentum-analysed in an Enge spectrometer and identified in a multi-element, gas-filled detector. Values of -20.017±0.025 and -24.282±0.017 MeV were obtained for the mass excesses of ^{34}Si and ^{35}P respectively, in good agreement with the predictions of mass relations.

A single excited state was observed in ^{34}Si at 5.33±0.05 MeV. Shell-model calculations performed in a complete sd-shell basis, using the Wildenthal interaction, predict the lowest excited state to be $J^\pi=2^+$ at 4.89 MeV. Further the experimental relative intensities to the ground and 5.33 MeV states are qualitatively reproduced by DWBA calculations using 2-proton spectroscopic amplitudes derived from the shell-model wavefunctions. States of ^{35}P were observed at 2.45(5), 3.86(4) and 4.66(4) MeV and from similar comparisons with calculations the 2.45 and 3.86 MeV states are identified with the $3/2_1^+$ and $5/2_1^+$ shell-model levels at 2.63 and 4.30 MeV respectively.

Thus the observed properties of both nuclei are in good agreement with shell-model calculations which assume a shell closure at N=20.

Session II Monday 2.20 - 2.40 p.m.

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RENORMALISATION OF g-BOSON EFFECTS IN THE INTERACTING BOSON MODEL

By
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Abstract

The Interacting Boson Model has been very successful in describing, phenomenologically, the properties of low-lying collective states in even-even medium to heavy mass nuclei. In the many such studies of nuclear spectroscopy that have been made it has been assumed that the spectroscopy is well described by the interactions between pairs of nucleons coupled to J=0, J=2 to be designated as s- and d-bosons respectively. However, a few complementary investigations have shown that the restriction to s- and d-bosons only could be too severe to adequately explain physical observables. Empirically s- and d-boson contributions in rotors account for $\sim$82% of the intrinsic quadrupole moments and for $\sim$88% of absolute energies while the (usually excluded) g-boson provides contributions of 15% and 11% to these same physical properties respectively.

But, if ever the g-boson is introduced, the IBM becomes quite complicated. For example, the most general Hamiltonian in phenomenoligical IBM-1 (and the simplest version of the IBM) involves 9 parameters under the restriction of s- and d-bosons only but that increases to 32 parameters when s-, d- and g-bosons are considered simultaneously. Similar, but more serious, proliferation occurs in microscopic descriptions of the IBM. Clearly it is not a minor task to incorporate g-bosons into any IBM and to account for attributes that can provide less than 15% of most observable results recommends evaluation by approximation.

The most obvious method of approximation of incorporating g-boson interaction effects is that of perturbation theory. However, it has been shown that such is inappropriate given the g-boson interaction strengths deemed realistic.

Alternatively one can seek to renormalise the full s-d-g boson Hamiltonian by applying a unitary transformation suitably chosen in form and with parameters specified to minimise g-boson coupling terms. Such a renormalisation scheme, recently proposed by Otsuka and Ginocchio[1]), will be presented and a critique given on assumptions deemed necessary[1]) to achieve viable results.

[1]) T. Otsuka and J.N. Ginocchio, Phys.Rev.Letts. 55 (1985) 286.

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THE ROLE OF PIONS IN NUCLEI

by

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Abstract

After a brief review of double charge exchange scattering (e.g. (p,π^-) and (π^+,π^-)), I will show that these reactions are partly dominated by two nucleon mechanisms including the excitation of isobars, and the first step to their understanding, requires a detailed knowledge of the reactions

$$\begin{aligned} pp &\to pp \\ &\to \pi d \\ &\to \pi NN \end{aligned}$$

and

$$\begin{aligned} \pi d &\to \pi d \\ &\to pp \end{aligned}$$

in free space. In the past few years there has been an extensive experimental effort to measure as many of the polarization observables as possible. I will review the experimental results and the corresponding theoretical calculations pointing out some of the shortcomings of the theory and possible ways to overcome the problem.

HOW GOOD IS THE N=20 SHELL CLOSURE WHEN Z<<N
I. THE MASS OF ^{33}Al

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Abstract

With the exception of ^{33}Al, ground state masses have been measured for all of the neutron-rich N=20 nuclei in the sequence from ^{31}Na to ^{36}S. For ^{31}Na and ^{32}Mg the measurements differ by several MeV from shell model and mass equation predictions. In contrast, the masses and level schemes of ^{34}Si, ^{35}P and ^{36}S are consistent with sd-shell model predictions. The discrepancies for ^{31}Na and ^{32}Mg have been interpreted as evidence for a new region of deformation, or equivalently, as evidence that N=20 is not a good magic number when Z<<N. However, the mass of the transitional nucleus ^{33}Al has not been measured, and a measurement is important in order to define a boundary of the region of deformation.

In the present work, the $^{48}Ca(^{36}S,^{33}Al)^{51}V$ reaction has been employed to determine the mass of ^{33}Al. The 198 MeV ^{36}S beams were provided by the tandem accelerator at the Daresbury laboratory, and reaction products were momentum analysed by a Q3D magnetic spectrometer. A total of 20 events corresponding to the production of both ^{33}Al and ^{51}V in their ground states was observed. A value of -13.53 ± 0.14 MeV for the mass of ^{33}Al was derived, which is in good agreement with shell model and mass equation predictions.

THE ANOMALOUS ANALYZING POWER FOR ONE $^{11}B(\vec{d},n)^{12}C$ REACTION TO THE 2^+ STATE AT 4.44 MeV

by

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Abstract

Vector analyzing power for the 0.00, 4.44, 9.64, 12.71 and 15.11 MeV states in ^{12}C were measured at the Indiana University Cyclotron Facility for the $^{11}B(\vec{d},n)^{12}C$ reaction at 79 MeV.

DWBA calculations reproduced the data satisfactorily for all of these states with the striking exception of the 4.44 MeV state where there was a serious disagreement between the calculated and experimental analyzing Powers.

The effects on the calculations of the inclusion of the deuteron D-state, the use of different bound state geometries and the possible roles of both indirect reaction processes and of admixtures from the 2p-1f shell in the direct transfer to the 4.44 MeV state were all investigated. However, the anomalous analyzing power for this state remains unaccounted for at present.

TRANSIENT FIELD STRENGTHS FOR HIGH VELOCITY ^{52}Cr IONS

by

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Abstract

Measured transient field strengths for Cr ions traversing Fa hosts at velocities up to 0.91c will be reported. These strengths are diminished compared with predictions based on extrapolation of lower-velocity data. The diminished field strenghts at high velocity give clues as to the mechanisms by which polarisation is transferred from the outer shells of the Fe host to inner vacancies of the moving Cr ion. Polarisation transfer mechanisms will be discussed.

EXCITATION FUNCTIONS FOR $^{24}Mg(^{16}O,^{16}O')^{24}Mg^{*}$ ($0 \leq E_x \leq 8.4$ MeV) SCATTERING AT FORWARD ANGLES

by

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Abstract

Excitation functions for the scattering of ^{16}O from ^{24}Mg with excitation energies, E_x, up to 8.4 MeV were measured for θ_{lab}=19.5° and 33.6 MeV $\leq E_{c.m.} \leq$ 49.2 MeV. A strong energy depencence is observed for states above 8 MeV excitation.

Coupled-channels calculations including the 0^+(gs), 2^+(1.37 MeV), 4^+(4.12 MeV), 2^+(4.24 MeV), 3^+(5.24 MeV), 6^+(8.11 MeV) and 4^+(8.44 MeV) states in ^{24}Mg were performed using the computer code ECIS [1]. The deformed optical potential employed for each channel was taken to be potential 2 of reference [2], which was determined by fitting angular distributions at $E_{c.m.}$=43.5 MeV for the lowest four levels of ^{24}Mg. The shape parameters for the nuclear potential were taken to be β_2=0.25, γ=22° and β_4=-0.065 [2].

The smooth excitation functions measured for E_x<8 MeV are well described by coupled-channels calculations but the strong energy-dependent structures observed for the 8.11 MeV and 8.4 MeV excitation functions are difficult to interpret in terms of previously proposed mechanisms [3,4].

References

[1] J. Raynal, Computing as a language of physics, Vienna, IAEA, 1972, p.281.
[2] J. Nurzynski et al., Nucl.Phys.A399(1983)259.
[3] B.A. Robson and R. Smith, Phys.Lett.123B(1983)160.
[4] J. Nurzysnki et al., Nucl.Phys.A363(1981)253.

A PHENOMENOLOGICAL NUCLEON-NUCLEON INTERACTION

by

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Abstract

A phenomenological NN interaction has been developed in momentum space, to fit the elastic scattering phase shifts and the deuteron properties. The interaction belongs to the OBEP class and is of the form $V(\underline{k},\underline{k}') = \sum_i G_i O_i F_i(q^2)/[q^2 + m_i^2]$ where G_i, O_i and $F_i(q^2)$ are the coupling constant (static part), the operators and form factor for the contribution of meson i and mass m_i. The special features of this interaction are Gaussian momentum transfer dependent form factors and the use of only three meson masses - that of one pion, that of two pions and an average mass for the ρ and ω mesons - to characterise the phase shifts up to 1 GeV and L=5. This interaction, which has only recently been determined, does not however include a definition of the operators O_i, but is characterised for the present by strength coefficients for each partial-wave state. The nuclear matter results are also presented.

LINKED CLUSTER EXPANSIONS FOR SU(3) YANG-MILLS THEORY

by

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Abstract

Linked cluster expansions are applied to calculate strong-coupling series and ELCE approximants for SU(3) Yang-Mills theory on a lattice in (3+1)D. We obtain asymptotic estimates $\sqrt{\sigma} = (1.7 \pm 0.4)\Lambda_{mom}$ and $m_s = (3.1 \pm 1)\Lambda_{mom}$. These results confirm the expected universality between the Euclidean and Hamiltonian formulations, within errors.

