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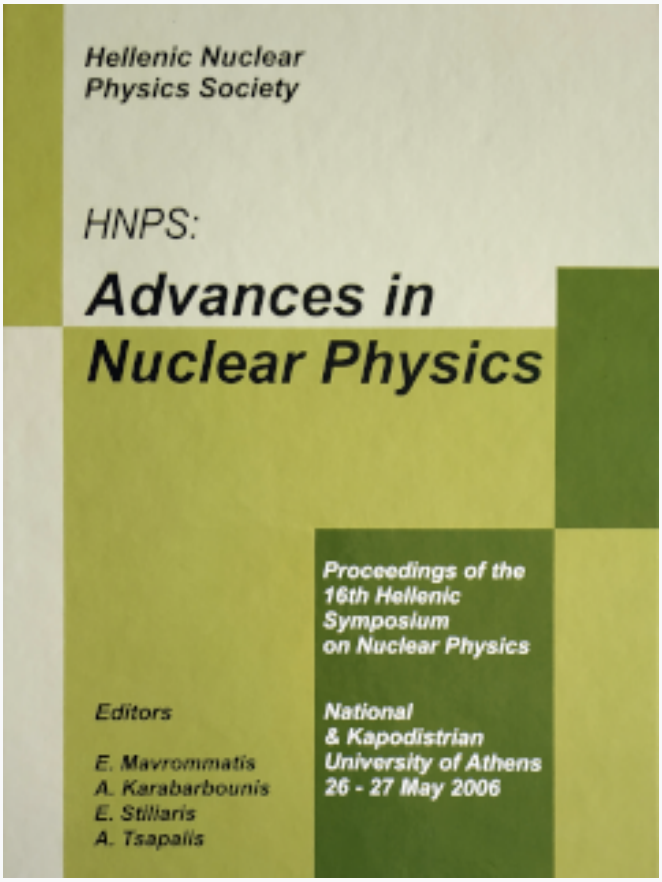

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THE PION CLOUD AND THE SHAPE OF HADRONS

C.N. Papanicolas [a*]

[a]Institute of Accelerating Systems and Applications and Physics Department, University of Athens, Athens,GREECE

Hadrons, complex objects made of quarks even though miniscule, have both size and a shape which can in certain cases be measured. There is no reason to expect that such complicated objects need to have spherical shape, especially if the role of the pionic cloud is taken into account. The conjecture of proton deformation, the only stable hadron, is vigorously being pursued both theoretically and experimentally, especially in the light of recent findings that strongly suggest that we need to abandon the concept of spherical hadrons. The presence of resonant quadrupole amplitudes in the transition to the only isolated excited state of the nucleon, the $\Delta(1232)$ resonance, is regarded as the definitive signature of deviation from the simplistic spherical models of the nucleon and of hadrons. Viewed in a broader context the detailed investigation of the N-$\Delta(1232)$ transition offers one of the best avenues to understand the structure of hadrons and the intricate dynamics of their constituents. An overview of the field both in terms of theory and experiment will be presented, followed by a more detailed presentation of the low momentum data and the first attempts to establish firm contact with QCD.

*e-mail: cnp@iasa.gr

FIRST OBSERVATION OF MUON NEUTRINO DISAPPEARANCE IN THE MINOS EXPERIMENT

George Tzanakos [a]

[a]Physics Department, University of Athens, Greece

The MINOS experiment was designed to make a precise study of the "atmospheric" neutrino oscillations observed in recent data from underground experiments. MINOS uses the NuMI neutrino beam at Fermilab, and two neutrino detectors with a mass of 980 ton and 5400 ton, located at distances of 1 km and 735 km from the neutrino source, respectively. The MINOS Far detector is located 713 m underground, in the Soudan mine, in Northern Minnesota. The MINOS Far and Near detectors were commissioned in 2003 and 2004 respectively, whereas the NuMI beam was commissioned in early 2005. Data taking with the NuMI beam started in March 2005 having at present accumulated neutrino interactions corresponding to 1.4×10^{20} protons on target (pot). In this work we will describe the MINOS experiment and present first results from the analysis of data corresponding to 0.93×10^{20} pot.

