The *p*-process around ^{112,114}Cd

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Introduction and Motivation

- ^{113}In is generally considered a *p* nucleus, known to be significantly underproduced in most astrophysical models
- ^{114}Cd nucleus is involved in the *s*-process
- Measurements of reaction rates and cross sections in this mass regime provide stringent tests to the theoretical models
- Measurements of cross sections inside the Gamow window (~1.6-4.8 MeV, corresponding to T_9~1.7-3.3 GK) are expected to provide data for better understanding the *p*-process in this mass region

Experimental Details and Data Analysis

- Radiative proton-capture reactions were studied at proton beam energies E_p = 3.0 - 4.0 MeV
- Array of 3 HPGe detectors, placed at 55^o, 90^o and 155^o, respectively
- Isotopically enriched ^{112}Cd, ^{114}Cd targets
- De-excitations to the g.s. were measured in-beam (* in Figs. 1 and 2)
- The activation method was employed for the measurement of the isomeric cross section, σis
- σ_{is} was also measured via the in-beam method, by measuring decays to the isomeric state in the in-beam spectra (# in Figs. 1 and 2)

In-beam Spectra and Data Analysis

- In-beam spectra -> Prompt de-excitations -> $\sigma_{gs} = \frac{A}{N_A} \cdot \sum_i^n \frac{N_i(\vartheta_j)}{N_p \varepsilon_{abs}(\vartheta_j)}$
- Activation -> Measurement of isomers in the background spectra -> $\sigma_{is} = \frac{A\lambda e^{\lambda t_w}}{N_i \phi e_{abs}(1-e^{\lambda t_{irrad}})(1-e^{\lambda t_c})}$
- Total cross section: $\sigma_T = \sigma_{gs} + \sigma_{is}$ -> Sf: $S(E) = E\sigma(E)e^{2\pi\eta}$

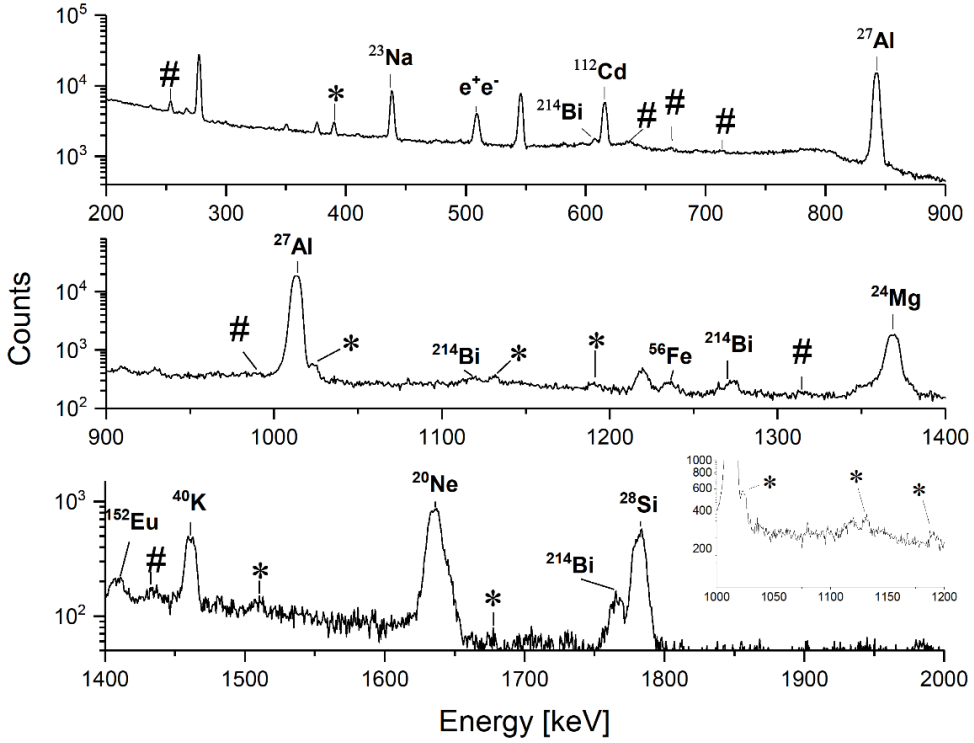


Fig. 1. Horizontal split-view (0.2-2.0 MeV) of a typical in-beam spectrum for the reaction ^{112}Cd+p. Transitions to the gs of ^{113}In are marked with an (*). Transitions to the isomeric state are marked with (#). Additional photopeaks arising from background radiation or other beam induced reactions are also marked.