APPLICATIONS OF OCTONION ALGEBRA TO TEN DIMENSIONAL SPACE-TIME

by

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Abstract

Superstring theories, which are currently attracting much interest, predict the dimensionality of space-time to be either 10 or 26 (with one time-like dimension in each case). One is naturally led to ask why such dimensionalities should be flavoured by nature. It has been established that the real, complex and quaternionic number fields correspond to space-time dimensions 3, 4 and 6 respectively. It has been conjectured that octonions may be associated with ten dimensional space-time. We have been able to show that, starting from an octonionic spinor formalism, two sets of matrices, each satisfying the Dirac algebra in ten dimensions, may be constructed. The existence of two such sets is a manifestation of the non-associative multiplication of octonions. We have shown also that the correspondence between octonions and ten dimensional spacetime is not as precise as for the other number systems.

ELECTRIC MOMENTS OF SOME HIGHER EXCITED STATES OF $^{194,196,198}Pt$

by

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and

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Abstract

Precise Coulomb-excitation probabilities of the 2_2^+ and 4_1^+ states of $^{194,196,198}Pt$ are used to obtain electric matrix elements between these states and the 2_1^+ and 0_1^+ states. Results will be presented and compared with theory.

CALCULATION OF THE ENERGY SPECTRUM OF NEUTRONS RELEASED IN FISSION

by

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Abstract

The energy spectrum of neutrons released in fission is an important standard for fission reactors. It can also be of great use for the calibration of neutron spectrometers. Unfortunately, measurements of the spectrum are difficult to perform, mainly because of the problem of the determination of the efficiency of the neutron detector. Therefore a prescription that calculates the spectrum for various fissioning nuclei and for a range of incident neutron energies is needed.

In recent years the Los Alamos group[1] has had success with such a calculation. However, important discrepancies remain. For example, their calculation for fission of ^{235}U agrees well with experimental data, but for fission of ^{239}Pu gives a result which is up to seventy per cent too high for that part of the spectrum above 8 MeV.

We have calculated fission neutron spectra for ^{235}U, ^{239}Pu and ^{252}Cf(sf) using the Los Alamos formalism. However, we have included additional physical processes e.g. anisotropic neutron emission, to better represent the fissioning system with a view to eliminating the above discrepancies. The results will be presented.

(1) D.G. Madland and J.R. Nix, Nucl. Sci. and Eng. 81 (1982) 213.

MICROSCOPIC ANALYSES OF ANTIPROTON SCATTERING IN THE ANALYTIC DISTORTED WAVE APPROXIMATION

by

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Abstract

Recently, an analytic representation of the conventional distorted wave approximation has been employed successfully in studies of proton, pion and kaon scattering from nuclei. In addition, this analytic distorted wave approximation (ADWA) has also proved most useful and realistic in analyses of photopion and electropion production reactions near threshold. Consequently the ADWA is incorporated in calculations of the elastic and inelastic scattering of low energy (46.8 MeV) antiprotons.

Several sets of optical model parameters are used to ascertain the appropriate analytic function form and to adequately account for the predominant effects of the annihilation potential. The inelastic scattering calculations are performed with a one boson exchange antinucleon-nucleon force containing central, tensor, spin-orbit and quadratic spin-orbit characteristics. Good fits to the existing elastic and inelastic [2_1^+(4.44 MeV) state in ^{12}C] scattering data are obtained and predictions for inelastic scattering leading to several other states in ^{12}C are also presented to show that such data analyses facilitate comparisons of (large basis) nuclear spectroscopies and selective estimates of different components in the $\bar{N}N$ interaction.

AHARONOV-BOHM EFFECTS FOR NON-ABELIAN GAUGE FIELDS

by

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Abstract

The Aharonov-Bohm effects for non-abelian gauge fields can be divided into two types. The first type also occurs for an abelian gauge field such as the electromagnetic field. The second type occurs only for a non-abelian gauge field. The first type can be investigated by studying the scattering of test particles by an impenetrable cylinder containing a flux of the appropriate "magnetic" field. The investigation of the second type, the essentially non-abelian Aharonov-Bohm effect, requires a more complicated geometry. The possibility of investigating the second type of effect experimentally will be discussed.

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CROSS SECTIONS AND THERMONUCLEAR REACTION RATES OF ALPHA PARTICLE INDUCED REACTIONS ON ^{45}Sc.

By

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Abstract

The abundances of the elements formed in the silicon burning zone of a supernova are largely determined from the cross sections of nuclear reactions. Since most of these involve reactions on radioactive target nuclei and therefore do not lend themselves to measurement in the laboratory, one must rely on theoretical cross sections. Therefore experimentally determined cross sections of as many reactions as possible on stable target nuclei as close to the mainstream as possible are required. These would then test the reliability of statistical model codes used to calculate the cross sections on neighbouring nuclei which play the dominant role in determining the results of nucleosynthesis. Scandium-45 is such a nucleus. It lies on the mainstream of nucleosynthesis and alpha particle induced reactions on it pass through the compound nucleus ^{49}V, also part of this mainstream. This is one of the better nuclei for testing statistical model codes because it is accessible not only by the ^{45}Sc + α reactions but also by the reaction ^{48}Ti + p. It is therefore possible to get experimental data involving all channels for its decay.

Experimental data for ^{45}Sc(α,p)^{48}Ti and ^{45}Sc(α,n)^{48}V will be presented and these, together with ^{48}Ti(p,γ)^{49}V data from the literature [1], will be used to test the statistical model code HAUSER*4 [2].

Thermonuclear reaction rates for the ^{45}Sc + α reactions will also be presented.

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ELASTIC SCATTERING OF ^{152}Eu AND ^{154}EU GAMMA RAYS

by

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Abstract

The elastic scattering of 444, 723, 1086 and 1112 keV γ-rays from a source containing ^{152}Eu and ^{154}Eu has been measured for scattering through 15, 20, 30 and 45° by targets and Mo, Sn, Ta, Pb and U. These measurements extend the region of our previous investigation [1] to momentum transfers greater than 10 $Å^{-1}$ where the validity of the modified form factor approximation in calculating total atom Rayleigh scattering amplitudes is questionable, and where the influence of Delbrück scattering is apparent for γ-ray energies above 1 MeV and for larger Z targets. The experimental cross sections have been normalized to theoretical carbon Compton cross sections at 7° and agree closely with the recent theoretical elastic cross sections of Kane et al [2] for Rayleigh plus nuclear Thomson plus Delbrück scattering in which exact numerical partial-wave inner shell Rayleigh amplitudes are used. The results are also in reasonable agreement with cross sections in which the total atom Rayleigh scattering is represented entirely by DHFS modified form-factor amplitudes [3].

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PLATINUM-196 AS A U(5) NUCLEUS

by

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Abstract

It is widely held that ^{196}Pt is an excellent example of the O(6) limit of the first version of the interacting boson model (IBM-1), which treats proton bosons and neutron bosons on an equal footing. However, the recent confirmation [1] that the first excited state of ^{196}Pt has a static quadrupole moment, $Q(2_1^+)$ of about $0.5[B(E2;0_1^+\to 2_1^+)]^{1/2}$ presents a difficulty, since the strict O(6) limit of the IBM-1, that is, the regimen which requires that the quadrupole operator as well as the hamiltonian have the O(6) symmetry, predicts that all quadrupole moments are zero. While seeking ways around this difficulty, it was discovered that, surprisingly, the U(5) limit gives just as good a description of ^{196}Pt as does the O(6) limit.

Predictions from the two limits of energies, E2 matrix elements and branching ratios are compared. The effects of mixing the two, or mixing in some of the SU(3) limit is also considered, but these are found not to give a significant improvement over the two limits.

Which of the limits is to be preferred is a difficult question because of the similarity of their predictions and because the two main differences lead to contradictory conclusions: the branching ratios for the decay of the 1604.5 keV and 1847.3 keV states argue for the O(6) limit whereas the values of $Q(2_1^+)$ and $B(E2;2_2^+\to 0_1^+)$, taken together, favour the U(5) limit.

[1] G.J. Gyapong et al., contribution to this conference.

DYNAMICALLY SELECTED VACUUM FIELD CONFIGURATION IN MASSLESS QED[1]

by

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Abstract

Using the Euclidean functional integral formalism an effective bilocal action is derived for massless Quantum Electrodynamics (QED). The vacuum field equation is obtained from this action and it is shown that the dynamically selected vacuum field configuration in massless QED is a class of degenerate, non-trivial field configurations related to each other through a one parameter Abelian chiral transformation. The existance of a chirally degenerate vacuum establishes that the chiral symmetry manifest in the action of massless QED becomes a hidden symmetry when a particular choice of the vacuum configuration is made. Thus it is established that chiral symmetry is spontaneously broken in the vacuum of massless QED.

A fundamental aspect of this work is the necessary identification of the lowest non-trivial approximate Schwinger-Dyson equation for the fermion self energy with the exact vacuum field equation of functional QED.

It is also important to note that in this bilocal formulation of massless QED the difference which measures the dynamical stability of the perturbative vacuum relative to the non-perturbative vacuum is unambiguously defined without the need for the introduction of a regularisation procedure.

Reference

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PARITY VIOLATION FROM SUSY VERTEX CORRECTIONS IN DEEP INELASTIC SCATTERING

by

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Abstract

The construction of supergravity GUT theories leads to a rich low energy phenomenology. Associated with each known particle (eg. leptons, quarks and gauge bosons) is at least one supersymmetric partner (eg. sleptons, squarks and gauginos). We calculate vertex corrections to the $ee\gamma$ and $qq\gamma$ vertices from these new states in terms of a general supergravity model. The induced parity violating interactions between electrons and nucleons is applied to the calculation of the lowest order SUSY contribution to the asymmetry in deep inelastic e + deuteron scattering.

Numeric results were obtained by considering specific examples of supergravity GUT models, representing a wide class of such models - the so called "Tree-Breaking" and "Renormalisation-Group" models.

The results indicate that, for a wide range of typical supergravity model parameter and sparticle masses, the SUSY contributions to the asymmetry in e + deuteron scattering lie well within constraints implied by present measurements.

MEASUREMENT OF THE CHIRAL CONDENSATE IN LATTICE QCD

by

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and

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Abstract

If lattice gauge theory is to be a useful tool for studying quantum chromodynamics (QCD) it must predict chiral symmetry breaking at zero quark mass. Without a spontaneously broken chiral symmetry, no Goldstone pion will be produced.

