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IX SIMPOSIO INTERNACIONAL SOBRE QUIMICA NUCLEAR RADIOQUIMICA Y QUIMICA DE RADIACIONES

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PHOTONUCLEAR REACTIONS OF COMPLEX NUCLEI AT INTERMEDIATE ENERGIES*

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We have currently been performing radiochemical cross section measurements of photonuclear reactions of more than 25 targets from ^{7}Li to ^{209}Bi at bremsstrahlung end-point energies E_0=30-1000 MeV in steps of 50 MeV or less. In these energy ranges photons are absorbed by target nuclei through different types of resonance depending on photon energy, and photospallation process dominates in competing exit channels including fission, fragmentation and/or simple (γ, $\pi^{\pm}$xn) reactions. The initial interaction in photonuclear reaction *is purely electromagnetic and is quite different from that in hadron reaction. The initiation of* the cascade process at higher energies may occur deep inside the nucleus in a photonuclear reaction, while the hadron reaction is induced by hadron beam incidence from the outside of the nucleus. We have been looking for the characteristics of photonuclear processes and trying to find whether and how the yield distribution of the reaction products is affected by this difference in the initial interactions.

In the present talk, we first review our recent results of the work on photopion, photofragmentation, photofission, and photospallation reactions. We then describe some details of the systematics of photopion and photospallation yields. The latter involves the data analysis of 40 nuclides from ^{197}Au, 13 from ^{175}Lu, 52 from ^{139}La, 44 from ^{133}Cs, 28 from ^{127}I, 31 from ^{89}Y, 24 from ^{63,65}Cu, 27 from ^{59}Co and 22 from ^{51}V in terms of Rudstam's five-parameter (P, $\hat{\sigma}$, R, S and T) CDMD formula which was modified to include the corrections of the isobaric precursor decays. The expressions for the parameters P and $\hat{\sigma}$ obtained in the present analysis were found to be applicable to $51 \leq A_t \leq 133$ and different at $E_0 \geq 600$ MeV, $300 \leq E_0 \leq 600$ MeV, and possibly $100 \leq E_0 \leq 300$ MeV. For the heavier targets ($A_t \geq 140$), the P values appear to be smaller and the $\hat{\sigma}$ larger than the predictions of the proposed expressions. The parameter R was confirmed to be expressed as $R=d'A^{-e'}$, and the new values of d' and e' have been proposed. The values of S and T are essentially the same as those previously reported by Jonsson and Lindgren. The yields of the products near the targets of $51 \leq A_t \leq 197$, from (γ , xn) reactions at $E_0 \geq 300$ MeV or possibly $E_0 \geq$ threshold, were found to be expressed as a function of A_t and x. Implications of the newly derived expressions are discussed in the light of reaction mechanism, comparing with those of hadron reactions and photon-induced cascade analysis calculation of Gabriel and Alsmiller.

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* The work has been undertaken by collaboration with S. Shibata of Institute for Nuclear Study, University of Tokyo, I. Fujiwara of School of Economics, Otemon Gakuin University and the author's students of Kanazawa University.

RC-4

PHOTOCHEMICAL REACTIONS OF CuInSe2 THIN FILMS IN SULPHURIC ACID SOLUTION

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When electrodeposited on SnO_2, $CuInSe_2$ thin films appear as p-type semiconductors. The photoresponse of such semiconductors has been studied in sulphuric acid aqueous solutions, as well as in a (0.1M H_2SeO_3 + 0.5M H_2SO_4) aqueous solution.

In this latter case, besides the photocurrent response, the formation of a selenium thin film was observed.

The results for hydrogen production in the $CuInSe_2$ thin films or in the newly formed phase ($CuInSe_2/Se$), accordingly, are presented and compared with those obtained with usual metallic electrodes.

MX9200204

RC 5

THE INFLUENCE OF IONIZING RADIATION ON THE FORMATION OF POLYMERIC MATERIAL FROM AQUEOUS MALONONITRILE

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The CN group might have made it appearance in the early stages of chemical evolution, for this reason the radiolytic behavior of nitriles have relevance to the study of prebiotic chemistry.

A systematic study of the influence of the irradiation on nitriles and dinitriles have been carried at ICN. In this paper we present the formation of polymeric material from the γ irradiation of aqueous solutions of malononitrile 0.1 M, oxygen free, at their natural pH's.

