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# NEGATIVE PION CAPTURE IN HETEROGENEOUS MIXTURES OF ELEMENTS

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Абазов В.М. и др. **E15 - 12013**

Поглощение отрицательных пионов в гетерогенных смесях элементов

Сообщаются результаты эксперимента по определению вероятности захвата медленных отрицательных пионов в химических соединениях ZnSe и CdTe и соответствующих механических смесях. Показано, что размеры зерен порошка в смесях элементов оказывают существенное влияние на относительную вероятность образования мезоатомов.

Работа выполнена в Лаборатории вычислительной техники и автоматизации ОИЯИ.

Препринт Объединенного института ядерных исследований. Дубна 1978

Abazov V.M. et al. **E15 - 12013**

Negative Pion Capture in Heterogeneous Mixtures of Elements

The relative probabilities of stopped pion capture in chemical compounds ( ZnSe and CdTe ) and the proper mixtures ( Zn + Se and Cd+Te ) have been determined. The results of experiments show that grain sizes affect the pion absorption probability of mesic atom.

The investigation has been performed at the Laboratory of Computing Techniques and Automation, JINR.

Preprint of the Joint Institute for Nuclear Research. Dubna 1978

Negative slow meson stopping in matter has been a subject of interest for a long time [1]. This problem has been covered in numerous experimental and theoretical papers. However, many details of this phenomenon remain not cleared out. In particular, there are no experimental data on the competition between the moderation and the atomic capture of mesons [2].

The study of the effect of chemical binding on the probability of pion atomic capture is of special interest. Usually, the probabilities of mesic atom formation in the chemical compounds and mixtures of elements are compared to distinguish mesochemical phenomena.

Thus, Grin and Kunselman [3] have found, when investigating the X-ray intensity of pionic atoms in chemical compounds, that the intensity ratio of 4f–3d transition in Zn and Se is 5.6 times greater for ZnSe than for a mixture of the same elements. At the same time the intensity ratio of the 5g–4f transition in Cd and Te being both in a compound and a mixture remain constant.

Up till now nobody could state uniquely the reason of such a strong effect observed in the ZnSe compound. Several reasons could be given for this effect.

First, this phenomenon can be caused by the chemical binding effect on mesic atom formation probability.

Second, it can be explained by the effect of the chemical binding on the structure of mesic X-ray series. Third, such an anomaly can be due to the sizes of powder grains in the mechanical mixture of elements. However, no experimental evidence for the dependence of the probability of meson capture on the sizes of powder grains has been given.

Recent calculations by H.Daniel[4] show that the sizes of powder grains in mixtures can considerably affect the relative probability of mesic atom formation.

The present paper describes the study of chemical compounds ( ZnSe and CdTe ) and the proper powder mixtures ( Zn+Se and Cd+Te ). An earlier proposed method[5] has been applied which is based on the measurement of the radioactivity of residual nuclei produced in pion absorption.

Powders of about 20 *g* put into plastic capsules were irradiated by the slow pion beam of the JINR synchrocyclotron . Pion beam intensity during the irradiation of all targets was kept constant.