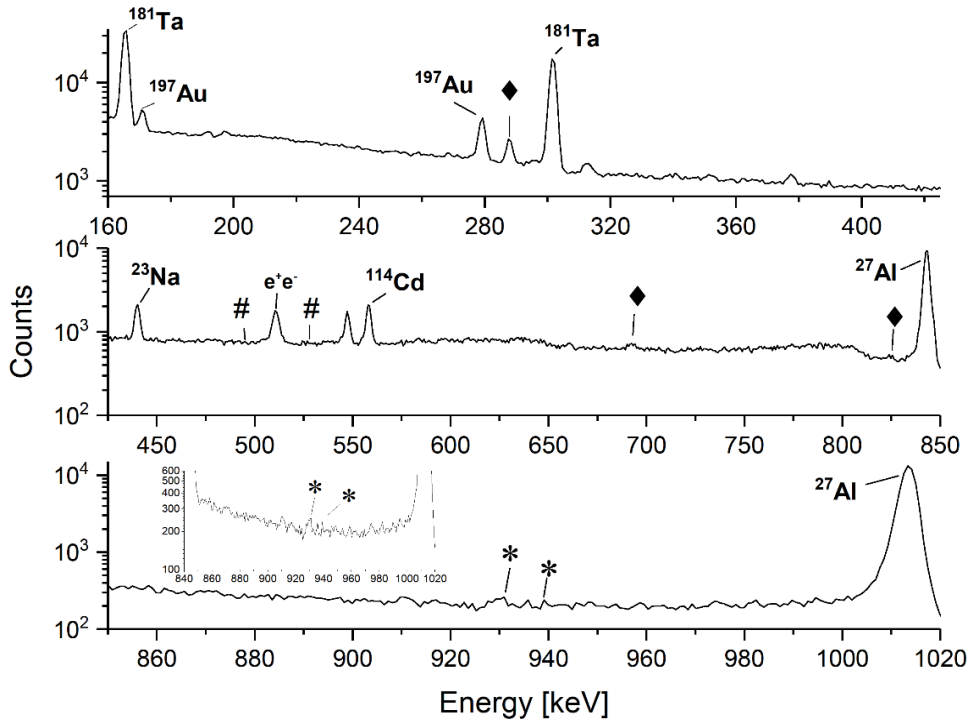


Fig. 2. Horizontal split-view (0.16-1.02 MeV) of a typical in-beam spectrum for the reaction ^{114}Cd+p. The notation used is the same as in Fig. 1. Additionally marked are transitions to the gs of ^{114}In (black diamonds in spectrum, corresponding to the (p,n) channel).