We have made Monte Carlo measurements of the chiral condensate and the chiral symmetry restoring temperature on Euclidean lattices. Gauge field configurations are generated with a standard Monte Carlo algorithm using the usual quenched approximation in which internal quark loops are ignored. Direct measurements of the chiral condensate are then made on these configurations. The method involves using a Lanczos algorithm to find the lowest few eigenvalues of an extremely large, sparse matrix.

Finite temperature fields are simulated by using lattices periodic in the time direction, or, in practice, shorter in the periodic time direction than in the space directions. Results are presented for the chiral symmetry restoring temperature of SU(3) quarks measured on $12^3 \times 6$ and $10^3 \times 6$ lattices and are checked for asymptotic scaling against previous $12^3 \times 4$ results. A comparison is also made with the deconfining temperature. We also give results for finite temperature chiral symmetry restoration of SU(2) quarks, transforming according to both fundamental and adjoint representations.

TOPOLOGICAL EFFECTS IN NEUTRON OPTICS

by

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Abstract

A class of experiments in Neutron Optics is related to the well-known Aharonov-Bohm experiments in Electron Optics with which they share a common topology. Two such experiments are being carried out by us using the neutron interferometer at the University of Missouri, and will be described in outline.

SUB-BARRIER FUSION OF THE OXYGEN ISOTOPES

by

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Abstract

We have measured the sub-barrier fusion cross-sections for the reactions of $^{16,17,18}O$ on ^{16}O at centre-of-mass energies from about 7 to 12.5 MeV.

For $^{16}O+^{16}O$ our data agrees well with the adiabatic time dependant Hartree-Fock calculations of Reinhard et al. [1]. This enables an extrapolation of the $^{16}O+^{16}O$ fusion cross-section down into the astrophysically interesting region at 4 MeV where the S-factor is found to be 1.1×10^{26} MeV.b, which is in good agreement with the review of thermonuclear reaction rates by Fowler, et al. [2].

The cross-sections for $^{16,18}O$ on ^{16}O are essentially the same, if a correction is made for the different radii of the fusing systems. This is not so for ^{17}O on ^{16}O and leads to a non-physical potential for this system when the data is analysed using a one dimensional potential barrier inversion model [3]. Using this model the potentials for $^{16,18}O$ on ^{16}O are reasonable.

Analysis is in progress using a coupled channels model.

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COSMIC RAYS WITH ENERGIES GREATER THAN 10 EeV

by

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Abstract

The Sydney University Giant Airshower Recorder (SUGAR) was used to measure the energy spectrum of cosmic radiation up to energies of about 100 EeV. At these energies the spectrum is expected to be affected by the 3 K universal background radiation [1], which to the cosmic ray nucleus appears to consist of photons with energies of about 3 to 300 MeV. The magnitude of the effect on the spectrum will depend on the distance travelled by the cosmic ray from its source to our detectors. Our spectrum [2] shows no sign of the cut-off expected from the effect of the universal black body radiation. Neither do our data show anisotropy in the arrival directions of high energy cosmic rays [3], a result which is to be expected if the sources of high energy cosmic rays are close to us.

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THE $^{58}Ni(\vec{d},{}^{3}He)^{57}Co$ REACTION AT 80 MeV

by

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Abstract

The results of a high-resolution $^{58}Ni(\vec{d},{}^{3}He)^{57}Co$ reaction using 80 MeV vector polarized deuterons obtained from the Indiana University Cyclotron Facility will be presented. The use of vector polarized deuterons allows measurements of analysing powers as well as differential cross sections to be made, and these in turn help to distinguish between $j = \ell + \frac{1}{2}$ and $j = \ell - \frac{1}{2}$ proton pick-up. In the present experiment use has been made of this in order to determine separately the $1d_{3/2}$ and $1d_{5/2}$ pick-up strengths in an attempt to measure the magnitude of the spin-orbit splitting in ^{58}Ni.

Results of local, zero-range DWBA calculations will be presented for many of the observed states in ^{57}Co and their spectroscopic factors quoted.

ELASTIC AND INELASTIC SCATTERING OF ^{16}O BY ^{24}Mg at 90° C.M.

by

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Abstract

Absolute cross-section data for elastic scattering of ^{16}O by ^{24}Mg at 90° C.M. are presented over the energy range $31.6 \leq E_{CM} \leq 45.2$ MeV. These data are compared with theoretical predictions based upon optical model potentials which include a real parity dependent and an imaginary anuglar-momentum dependent term. Absolute cross section data are also presented for inelastic scattering at the same lab. angle leaving ^{24}Mg in its 2^+ first excited state at 1.37 MeV.

COMPUTER SIMULATION OF "NEUTRON BALL"; THE NEW GENERATION SPIN SPECTROMETER

by

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Abstract

De-excitation of the compound nucleus formed in heavy-ion reactions is normally initiated by the emission of several neutrons and/or charged particles followed by γ transitions. The entry line is the starting level of γ de-excitation in a final residual nucleus, which is about parallel to the yrast line. Thus, the total γ-ray de-excitation energy is a function of spin as well known. The total particle decay energy (the total particle kinetic energy, plus their separation energies) can be also a measure of the entry line. Thus, in (H.I.,xn) reactions, an 100% efficient neutron detection device therefore would constitute an ideal new spin spectrometer. Such a device called "neutron ball (NB)" was proposed.

The proposed NB is a 4π array assembly of neutron detectors composed of more than 24 optically isolated NE213 liquid scintillators. Each segment has 20 cm thickness which is capable of nearly fully absorbing the energy of 10 MeV neutrons. This device is proposed to measure the total neutron energy and the neutron multiplicity in the decay of compound nucleus with close to 100% efficiency. The computer simulation was carried out to verify the capability of measuring neutron energy directly from the pulse height at energy resolution of 20% for a 1 MeV neutron.

The neutron response obtained from the large neutron detector which has the same size as a segment of the neutron ball was reproduced well by the simulation.

The use of large-volume NE213 detectors in the NB provides yet another important feature. It possesses a large detection efficiency for γ-rays. Our test NE213 detector displays a surprisingly good γ-ray peak due to multiple scattering. Thus, the neutron-ball will be able to also simultaneously be used as a total γ-ray energy device and as a reasonably good γ-ray multiplicity device, as well.

RECENT RESULTS FROM UA2

by

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Abstract

Two large detectors, UA1 and UA2, have been studying the collisions of protons and antiprotons at very high energies (typically 630 GeV in the centre of mass system) at the CERN Collider.

The analyses of data collected up to and including 1984 are in their final stages, and analysis of the 1985 data is proceeding. The latest available results will be discussed, with emphasis on:

- the hard scattering of the constituents of the proton and antiproton projectiles, leading to final states involving quarks, antiquarks, gluons and photons.
- the production and decay of the Intermediate Vector Bosons, $W^{\pm}$ and Z^{o}, including comparisons with the "Standard Model" (Quantum Chromodynamics and Glashow-Salam-Weinberg).
- searches for new phenomena.

EFFECTS OF QUADRUPOLE DEFORMATION IN SCATTERING OF 52 MeV VECTOR POLARIZED DEUTERONS FROM s-d SHELL NUCLEI

by

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Abstract

Angular distributions of the differential cross sections, $d\sigma(\theta)/d\Omega$, and of the vector analysing powers, $iT_{11}(\theta)$, for the elastic and inelastic scattering of vector polarized deuterons at 52 MeV were measured for ^{20}Ne, ^{22}Ne, ^{26}Mg, ^{28}Si, ^{32}S, ^{34}S, ^{36}Ar and ^{40}Ar. All data reduction calculations were carried out using program LORNA [1].

Coupled-channels analysis of the experimental data was carried out using computer code ECIS [2]. Global potential F′ [3] was used to describe deuteron-nucleus interaction. The potential included the imaginary spin-orbit component which was found to play an essential role in the calculations. A symmetric rotor with quadrupole and hexadecapole deformations was used to describe the shape of the potentials.

For each target nucleus, all four distributions ($d\sigma(\theta)/d\Omega$ and $iT_{11}(\theta)$ for the ground state and for the first, 2_1^+, excited state) were fitted simultaneously assuming either prolate or oblate quadrupole deformations. Except for ^{28}Si, all nuclei studied here are described better assuming prolate rather than oblate deformations.

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THE $^{12}C(\gamma,n)$ CROSS SECTION AT 65^{o} AND ENERGIES FROM E_{γ} = 30 MeV TO 100 MeV, USING TAGGED PHOTONS

by

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Abstract

In the energy region above the giant dipole resonance but below the pion threshold direct absorption of a photon is only allowed for a nucleon in a high momentum state in the nucleus. Photonucleon cross sections at these energies, therefore, will be sensitive to high-momentum, short-range effects.

Using the 300 MeV Electron Linear Accelerator and 150 MeV pulsed beam stretcher at Tohoku University, in Japan, it is possible to produce continuous beams of electrons, which have been used to produce tagged photons in the energy range 30 to 100 MeV.

These monochromatic photons have been used to measure $^{12}C(\gamma,n)$ cross sections at 65^{o}, which can be compared to $^{12}C(\gamma,p)$ measurements, made also using tagged photons at the same laboratory. Cross sections to the ground state of ^{11}C have been resolved, as well as those to higher excited states. The magnitudes of the $^{12}C(\gamma,n_{0,1})$ cross section are similar to measurements of the $^{12}C(\gamma,p_{0,1})$ cross section, in agreement with models that incorporate the effects of short range correlations.

In particular, comparison is made with a modified quasi-deuteron model which makes predictions for the cross sections at residual nucleus excitation energies above the ground state. Good agreement is observed, lending support to the theory that nucleon emission at these high gamma energies is better explained by correlations of nucleon pairs rather than by single particle knock-out models.

