Experimental study of alpha-induced nuclear reactions on Tellurium isotopes for the astrophysical γ-process

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Astrophysical γ-process

The p-isotopes are those heavy, proton rich isotopes, which cannot be created by neutron capture reactions in the s- and r-processes.

Heavier p isotopes can be produced via the γ-process. The path of the process can be followed with network calculations.

These calculations include over 20000 reactions. Theoretical cross sections are very sensitive to the alpha-nucleus optical potential.

The studied reactions

- The alpha-nucleus optical potential can be studied with alpha-induced reaction cross section measurments
- (α,n) reactions close above the threshold can provide valuable information
- The aim of the present work is to measure (α,n) cross sections on tellurium isotopes. For ^{120}Te(α,n) there are data in the literature*. Our plan is to measure (α,n) cross section on three other isotopes: ^{122,124,130}Te.

A. Palumbo et al., Phys. Rev. C 85, 028801 (2012)

Experimental techniques

- Solid state targets: Vacuum evaporation of natural Te targets on Al carrier foils
- Proton RBS for the target thickness measurment (α-RBS, PIXE planned)
- Activation technique: The ATOMKI cyclotron particle accelator has been used to provide an alpha beam with 17 MeV and 12 MeV for the first test experiments. After the irradiation of the targets, the activity of the produced Xe isotopes was measured using a HPGe detector.

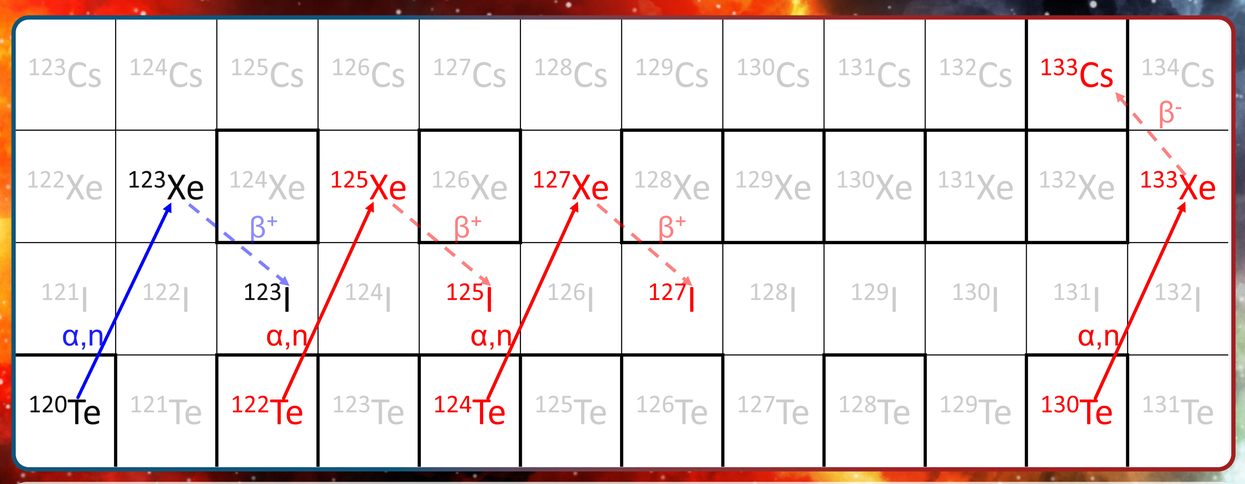

Figure 1: Schematic figure about the reactions. The red labeled nuclei show our targets, the products and their decay daughter nuclei. The ^{120}Te(α,n)^{123}Xe shown in blue was measured by A. Palumbo et al.

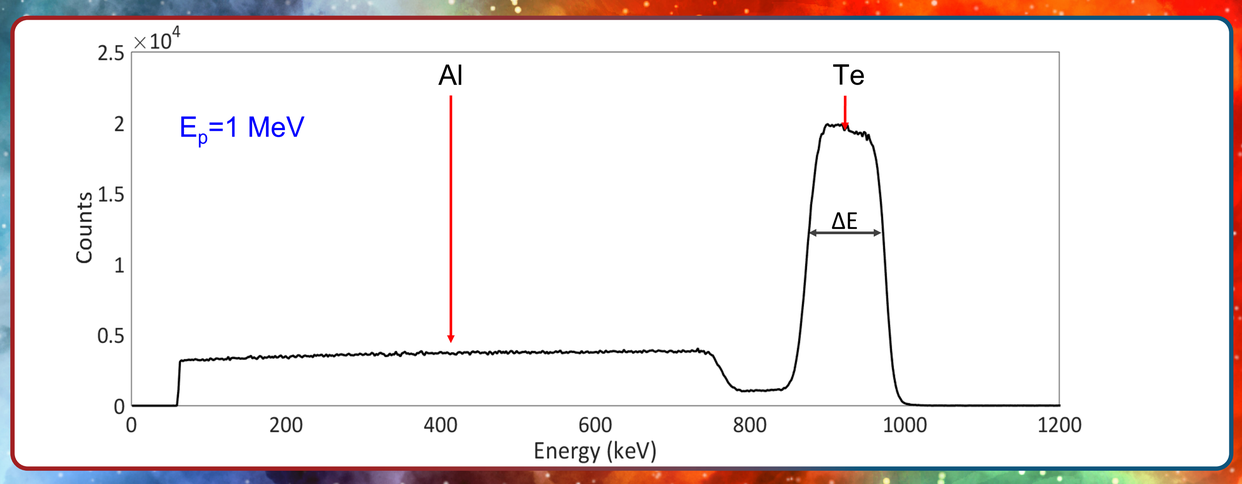

Figure 2: Spectrum of the proton-RBS. The width of the Te peak related with the Te layer thickness.