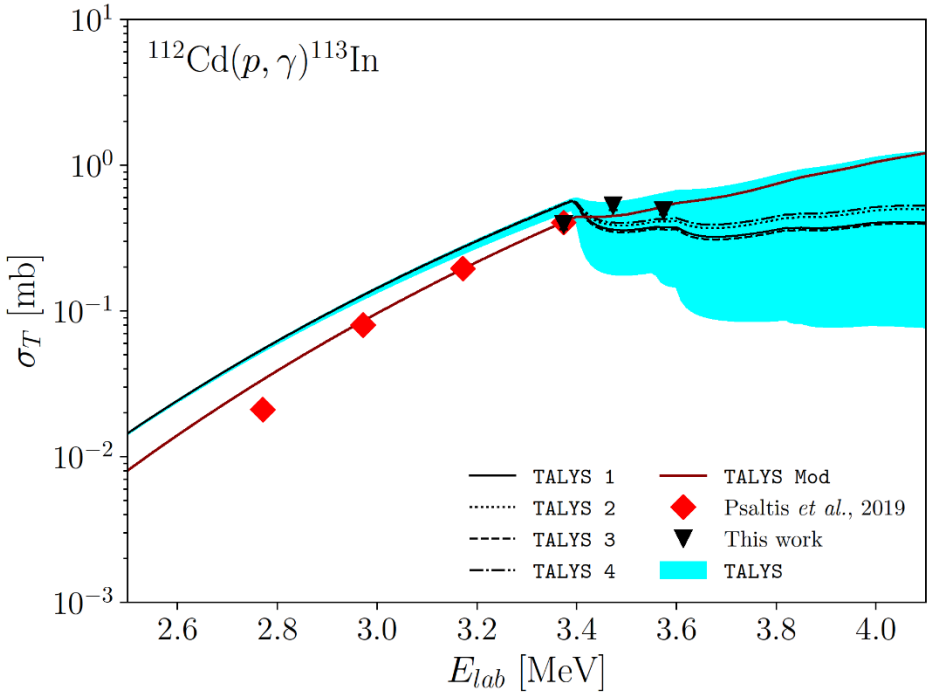
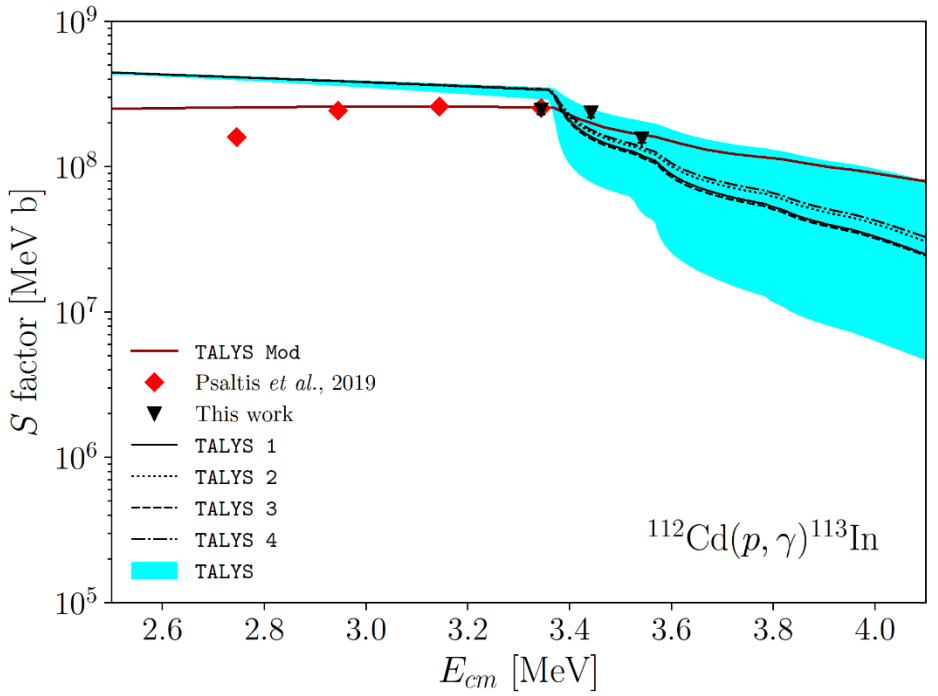


Fig. 3. Total cross sections (left) and astrophysical *S* factors (right) for the reaction ^{112}Cd(p,γ)^{113}In. The shaded areas correspond to the full range of calculated values with every combination of models employed. The lines correspond to the best data-matching calculations. The results are compared to experimental data, previously published from our group [2].