SUPERSYMMETRY - IN NUCLEAR AND PARTICLE PHYSICS

by

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The importance of symmetry principle in underpinning our understanding of the behaviour of physical systems has long been recognised. Recently the "factorization technique", known since the early development of quantum mechanics, has been shown to be intimately related to a description entailing "supersymmetry". The resulting elegant formulations not only apply to solvable models, but also extend to a variety of more realistic situations. The scope of such applications will be reviewed, with examples drawn from particle theory and nuclear models.

1. Anomalies in relativistic field theories arise when classical symmetries (e.g. gauge freedoms) are incompatible with the quantization process. It has recently become appreciated that they are intimately bound up with questions of geometry and the existence of certain topological constructions required for quantization. Significantly one can identify underlying supersymmetric quantum mechanical systems wherein simple calculations yield information about indices, index theorems and anomaly cancellations in the overlying gauge theories.

2. Dynamical nuclear symmetries via interacting bosons have provided a result revival of interest in nuclear models. Odd A nuclei can be handled by incorporating unpaired nucleons with the s and d bosons into dynamical supersymmetry schemes. Developments will be reviewed, including the use of orthosym plectic groups to describe pairing forces and high spin anomalies.

THE PICK-UP REACTION $^{13}C(\vec{p},d)^{12}C$ INDUCED BY 120 MeV POLARISED PROTONS

by

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Abstract

Both differential cross sections and analysing powers have been obtained for several states for ^{12}C. Despite the use of the exact finite range DWBA, which is generally successful in this energy region here, both magnitudes and shapes are not satisfactorily reproduced. Results from these calculations will be discussed.

QUADRUPOLE MOMENTS OF THE FIRST EXCITED STATES OF $^{192,194,196,198}Pt$

by

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and

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Abstract

Coulomb excitation of $^{192,194,196,198}Pt$ by ^{4}He, ^{12}C and ^{16}O projectiles has been used to determine the static electric quadrupole moments $Q(2_1^+)$ of the first excited states of these nuclei, together with values of $B(E2;0_1^+\rightarrow 2_1^+)$. The analysis for ^{192}Pt is not yet complete. It is clearly established that $Q(2_1^+)$ for $^{194,196,198}Pt$ is positive, having values of 0.48(14) e b, 0.66(12) e b and 0.42(12) e b, respectively. Results obtained for $B(E2;0_1^+\rightarrow 2_1^+)$ are 1.661(11) e^2 b^2, 1.382(6) e^2 b^2 and 1.090(7) e^2 b^2, respectively. It is assumed that interference effects from higher states are such that $P_4(2_2^+) > 0$ and $P_3(4_1^+) < 0$, as indicated experimentally. The results are compared with the predictions of various nuclear models.

RELATIVISTIC FERMIONS IN PERIODIC STRUCTURES

by

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Abstract

The possibility of quark deconfinement in the nucleus has led to the study of the properties of quarks in periodic structures. Goldman and Stephenson [1] considered quarks described by a Klein-Gordon equation, ignoring the Dirac properties of the quark. In this report we show how the classic results of Kronig and Penney [2] for non relativistic electrons in a one dimensional lattice of delta function potentials may be generalised to the relativistic case.

The generalisation is somewhat different depending on the Lorentz transformation properties of the potential, which may transform as the time component of a vector, or as a Lorentz scalar.

The initial step in setting up the problem - the solution of the Dirac Equation for a delta function potential - raises interesting questions about the Klein Paradox [3] which will be discussed.

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SUPERSYMMETRIC NON-LINEAR σ-MODELS OF COMPOSITE QUARKS AND LEPTONS

by

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Abstract

Massless composite spin-½ particles arise in confining supersymmetric gauge theories as the superpartners of Goldstone bosons. These supersymmetric Goldstone multiplets from non-linear realizations of the broken generators of the theory. Interesting restrictions on the low energy effective action of the supersymmetric Goldstone multiplets are obtained by requiring invariance under these non-linear transformations. The effective actions for confining supersymmetric gauge theories with dynamical chiral symmetry breaking of the form $SU(6) \times SU(6) \rightarrow [SU(4) \times SU(2) \times U(1)]^2$ and $SU(6) \times SU(6) \rightarrow [SU(4) \times SU(2)]^2$ are studied as models for the low energy behaviour of composite quarks and leptons.

THE QUADRUPOLE MOMENT OF ^{136}Ba

by

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and

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Abstract

Previous measurements of the electric quadrupole moment, Q_{2^+}, of the first excited state of ^{136}Ba are in conflict: one of them [1] gives $Q_{2^+} = -0.19 \pm 0.17$ eb while another [2] gives $Q_{2^+} = +0.01 \pm 0.05$ eb. Both values are for constructive interference from the second 2^+ state.

To resolve this conflict, we have measured Q_{2^+} and the reduced transition probability $B(E2;0^+ \rightarrow 2_1^+)$ for ^{136}Ba using the reorientation effect in Coulomb excitation. Targets of ^{136}Ba were bombarded with ^4He, ^7Li and ^{16}O ions and elastically and inelastically scattered projectiles were detected near 180° with an annular silicon surface-barrier detector. Analysis of the data yields the results $Q_{2^+} = -0.19 \pm 0.06$ eb and $B(E2;0^+ \rightarrow 2_1^+) = 0.419 \pm 0.004\ e^2b^2$ for constructive interference from the second 2^+ state. These values are in marked disagreement with the more precise of the previous measurements.

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L^2 SOLUTION OF THE SCHRÖDINGER EQUATION WITH A SEPARABLE POTENTIAL

by

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Abstract

The technique of describing scattering solutions of the Schrödinger equation by means of square-integrable [L^2] functions [1,2] is illustrated for a simple separable potential which admits an exact solution. We have investigated the orthogonal polynomials associated with the solution and derive explicit formulae for the weight function. The solution is studied as a function of the coupling constant of the potential. Of particular interest is the region corresponding to the onset of the bound state where the weight function becomes a distribution. The associated functional is positive definite initially but there is a critical value beyond which it is no longer positive definite.

By means of this model one can investigate the numerical procedures adopted in renormalizing the L^2 scattering solutions to approximate the δ-function normalized scattering wave functions. In particular the Heller equivalent-weight prescription is analyzed in the form given by Broad [3,4]. Our results show that the renormalization procedure works for arbitrary strengths of coupling constant.

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PHOTODISINTEGRATION OF ^{17}O LEADING TO EXCITED RESIDUAL STATES

by

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Abstract

The decay modes of dipole states in ^{17}O were studied by measuring the de-excitation γ-rays emitted from the residual nuclei following photodisintegration of ^{17}O using high resolution germanium detectors.

Bremsstrahlung weighted cross sections were measured for the total $^{17}O(\gamma,p)^{16}N$ cross section and also for photoreactions leading to population of the 1st excited state in ^{16}N. The average branching ratio for decay to the ground and 1st excited state of ^{16}N were determined at four energies with special emphasis on the extremely strong resonance seen at 15.1 MeV in previous measurements [1] of the photoproton cross section for ^{17}O.

Bremsstrahlung weighted cross section for photoneutron reactions on ^{17}O leading to specific states in the residual nucleus were measured for the Giant Dipole Resonance (GDR) only.

The results are discussed with reference to a recent 2p-1h model calculation for ^{17}O [1], specifically for the 15.1 MeV state in ^{17}O.

Energy Interval	Branching Ratio to 1st excited state in ^{16}N
threshold - 16.5	(19.3 ± 6.7)%
16.5 - 18.5	(40.4 ± 51.4)%
18.5 - 21.5	(12.0 ± 15.8)%
21.5 - 28.0	(14.9 ± 5.7)%

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VALENCE CONFIGURATIONS IN ^{213}Rn

by

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Abstract

Excited States in ^{213}Rn have been studied using γ-ray and electron spectroscopy, and the $^{208}Pb(^{9}Be,4n)^{213}Rn$ reaction. The g-factors of several of the long-lived states (about 10 isomeric states have been identified) have also been measured using the TDPAD technique. The level scheme differs considerably from previously published work [1], with many new transitions being identified. Modifications to the level scheme include the insertion of several states into the main yrast sequence, states which decay by previously unobserved, very low energy transitions.

The spectroscopic data, which includes angular distributions, transition strengths deduced from lifetime measurements, and conversion electron measurements, allows firm spin and parity assignments to be made for most of the states. The states are interpreted in terms of different couplings of the valence neutron (outside the N=126 shell) which can occupy the $g_{9/2}$, $j_{15/2}$ and $i_{11/2}$ orbitals, and the four valence protons. The strongly attractive proton-neutron interaction for mutually aligned high spin protons and neutrons leads to relatively high-spin states at low excitation energy. Very enhanced E3 transitions are a signature of such configurations.

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CROSS SECTIONS AND THERMONUCLEAR REACTION RATES FOR ALPHA PARTICLE INDUCED REACTIONS ON ^{39}K and ^{41}K

By

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Abstract

The mainstream flow of nucleosynthesis in explosive oxygen and silicon burning, in a supernova, passes through ^{39}K and ^{42}Ca by way of $^{39}K(\alpha,p)^{42}Ca$ and the reaction sequence $^{39}K(p,\gamma)^{40}Ca(n,\gamma)^{41}Ca(n,\gamma)^{42}Ca$. It is therefore important to our understanding of the process of nucleosynthesis, in this mass region, that the cross section of these reactions be known. Experimental data for $^{39}K(\alpha,p)^{42}Ca$ and thermonuclear reaction rates derived from them will be presented.

Many of the nuclei involved in the network of reactions which determine the nucleosynthesis in masses greater than 42 are radioactive, and the cross sections of reactions involving them must be determined theoretically by means of statistical model codes. Experimental data on the reactions $^{41}K(\alpha,p)^{44}Ca$ and $^{41}K(\alpha,n)^{44}Sc$ together with the already published data on $^{44}Ca(p,\gamma)^{45}Sc$ and $^{44}Ca(p,n)^{44}Sc$ [ref[1])] provide excellent material for testing the validity of these codes in this mass region, since they involve all channels available for the decay of the compound nucleus ^{45}Sc. Data for $^{41}K(\alpha,p)^{44}Ca$ and $^{41}K(\alpha,n)^{44}Sc$ will be presented and these, together with the $^{44}Ca(p,\gamma)^{45}Sc$ and $^{44}Ca(p,n)^{44}Sc$ data, will be used to test the statistical model code Hauser*4 [ref[2])].