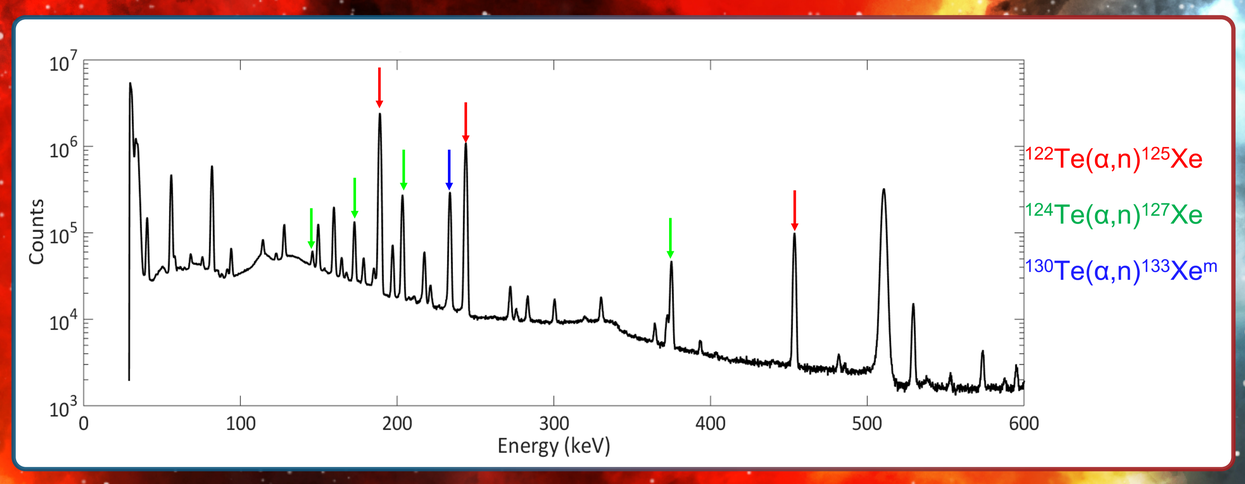

Figure 3: A gamma spectrum taken after the irradiation. Gamma peaks used for the analysis are labeled.

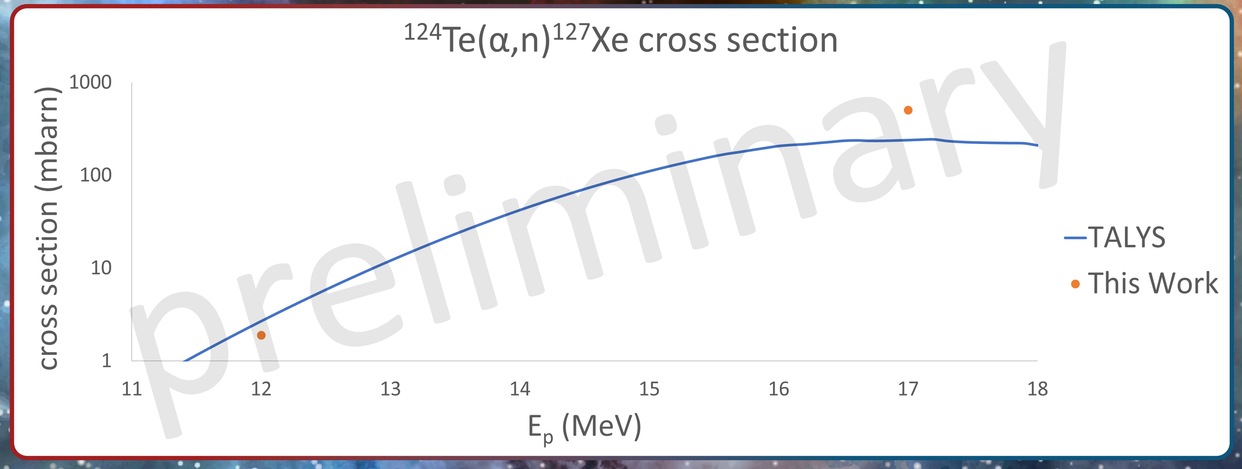

Figure 4: Our preliminary results and the statistical model calculations from the TALYS code in the case of the ^{124}Te(α,n)^{127}Xe reaction. Our data points will have a typical uncertainty below 10%.

Preliminary results of the two test-runs and the comparison with theory

As an example, ^{124}Te(α,n)^{127}Xe cross section calculations using the TALYS code (with default parameters) can be seen in figure 4 along with our preliminary result at the two measured energies. Similar results are available for the two other reactions.

In the case of ^{130}Te we have preliminary result only for the cross section leading to the isomeric state of ^{133}Xe. The calculations for the ground state cross section are in progress.

Summary and outlook

Based on our preliminary results, the experimental technique seems feasible and further measurements are planned. In the next months we will measure the cross section of the three studied reactions at different beam energies between the threshold and about 18 MeV. The results will be compared with theoretical calculations using different alpha nucleus optical potentials in order to select the best models and improve their parameters.