The analysis of the radiolytic product was by exclusion chromatography, some characteristics of the polymer material were found by IR spectroscopy, Biuret test, etc.

The results showed that in this system several polymeric materials are formed with a molecular weight about 10,000 daltons.

RC6

[illegible]

ACTION OF GLOW DISCHARGE ON ORGANIC SOLIDS: PRIMARY RADIATION-CHEMICAL PROCESSES,FORMATION OF RADICAL DISTRIBUTION,RADICAL REACTIONS AND APPLICATION.

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In this report the new experimental method for solving the problem of the radical recombination in organic solids is suggested. The act of recombination requires diffusion , encounters and the reaction between radicals. To understand the regularities of the recombination demands independent investigation diffusion and reaction as well. Untill now the application of electron spin resonance for investigation of the radical recombination yielded only the dependence of the amount of the radicals N(t) in the sample on time and did not allow to solve the problem of the limiting stage of the recombination process.

Therefore we developed methods of generation of the well-defined radical distributions, f(r), and the methods of investigating the changing radical distribution during recombination, f(r,t) to obtain information about the regularities of diffusion itself. Combining this information with the dependence of N(t) a conclusion about the limiting stage can be made.

The initial radical distribution was prepared in glassy alcohols having used glow discharge for radical generation. Glow discharge generates the radicals near the surface. The characteristic depth of radical generation is between 100A - 10 micron and depends on the type of generator, the nature and pressure of gas, and the time of treatment.

Determination of the distribution functions was based on the investigation of the dipole-dipole interactions between radicals. In this way, the information about the changing distribution function during the action of the glow discharge was obtained and the model describing the radical accumulation during the action of glow discharge was developed. Having used the distribution functions f(r,t) and the radical amount, N(t), during recombination, we obtained the specific rates of recombination ,k, and the diffusion coefficients,D, of the different alkoxil radicals in the temperature interval 120-150K.

It was shown that for all radical systems under investigation $k/k_d << 1$, i.g. these reactions are under kinetic control.

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RC 7

IDENTIFICATION OF IRRADIETED MANGOES BY THE ELECTRON SPIN RESONANCE TECHNIQUE.

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The espectrometric technique of Electron Spin Resosonance (ESR) is based in the detection of magnetic centers, a property that free radicals present due to the odd electron. This property has been used for the identification of irradiated foods.

The technique has rendered good results for the identification of several irradiated fruits.

In this work the technique was used to identify irradiated mangoes in the Tommy Alkins, Haiden, and Ataulfo varieties.

Doses of 0.0,0.15, 0.30, 0.75, and 1.00 KGy. were applied and the samples werw stored for 0, 24, 48, 72, and 96 hours post-irradiation. After the elapsed time the samples were vacuum dried or Lyophilization, and afterwaeds their spectrum was taken. A significative diference was found for each of the treatments, specially for the 0.75 and 1.00 KGy.

ELIMINATION OF ORGANICS CHEMICHALS IN AQUEOUS SOLUTIONS BY GAMMA RADIATION PROCESSING

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ABSTRACT

The objetive this work was to evaluate the gamma radiation processing for elimination of organic contaminants on industrial wastewater. Standard samples with 17 hydrocarbons (acetophenone, anisole, benzene, chlorobenzene, cyclohexanone, N,N-dimethylaniline, phenol, naphthalene, 1-chloronaphthalene, n-octadecane, p-nitrotoluene, toluene, tetrachloroethane, tetramethylbenzene, n-undecane, m-xylene and o-xylene) was prepared in hexane with total concentration of $1 \mu g/\mu l$ which was analized by gas chromatography. Other sample with the same concentration of these hydrocarbons in acetone was used to contaminate water samples, which were irradiated with gamma radiation from Co-60 between doses 5.0 to 20.0 KGy and dose rate of 1.162 KGy/h. The activity of source was 1470 Ci. Percents destruction of hydrocarbons were: 79.76% to 5.0 KGy, 85.97% to 7.5 KGy, 86.24% to 10.0 KGy, 86.72% to 12.5 KGy, 88.92% to 15.0 KGy, 91.74% to 17.5 KGy and 92.38% to 20.0 KGy. The conclusion of this paper is that the radiation processing is efficient to eliminate hydrocarbons on aqueous solutions in direct proportion to the processing doses at this dose rate.