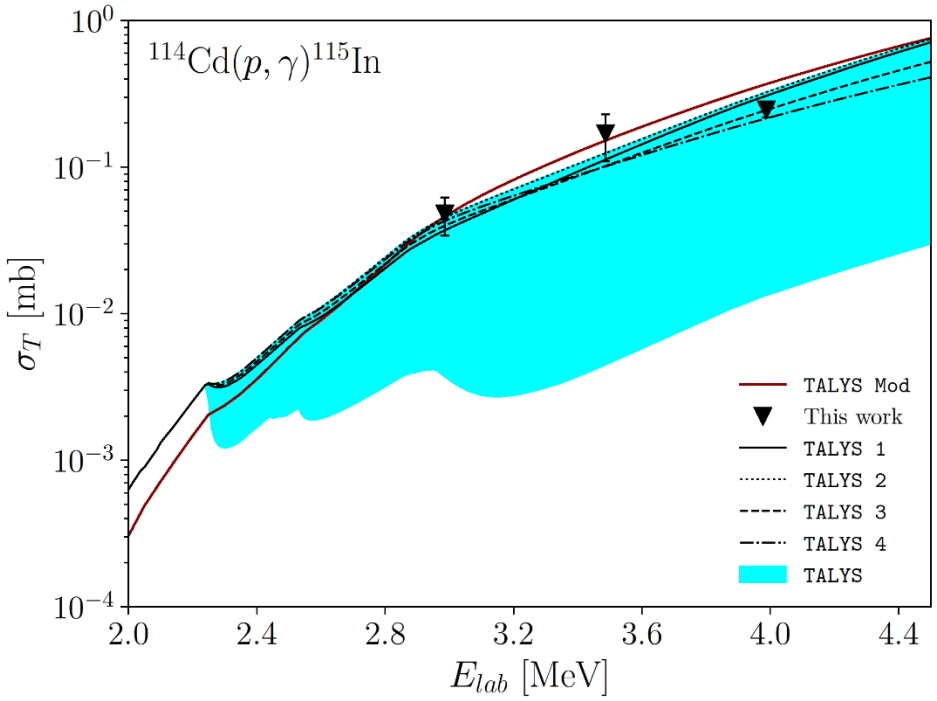
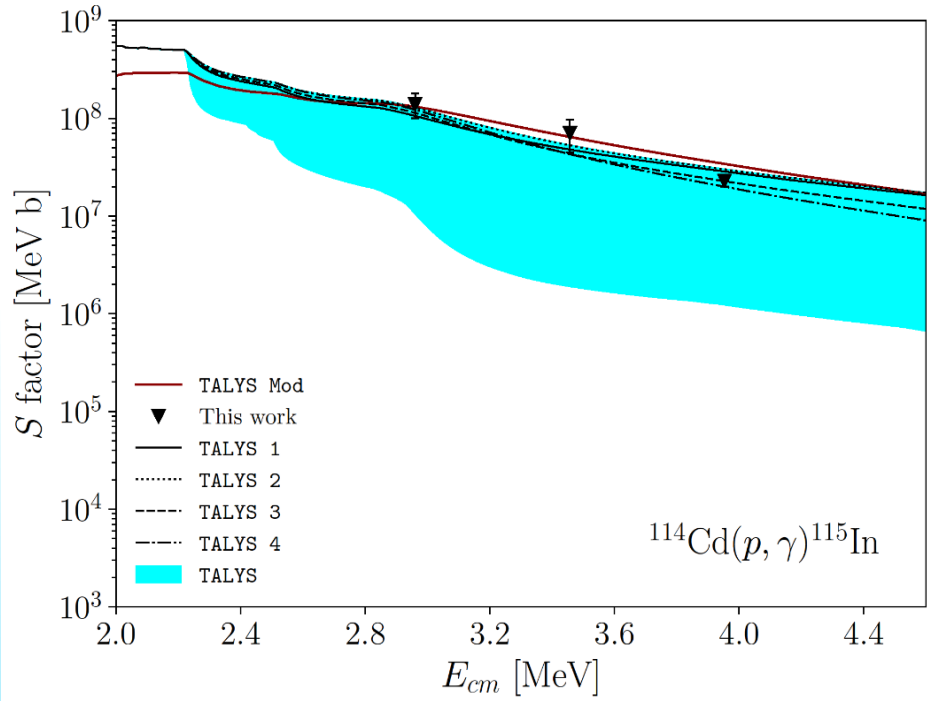


Fig. 4. Same as in Fig. 3, for the reaction 114Cd(p,γ)115In.



Overview and Conclusions

- An experimental attempt to measure the total reaction cross sections and the S factors for the reaction $^{114}Cd(p,\gamma)^{115}In$ has been carried out for the first time, inside the astrophysically important energy regime (at beam energies of 3.0, 3.5 and 4.0 MeV)
- Extension of the results from a recent experimental effort in ^{112}Cd to energies above the neutron emission threshold (E_{th} = 3.397 MeV), while still inside the Gamow energy window of astrophysical importance
- Excellent agreement with the data from the earlier work of Ref.[2]
- Additionally, the experimental results are compared to theoretical predictions using every possible combination of Optical Model Potential (OMP) + Nuclear Level density (NLD) + γStrength Function (γSF) provided by the TALYS v1.95 code [3] (blue shaded area in Figs. 3, 4)
- The best set of OMP+NLD+γSF model parameters was determined, in an effort to achieve a good description of the experimental data for each reaction channel in a simultaneous fashion
- Further experimental and theoretical work is required to acquire firm insight at the driving mechanisms behind the p-process nucleosynthesis, in an energy region where the experimental data are scarce

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