Monte Carlo calculations of nucleon-induced fission in the GeV energy range

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Description of the work

In the present work we extend up to an incident energy of 8 GeV the Monte Carlo calculations of nucleon-induced fission of actinides and pre-actinides from 100 MeV to 1 GeV described in a recent paper of ours [1]. Use is made of version 5.2 of the Liège Intra-nuclear Cascade Model INCL++ [2], including multiple pion production as described in Ref.[3] and of different evaporation-fission models (GEMINI++ and ABLA07, see Ref. [4]). We have examined both actinides (^{235}U, ^{238}U) and pre-actinides (^{181}Ta, ^{197}Au, ^{209}Bi).

Our calculated (p,f) cross sections are compared with available experimental data in the energy range from 100 MeV to 8 GeV; the same model parameters are used to predict (n,f) cross sections, which compare reasonably well with experiments performed, among others, by the n_TOF Collaboration at CERN[5], with particular reference to the recently published results on the ^{238}U(n,f)/^{235}U(n,f) cross section ratio up to 1 GeV [6].

References

[1] S. Lo Meo et al., Nucl. Phys. A 933 (2015) 43.
[2] D. Mancusi et al., Phys. Rev. C 90 (2014) 054602.
[3] S. Pedoux and J. Cugnon, Nucl. Phys. A 866 (2011) 16.
[4] Proc. ICTP-IAEA Advanced Workshop on Model Codes for Spallation Reactions, IAEA, Vienna, 2008.
[5] C. Guerrero et al., Eur. Phys. J. A 49 (2013) 27.
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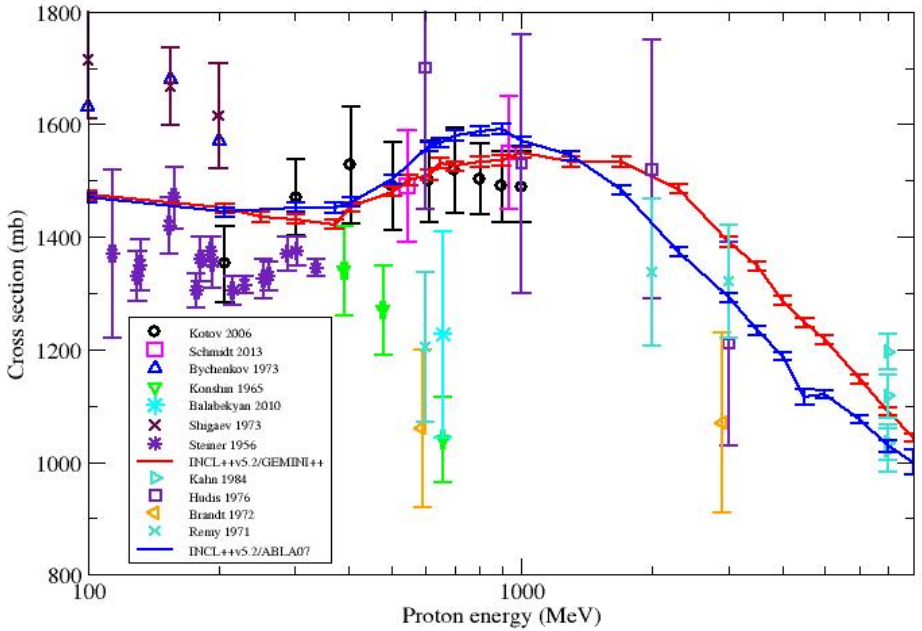
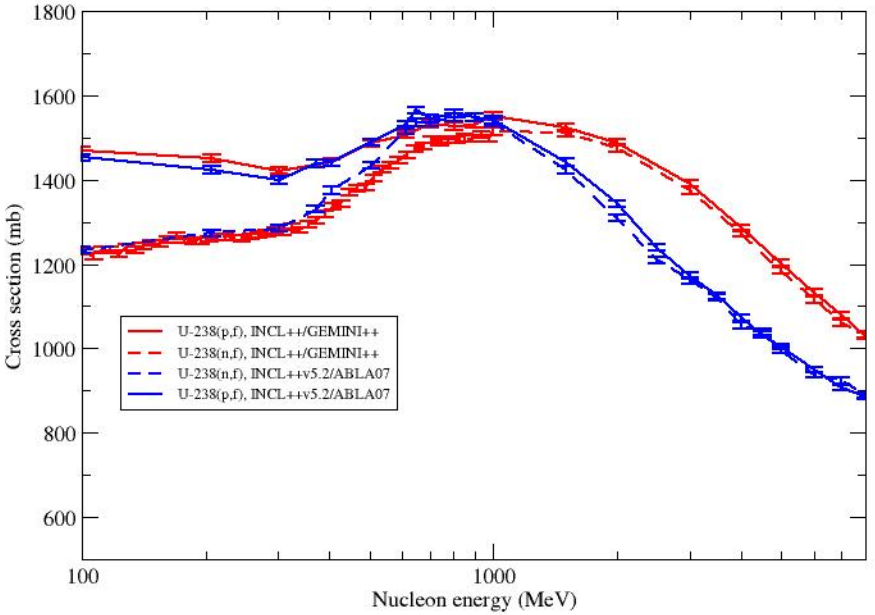
^{238}U(p,f) and ^{238}U(n,f)