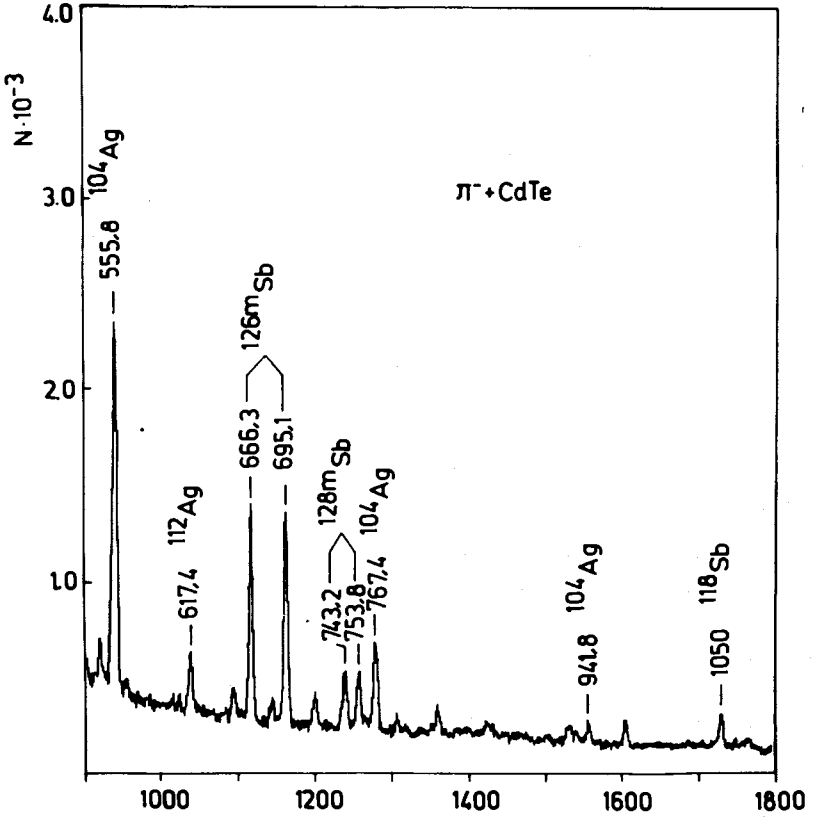


*Fig. 1. A part of the gamma-ray spectrum of isotopes produced in pion capture by the* CdTe *compound.*



Targets of powder mixtures were composed of identical weight ratios as the corresponding chemical compounds. Special measures have been taken to mix powders uniformly.

Irradiation, "cooling" and measuring times were identical for both compounds and mixtures and equal to 60, 5 and 60 minutes, respectively, to an accuracy of 5 *sec.*

The measurements were performed in strictly equal geometries in the same conditions of spectrometer operation.

*Figures 1-4* show the parts of the gamma spectra of Ag , Sb , Cu and As isotopes produced in pion absorption by nuclei of the elements under investigation.

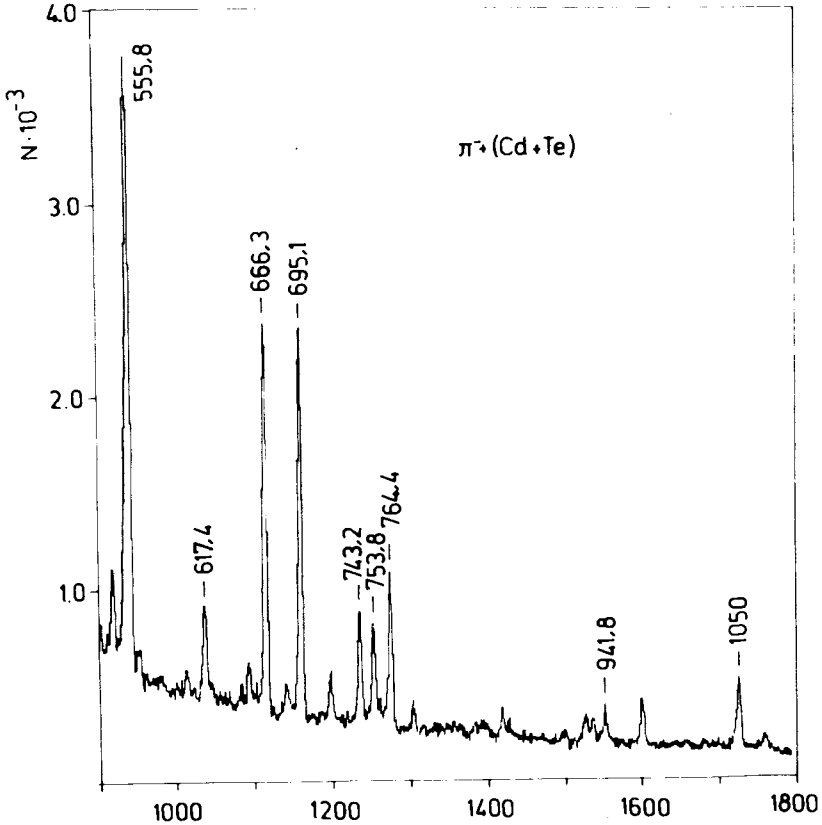


*Fig. 2. A part of gamma-ray spectrum of isotopes produced in pion capture by the* Cd+Te *mixture.*