Thermonuclear reaction rates for the $^{41}K + \alpha$ reactions at termperatures corresponding to supernova conditions will be presented.

Comparisons will also be made between the $^{39}K(\alpha,p)^{42}Ca$ cross sections and the predictions of Hauser*4.

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A COVARIANT CALCULATION OF $\rho\to\pi\pi$ DECAY IN QCD USING A $1/N_c$ COLOUR EXPANSION

by

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Abstract

Quantum chromodynamics (QCD) is the now standard model for hadrons in which the hadrons are understood as colour-singlet bound states of quarks and the force between the quarks is mediated by the exchange of self-interacting gluons. Except for Monte-Carlo lattice calculations however, there has been little success in actually deriving hadron properties from QCD. Here we present a bilocal treatment of QCD using functional-integral methods to obtain effective local-meson-field actions. This fully covariant approach has previously been successful in calculating meson masses and in deriving various hadron phenomenologies. It thus provides us with a direct path between QCD and hadron physics and we now consider its further application to meson couplings, in particular the process $\rho\to\pi\pi$. Previous treatments of this decay were necessarily phenomenological and include Cloudy Bag Model and earlier current algebra calculations.

We find that by retaining only the leading order terms in a $1/N_c$ expansion of the gluon generating functional it is possible to derive a bilocal-field bosonisation of QCD. The vacuum of this bilocal theory is highly degenerate and displays the dynamical breaking of chiral symmetry in QCD. Local meson-field actions are obtained by restricting the bilocal fluctuations about the vacuum to ones described in terms of local fields. The parameters in these actions are divergence-free functionals of the running coupling constant. Applying this approach to $\rho\to\pi\pi$ we obtain values for the coupling constant $g_{\rho\pi\pi}$ and the ρ mass which are in good agreement with experiment.

EFFECTS OF COLLECTIVE EXCITATIONS IN THE ELASTIC SCATTERING OF VECTOR POLARIZED DEUTERONS

by

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Abstract

Earlier studies carried out using both polarized and unpolarized deuterons indicated that parameterization of the deuteron-nucleus interaction potential depends not only on the mass of the target nuclei but also on the $B(E2;0_1^+ \rightarrow 2_1^+)$ gamma excitation probabilities [1,2]. In these studies coupling between the elastic and the inelastic channels was not considered.

In the present study angular distributions of the differential cross sections, $d\sigma(\Theta)/d\Omega$, and of the analysing powers, $iT_{11}(\theta)$, for $(\vec{d},d)$ scattering [2] from A=40-90 nuclei at E_d=12 MeV were analysed using coupled-channels formalism. The interaction potential was assumed to have three components: central real, central surface imaginary and real spin-orbit. Two channel coupling $(0_1^+ \leftrightarrow 2_1^+)$ was considered in the calculation.

The analysis yielded excellent description of the experimental data and the interaction potentials were found to be independent of the $B(E2;0_1^+ \rightarrow 2_1^+)$ probabilities.

Results of this study indicate that the dependence of potential parameters on the gamma excitation probabilities (or on the quadrupole deformation parameters), observed in earlier studies, can be explained as being due to coupling effects neglected in conventional optical model analyses.

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Session VII Tuesday 1.20 - 2.00 p.m.

CROSS SECTIONS AND THERMONUCLEAR REACTION RATES OF ALPHA PARTICLE INDUCED REACTIONS ON ^{59}Co.

By

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Abstract

In supernova explosions of massive stars iron group nuclei are produced with abundance determined by nuclear statistical equilibrium centred on ^{56}Ni. Since all strong and electromagnetic reactions are in equilibrium with their inverses, the relative abundances will be determined by the spins and binding energies alone. As the material ejected from the explosion expands and cools this state of balance is destroyed one reaction at a time, modifying the relative abundances established by the equilibrium. Most of the nuclei present in nuclear statistical equilibrium are unstable: calculation of the modifications which occur during this freeze out process must, therefore, depend on calculated reaction cross sections obtained from statistical model codes. It is important to measure as many cross sections on stable iron group nuclei as is possible to test the reliability of the parameters used in the statistical model codes. Alpha particle induced reactions in ^{59}Co are very useful in this regard. Cross sections and thermonuclear reaction rates for ^{59}Co$(\alpha,p)^{62}$Ni and ^{59}Co$(\alpha,n)^{62}$Cu are presented and their significance for statistical model calculations discussed.

MEASUREMENT OF TIME-OF-FLIGHT AROUND THE ENGE SPECTROMETER

by

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Abstract

The focal plane of the Enge magnetic spectrometer is equipped with a hybrid gas filled detector that measures the radius of curvature, energy and rate of energy loss of the analysed ions. These parameters allow reaction products to be separated according to their atomic and mass numbers, but without any redundant information. Ions with exceptionally low counting rates can be impossible to identify if even a very small fraction of events from a more intense species gives degraded signals. This situation has arisen in mass measurements of exotic nuclei that are only produced with microbarn cross sections. Measurement of the time of flight around the spectrometer provides enough extra information to resolve such ambiguities in identification.

The time-of-flight system that has been developed consists of a microchannel plate detector at the spectrometer entrance and a parallel plate avalanche counter at the focal plane. The microchannel plates detect electrons produced by ions passing through a 30μg cm^{-2} carbon foil mounted across the spectrometer entrance. The system allows the full solid angle of 3.4 msr to be used. The efficiency for heavy ions is > 90% and the timing resolution observed under experimental conditions is 1.1ns (FWHM) or 2.7ns (total base width). For a typical detected mass of A=20 this corresponds to 0.5 mass units (base width). Details of the construction and operation of the detectors will be presented.

QUASIPARTICLE STATES IN THE IBA

by

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Abstract

The interacting boson approximation (IBA) model has been very successful in describing low-lying collective levels of medium and heavy nuclei [1]. Through a number conserving quasiparticle transformation, the model was extended to include an arbitrary number of quasiparticle excitations [2]. In this work, formalism of ref. [2] is applied to describe the backbending phenomena in various nuclei. In particular, we give a unified description of backbending in even and odd-mass Hg isotopes, explain the triple forking of three 8^+ states in ^{68}Ge and study the simultaneous band crossing systematics due to $(\nu h_{11/2})^{-2}$ and $(h_{11/2})^2$ configurations in the Ba and Ce isctopes.

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THE RENORMALISED π-NN COUPLING CONSTANT IN THE CLOUDY BAG MODEL.

by

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Abstract

Most applications of the Cloudy Bag Model to πN scattering involve unitarising the bare diagrams arising from the Lagrangian by iterating in a Lippmann-Schwinger equation. However analyses of the renormalisation of the coupling constant proceed by iterating the Lagrangian to a given order in the coupling constant. These two different approaches means there is an inconsistency between the calculation of phase shifts and the calculation of renormalisation. In fact if one tries to calculate the renormalisation using the same series of diagrams that arises from the Lippmann-Schwinger approach, the renormalisation becomes excessively large for all bag radii less than about 1.1 fm. This apparently arises from not including all diagrams in the Lagrangian of a given order in the coupling constant. A remedy to this problem is presented that has the added advantage of improving the fit to the phase shifts in the P11 channel. This is achieved by using physical values of the coupling constant whenever there is another pion 'in the air'. This approach can be justified by examining equations for the ππN system that incorporate three-body unitarity.

CROSS SECTIONS OF PROTON INDUCED REACTIONS ON SOME ISOTOPES OF NICKEL

by

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Abstract

The natural abundances of the iron group elements are determined during the process of freeze out from nuclear statistical equilibrium in supernova explosions and depend upon the rates of a large number of nuclear reactions, most of which involve unstable target nuclei [1]. Nucleosynthesis calculations for the iron group are therefore heavily dependent on theoretical cross sections calculated with global statistical model codes and hence it is important to test the reliability of such codes with cross section measurements on as many stable iron group nuclei as possible. Isotopes of nickel, having a closed shell of 28 protons, are of particular interest in this regard since cross section measurements of proton induced reactions on the stable isotopes with a closed shell of 28 neutrons showed the statistical model predictions to be consistently high by factors $\gtrsim 2$ [2] and a measurement of the cross section of $^{58}Ni(p,\gamma)^{59}Cu$ showed the predictions to be high by a factor of ~ 2.5 [3]. The most abundant product of nuclear statistical equilibrium is ^{56}Ni, which has closed shells of both protons and neutrons, and accurate knowledge of the rates of reactions on this nucleus is of particular importance for nucleosynthesis calculations in the iron group region. Such rates must necessarily come from statistical model codes and this points up the need for testing and improving the performance of the codes for reactions on all the stable isotopes of nickel.

Cross section and thermonuclear reaction rate data are presented for proton induced reactions on the nuclei ^{60}Ni and ^{61}Ni and compared with global statistical model predictions. The significance of the results for nucleosynthesis is discussed.

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HIGH SPIN STATES IN $^{211,212,213}Fr$

by

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Abstract

The level structures of ^{211}Fr, ^{212}Fr and ^{213}Fr have been observed to high spins, $\sim 28\hbar$ using a wide variety of γ-ray spectroscopic techniques. The nuclear structure can be explained well in terms of couplings of single particle states and empirical shell model calculations give good agreement with the observed energy spectra [1].

Enhanced E3 transitions which result from particle-vibration coupling were also observed. A sample of the results will be presented.

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PARTIAL FUSION REACTION STUDY WITH THE CRYSTAL BALL

by

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Abstract

The crystal ball experiment was undertaken for the partial fusion reaction of $^{150}Sm(^{14}N,p(d,t)xn)$. The centroid of γ-multiplicity distributions was found to shift to higher as an ejectile energy. The width of the distribution was slightly narrower for the partial fusion reaction than for a complete fusion reaction. A large body of summarized γ-multiplicity data indicates that the fusion limit of the break-up fragment takes essential role as predicted by the massive transfer model, rather than the entrance channel angular momentum limit. It is discussed that the sum-rule model is at the limit of much too simplified picture of the bin model.

