



“Statistical Model and Atomic Mass Evaluation 2020”

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Aim: To check the validity of statistical model code CASCADE.

- Realistic model calculations are fundamental to any physical problem in physics.
- In nuclear physics, experimental results are compared with theoretical calculation. So it becomes important to have theoretical models which use experimental mass tables for calculations.
- Statistical theory of compound nucleus, which is based on the assumption that once compound nucleus (CN) is formed with different projectile and target combination above coulomb barrier with certain excitation energy, is fully equilibrated in all degrees of freedom.
- This theory has been implemented by CASCADE code [1]. This code calculates from n,p, α spectrums to fission, evaporation residue cross-section to name a few. Over many years it has been extensively used by the nuclear physics community and it still remain relevant.
- Q-value of reaction is one of the important parameters, which not only decides whether reaction will take place but also determines the excitation energy of the system at different stages of de excitation of the compound nucleus.
- In this work, we have compared atomic masses used in the statistical model with recently measured atomic masses Atomic mass evaluation (AME)-2020 [2].

Formalism

- Q value of any reaction $a + b \rightarrow c$ in terms of binding energy can be given as:

$$Q = B(c) - B(b) - B(a)$$

- This code uses binding energy of nucleus to calculate the Q-value.

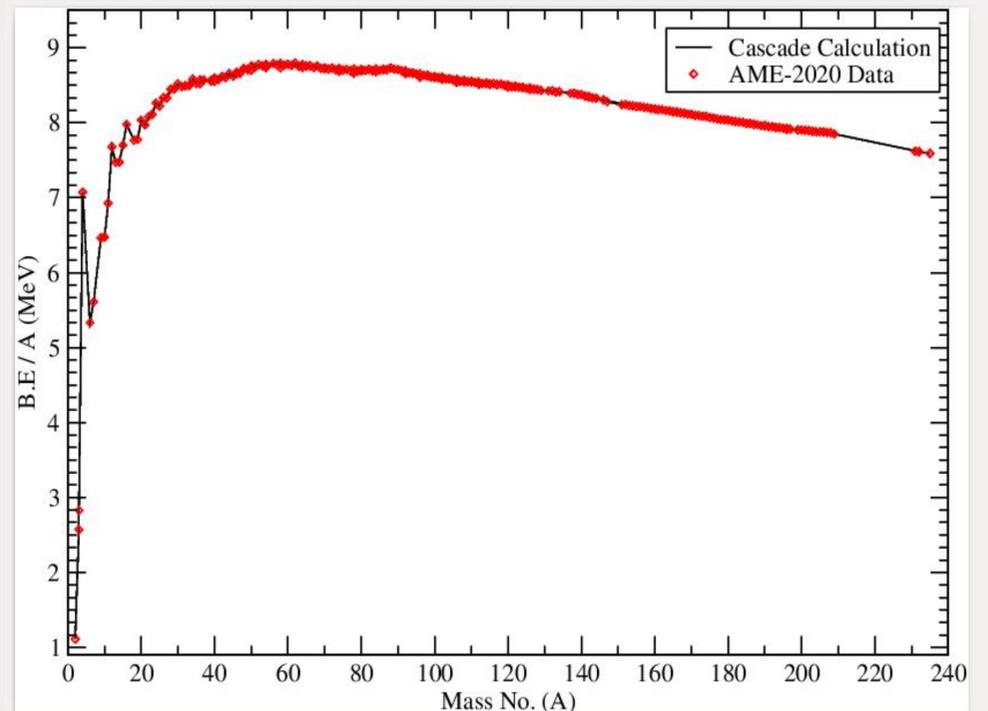
B.E formalism was adopted from Myers et. al. [2]

$$(B)_{A,Z} = \underbrace{-c_1 A}_{\text{Volume Term}} + \underbrace{c_2 A^{2/3}}_{\text{Surface Term}} + \underbrace{(c_3 Z^2/A^{1/3} - c_4 Z^2/A)}_{\text{Electrostatic Term}} + \underbrace{\delta}_{\text{Pairing Term}}$$

Where c_1, c_2, c_3, c_4 are various parameters.

Results

- Using Myers binding energy formula, we have compared total of “254” stable nuclides binding energies with AME-2020 table.
- Results of B.E per unit nucleon variation are shown below:



Conclusion

- B.E from the statistical model code CASCADE for different elements was compared with AME-2020 table. As shown in figure, results from statistical code were found to be satisfactory.
- AME-2020 binding energy/mass tables should be used in all theoretical calculations wherever necessary to get realistic results.

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