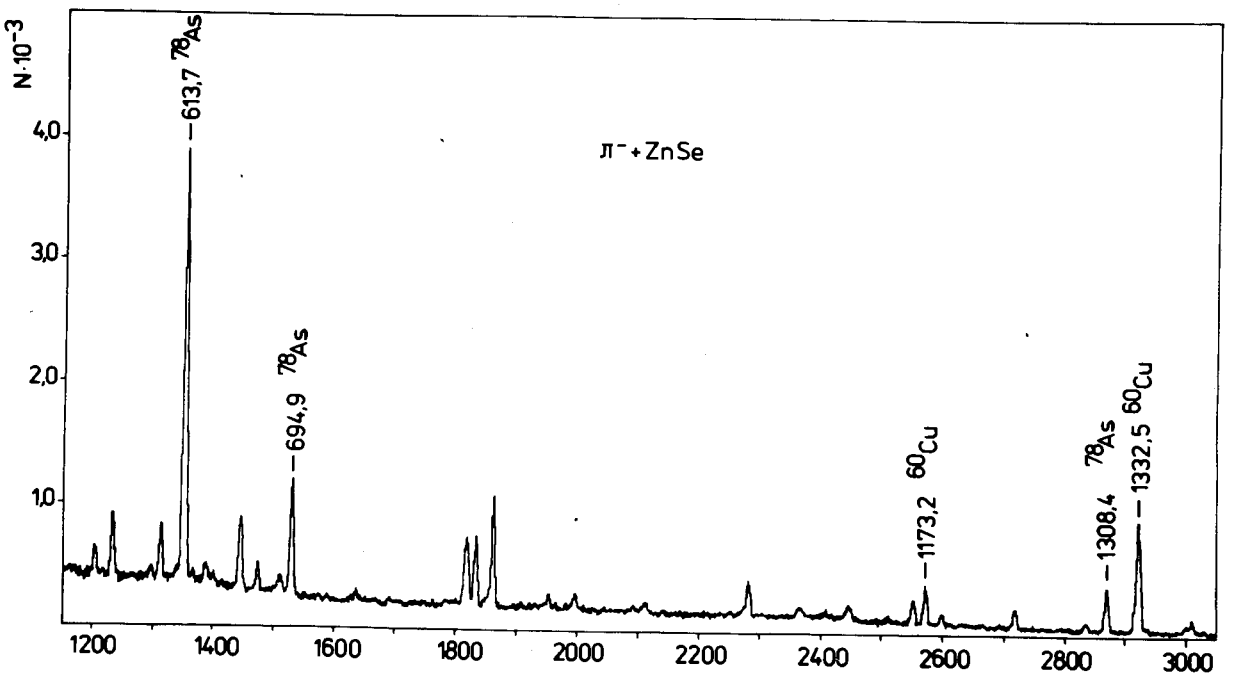


*Fig. 3. A part of the gamma-ray spectrum of isotopes produced in pion capture by the* ZnSe *compound.*

