Target mass dependence of the formation of double and twin hypernuclei from Ξ^- absorption at rest

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- Introduction

Ξ^- absorption reaction ($\Xi^- + p \rightarrow \Lambda + \Lambda$ +28.3 MeV)

$\Xi^- + A$

$\rightarrow {}_{\Lambda\Lambda}Z+$,,,:Double Hypernuclei

precious information of low energy $\Lambda\Lambda$ interaction

(${}^{10}_{\Lambda\Lambda}Be$(1963) [1] , ${}^{6}_{\Lambda\Lambda}He$(1965) [2], ${}^{13}_{\Lambda\Lambda}B$ or ${}^{10}_{\Lambda\Lambda}Be$(1991) [3, 4])

favorable indentification of KEK E176 (1991):

$$\Xi^- + {}^{14}N \rightarrow {}^{13}_{\Lambda\Lambda}B + p + n$$

$\Lambda\Lambda$ interaction $\approx$ attractive

$\rightarrow {}_{\Lambda}Z + {}_{\Lambda}Z$,,,:Twin Hypernuclei

interesting fragmentation discovered in ${}^{12}C$ target [5, 6]

(${}^{4}_{\Lambda}H + {}^{9}_{\Lambda}Be$)

Now various experimental serches are being carried out.

- E885 [7] ,E373 [9] ${}^{12}C$ Target
- E906 [8] ${}^{9}Be$ Target

- Subject

  The Analysis of $\Xi^- + {}^9\mathrm{Be}, {}^{12}\mathrm{C}, {}^{14}\mathrm{N}$ reaction
  based on Microscopic Simulation Approach.

- What is the theoretical prediction for the production probabilities of Double Hypernuclei?

- Whether Twin Hypernuclear formation is possible or not in the Ξ^- stopped event on ${}^{14}\mathrm{N}$ and ${}^9\mathrm{Be}$ target?

- Model: Microscopic Simulation Approach

(A)Description of Dynamical Process:

Time Dependent Molecular Dynamics AMD-QL [12, 13]

Phase Space : $\mathbf{Z}_i = \sqrt{\nu}\mathbf{r}_i + \frac{i}{2\hbar\sqrt{\nu}}\mathbf{p}_i$

Time Evolution of Phase Space: Langevin Equation

$$\dot{\mathbf{Z}}_i = \frac{i}{\hbar}\mathbf{F}_i + \beta\sum_{kl} g_{ik}g_{kl}\mathbf{F'}_l + \sum_k g_{ik}\zeta_k$$

AMD (Antisymmetrized Molecular Dynamics) [10]+ Phenomenological Langevin Force

$\mathbf{g}_{ij}$ involves phenomenological parameter

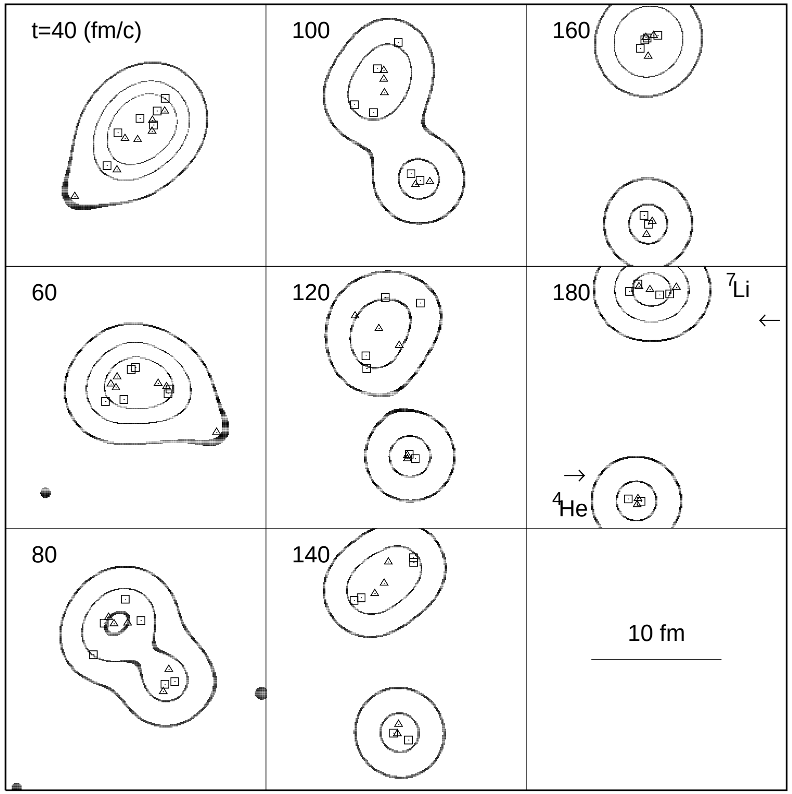
+

(B)Description of Decay process of Compound like State:

Statistical Cascade Decay Model [11]

- Example of Phase Space Time Evolution: $^{12}C+p$ reaction

Dynamical Fragmentation can be described.