NEUTRON RICH NUCLEI NEAR THE N=20 SHELL CLOSURE: STUDIES OF ^{31}Al, ^{35}Si, $^{36,37}P$ and ^{39}S

by

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Abstract

As part of a program to investigate the properties of neutron-rich nuclei, the masses and level schemes of a number of $T_Z \geq 5/2$ nuclei near the N=20 shell closure have been measured using heavy-ion induced transfer reactions on neutron-rich targets. The interest in these measurements derives from the breakdown in shell closure for the N=20 isotones ^{31}Na and ^{32}Mg which are believed to be strongly deformed [1].

Apart from ^{31}Al, the nuclei in the present study have some neutrons occupying the 1f2p-shell. Thus these new measurements allow the testing of shell model calculations based on models encompassing 1f2p-shell neutron configurations.

The shell model calculations have been performed using a new interaction in a 0ħω space and allowing active protons in the $1d_{5/2}$, $2S_{1/2}$ and $1d_{3/2}$ orbitasls in conjunction with active neutrons in the $1f_{7/2}$ and $2p_{3/2}$ orbitals.

At present no positive experimental observation of ^{37}P has been obtained.

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DIRECT CALCULATION OF NEUTRON DAMAGE FROM ACTIVATION INTEGRALS

by

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Abstract

Considerable effort has been devoted over many years to obtaining neutron flux spectra as a function of neutron energy inside reactors. The measured data has commonly been a set of activities of foils of various materials exposed for suitable times to the flux under consideration. A major purpose of the effort has been to use the flux so obtained as input data in calculating the damage caused to materials by neutrons. It has been observed that different methods of calculation of the spectra, starting from the same sets of data, can lead to widely divergent shapes of the flux, but may agree fairly closely about the damage done by the flux. It will be shown that the damage can be calculated from the activations. The standard deviation of the predicted damage can also be calculated. The sensitivity of the results to any assumed parameters of the flux will be explored.

FIELD THEORY AND POTENTIAL APPROXIMATIONS

by

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Abstract

As part of a continuing project involving the application of field theory approximation techniques to the derivation of the internucleon potential and on investigation of how systematic corrections to the potential picture can be obtained from an underlying field theory we consider various treatments of field theory models for nucleons and mesons.

LOW-LYING STATES IN EVEN HEAVY-TRANSITIONAL (W, OS,PT) NUCLEI

BY

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Abstract

Recent transient field measurements of g-factors of low-lying excited states in the even-even nuclei $^{184,186}W$, $^{188,190,192}Os$ $^{196,198}Pt$.

Comparisons of the recent data with nuclear models, particularly the interacting Boson Model (IBM), will be made.

Evidence for shape co-existence/competition is provided from g-values of the low-lying states of some isotopes.

AN ABSOLUTE DETERMINATION OF THE $^{9}Be(\gamma,p)$ REACTION CROSS SECTION

by

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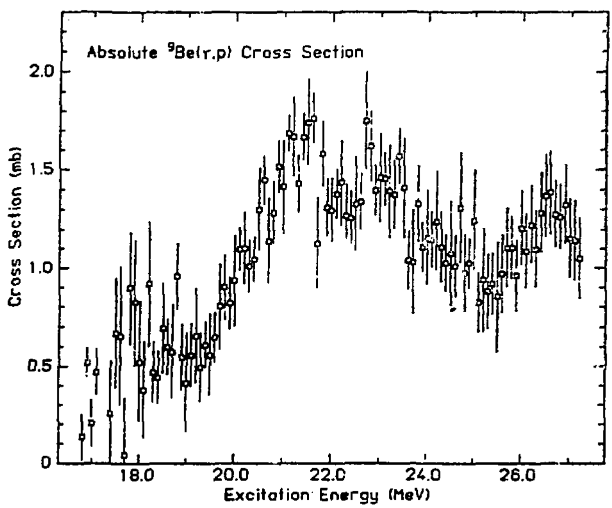
Abstract

While the ^{9}Be nucleus has been extensively studied via photonuclear reactions, previous measurements of the $^{9}Be(\gamma,p)$ reaction cross section have poor resolution and differ considerably in magnitude. A high resolution measurement of the relative cross section and a determination of the absolute scale are presented here.

Together with the known $^{9}Be(\gamma,n)$ cross section an estimate of the total absorption cross section is made, for comparison with a previous measurement of the total absorption cross section and with theoretical predictions. The distribution of the components of the giant dipole resonance is estimated and shows that isospin splitting and the relative $T_<$ and $T_>$ strengths are in agreement with theoretical predictions.



RADIATIVE DECAY OF THE KAON HYDROGEN ATOM

by

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ABSTRACT

Using the cloudy-bag model the results of the branching ratio for the decay of the kaon hydrogen atom to $\Lambda\gamma$ and $\Sigma^0\gamma$ are obtained,

$$R_1 = \frac{K^-p \rightarrow \Lambda\gamma}{K^-p \rightarrow \text{anything}} = 2.08 \times 10^{-3}$$

$$R_2 = \frac{K^-p \rightarrow \Sigma^0\gamma}{K^-p \rightarrow \text{anything}} = 1.66 \times 10^{-3}$$

R1 is compatible with the experimental data [1] $(2.8 \pm 0.8)\times 10^{-3}$. As the cloudy-bag model calculations of Viet et al. [2], the $\Lambda(1405)$ is predominantly a $\bar{K}N$ bound state, from this understanding and the calculated R_1 the decay width of $\Lambda(1405)$ to $\Lambda\gamma$ is 83.3 keV.

In our calculation, the parameters are R = 1fm (bag radius) f = 105 MeV (the Meson-octet decay constant) and m_{Λ^*} = 1640 MeV (the bare mass of 3-quark state Λ^*) all taken from [2].

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THE COLOUR-DIELECTRIC MODEL AS AN EXPLANATION OF THE NOLEN-SCHIFFER ANOMALY

by

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ABSTRACT

There is considerable interest in the potential importance of QCD-motivated quark models for a microscopic understanding of nuclear phenomena. It is important to establish what tests can now be made which might give some guidance as to the best phenomenological quark models. Even though a particular quark model may not successfully reproduce the whole N-N force, it can still be reasonable to estimate its symmetry breaking effects. Such a calculation is particularly interesting where conventional models of the N-N force fail to agree with experimental data.

One systematic failure of conventional nuclear physics is the Nolen-Schiffer Anomaly (NSA), [1]. This is the discrepancy between the measured mass differences of mirror nuclei (a charge symmetry breaking (CSB) effect) and the calculated Coulomb corrections (after allowing for the proton-neutron mass difference). This discrepancy exists over a wide range of mirror nuclei and has the same sign in each case.

We have studied one particular QCD-motivated quark model, the colour-dielectric model of Nielsen and Patkos [2]. This model has previously been considered in connection with the EMC effect and has potential for large CSB effects. We have shown, using some straight forward approximations and standard nuclear structure properties, that for suitable choices of parameters this colour-dielectric model can explain the NSA [3].

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THE EMC EFFECT AND THE SMOKING-GUN

by

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ABSTRACT

Deep inelastic scattering (DIS) of leptons by nuclear targets shows that the structure function per nucleon, expressed as a function of the Bjorken scaling variable x, has a dependence on the mass number, A, of the target. The nuclear dependence, known as the EMC effect, may be described as a shift of the dominant region of the structure function towards smaller x.

DIS structure functions may be expressed as Fourier transforms of current correlation functions and in the Bjorken limit are dominated by light-cone correlation lengths: $\xi^2=0$ but $|\xi^0|$ and $|\xi^3| < {}^1/m_N x$ are non-zero. It appears therefore that the EMC effect implies an increased correlation length in nuclei. In the limit that the speed of light is infinite the light-cone correlation function becomes an equal-time correlation function and is then a direct measure of the size of a nucleon. In the physical case of a finite speed of light the correlation function should still display some dependence on size and so the EMC effect has been interpreted as revealing an increased quark confinement volume in nuclei. This has in turn been suggested to be a precursor to a deconfining phase transition at higher density. The EMC effect would therefore appear to require a revision of the traditional picture of the nucleus.

However, the correct scaling variable, with which the momentum fraction of quarks may be equated, is $Q^2/2\,p.q$ and for a bound nucleon $p.q \neq m_N\nu$ but rather $m_N\eta\nu$ where $\eta<1$ is related to the single particle separation energy. Thus the EMC effect can be understood as a purely kinematic rescaling in x. The apparent change in quark correlation lengths is seen to be entirely illusory and stems from a failure to appreciate the effect of nuclear binding on the interpretation of the scaling variable.

PROGRESS IN NUCLEAR TECHNIQUES OF ANALYSIS

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The Fourth Australian Conference on Nuclear Techniques of Analysis was held at Lucas Heights in November 1985 with an increased number of papers and participants. A broad range of applications of ions, neutrons and radioisotopes was discussed with review papers showing vigorous activity in many important fields. Results presented at this conference and at recent international conferences will be used to review general trends in applied nuclear science.

TIMESCALE OF FUSION-FISSION

by

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*** Van de Graaf Lab., Bhabha At. Res Centre, Bombay 400 085, India.

Abstract

Neutron-fission fragment angular correlations have been measured for the compound nuclei ^{168}Yb, $^{192,198,200}Pb$, ^{210}Po, ^{213}Fr and ^{251}Es, formed by fusion reactions induced by beams of $^{16,18}O$, ^{19}F and $^{28,30}Si$. Analysis allows the determination of the mean multiplicities of neutrons originating from the fused system (ν_{pre}) and the fission frragments ($2\nu_{post}$). However, calculations of ν_{pre} using the statistical model code ALERTI underestimate the multiplicities, the discrepancy increasing with excitation energy and fissility. This is interpreted in terms of the dynamics of the fission process, and can be resolved by including in the calculations the effects of a delayed onset of fission or a slow saddle-to-scission transition. The data can also be fitted when both effects are applied, each for 20×10^{-21}s. Such long times are not inconsistent with the results of pure one-body dissipation calculations, and are supported by recent results on the timescale of quasi-fission. It is concluded that motion in the fission direction is overdamped.