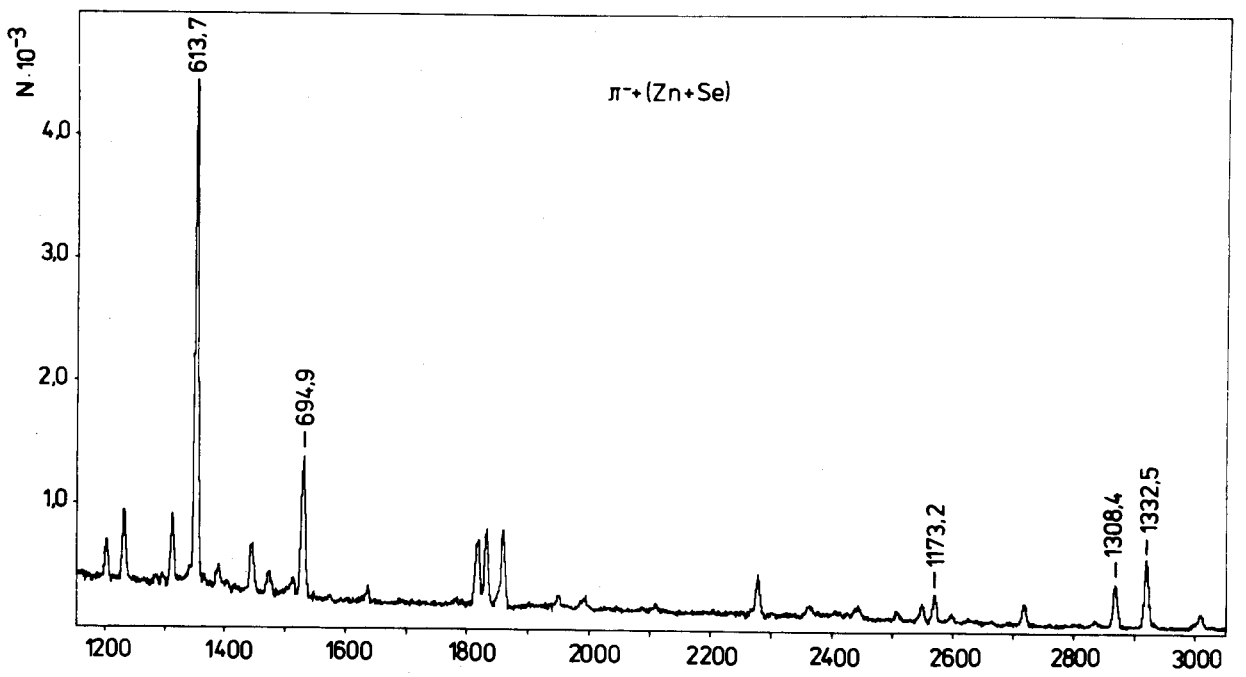


*Fig. 4. A part of the gamma-ray spectrum of isotopes produced in pion capture by a* Zn+Se *mixture.*