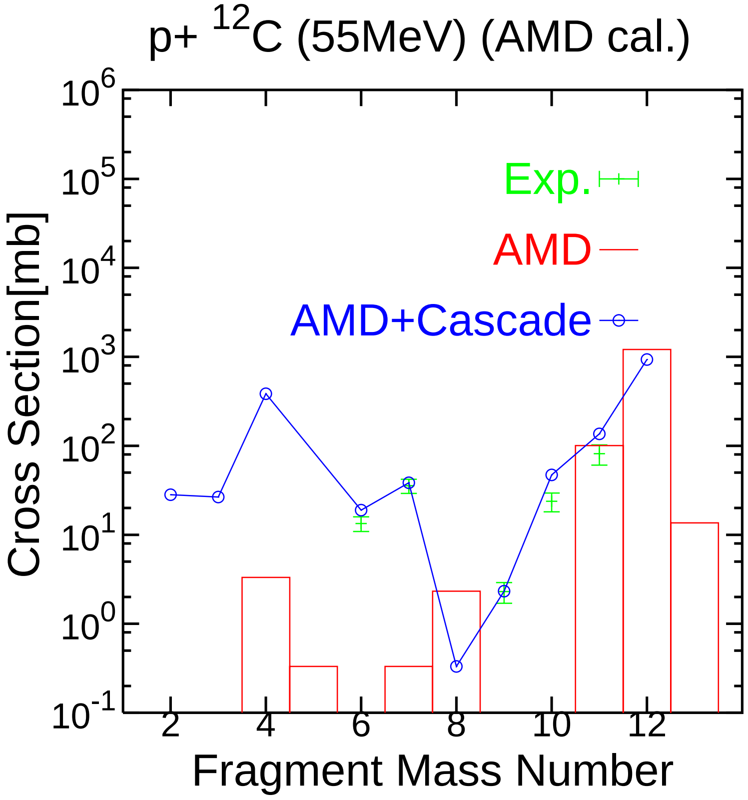


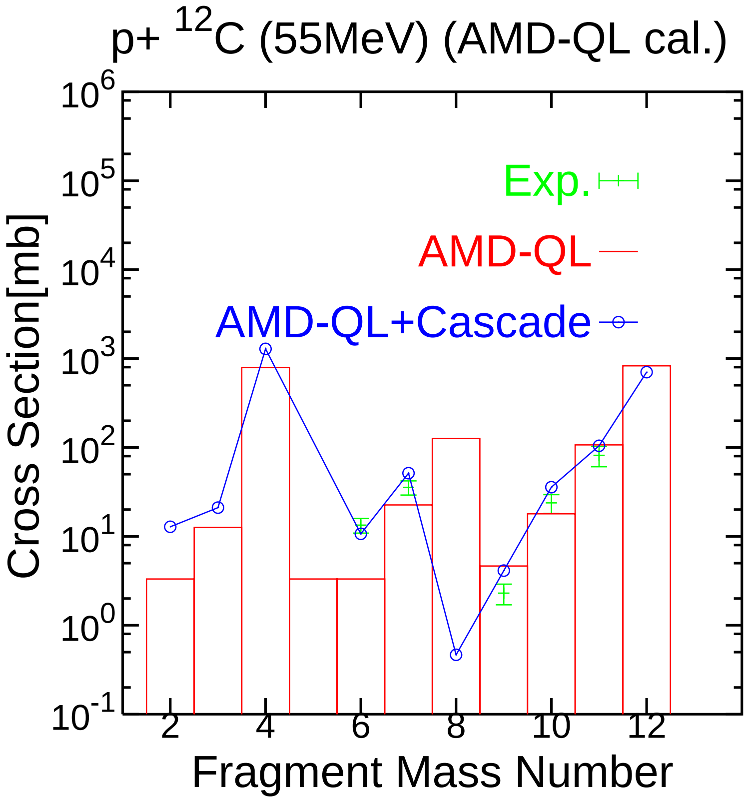
Determination of g_{ij} from p + ^{12}C Reaction

- Incident Energy:45MeV (coparable with $\Xi^- + {}^{12}$C)