RC 9

CHARACTERIZATION OF MMA/LDPE COPOLYMER FILMS OBTAINED BY GAMMA RADIATION

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Gamma induced grafting in crystalline or vitreous polymers produces a number of polymer radicals which remain trapped in the rigid polymer matrix. Grafting takes place during the diffusion process and it is accomplished as soon as the polymer is swollen upon which the radicals acquire enough mobility to combine among them. Since graft polymerization involves processes such as polymeric free-radicals generation, monomer molecules penetration and incorporation into the polymer matrix, it provides a promising field for the application of the Positron Annihilation Lifetime (PAL) technique. In the present work PAL was applied to the study of the microstructure of the graft copolymer of methyl methacrylate (MMA) onto low-density polyethylene (LDPE). Micrographs were taken along the copolymer formation process which show a characteristic morphology of graft copolymers. Direct method of g-induced graft polymerization was the best technique to carry on the preparation of the MMA/LDPE copolymer.

RC10

IMPEDANCE MEASUREMENT OF IRRADIATED POTATOES:
A METHOD TD IDENTIFY RADIATION PROCESSING

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Radiation-induced chemical interactions may be manifested by a change in physical properties. Besides the nucleus, membranes are vital targets during cell irradiation. Membranes of living tissue, regardless of plant or animal origin, play a vital role for the selective transport of ions. A change in membrane properties may be traceble by a change in ion transport mechanism implicating a shift in electrical impedance.

The potato is firmly established in many parts of the world as a major staple food. Then, radiation processing of potato is aproved in many countries for sprouting inhibition and extension of shelf life in a dose range from about 0.01 to 0.15 kGy of ^{60}Co.

The use of electrical conductance methods for the detection of salmonella, some virus or the action of herbicides on plant has been reported and differences have been observed between instruments in respect of the magnitude of conductance change or rates of change in conductance response.

A reliable techique to identify irradiated potatoes or other food products has not been established so far, though several methods have been reported. Electrical impedance migth thus serve for characterization of unirradiated and irradiated tissue and cells. In this work, potato tubers from an European variety, named Bintje, grown in São Paulo State were employed. Potatoes were punctured with steel electrodes and impedance measured at different frequencies (1kHz-100kHz) by passing 3-5mA alternating current through it. The impedance ratio of 50kHz/5kHz calculated from ten replicate samples decreased with the increment of dose when doses of 0, 0.075 and 0.15kHz from a Gammacell 220 were utilized. The impedance measurements were slighty affected by the place of puncture but not by storage up to 3 months.

MX9200218

RC 11

REDUCTION OF PHENOLS, DETERGENTS AND COLIFORM BACTERIA IN SAMPLES OF WASTEWATER BY GAMMA RADIATION PROCESING.

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ABSTRACT

The objetive this paper is to find the stage on the conventional treatment of wastewater in which is more convenient the application of gamma radiation for the reduction of toxic chemicals and coliform bacteria. Samples of wastewater wiht different grade of contamination from primary and biological treatment of a plant of wastewater municipal and industrial. Samples were irradiated with 10 diferent doses between 6 to 37 KGy (using Cobalt-60 from 25 KGy/h). Doses between 6 to 10 KGy reduced the population of coliform bacteria even 5 orders of magnitude. Had not find specific dose of radiation to reduce phenols, but it were best eliminated when their initial concentration was between 7 to 20 mg/l. The detergents were significatively reduced with doses between 20 to 30 KGy when their initial concentration was between 3 to 4 mg/l. It is very important to mention that the reduction of phenols and detergents were greater in samples irradiated after biological treatment that samples irradiated after primary treatment. However the reduction of coliform bacteria was on the same magnitude in both.

THE LETHAL EFFECT OF GAMMA IRRADIATION ON THE METACESTODE OF *Taenia solium* IN PORK

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With the objective of interupting the cycle of the parasite *Taenia solium*, which is a public health problem in Mexico, the 100% lethal dose of gamma radiation from cobalt-60 for the larval or metacestode phase was determined in meat seized from different slaughterhouses and in experimentally infected hogs. The sensory characteristics of uninfested meat, irradiated to a determined dose, was evaluated. Metacestodes irradiated with doses between 4.9 and 11.8 kGy were submitted to tests of evagination *in vitro* to evaluate their viability. Doses of 6.5 kGy or more were lethal for the larvae. The larvae irradiated to 7 kGy were inoculated by oral means in immunosuppressed hamsters. Development of tapeworms or of the adult phase in the intestines was not seen, in contrast to groups of control hamsters where growth occurred. By means of sensorial analysis of the meat by comparative differential tests, changes in smell and flavor were detected which were statistically insignificant. It is concluded that gamma irradiation is an effective method to control parasites which are transmitted by foodstuffs.

