Краткие сообщения ОИЯИ №5[38]-89   JINR Rapid Communications No.5[38]-89
УДК 539.172.17

FIRST OBSERVATION OF THE NEUTRON-RICH NUCLEI ^{42}Si, $^{45,46}P$, ^{48}S and ^{51}Cl FROM THE INTERACTION OF 44 MeV/u $^{48}Ca + ^{64}Ni$*

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The five new very neutron-rich isotopes of ^{42}Si, $^{45,46}P$, ^{48}S and ^{51}Cl are identified from the interaction of a 44 MeV/u ^{48}Ca beam with a ^{64}Ni target.

Наблюдение новых нейтроноизбыточных ядер ^{42}Si, $^{45,46}P$, ^{48}S и ^{51}Cl в реакции $^{48}Ca + ^{64}Ni$ (44 МэВ/А)

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В реакции $^{64}Ni + ^{48}Ca$ (44 МэВ/А) синтезированы пять новых сильнонейтроноизбыточных изотопов ^{42}Si, $^{45,46}P$, ^{48}S и ^{51}Cl. Идентификация производилась комбинацией магнитного анализа, измерения времени пролета и ионизационных потерь ($\Delta E, E$)-техникой.

In recent experiments at GANIL with intermediate-energy ^{48}Ca beams a number of new neutron-rich isotopes has been observed and studied for the first time /1-3/ . Though the neutron drip-line has been reached for light isotopes up to fluorine /1,2/ , for nuclei closer to the projectile still several isotopes of each element are predicted to be particle-stable /4/ and remain to be observed.

Experiment performed at the French National Facility GANIL.

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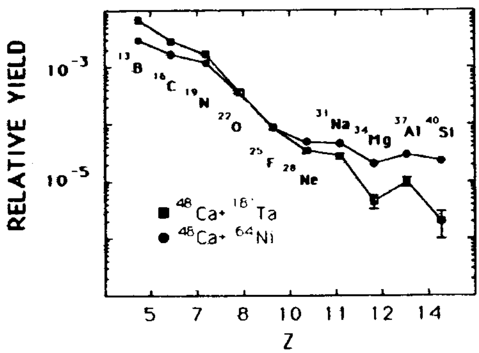

Fig. 1. Isotopic production along a line given by neutron number N = 2Z – 2 for the nickel and tantalum targets.

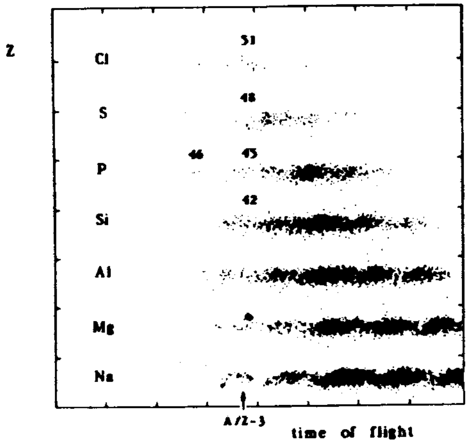

Fig. 2. Two-dimensional plot of atomic number Z versus time of flight through the LISE spectrometer for projectile-like fragments from the reaction ^{48}Ca (44 MeV/u) + ^{64}Ni. The mass numbers of the five isotopes observed for the first time are indicated.

Here we would like to report on the production and identification of five new isotopes with an atomic number from 14 to 17.

Essentially the same experimental set-up consisting of the magnetic spectrometer LISE with a four-stage semiconductor telescope in the focal plane were used as described in detail in ref. /2/ and /5/. The simultaneous measurements of ΔE-E, magnetic rigidity and time of flight provided redundant fragment identification in atomic mass and number. The magnetic rigidity of the spectrometer was set to a value $B\rho$ = = 2.603 Tm, optimized for the production of nuclei around ^{48}S. The counting rate for these nuclei was studied for three different targets of equivalent energy-loss (94 mg/cm^2 ^{9}Be, 131 mg/cm^2 ^{64}Ni and 173 mg/cm^2 ^{181}Ta) in order to examine the target influence on the production. Figure 1 shows, for example, the isotopic production along a line with neutron number N = 2Z – 2 for the Ni and Ta targets. It is clear that the very neutron-rich ^{64}Ni target (^{nat}Ni contains 0.91% of ^{64}Ni) gives the highest counting rate for isotopes close to the projectile. The production for the Be target (not shown in fig. 1) was slightly above the level of the Ta target. This result is in contrast to the behavior for light nuclei for which the Ta target was the most efficient one /2/. It is however difficult to disentangle the complicated interplay between reaction cross sections, effective number of target nuclei, number of neutrons in target and projectile nuclei, and changing velocity and angular distributions (leading to a different transmission of the spectrometer). Clearly, more comprehensive studies are needed to understand the rather strong effects at intermediate energies.

Figure 2 shows a particle-identification plot of the projectile-like reaction products from the interaction of $^{48}Ca + ^{64}Ni$ at 44 MeV/u after about 15 hours of collection time at an average beam intensity of I = = 100 enA. The isotopes of ^{42}Si, $^{45,46}P$, ^{48}S and ^{51}Cl are identified for the first time. It is worth mentioning that all of them have a neutron number N > 27 indicating that they are produced in transfer reactions.

The predictions of different mass-formulae compiled by Haustein [4] suggest that none of the five new isotopes observed in this experiment is the last stable isotope of corresponding element. It is somewhat surprising to observe, however, that ^{46}P is relatively strongly produced whereas not a single count is present for ^{49}S for which one would expect (notwithstanding the above considerations) a similar yield. Additional, the present level of statistics precludes any conclusion on the possible particle instability of ^{49}S . On the other hand, it may be worth noting , that three (i.e. Comay et al., Tachibana et al. and Janecke-Masson) out of six mass-formulae [4] predict the particle-instability of ^{49}S , whereas ^{50}S is bound again.

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Recieved on November 24, 1989.