ized G_{eff} and ϵ_α values into the BCS equations. Both these methods give nontrivial solutions, no matter how weak the pairing-force strength. Such new methods appear to be of great importance in pairing-force calculations where small or no configuration mixing would appear in the ordinary BCS solutions.

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New Isotope In^{124}†

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Irradiation of Sn^{124} samples with 14–15-MeV neutrons was found to produce a new radioactive nuclide which was assigned to In^{124}. The following radiation characteristics have been observed to belong to the decay of In^{124}: half-life, 3.6 ± 1.0 sec; beta end-point energy, 5.3 ± 0.8 MeV; gamma rays having energies 1.13 ± 0.01 MeV, 0.99 ± 0.02 MeV, and 3.21 ± 0.03 MeV, and relative intensities 100, 33 ± 7, and 33 ± 7, respectively.

THE investigation of In^{124} has been a continuation of recent work on indium isomers of mass numbers 118, 120, and 122, in connection with the systematic study of energy levels in the even tin isotopes.[1] The indium isomers were produced in (n,p) reactions in various samples of enriched tin isotopes, by irradiating them with 14–15-MeV neutrons from the neutron generator at the University of Arkansas. The same procedure was apparently favorable in the case of In^{124}, too. Because the activation cross section of the (n,p) reaction in Sn^{124} turned out to be several times smaller than that of the reaction Sn^{122} $(n,p)In^{122}$, a sample containing 300 mg of 96% enriched metallic Sn^{124} was needed (supplied by Stable Isotopes Division, Oak Ridge National Laboratory, Oak Ridge, Tennessee). In order to obtain satisfactory statistics, the pulse-height spectra had to be accumulated from several hundred short runs. Typically, some 1000 counts were collected to the gamma-ray peaks of the new activity in the spectra, the background not being higher than that within the peak. The stability of the electronics was carefully checked and the shift in calibration amounted to less than 1% during every experiment.

The detectors used in the investigation were two 3×3-in. NaI(Tl) crystals and one $1\frac{1}{2}$-in. diameter, 1-in. deep plastic beta detector. A fast pneumatic transport system was available to bring samples to the detection room. For details of irradiation and detection techniques used, see Ref. 2.

None of the radiations from other indium isomers previously detected after short irradiations of enriched samples of Sn^{118}, Sn^{120}, and Sn^{122} were observed from the fast transport Sn^{124} capsule, chemically identical and bombarded under the same conditions. This supports the fact that the 3.6-sec activity is a neutron-induced reaction product of Sn^{124}. The dominating activities in the Sn^{124} sample were N^{16} from contaminating oxygen and a 40-min Sn^{123} as a $(n,2n)$ product of Sn^{124}.

In the decay of In^{124}, as in the decay of every indium isomer studied earlier, the first excited 2^+ state of the product nucleus could be expected to be populated at least in part of the disintegrations. The first excited state of Sn^{124} is well known to lie at 1.13 MeV,[3] and as anticipated a gamma ray of energy 1.13 ± 0.01 MeV was observed in the singles gamma spectrum of the irradiated Sn^{124} sample, exhibiting a much more rapid decay than N^{16}. Two other gamma rays of energies 0.99 ± 0.02 MeV and 3.21 ± 0.03 MeV were found to follow the same decay rate as the 1.13-MeV gamma. The relative intensities of the 0.99 and 3.21-MeV gammas were measured to be 33 ± 7% of the intensity of the 1.13-MeV gamma. The result, 3.6 ± 1.0 sec, for the half-life was obtained by following the decay of the photopeaks of the three gammas in many consecutive spectra.

The beta spectrum was badly masked by the strong betas from N^{16}, but by comparing the spectrum of the Sn^{124} sample with the pure N^{16} spectrum, a short-lived excess of about 10% was found in the former. The half-life of the fast decaying part of the spectrum was found to agree within the limits of error with the gamma half-life. The beta spectrum had the main component with

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the end-point energy of 5.3±0.8 MeV and a possible component with 2 MeV higher end point, the latter had much lower intensity and was discarded because of the danger of the summing of the coincident gamma rays to the main beta component. The subtraction of the higher energy component did not change the end-point energy of the 5.3-MeV component, therefore the value is believed to be free from gamma contribution.

The coincidence gamma spectrum taken with the beta crystal biased integrally at 1.3 MeV, established the feeding of the 0.99- and 1.13-MeV gammas by strong beta rays. This experiment shows that the new nuclide is beta active, with the beta-decay energy more than 3 MeV.

The gamma-gamma coincidences were studied with sum-peak spectrometry. A double sum-peak was observed at 2.19±0.03 MeV, clearly showing the coincidence of the 1.13- and 0.99-MeV gammas. The energy difference between the sum peak and the arithmetic sum of the gamma-ray energies is in agreement with the nonlinearity of NaI(Tl) detectors.[4] On the basis of the absence of a sum peak with an energy of ~2.3 MeV, it is concluded that more than 70% of the 1.13-MeV peak is due to a single gamma, therefore, the multiplicity of the first excitation energy observed in the decay of the other high-spin In isomers, is less than 30% of the 1.13-MeV peak in the decay of In^{124}. The possible coincidence of 3.21-MeV gamma between 0.99- and 1.13-MeV gammas was not conclusively established partly because of the strongly interfering gammas from N^{16}, and partly because of the large escape probability of one or both annihilation quanta from the 3.21-MeV gamma. This produces secondary sum peaks which remain poorly resolved.

The observed feeding of 2.12-MeV level by strong beta rays rules out all other reaction products of Sn^{124} except $In^{124}(n,p)$ and $Cd^{121}(n,\alpha)$. Yamada and Matumoto[5] predict the beta disintegration energy of 7.4 MeV for In^{124} and 4.6 MeV for Cd^{121}. If the 5.3-MeV beta component would feed the level at 2.12 MeV, the total beta-disintegration energy would coincide with the predicted value for In^{124}. This feeding, although likely, could not be conclusively shown. Therefore, the assignment of the 3.6-sec activity to In^{124} is based on the energy fit between the observed gamma-ray energy of 1.13 MeV and the known first excitation energy of Sn^{124}. Furthermore, there are pronounced similarities in the decay of the odd-odd indium isomers.[1] The same systematic features are evident also in the decay of the 3.6-sec activity.

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Shell-Model Calculation of the Even-Parity States of Ne^{20}†

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The nuclear shell model has been applied to calculate the positive-parity energy levels of Ne^{20}. The problem of four interacting particles in the 2*s*-1*d* shell has been solved for low-lying states using a technique which is particularly suited to automatic computation. The resulting energy levels are in quite good agreement with the experimental results for a reasonable internucleon potential.

I. INTRODUCTION

THE nuclear shell model has met with considerable success in describing the properties of nuclei which are close in the periodic table to closed-shell nuclei. An extensive theory, initiated by the work of Racah, has been developed for the purpose of classifying and computing nuclear states in the shell model. Despite the generality of these methods, calculations for systems of more than three nucleons have rarely been attempted, particularly in the full intermediate coupling scheme. The reason for this is that it is necessary to compute and diagonalize very large matrices since the number of possible configurations increases rapidly with increasing particle number.

In view of the increasing importance of large scale automatic computation it is desirable to develop techniques which are readily adaptable to machine calculation even though they may be less efficient. It is the purpose of this paper to describe one such method and its application to the positive-parity states of the Ne^{20} nucleus.

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