RC 13

EFFECTS OF CHAIN ORIENTATION ON THE RADIATION RESPONSE OF ATACTIC POLYSTYRENE

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ABSTRACT

Chain orientation of an amorphous (one component-one phase system) atactic polystyrene PS, was cuantitatively measured by a suitable rheo-optical method: infrared linear dichroism. Oriented and unoriented thin films were irradiated with low energy electrons (175 keV) in air atmosphere, at doses up to 450kGy. Gel permeation chromatography analysis was performed to evaluate the molecular weight distribution. The results do not reveal significant differences between the two kind of samples, which confirms the great resistance of PS to radiation.

CRYSTALLITE SIZE DISTRIBUTION IN THE SYNTHESIS OF γ-LiAlO$_2$

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ABSTRACT

γ-LiAlO$_2$ is being strongly considered as a tritium breeder material because of its thermophysical, chemical and mechanical stability at high temperatures and its favorable irradiation behavior. Crystallite size is expected to alter these features.

Crystallite size mean value may be misleading, if crystallite size ditribution is bimodal or trimodal.

In this work, the crystallite size distribution and the mean value size of γ-LiAlO$_2$ crystallites are compared and correlated to the synthesis procedure of this material. A computer program based on indirect Fourier transform was used.

MX 9300222

SORPTION OF RADIOACTIVE COBALT BY SEPIOLITE.

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Ionic exchange is an effective method to purify the waste water containing ^{60}Co which has a 5.3 year half life. Zeolites and clays are known to be excellent ionic exchangers, they are often used to sorbe radioactive wastes.

In this work Na – $^{2+}$Co (^{60}Co labelled) kinetics exchange is studied using sepiolite (natural clay from Vallescas, Spain*).

The results are compared to those reported previously using erionite (natural zeolite from Sonora, Mexico). In both cases the identification of compounds and the cristallinity was determinated by X-ray diffraction.

Sepiolite exhibits a higher exchange percent than erionite and, therefore, is recommended to purify waste water containing ^{60}Co.

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*Provided by F. Melo as part of the program V of the Cyted-D.

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RC-16

FAST SUCCESSIVE CHARGE CAPTURES IN THE POSITRON SPUR BY HALOGENATED COMPOUNDS IN METHANOL

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Introduction. The formation of positronium (Ps), the bound-state of a positron (e^+) with an electron (e^-), in liquids is well described by the so-called "spur model"[1], which essentially proposes that Ps is formed by the reaction of e^+ with one of the e^-'s released by ionisation of the medium at the end of the e^+ track. This would occur in competition with other reactions such as electron-cation recombination. The very small region of the liquid containing the reactive, labile species involved represents the "spur". However, there are still many characteristics of the e^+ spur which are poorly known, such as its size or the number of species. In a previous work, the possibility of having successive reactions of e^-, then of e^+ capture by a solute was assessed, and evidenced, by using a halogenated compound, $HgCl_2$, in polar solvents. Owing to the very short time scale involved (ps), the existence of such reactions is not granted a priori, and the experimentally derived parameters should give more information on some of the spur characteristics. This work was therefore extended to the study of various organic chloro and iodocompounds in methanol.

Results and discussion. By combining the two techniques of lifetime spectroscopy and Doppler broadening of the annihilation radiation lineshape, it is confirmed that halogenated compounds (RX, where X is the halogen) react successively with an electron ($RX + e^- \longrightarrow RX^-$), resulting in Ps formation inhibition, then with the positron, to form a bound-state ($RX^- + e^+ \longrightarrow [RX^-e^+]$). By comparing the Doppler parameters of the latter with those of the corresponding halide bound-state, $[X^-e^+]$, it is found that there is no halide detachment after e^- capture. In all cases, the Ps inhibition constants and the e^+ bound-state formation constants are very close. This would suggest that the number of spur electrons which are effectively available for Ps formation is close to unity.