CRITICAL QCD PHENOMENA IN RELATIVISTIC NUCLEAR COLLISIONS

N.G. Antoniou [a]

[a]Department of Physics, University of Athens

The goal of a new generation of experiments with relativistic ions at CERN-SPS, BNL-RHIC, GSI-FAIR, and CERN-LHC is mainly the exploration of the QCD phase diagram in the neighborhood of the quark-hadron critical line. The behavior of strongly interacting matter in the vicinity of a critical endpoint at high temperatures and in particular the underlying universal critical fluctuations are basic elements of the deconfinement mechanism. Theoretical progress and experimental prospects for the discovery of the QCD critical point are briefly discussed.

DETECTION RATES OF COLD DARK MATTER CANDIDATES BY USING DEFORMED HARTEE-FOCK METHOD*

T. S. Kosmas[1] and R. Sahu[2]

[1] Division of Theoretical Physics, University of Ioannina, GR-45110 Ioannina, Greece
[2] Physics Department, Berhampur University, Berhampur 760007, India

Cross section calculations for the direct detection of cold dark matter candidates are performed for the ^{71}Ga and ^{73}Ge targets [1,2]. The dark matter candidate has been assumed to be the Lightest Super-symmetric Particle (LSP) with masses in the region of 100-130 GeV.

The relevant nuclear matrix elements (for coherent processes) have been obtained in the context of a deformed configuration mixing approach based on Hartree-Fock states [3,4]. This method is appropriate for descriptions of axially deformed medium heavy and heavy even-even and odd-even nuclei. The low-lying spectra for the ^{71}Ga and ^{73}Ge nuclear isotopes have been built on the reference nucleus ^{72}Ga studied recently in the framework of the deformed Hartree-Fock [1]. In addition, the method has been tested in the reproducibility of the experimental values for the nuclear magnetic moments, separately for the orbital and spin parts of the above nuclei.

As realistic two-body interaction we used the modified Kuo effective-interaction for the $f_{5/2}pg_{9/2}$ valence space [4]. The results are compared with previous results obtained by using the Quasi-particle Phonon Model (QPM) based on spherical basis which is reliable in describing odd-even nuclear system in that region of the periodic table [1,2].

The elastic scattering cross sections obtained, are much smaller compared to those of the QPM, as is the case in all shell model type methods where restricted model space is used. Currently elastic and inelastic scattering cross sections are investigated in the context of large-scale shell model.

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THE USE OF NUCLEAR TECHNIQUES IN ENVIRONMENTAL RESEARCH: ^{137}CS DETERMINED BY GAMMA SPECTROMETRY, AS A TRACER TOOL IN MARINE PROCESSES.

Florou H., Evaggeliou N., Psomiadou Ch., Zafiropoulou A.

N.C.S.R. "Demokritos", INT-RP, ERL

Abstract: Cesium – 137 activity concentrations in the Greek marine environment until 1986 varied from 2–4 Bq m^{-3}. After Chernobyl nuclear accident, the concentrations were increased over one order of magnitude. Local maximum of 160 Bq m^{-3}, about 80 times higher than those of pre – Chernobyl time, was observed in the mouth of Dardanelles Channel, in the northern Aegean Sea. According to the time series measurements, the concentration of ^{137}Cs tend to be reduced by a velocity dependent on water mass balance between Aegean and Black Sea, initial concentrations in Aegean and Black Sea, cesium sinking time and physical half life. As the water current movements seem to play a major role to the dispersion of cesium, one can note vice versa that the study of ^{137}Cs behavior comprises a tracer tool in marine environmental research for water mass circulation (recent relevant studies in the issue). Cesium – 137 activity concentrations were determined by using a high resolution gamma – spectrometry system of 90 % relative efficiency after in situ pre – concentration and radiochemical analyses of the samples.

Keywords: ^{137}Cs, marine radioactivity, gamma – spectrometry.