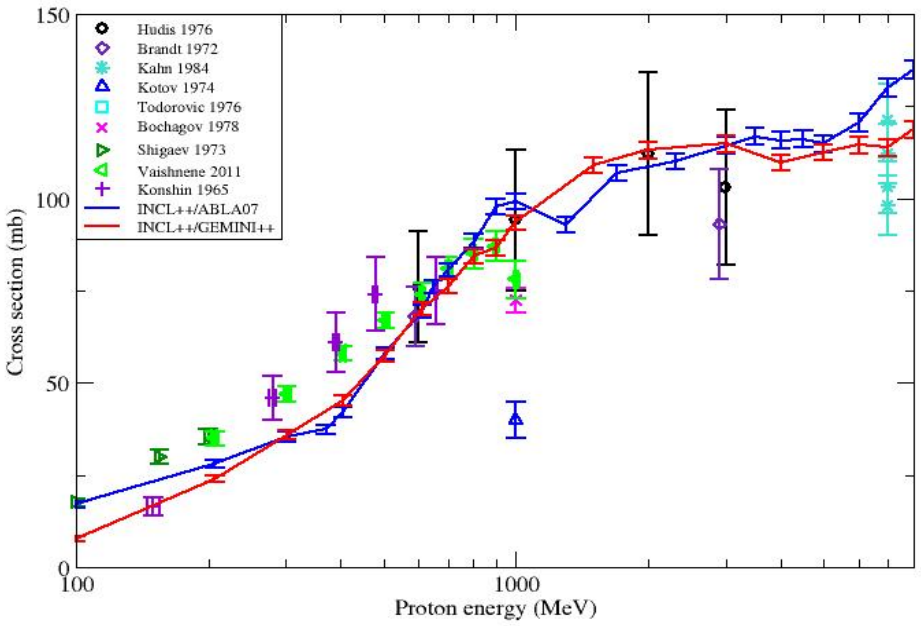


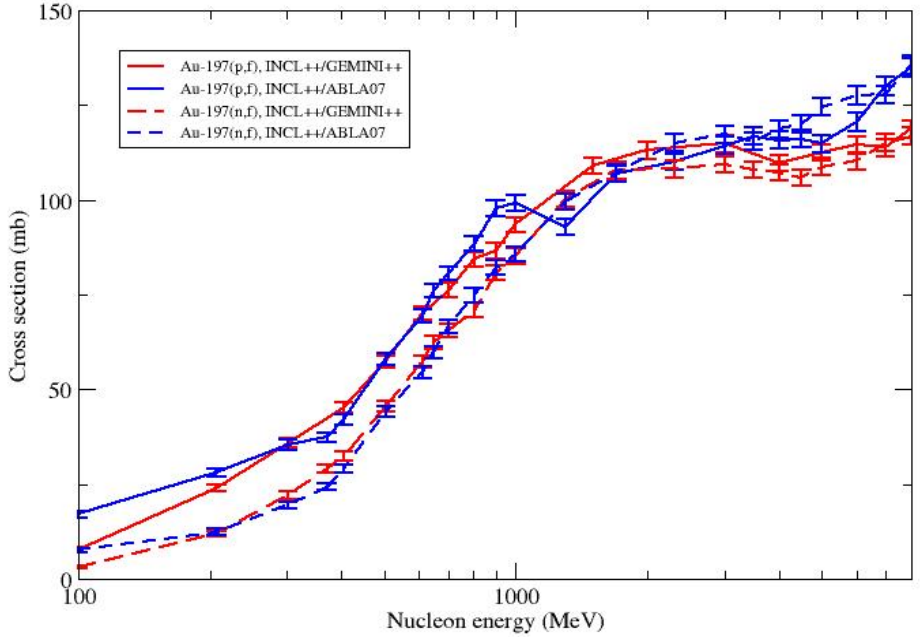


^{238}U(p,f) calculations with **INCL + ABLA07** and **INCL + GEMINI** vs Experimental Data.

^{238}U(p,f) Calculations with:
INCL + ABLA07 (————)
INCL + GEMINI (————)
^{238}U(n,f) Calculation with:
INCL + ABLA07 (– – – – –)
INCL + GEMINI (– – – – –)

^{197}Au(p,f) and ^{197}Au(n,f)





^{197}Au(p,f) calculations with **INCL + ABLA07** and **INCL + GEMINI** vs Experimental Data.

^{197}Au(p,f) Calculations with:
INCL + ABLA07 (————)
INCL + GEMINI (————)
^{197}Au(n,f) Calculation with:
INCL + ABLA07 (– – – – –)
INCL + GEMINI (– – – – –)

Conclusion

In the energy range up to 1 GeV, the performances of the two chains, INCL++/GEMINI++ and INCL++/ABLA07, are almost equivalent in comparison with experimental (p,f) and (n,f) data. It is worth stressing that (n,f) data are satisfactorily reproduced with the same model parameters as (p,f) data, without further adjustments.

In the energy range from 1 GeV to 8 GeV, only few (p,f) data are available and, in spite of the fact that the discrepancies between ABLA07 and GEMINI increase with increasing incident energies, the large experimental errors, however, do not permit to express a clear preference for either chain.

Preliminary calculations beyond 8 GeV seem to indicate failures of the fission models in both chains, possibly connected with the formalisms of nuclear level densities, no more adequate at remnant excitation energies larger than 3 MeV/nucleon.