NAT 1

APPLICATION OF THE SPECIES EXISTENCE-PREDOMINANCE AND DISTRIBUTION DIAGRAMS TO THE PLUTONIUM AND AMERICIUM ELECTRODEPOSITION

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In a previous work[1], the construction of species existence-predominance diagrams for a lanthanide (samarium) has been showed.
Now we present a set of species existence-predominance and distribution diagrams for plutonium and americium in function of the sulfate concentration and pH. In these diagrams, different chemical species of both elements are shown. For the plutonium diagrams the different oxidation states are considered and for plutonium and americium the appearance of solid phases like oxides or hydroxides can be observed. The diagrams are an interesting tool to predict the optimal experimental conditions in function of sulfate concentration and pH for the deposition of plutonium and americium as hydroxides and/or oxides by electrolytical means. Also, the precipitation conditions differences for both elements are analyzed.

(1). Becerril A., Rojas A., Meas Y., Int. J. Radiat. Appl. Instrum.., Part C. Radiat. Phys. Chem. 38, No. 2, p250 (1991).

NAT2

11Y9300225

FAST REACTIONS IN THE POSITRON SPUR IN POLAR SOLVENTS

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Numerous experiments have been aimed at establishing the bases of the spur model of positronium (Ps) formation. In essence, the model proposes that Ps, the bound-state of an electron with a positron (e^+), is formed by the reaction of e^+ with one of the electrons released by ionisation of the medium, at the end of the e^+ track. This would occur in competition with other processes, such as solvation and pair recombinations. in a small region containing several radiolytic, labile species and constituting the "spur".

In polar solvents, an outstanding argument in favour of the model consists in the strong correlations found between the ability of a solute (S) to inhibit Ps formation (measured by the inhibition constant, k) and either the reaction rate constant of S with the solvated electrons (k_s) or its constant for scavenging the non solvated electrons (K_{37}).

Still, several characteristics of the spur are unknown, such as its size or the number and distribution of the reactive species. Recent experiments have been performed to unravel some of these unknowns, by using specific solutes and mixtures of solutes. In spite of the very short times involved, within picoseconds, it appears that consecutive reactions can take place, such as electron capture by a solute molecule followed by either positron capture by the same molecule, or electron transfer to another solute molecule. These results contain potential information on some important features of the spur. In particular, it is shown that, probably because of the rapidity at which solvation occurs, only one of the spur electrons has a chance to reach e^+ and form Ps. These data should prove very useful for any theoretical approach to the non homogeneous spur processes.

NAT 3

PIXE ANALYSIS SETUP USING A PROTON IN AIR BEAM FACILITY AT THE ININ

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One of the most useful techniques implemented in many small accelerator laboratories around the world, is that of PIXE, in which multi elemental analysis is performed based on proton induced characteristic X-rays, with samples prepared and confined for use in a vacuum scattering chamber. However, these vacuum conditions are not always apropiate for volatile and liquid samples to be analyzed directly, or for specimens whose dimensions and characteristics turn out to be inadequate for the vacuum chamber's conditions. With this in mind, we designed, constructed and tested an experimental arrangement in which a proton beam is extracted to air through a thin foil (kapton, aluminum), in order to perform the PIXE analysis in open atmosphere conditions, using a Si(Li) detector and a conventional electronic arrangement for the corresponding pulse analysis.

In this work, we present the overall characteristics of the experimental arrangement, as well as some preliminary results obtained from the analysis of liquid samples prepared for the purpose of testing our facility.

NAT4

N93-22227

POSITRONIUM INTERACTIONS WITH TRANSITION METALS IN SODIUM DODECYL SULFATE MICELAR SYSTEMS (SDS).

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Coordinación de Proyectos Especiales.

OBJECTIVE:

To determine the Ps reactivity toward Cd^{++}, Zn^{++} and Co^{++} in SDS aqueous solutions comparing micellar and homogeneous systems.

METODOLOGY:

1. In order to determine the rate constant of Cd^{2+}/Ps, Zn^{++}/Ps and Co^{2+}/Ps reactions, aqueous solutions of the metals chlorides were prepared from 0.0 M to 0.25 M.
2. To determine the SDS critical molar concentrations (CMC), SDS aqueous solutions were prepared from 0.0 to 0.2 M.
3. To determine the Ps reactivity toward Co^{++} in SDS micellar and homogenous aqueous systems, SDS aqueous solutions were prepared by using 0.02 and 0.005 molarities respectively and, Co^{++} concentration was varied.

All these systems used liquid $Na^{22}Cl$ as a positron source (6 µCi) and degassed under vacuum by a freeze-thaw technique to remove oxigen and the vials sealed off. Positron lifetime measurements were carried out at 20°C and by the usual fast coincidence γ-γ system.