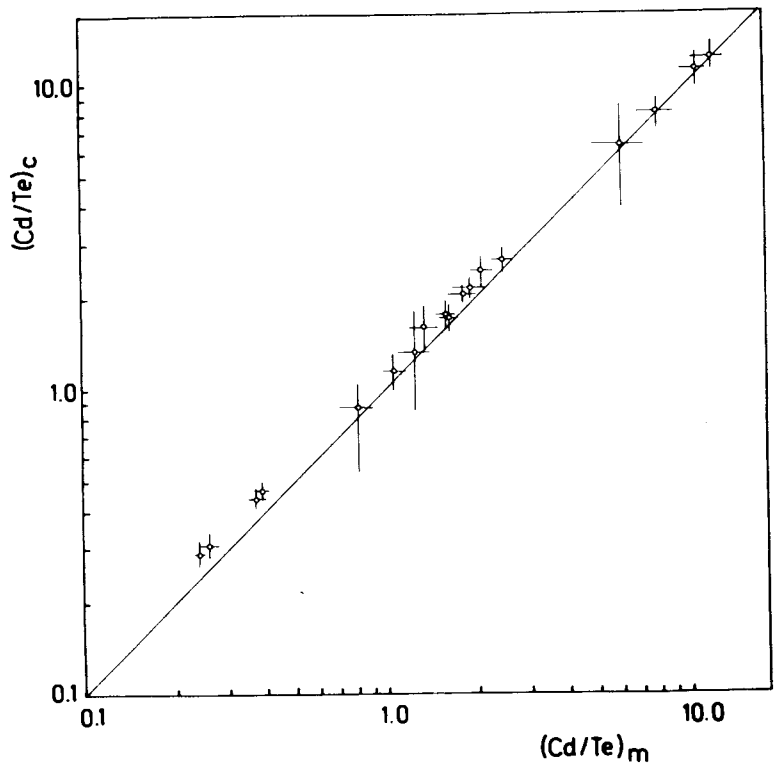


*Fig. 5. The gamma-ray intensity ratios of the products of* $Cd+\pi^-$ *and* $Te+\pi^-$ *reactions. The ordinate is the value of the mixture. The absciss is the values for chemical compounds.*

*Figures 5* and *6* show the ratios of gamma-ray intensities of the above isotopes produced in compounds and mixtures.

One can see that the ratio of the mesic atom formation probability in Cd and Te in this experiment was independent of the target type. This result agrees with the data of ref.[3]. Note that the sizes of Cd and Te powder grains were identical in our experiment and amounted to $10\,\mu$.

In the experiment with Zn and Se powders the sizes of Se powder grains varied from $10\,\mu$ to $1000\,\mu$, while the sizes of Zn powder grains did not vary.



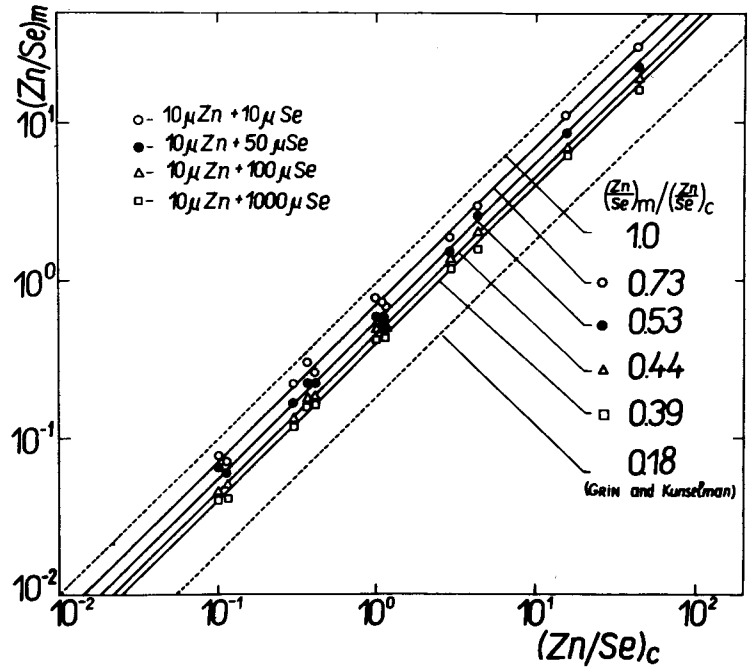


*Fig. 6. The gamma-ray intensity ratios of the products of* $Zn+\pi^-$ *and* $Se+\pi^-$ *reactions. The ordinate is the values of powder mixtures having various grain sizes. The absciss is the values for a chemical compound.*

The results of our experiments (*Fig. 6*) show that the larger the grains of one of powder components ( Se in this case), the greater the probability of pion stops in these grains. The probability of pion absorption in a mixture approaches that in a compound if smaller powder grains of both elements are taken.

Thus, one can assume that the observed anomaly in ZnSe is connected with the effect of grain sizes on the pion absorption probability in a powder mixture of Zn and Se. Dashed lines in *Fig. 6* represent the data of Grin and Kunselman[3].

It should be emphasized that special care should be taken when studying mesochemical effects on heterogeneous mixtures of elements.

Evidently, the elemental analysis by means of mesic X-rays [6] requires detailed knowledge on the spatial distribution of elements in samples, which is not always possible. Therefore, in contrast to the neutron activation analysis the mesonic method seems to be rather qualitative than quantitative.

And at last, the dependence of the mesic capture probability on the sizes of powder grains can prove useful for some fields of technology, in particular, in powder metallurgy.

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