POTENTIAL ENERGY FOR QUARKS

by

L. Heller

Visiting University of Adelaide
from Los Alamos

Abstract unavailable at time of printing

FIRST TAKE YOUR HIGH SPIN ORBITALS...AND THEN CONSTRUCT ^{214}Rn

by

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Abstract

In principle nuclei which have a few neutrons and a few protons outside the closed shell ^{208}Pb nucleus should provide an extremely interesting laboratory for the investigation of high spin excited states. This is because both the valence protons and the valence neutrons are occupying high spin orbitals. For protons the $h_{9/2}$, $i_{13/2}$ and $f_{7/2}$ orbitals and for neutrons the $g_{9/2}$, $i_{11/2}$ and $j_{15/2}$ orbitals are of interest. In addition these nuclei should yield information on how the proton-neutron residual interaction influences the actual state energies.

In practice these nuclei are actually not readily produced in such as way as to populate high spin levels with any intensity. One of them is however ^{214}Rn (^{208}Pb + 4 protons + 2 neutrons). We have used the $^{208}Pb(^{9}Be, 3n)^{214}Rn$ reaction to populate levels in the residual nucleus to a spin of about 20ħ. Our analyses have established the properties of yrast states up to $J^{\pi}=18^{+}$ and an excitation energy of 3490 keV. An interpretation will be given in terms of excitations of both the neutrons and the protons and of their interactions.

UNEXPECTED RESTRICTIONS OF A QUATERNIONIC QUANTUM FIELD

by

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Abstract

There are a number of natural generalizations of the U(1) symmetry to a quaternionic context, some of which have been examined in the literature. However Poincaré covariance and commutation relations ensure that only one of these generalizations may survive as a symmetry of a quaternionic quantum field theory. That is $\phi \to q\phi q^{-1}$ where q is a unit quaternion

SHAPE COEXISTENCE IN VERY NEUTRON-DEFICIENT PT ISOTOPES

by

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Abstract

Yrast bands in the very neutron-deficient isotopes of platinum, ^{176}Pt and ^{178}Pt, haave been identified using γ-ray spectroscopy, and the ^{144}Sm(^{35,37}Cl,p2n)^{176,178}Pt reactions. The level scheme of ^{176}Pt resembles that of a vibrator at low spin, but changes to that of a well deformed rotor. This behaviour is attributed to a band-crossing effect, due to shape coexistence, analogous to the well established shape coexistence in the very light Hg isotopes[1]. Analysis of the properties of the yrast bands in the range of isotopes from ^{176}Pt to ^{188}Pt suggests that mixing between two different shapes is present in the ground state of the mid-shell isotopes ^{180}Pt to ^{186}Pt. This result agrees with predictions that a deformed "intruder" state will be lowest in the middle of the shell, and will rise in energy at the extremities (near ^{176}Pt), because of changes in the proton-neutron interaction, with the number of valence neutrons[2,3].

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CAN WE MEASURE FISSION BARRIERS?

by

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Abstract

For many years projectiles lighter than α-particles have been used to directly determine fission barriers of actinide nuclei, e.g. by measuring fission threshold energies.

For lighter nuclei ($A \lesssim 200$), the conventional fission barrier, that associated with near zero angular momentum, is much greater than the particle binding energies and fission cross sections are too small to use these direct methods.

The fission barrier can be effectively lowered by the introduction of angular momentum into a nucleus using heavy ion fusion reactions. The resultant fission cross sections can only be interpreted if the processes involved in the formation (fusion) and decay of hot, rotating nuclei are well understood. Progress towards this understanding will be discussed.

ANALYTIC CALCULATION OF FEYNMAN INTEGRALS IN AXIAL GAUGE USING RECURRENT RELATIONS

by

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Abstract

An algorithm is described which enables the calculation of Feynman integrals in the axial gauge. The algorithm is based on recurrence relations, which are used to simplify integrals associated with both massless and massive particles. The resulting formulas can be used to tabulate all Feynman integrals that are relevant for the calculation of propagators in axial gauge quantum chromodynamics and quantum gravity. The algorithm is most useful if implemented in a computer code for algebraic manipulations.

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QUASIPARTICLES AND IBA MAPPINGS

by

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Abstract

The success of the Interacting Boson Model (IBM) in providing a phenomenology and taxonomy for the study of nuclei has prompted several questions on the degree of microscopic justification for the model assumptions. The necessity in rotational systems to include the L=4 (g) boson and the difficulty, in the standard model, in explaining B(M1) and g-factor "anomalies" in lowest order has led to a plethora of parameters in the phenomenology and ambiguities in interpretation. A study of the mappings of fermion systems into an equivalent boson form can provide a guide to the functional forms and parameterisation of the phenomenological models, improving their utility. Previously these mappings have been derived in the limit of spherical nuclei and applied with some success, but the inherent approximations are inappropriate in rotational nuclei where the greatest requirement exists for Hamiltonian and M1 operators.

We present, using a similar philosophy to the spherical (sd) mapping, a mapping appropriate to s,d and g bosons in rotational systems, where the bosons additionally carry spin and isospin (S,T). This mapping additionally maps complete band structures in comparison with the spherical system which maps 0_1^+, 2_1^+ levels only. Initial application to the nuclear (sd) shell will be given.

THE "NEUGAT" SYSTEM - EXPERIMENTS ON COMPOSITION USING SIMULTANEOUS NEUTRON AND GAMMA TRANSMISSION IN SOLIDS

by

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Abstract

The transmission for neutrons and gamma-rays in materials using the same source-to-detector geometry can provide the mass fraction of a binary component and the composite density. This system previously only mentioned lightly in the literature, is rapidly being developed now to meet a range of industrial and medical demands with considerable economic impact.

Previously used as a source-based technique, now an accelerator is used to generate the neutron and gamma-ray flux in applications where a portable source is not required. Standard nuclear physics experimental techniques such as time-of-flight and pulse-shape-discrimination are required. A provisional patent has been filed on the new developments which have been forthcoming.

Applications under way include measurements of water in soil (Soil Bureau, Taita), water in wood (Odlins), fat in meat (N.Z. Meat Industry Research Institute and Ministry of Agriculture and Fisheries).

The system in use at INS, the development of an industrial system, and the various applications will be discussed.

ANGULAR MOMENTUM DISTRIBUTION OF THE COMPOUND NUCLEUS

by

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Abstract

To examine the angular momentum distribution following heavy ion fusion we have used the sensitivity of fission to the shape of this distribution. We apply this method to the $^{58}Ni + ^{124}Sn$ and $^{64}Ni + ^{118}Sn$ systems and show that the very wide angular momentum distributions of the "elastic fusion" model [1] , which is based on direct reaction theory, are not inconsistent with experimental fission cross sections.

Reference

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SMALL ANGLE COMPTON SCATTERING OF ^{152}Eu AND ^{154}Eu GAMMA RAYS

by

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Abstract

The Compton scattering of 344, 779, 964, 1086 and 1408 keV γ-rays from a source containing ^{152}Eu and ^{154}Eu has been measured for scattering through 5, 7, 10 and 15° by targets of Al, Mo, Ta and U. For many cases the Compton and elastic lines overlapped and the individual contributions had to be extracted [1] using a least squares curve fitting analysis based upon Compton and elastic line shapes measured for carbon. The experimentally determined Compton line profiles exhibit a Z-dependent width which increases with energy and scattering angle. These experimentally determined profiles are significantly broader than theoretical line profiles calculated using the non-relativistic form factor expressions of Schumacher, Smend and Borchert [2] for the case of a free final electron.

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MAGNETIC MOMENTS OF EXCITED STATES IN THE TRANSITIONAL NUCLEI ^{150}Sm AND ^{152}Sm

by

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Abstract

The measurement of the gyromagnetic ratio of excited states can provide a sensitive test of nuclear models. Our group has recently measured the g-factors of states in the heavier transitional nuclei, Os and W, and found them to be in disagreement with IBA-2 first order M1 operator calculations [1]. In view of these results, measurements were performed on the lighter transitional Sm isotopes. The g-factors of ground state band states and 2_2^+ and 2_3^+ states were measured in both ^{152}Sm and ^{150}Sm using the transient magnetic field perturbed γ-ray angular distribution technique.

The 2_3^+ states are of particular interest since it has been suggested recently that these states are predominantly non-maximum F-spin [2].

The present results indicate that there is not a significant difference in the g-factors of the excited 2^+ states in either ^{152}Sm or ^{150}Sm.

References

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ISOSPIN MIXING IN THE 1^-, 6.88 MEV LEVEL OF ^{10}B

by

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Abstract

Just 30 years ago, Wilkinson and Clegg [1] showed that the 1^-, 6.88 MeV level of ^{10}B is mainly $T=0$ but has some tens of percent $T=1$ admixture. They suggested that this state is essentially ^{9}Be(g.s.) + s-wave proton, and that the admixture is due to the similarly constituted $T=1$ state, which would be the analogue of a 1^- level at about 6 MeV in ^{10}Be. Fifteen years ago the available data appeared to indicate that this mainly $T=1$ level of ^{10}B is at 7.44 MeV, and that the 6.88 and 7.44 MeV levels satisfy a two-state isospin-mixing model, with a rather large mixing matrix element of order 200 keV. More recent experiments and analyses [2,3], however, have found no evidence for such a 1^- level near 7.44 MeV. We attempt to resolve this dilemma.

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THE FLY'S EYE
A SCINTILLATING VIEW OF THE COSMOS

by

Peter R. Gerhardy

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School of Physics,
University of Sydney
N.S.W. 2006

Abstract

The Fly's Eye, a unique high energy astrophysics observatory located in the western desert of Utah, was built to observe the passage of ultra high energy cosmic rays through the atmosphere by means of atmospheric scintillation. Its design and performance will be described.