RESULTS AND DISCUSSION.

The variations of $1/\tau_2$ vs: $CdCl_2$, $ZnCl_2$ and $CoCl_2$ concentration are linear and they can be described by:

$$1/\tau_2 = 1/\tau_2^\circ + k'c$$

where: τ_2 & τ_2° are the o-Ps lifetime at the concentration C of solute and in the pure solvent, respectively, and k' is the rate constant with the resulting values:

$$k_{Cd^{2+}} = 0.00432, \quad k_{Zn^{++}} = 0.0429$$

$$k_{Co^{++}} = 1.699 \ ns^{-1} \ mol^{-1} \ dm^3$$

Cd and Zn were found virtually unreactive toward Ps and, therefore only Co^{++}/Ps interactions in SDS micellar and homogenous solutions were studied.

N92-20228

SAT 5

EMISSION MOESSBAUER SPECTROSCOPIC STUDIES ON MIXED-VALENCE STATES OF Fe-57 ATOMS PRODUCED IN Co-57-LABELLED TRINUCLEAR COBALT-IRON CARBOXILATES

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In order to clarify the chemical effects of EC-decay on the valence state, a series of Co-57-labelled trinuclear cobalt-iron carboxylate complexes, $[Co^{II}Fe^{III}{}_2O(CH_{3-n}X_nCO_2)_6(H_2O)_3]$, $(X = Cl, Br, \text{or } I; 0 \leq n \leq 3)$, were investigated by means of emission Moessbauer spectroscopy.

It has been found that emission Moessbauer spectra of the complexes show temperature dependences of mixed-valence state similar to those found in the absorption Moessbauer spectra of analogous trinuclear $[Fe^{II}Fe^{III}{}_2O(CH_{3-n}X_nCO_2)_6(H_2O)_3]$ complexes. $[Co^{II}Fe^{III}{}_2O(CH_3CO_2)_6(H_2O)_3]$, $[Co^{II}Fe^{III}{}_2O(CCl_3CO_2)_6(H_2O)_3]$ and $[Co^{II}Fe^{III}{}_2O(CH_2ICO_2)_6(H_2O)_3]$ show temperature-depending trapped-to-averaged type spectra, which consist of two doublets ascribed to an Fe(II) and an Fe(III) state at 78 K and become nearly one single component ascribed to an averaged-valence state with an increase in the temperature. $[Co^{II}Fe^{III}{}_2O(CH_2ClCO_2)_6(H_2O)_3]$, $[Co^{II}Fe^{III}{}_2O(CHCl_2CO_2)_6(H_2O)_3]$ and $[Co^{II}Fe^{III}{}_2O(CH_2BrCO_2)_6(H_2O)_3]$ show an Fe(II) and an Fe(III) state even at room temperature. It is suggested that most of Fe-57 atoms produced by the EC-decay recover the valence state remaining in their original trinuclear molecular structure.

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MX9300229

ALPHA-PARTICLE SPECTRUM OF ^{222}Rn AND ITS DAUGHTERS USING SILICON SURFACE-BARRIER DETECTORS

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A method for measuring the ^{222}Rn isotope which utilises silicon surface-barrier detectors is described. This procedure makes possible a well identification of alpha particle spectrum of ^{222}Rn and its daughters (^{218}Po, ^{214}Po and ^{210}Po isotopes). The source of ^{226}Ra was electroplated on stainless-steel discs previously polished. The ^{222}Rn was obtained from the discs after ^{226}Ra was dissolved with concentrated nitric acid.

The radon-222 was rested on the discs, this isotope was measured for 15 days and its radioactive decay was observed.

MX9300230

NAT 7

EFFICIENCY CURVE DETERMINATION OF Si (Li) DETECTOR

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Si(Li) detectors are widely utilized in X-Ray energy spectrometry, in this paper we discuss the experimental method to obtain Si (Li) detector's efficiency, based on the analysis of selected thin targets spectra using PIXE and Rutherford backscattering techniques.

The experimental points are then proposed to fit a function based in a Si (Li) detector model derived by PAJECK(*). The parameters involved in this function (ice layer, uniform Si-dead layer relative peripheral area and peripheral Si dead layer), which are taken as free parameters, are discussed as well as the results obtained.