SPIN-SPIN INTERACTIONS OF ELECTRONS AND ALSO OF NUCLEONS CREATE ATOMIC MOLECULAR AND NUCLEAR STRUCTURES

L. A. Kaliambos

Institute of Larissa Komninon 15
Larissa 41223 Greece

Fundamental interactions of spinning electrons at an interelectron separation less than 578.8 *fm* yield attractive electromagnetic forces with S=0 creating vibrations under a motional *emf.* They explain the indistinguishability of electrons and give a vibration energy able for calculating the ground-state energies of many-electron atoms without using any perturbative approximation. Such forces create two-electron orbitals able to account for the exclusion principle and the mechanism of covalent bonds. In the outer subshells of atoms the penetrating orbitals interact also as pair-pair systems and deform drastically the probability densities of the quantum mechanical electron clouds. Such a dynamics of deformation removes the degeneracy and leads to the deviation from the Bohr shell scheme. However in the interior of atoms the large nuclear charge leads to a spherically symmetric potential with non interacting pairs for creating shells of degenerate states giving an accurate explanation of the X-ray lines.

On the other hand considerable charge distributions in nucleons as multiples of 2e/3 and –e/3 determined by the magnetic moments, interact for creating the nuclear structure with p-n bonds. Such spn-spin interactions show that the concept of the untisymmetric wave function for fermions is inapplicable not only in the simple p-n systems but also in the LS coupling in which the electrons interact from different quantum states giving either S=0 or S=1.

NUCLEAR β^+/EC DECAY HALF-LIVES CALCULATED WITH NEURAL NETWORKS

I. Kerasovitis[1], E. Mavrommatis[1], K.A. Gernoth[2] and J.W. Clark[3]

[1] Department of Physics, University of Athens, GR-15771, Athens, Greece
[2]Department of Physics, UMIST, P.O. Box 88, Manchester M60 1QD, United Kingdom
[3]McDonnell Center for the Space Sciences and Department of Physics, Washington University, St. Louis, Missouri 63130, USA

One of the principal challenges of nuclear astrophysics is to understand the various processes of nucleosynthesis and to explain the nuclear abundances [1]. These problems usually require the use of numerical simulations and calculations using among others weak interaction rates as input parameters. Nuclear structure research far from the stability is also interested in beta decay rates.

In this work [2] we focus on the modeling of β^+/EC decay half-lives. Some results have been obtained from macroscopic, semi-microscopic models i.e Gross theory and variations, Quasi-Particle-Random-Phase approximation [3]. We use the neural-network methodology by which global statistical models are constructed based on nonlinear regression [4]. Our neural networks are trained by back-propagation and related algorithms [5]. Subsequently improved results are obtained when evolutionary algorithms [6] are combined with back-propagation. Experimental information [7] is suitably encoded in the free parameters of the network model. Results will be presented for suitable statistical quantities of the prediction error for different nuclides (including those involved in rp-process). It is shown that predictive performance of our models is comparable with the one of the other macroscopic, semi-microscopic models.

TRACE ELEMENTS AND NATURAL RADIONUCLIDES IN THE MARINE SEDIMENTS OF PSYTTALIA-KERATSINI STRAIT (SARONIKOS GULF), GREECE

A. Moustakli[a], G. Papatheodorou[b], H. Papaefthymiou[a*]

[a] *Division of Physical, Inorganic and Nuclear Chemistry, Department of Chemistry, University of Patras, Patras 265 00, Greece. E-mail: epap@chemistry.upatras.gr*
[b] *Laboratory of Marine Geology and Physical Oceanography, Department of Geology, University of Patras, Patras 265 00, Greece. E-mail: George.Papatheodorou@upatras.gr*

Three sediment cores were collected using a 3m-long gravity corer (BENTHOS type) from the Psyttalia-Keratsini Strait, which is a heavily polluted area. Sewage from the Athens area was discharging through an outfall sewer at Keratsini coastal environment from 1950s to the late '90s. An integrated marine geological survey showed that the discharged sewage has formed a surficial layer of organic mud up to 6m thick which covers a seafloor area of about 2 km^2. Two sub-samples from each core (surface and subsurface samples), were analyzed for (i) trace element concentration using INAA and (ii) radionuclide specific activities using direct γ-ray spectrometry (DS). Prior to analysis the samples were air-dried, crushed to fine powder and homogenized. All samples were counted on a Canberra HPGe detector with an energy resolution of 1.9 keV at the 1.33 MeV of ^{60}Co γ-ray and relative efficiency 25%.

