Isometric levels in the region of heavy nuclei

Nucleus	Configuration	Spin	Excitation energy (MeV)	Nucleus	Configuration	Spin	Excitation energy (MeV)
Bi^{210}	$\{g_{9/2}, h_{9/2}\}$	9	~0.25	At^{214}	$\{g^3_{9/2}, h^3_{9/2}\}$	21	~3.5
Bi^{211}	$\{g^2_{9/2}, h_{9/2}\}$	25/2	~0.8	Rn^{216}	$\{g^4_{9/2}, h^4_{9/2}\}$	24	~5.0
Po^{211}	$\{g_{9/2}, h^2_{9/2}\}$	25/2	~1.2	Ra Th	$\{i^2_{11/2}, f^2_{7/2}\}$	16	~3—4
Po^{212}	$\{g^2_{9/2}, h^2_{9/2}\}$	16	~2.9		$\{i^2_{11/2}, i^2_{13/2}\}$	22	
Po^{214}	$\{g^4_{9/2}, h^2_{9/2}\}$	20	~4.0	U Pu Cu	$\{g^2_{7/2}, i^2_{13/2}\}$ $\{j^2_{15/2}, f^2_{5/2}\}$	18	~3—4

(s = seniority) for configurations whose Nordheim number is even (region of heavy nuclei). This is equally true for both odd-odd and even-even nuclei and for odd A nuclei. We note that the isomeric levels caused by np forces can be both low-lying and high-lying with respect to the ground state, from 100 keV to 5 MeV.

The following fact extends the region of the nuclei in which isomeric levels can be observed. Upon removal from the twice-filled shells the neutrons, as well as the protons separately, may be distributed simultaneously over two or more levels. If the nucleons at all these levels, except for one neutron level j_1 and one proton level j_2, are bound into states with zero angular momenta, then the splitting of the multiplet under the effect of the np forces is determined by the properties of the configuration $\{j_1^{n_1}, j_2^{n_2}\}$. In other words, the nucleons in states with zero angular momenta play no part in extending the configuration under consideration, and thus the assumption made above can be used to identify isomeric levels.

We must make special mention of isomerism in the region of transuranium elements. This region is characterized by the fact that several configurations, in which the nucleons are distributed over the levels in different fashion, will simultaneously be the lowest in energy. These configurations will also include those conducive to the formation of isomeric states. It is only if levels of other configurations with similar spin values should chance to be below this level that isomerism will not take place or will be attenuated. The table shows the isomeric levels in the region of heavy elements, their configurations, spins, and approximate excitation energies.

Thus, high-lying isomeric states must occur fairly frequently. The observation of isomeric levels in nuclei with short-lived ground states is of particular interest. In addition, the identification of these isomeric levels, and also the determination of their lifetimes, makes it possible for us to obtain more accurate knowledge of the nature of np interaction in nuclei.

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DIFFUSION LOSSES OF C^{11} NUCLEI IN PLASTIC FILMS ACTIVATED BY HIGH-ENERGY PROTONS

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In many experiments [1] it is necessary to measure the intensity of the internal proton beam in an accelerator. Usually activated carbon-containing materials are used for this purpose. The intensity of the proton beam is determined from the number of produced β-active nuclei C^{11} ($C^{11} \rightarrow \beta^+ + B^{11} + \nu$). It was observed, however [2-4], that a definite part of the C^{11} nuclei in films made of polyethylene and other carbon-containing materials is lost upon irradiation in the accelerator, as a result of the diffusion of the gaseous products which are formed during the irradiation. Fuchs and Lindenberger [3] have shown that these losses are essentially due to realignment of the molecular

chains in the plastic. When polyethylene films are irradiated, gaseous products are formed, viz: methane, acetylene, and ethylene, which diffuse from the sample within a time that depends on the thickness. In the same paper [3] it was observed that the activity losses may differ in different batches of the same material. It is obvious that this effect can introduce a considerable error in the measured values of the cross sections. We therefore found it advantageous to measure the diffusion losses of C^{11} nuclei in sample of the polyethylene which was used in the particular experiment [1]. Stacks of polyethylene films 0.2 to 20 mg/cm^2 thick and stacks of ethylene copolymer with propylene of equal thickness were irradiated by the internal proton beam of the proton synchroton at 9 GeV. The films stacked to avoid activity loss due to the recoil nuclei. To determine the percentage loss due to diffusion, a polystyrene sample (plastic scintillator) 95 mg/cm^2 thick, whose diffusion losses do not exceed (0.8 ± 0.1) per cent (according to [2]), was placed in the stack. The number of C^{11} nuclei in the films and in the plastic scintillator was measured by counting the β particles with scintillation counters. A brief description and the parameters of this installation are given in [5]. The main measurement error is due to the uneven thickness of the film. In different exposures, values from 9 to 14 per cent were obtained for the diffusion losses in the polyethylene and in the copolymer of ethylene with propylene. By averaging the data for the diffusion losses from these materials, a value of (11.8 ± 1) per cent was obtained. It was found that the losses depend neither on the radiation intensity nor, in a wide range, on the energy and character of the irradiating particles.

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EFFECT OF AN INTENSE LIGHT BEAM ON MATTER AND PARTICLE BEAMS IN A MAGNETIC TRAP

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In this note we consider possible methods of filling a magnetic trap with fast ions; these are produced either by the disintegration and expansion of dense matter heated and ionized by an intense flash of focused light, or by the effect of an intense light beam on a beam of fast particles injected into a trap.

1. Filling a trap with ions in heating of matter by light in a magnetic field. The heating of ions by electron collisions in the interaction of a focused beam of coherent light with matter is not very effective. [1] To obtain high ion temperatures by this method it is necessary to have high electron temperatures; however, high electron temperatures are difficult to achieve because radiation losses increase with temperature. Moreover, the electron collision frequency decreases with increasing temperature ($\nu \sim T^{-3/2}$) and this leads to a sharp drop both in the absorption of optical energy by the electrons and in the rate of energy transfer from the electrons to the ions. (The transfer time $t \approx M/m\nu \sim T^{3/2}$ becomes greater than the expansion time and the temperatures cannot come to equilibrium with each other.)

We believe that the interaction of light with dense matter in a magnetic trap is more effective because, in the expansion of the plasma that is formed, the plasma pressure causes a direct