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NAT8

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DETERMINING URANIUM ENRICHMENT BY GAMMA SPECTROMETRY

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Unexplored aspects of the method of determining uranium enrichment by gamma spectrometry were investigated in uranium compounds in radioactive equilibrium, based on measurements and comparison of the gamma radiation spectra of uranium-235 and protactinium-234m without using standard samples. The study presents results essential to the successful experimental implementation of the determination.

A method was develope to minimize ln k, where k is the ratio of the radioactivities of ^{238}U to ^{235}U. A careful statistical study permitted determining the degree of enrichment of uranium with less than a 3% deviation for samples of powdered UO_2 with masses which varied from 13 to 300 g. The source of this small variation may be geometric factors or physical-chemical factors within the sample. Studies in progress are attempting to specify the source of this variation to reduce the error of the method. Possible errors in the gamma ray intensities from these radionuclides are also under investigation.

The method has been applied to natural UO_2 and to verify enrichments which varied from 5% to 20%.

MX9300232

PIXE ANALYSIS SETUP USING A PROTON IN AIR BEAM FACILITY AT THE ININ

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One of the most useful techniques implemented in many small accelerator laboratories around the world, is that of PIXE, in which multi elemental analysis is performed based on proton induced characteristic X-rays, with samples prepared and confined for use in a vacuum scattering chamber. However, these vacuum conditions are not always apropiate for volatile and liquid samples to be analyzed directly, or for specimens whose dimensions and characteristics turn out to be inadequate for the vacuum chamber's conditions. With this in mind, we designed, constructed and tested an experimental arrangement in which a proton beam is extracted to air through a thin foil (kapton, aluminum), in order to perform the PIXE analysis in open atmosphere conditions, using a Si(Li) detector and a conventional electronic arrangement for the corresponding pulse analysis.

In this work, we present the overall characteristics of the experimental arrangement, as well as some preliminary results obtained from the analysis of liquid samples prepared for the purpose of testing our facility.

NAT10

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APPROXIMATED EXPRESSION FOR THE DISPERSION EPR PROFILE

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The shape of the absorption line in Mössbauer, EPR, and other spectroscopies can be represented by means of the Voigt profile if the Lorentzian spectral lines are folded with Gaussian distributions. These distributions describe the random processes that affect the absorption and emission mechanisms. Nonetheless in some spectroscopical applications the dispersion profile is also of great usefulness. In this work an approximated expression for the dispersion line that takes into account internal and external random phenomena is presented. The expression is obtained by taking the Hilbert transform of an approximated expression for the Voigt profile. The resulting approximated dispersion profile is valid in the interval $a >> 1/\sqrt{2}$, where a is a parameter that characterizes the Voigt profile. In this way a pair absorption-dispersion is available to fit experimental data to extract information concerning the nature of spectral lines and the instrumental resolution.

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NAT

SPECTROPHOTOMETRIC METHOD FOR THE DETERMINATION OF THORIUM IN URINE USING ANIONIC RESIN AND ARSENAZO (III)

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In this paper we present an analytical procedure for the determination of Thorium in Urine. It can be analysed 80 nanograms of the element in 100 ml of sample. The Th --- present is coprecipitated with Calcium nitrate, phosphoric acid and ammonium hydroxide.
The precipitate is dissolved in nitric acid and the Th - is separated by anionic resin. The fixed Th is eluted -- with chlorhidric acid, and arsenazo (III) is employed to develop the color for final spectrophotometry.

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^{10}Be AND ^{26}Al PRODUCTION CROSS SECTIONS WITH 12 GeV PROTONS MEASURED BY ACCELERATOR MASS SPECTROMETRY

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Formation cross sections for long-lived radioisotopes such as ^{10}Be and ^{26}Al with high-energy protons are indispensable to solve the reaction mechanism of spallation and fragmentation, and also provide important keys to decipher fossil records stored in terrestrial and extra-terrestrial materials. However, the information about their production cross sections seems to be still insufficient. Therefore, we have measured the cross sections of ^{10}Be and ^{26}Al from Al, Fe. Co, Ni, Cu, Zn, Ag and Au targets with 12 GeV protons by accelerator mass spectrometry (AMS).

The irradiation was carried out at the 12 GeV proton synchrotron, National Laboratory for High Energy Physics (KEK) in 1981. The number of protons irradiated was measured to be 1.57×10^{14}. The irradiated targets were dissolved in acid after addition of Be and Al carriers. The Be and Al fractions were separated and purified by anion and cation exchanges. The produced ^{10}Be and ^{26}Al were measured by AMS using the 4 MV tandem accelerator at the Research Center for Nuclear Science and Technology, University of Tokyo.