Recent results from the experiment include measurements of the energy spectrum, anisotropy and composition of ultra high energy cosmic radiation, the detection of ultra high energy galactic gamma ray sources, and also a measurement of the proton-air, and proton-proton interaction cross-sections at centre of mass energy of 30 TeV. These results will be discussed.

NEUTRON FISSION OF ^{230}Th

by

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Australian Atomic Energy Commission

Abstract

The existence of a triple-humped barrier shape for the ground and near ground state fission channels for nuclei near thorium has been a controversial subject since the original prediction by Möller and Nix in 1971. Attempts to verify this proposal have been based on simultaneous analyses of high resolution neutron fission cross sections and fission fragment angular distributions for the thorium nuclei, particularly ^{230}Th. To compound the debate there has been serious dispute between various groups about the accuracy and relevance of the different data sets. To attempt to end this debate, the fission fragment angular distributions have been remeasured with higher precision and an experimentally demonstrated energy resolution. A reanalysis of the data is also presented.

KAON CONTRIBUTION TO THE NUCLEON STRUCTURE FUNCTION

by

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ABSTRACT

We investigate a possible kaon contribution to deep inelastic scattering (DIS) off a nucleon target. This is analogous to the pion contribution first investigated by Sullivan [1].

While the contribution is small, it leads us to an estimate of the distributions of the strange quark and its anti-quark in the nucleon, and, importantly, the difference between these two distributions.

REFERENCES

[1] J.D. Sullivan, Phys. Rev. D5, 1732 (1972).

TRANSFER CONTRIBUTION TO ELASTIC ^{16}O + ^{20}Ne SCATTERING AND PARITY-DEPENDENT INTERACTIONS

by

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Abstract

Resonant structures observed in $^{20}Ne(^{16}O,^{16}O)^{20}Ne(g.s.,2_1^+,4_1^+)$ scattering have been successfully explained in extended optical model [1] and coupled-channels [2] analyses using a parity-dependent real potential and J-dependent absorption. In this paper the effects of elastic α-transfer as a possible source of the parity-dependent term will be discussed.

Calculations in which the elastic α-transfer amplitude at angle (π-θ) is coherently added to the elastic scattering amplitude at angle θ have been performed and the results compared with the measured excitation function for elastic $^{16}O+^{20}Ne$ scattering at $\theta_{c.m.} = 154°$. Two sets of optical model parameters corresponding to surface transparent potentials which describe elastic $^{16}O+^{20}Ne$ scattering equally well but differ mainly in the sign of the parity-dependent term were employed. This ambiguity arises because of uncertainty in the spins of the resonant structures. The data, which show four gross resonant structures for the energy range 23 MeV < $E_{c.m.}$ < 38 MeV, are well described by calculations in which no parity-dependent interaction is used and the strong structures arise from interference of the potential scattering with the α-transfer. It was found that the effects of the elastic α-transfer are well simulated by the explicit inclusion of a parity-dependent term in the real potential in optical model calculations. Furthermore, the sign of the parity-dependent term is in accord with microscopic calculations of Baye et al. [3].

References

[1] Y.Kondō, B.A.Robson and R.Smith, Nucl. Phys. A410 (1983) 289.
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[3] D.Baye, J.Deenen and Y.Salmon, Nucl. Phys. A289 (1977) 511.

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THE UNIVERSITY OF SYDNEY
UNDERGROUND PHYSICS PROGRAM

by

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Falkiner High Energy Physics Department,
School of Physics,
University of Sydney
N.S.W. 2006

The Falkiner High Energy Physics Department of the University of Sydney is currently constructing an underground physics laboratory at Broken Hill - at a depth of 1230 metres.

Some of the physics experiments to be undertaken in the laboratory will be discussed; including the measurement of neutron and high energy gamma ray spectra.

The main aim of this laboratory will be the construction of a solar neutrino detector - and details of plans and progress will be presented.

ASTROPHYSICAL IMPORTANCE OF NUCLEAR REACTION RATE MEASUREMENTS

by
D. G. Sargood
School of Physics
University of Melbourne
Parkville, Vic. 3052, Australia

Abstract

Interest in hydrogen burning reactions has been revived in recent years not only by the solar neutrino problem but also as a result of the development of computer models of massive stars which trace the evolution of a star from protostar to supernova. At the comparatively low temperatures of hydrostatic hydrogen burning, the collision energies of importance are below the limit for which experimental data can be obtained and extrapolation techniques are used to determine the rates of the reactions involved. Cross sections have been remeasured in recent years and improved extrapolation procedures have been developed. This is well illustrated by new work on $^{13}C(p,\gamma)^{14}N$.

Hydrogen burning at supernova temperatures presents different problems, the most important being that the target nuclei of importance, having half-lives of only a few minutes, are not suitable as targets for laboratory experiments. Hopefully the development of a radioactive ion beam facility at TRIUMF will solve this problem. For example, a beam of ^{13}N ions incident on a hydrogen target would permit measurement of the cross section of $^{13}N(p,\gamma)^{14}C$, an important reaction in the hot CNO cycle.

In the more advanced burning stages, such as carbon, neon, oxygen, and silicon burning, the occurrance of important reactions involving short lived targets is commonplace, and it is unlikely that more than a few of these will ever have their cross sections measured with the radioactive ion beam facility. One must therefore rely on theoretical cross sections for the vast majority of reactions which are included in the nucleosynthesis networks of the stellar evolution codes. The theoretical cross sections are determined by means of the Hauser-Feshbach statistical model with optical model well parameters for the particle channels determined globally from elastic scattering measurements. The use of these global parameters for calculation of cross sections of reactions on nuclei in the range A=23-68 has had a mixed record of success when the results are compared with experimental data for stable target nuclei. Experimental programmes of cross section measurements therefore continue with the aim of understanding why the present calculations are sometimes successful and sometimes unsuccessful and then identifying a truly reliable set of global parameters.

GENERAL INFORMATION

GENERAL INFORMATION

CONFERENCE VENUE

University of Melbourne, Physics Building - Laby Theatre. See Map p. 98

DATE

Monday 3rd, Tuesday 4th & Wednesday 5th February, 1986

PAPERS

Timing - Green light - presentation of paper.
Warning lights - 5 and 2 minutes remaining.
Red light - presentation time expired.
Discussion time of 5 minutes is then allowed by the Chairman.

Slides - Authors using 35 mm slides in conjunction with their talk are requested to place their slides in the projector magazine during the break preceding the session in which the paper is scheduled.

ACCOMMODATION

For out of Melbourne participants whose nominations have previously been accepted, bed and breakfast accommodation has been arranged at *Janet Clarke Hall, University of Melbourne* - see Map p. 98

The Institute (AINSE) will make payments directly to the Janet Clarke Hall management for all bed and breakfast charges relating to the period of the AINSE Conference (i.e. nights of Sunday 2nd to Wednesday 5th February, 1986, incl.) if applicable, and subsequently recover from individual participants, any costs for which the individuals are personally liable under the terms set out in AINSE letters to the relevant group leaders.

LUNCHES Facilities are available on the campus for purchase of lunches. (Lunch is not available at Janet Clarke Hall).

EVENING MEALS

Evening meals are available at Janet Clarke Hall at a cost of $14.00 (Please add your name to the list provided in the kitchen when obtaining your meal). The Institute will pay charges directly to the management and recover these charges after the conference. Please advise Joan Watson (02) 543-3411 if you require an evening meal on Sunday 2nd February.

CONFERENCE DINNER - MONDAY 3RD FEBRUARY, 1986

Pre-dinner	-	Laby Theatre Foyer	5.00 - 6.00 p.m.
Dinner	-	Janet Clarke Hall	6.15 p.m.

PUBLIC LECTURE - TUESDAY 4TH FEBRUARY, 1986

Laby Theatre - 8.00 p.m.

"The Impact of Sixty Years of Quantum Mechanics"

Professor G.I. Opat

TELEPHONE MESSAGES

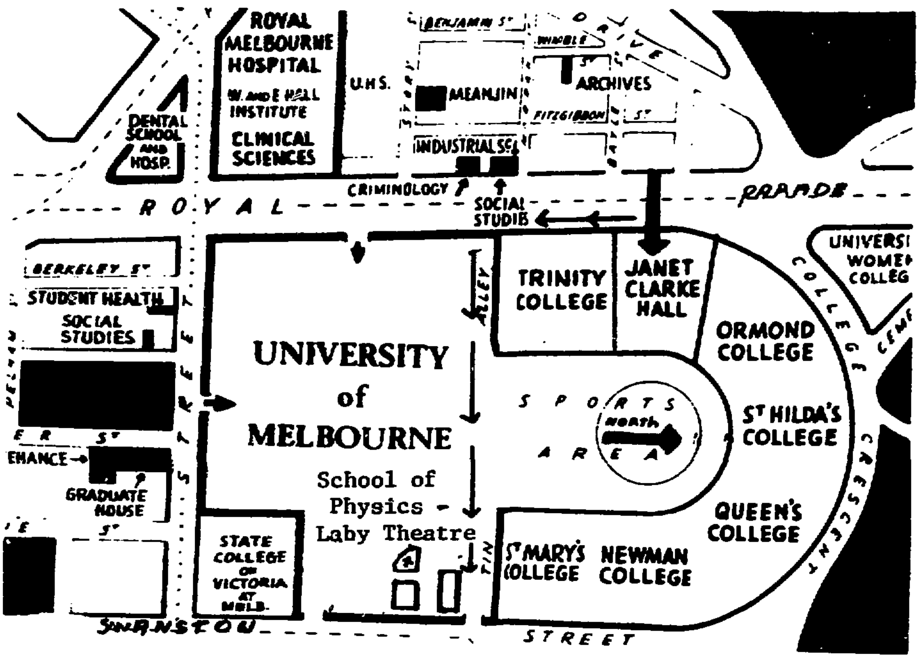
Telephone messages will be taken for participants in Melbourne on

(03) 344-5459 (03) 344-5454

All enquiries concerning the conference arrangements should be directed to -

Mrs. Joan Watson,
Conference Secretary,
A.I.N.S.E.
Private Mail Bag,
SUTHERLAND. N.S.W. 2232

Phone: (02) 543-3411



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