The elements As, Ba, Br, Ce, Co, Cr, Cs, Eu, Fe, Hf, La, Na, Nd, Ni, Rb, Sb, Sc, Se, Sm, Ta, Tb, Th, U, Yb, and Zn were determined in all the sediment samples. The majority of the elements present higher concentrations in surface sediments compared to those of subsurface. For a better estimation of the anthropogenic input, the Index of Geoaccumulation (I-geo) was calculated (Muller, 1979). All the sediments of the study area are heavy to moderate contaminated for As, Cr, Zn, Sb and Se as indicated by the elevated I-geo classes (2 to 4, 1 to 4, 0 to 4, 0 to 2 and 3 to 5, respectively).

The specific activities of the natural radionuclides ^{226}Ra, ^{232}Th, ^{226}Ra, ^{40}K and ^{137}Cs were determined in all sediment samples. The activities of ^{226}Ra ranging from 11.2 to 32.6 Bq kg^{-1} with an average value of 22.9 Bq kg^{-1}, activities of ^{232}Th are in the range 4.4 – 15.4 Bq kg^{-1} with an average value of 10.7 Bq kg^{-1} and those of ^{40}K ranging from 105 to 215 Bq kg^{-1} with an average value of 161 Bq kg^{-1}. ^{137}Cs was detected in all the sediments of the study area**,** with surface sediments presenting higher ^{137}Cs activity values (5.6-6.8 Bq kg^{-}1) compared to those of subsurface samples (0.7-3.5 Bq kg^{-1}). The specific activities of the measured radionuclides are within the world average values (UNSCEAR, 2000) and also comparable with those found in sediments of the Aegean Sea, except that of Milos island which is a volcanic area (Florou and Kritidis, 1991).

Considering secular radioactive equilibrium in ^{238}U series, the uranium concentrations in sediment samples calculated by INAA are all higher than that calculated by direct γ-ray spectrometry (eU) (U/eU is in the range 1.9-3.8), It should be mentioned that these differences does not attain significance (P=0.06) probably due to the small size of the dataset. These results may indicate a state that secular radioactive equilibrium in ^{238}U decay series is disturbed in the sediments from Psyttalia-Keratsini Strait. The radioactive disequilibrium may be attributed to the high accumulation rate of contaminants released by industrial and domestic effluents.

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RADIOLOGICAL IMPACT ASSESSMENT IN THE WIDE AREA OF THE METALLIC AND THERMOMETALLIC SPRINGS IN THE ISLAND OF IKARIA

Trabidou Georgia* **and Florou Heleny**

ERL/INT-RP/NCSR "Demokritos", Athens, Greece

The levels of natural radionuclides in metallic spring water (either for spa and household use), potable water (local domestic network), soil and rock samples were measured in the island of Ikaria in the Aegean Sea, Greece, by use of in situ and laboratory nuclear techniques. The concentrations of ^{222}Rn and natural gamma emitters were found to be significantly elevated in spring water and some soil and rock samples. In terms of pathway exposure to humans, external and internal dose rates calculations were carried out. The external and internal dose rates (μSv y^{-1}) were estimated in three critical groups according to the water use. The fluctuations of external and internal dose rates for the habitants, workers and spring water users were very high (Table 1). The maximum external dose rates were found to be at the upper limits of the levels reported in the literature. Moreover, high dose rates were estimated for the workers in spa installations.

Keywords: Natural radioactivity, radon spas, dose rate.

Table 1. Summarised results of dose rates to habitants, thermal spa workers and users of spa in the Ikaria (μSv y^{-1}).

Habitants	μSv y^{-1}
Dose equivalent rate due to terrestrial gamma radiation	200 – 3310
Effective dose equivalent due to the ^{222}Rn intake from potable water	30 – 114
Effective dose equivalent due to the ^{226}Ra intake from potable water	25 – 175
Effective dose equivalent due to the inhalation of ^{222}Rn released from potable water	0.36 – 85
Thermal spa workers	
Effective dose equivalent due to the inhalation of ^{222}Rn released from spa water	5000 – 35000
Spa users	
Dose rate due to γ-radiation during the immersion into bath water	0.0012 – 0.012
Dose rate due to ^{222}Rn radiation during the immersion into bath water	240 – 1700
Effective dose equivalent due to the inhalation of ^{222}Rn released from spa water	40 – 290