The obtained cross sections were compared with those appeared in references, and agreed well within the experimental uncertainties. The ^{10}Be cross sections increased with the increment of target mass. For ^{26}Al the cross sections decreased from Al to Ag target but somewhat increased from Ag to Au target.

ANALYSIS OF PRECOLOMBIAN MEXICAN GOLDEN PIECES BY X-RAY FLUORESCENCE SPECTROMETRY.

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PreColombian golden pieces were analyzed, to know their alloy composition and correlation with others from different Mexican cultures. Also, they were compared with Roman golden pieces.

X-Ray Fluorescence Spectrometry was used to obtain characteristic spectrums of those pieces. An experimental mercuric iodide detector, from the University of California, coupled with a MCA and PC computer was utilized to make such analysis.

Some pieces, with known-origin, were analyzed and those spectrums could be used as "standards" for identification of unknown-origin or lost pieces.

This research was a joint project among Instituto Nacional de Investigaciones Nucleares, Instituto Nacional de Antropología e Historia, University of Rome, University of California and International Atomic Energy Agency.

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MX9300237

DETERMINATION OF U-235 ENRICHMENT ON URANIUM MATERIALS BY GAMMA SPECTROMETRY

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The gamma spectrometry has proven to be a reliable, fast and accurate nondestructive analytical method. It is based on the measurement of the isotopic gamma rays which provides an unique characterization of nuclear materials.

Briefly, the U-235 enrichment analysis by gamma spectrometry relies on an accurate intensity measurement of the 185.7 keV gamma rays from U-235 in a well defined and calibrated geometry. The calibration of the spectrometer was made with six samples of U_3O_8 *reference materials supplied by New Brunswick Laboratory with certified enrichments of 0.5 %, 1 %, 1.5 %, 2 %, 3 % and 5 % U-235/U.*

In the present work, it was found that the intensity of the 185.7 keV gamma peak is directly proportional to the U-235 concentration in the samples. Several corrections to the measured count rate for the 185.7 keV photo-peak were applied including the interference from Pa-234, Pa-234m, Ra-226 and absorption in the container.

The system used for this project consists of a high purity germanium detector, low noise electronics, a computer based analyzer system and a graded shielding to minimize radiation background.

The conclusion is that the system is well suited for continuos in-line measurements in uranium processing facilities.

NAT 15

ESR-TRIS SYSTEM AS A GAMMA DOSIMETER

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ABSTRACT

The ESR readout of free radical concentrations produced upon irradiation of tris (hydroxymethyl) aminomethane was studied in order to analyze its possible use in high dose level gamma dosimetry.

The ESR-tris system permits determination of absorbed doses in the range from 5 - 10^5 Gy with an uncertainty of 3% and exhibiting negligible fading at room temperature.

NAT16

COMPARISON OF RADIOCHEMICAL AND SPECTROPHOTOMETRIC DETECTION METHODS FOR HPLC-SEPARATED Cr(III) HYDROLYTIC SPECIES

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Chromium, in aqueous solution, may be present in either the (VI) on the (III) oxidation state. The Cr(III) species include monomeric, dimeric, trimeric and higher polymeric species which must be separated chromatographically for accurate determination of species distribution.

The separation of several Cr(III) hydrolytic species can be carried out using small, low pressure ion exchange columns. This procedure is time consuming and leaves some doubt as to the identity of the post-monomeric species, since the eluents impede post-elution analysis.

This study reports the use of small particle bonded phase ion exchange materials, using an appropriate HPLC system, to improve the separation of these hydrolytic species. Detection of the eluted species was carried out spectrophotometrically or by monitoring the radioactive (Cr-51) content of collected fractions.

Since the hydrolytic species absorb visible light (410 nm) very poorly, the spectrophotometric detection limits for the separated species were enhanced using post-column derivatization, with a FIA type system in which each eluted species was oxidized to Cr(VI) by Ce(IV), then converted to the Cr(VI)-diphenylcarbazide complex for detection at 540 nm. Detection limits were thus extended to below 10 ppm.

Use of the Cr-51 tracer permitted quantitative comparisons of the fractions separated using the low-pressure column and HPLC column techniques, as well as those obtained with and without post-column derivatization.

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