Application for p + ^{12}C Reaction

- Incident Energy:55MeV

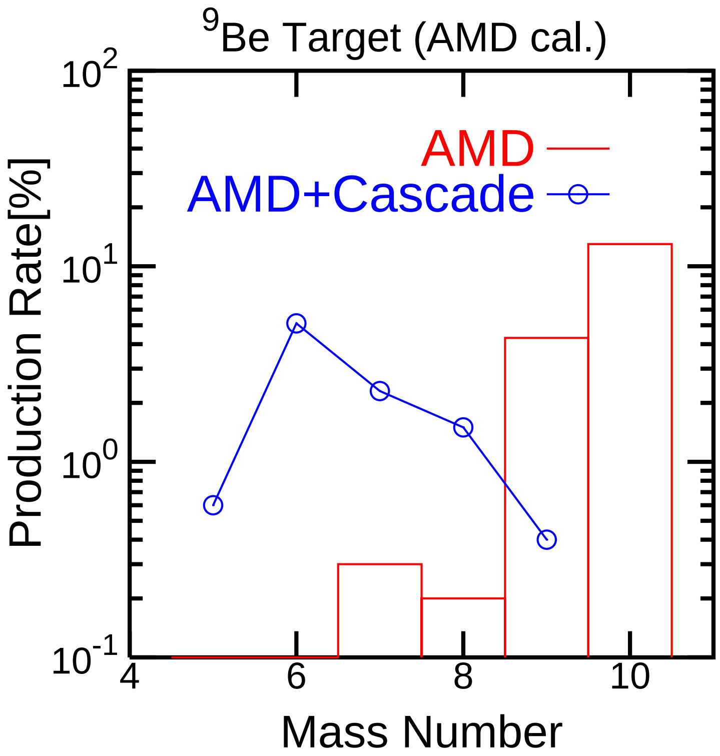


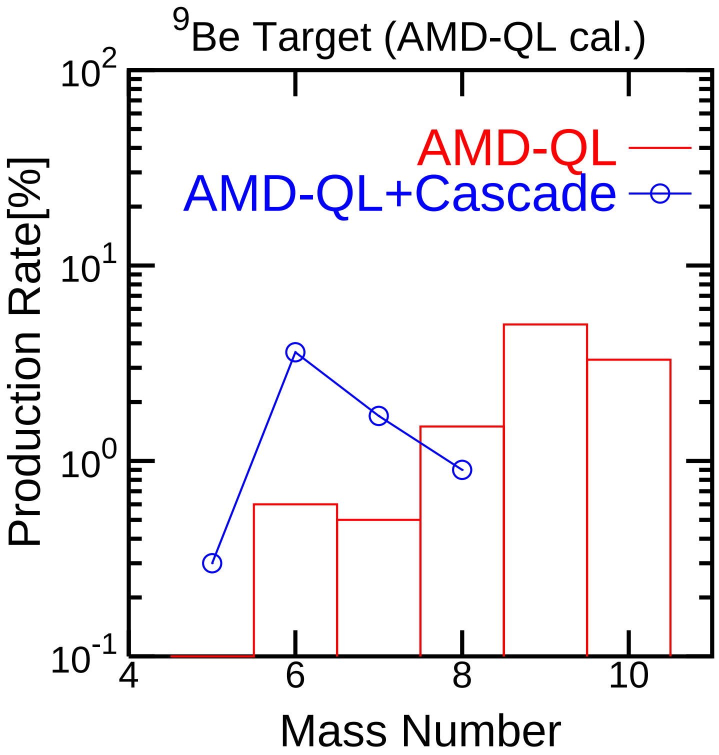


AMD-QL+Cascade Model works very well.

Double Hypernuclei Production Mass Distribution

- ^{9}Be Target

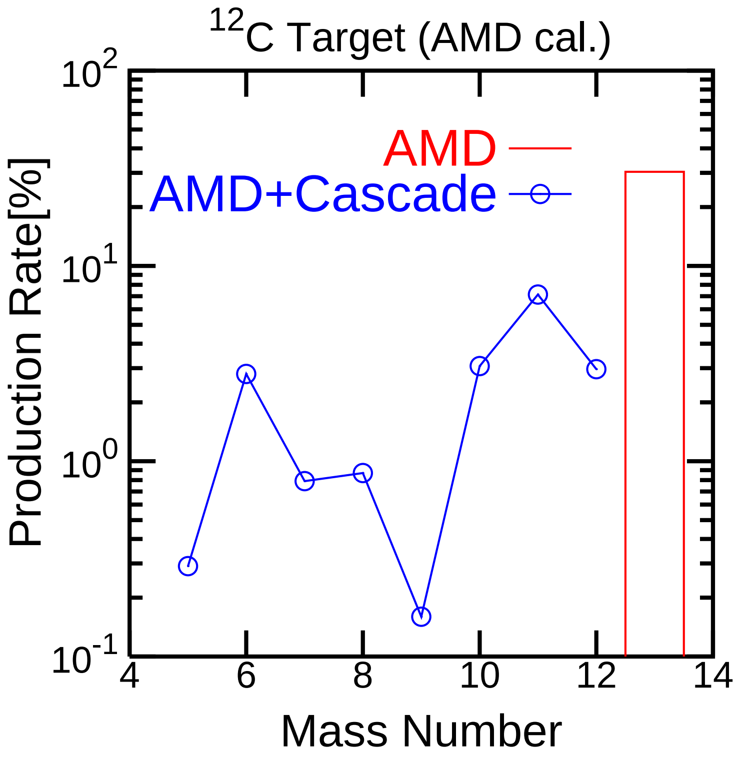


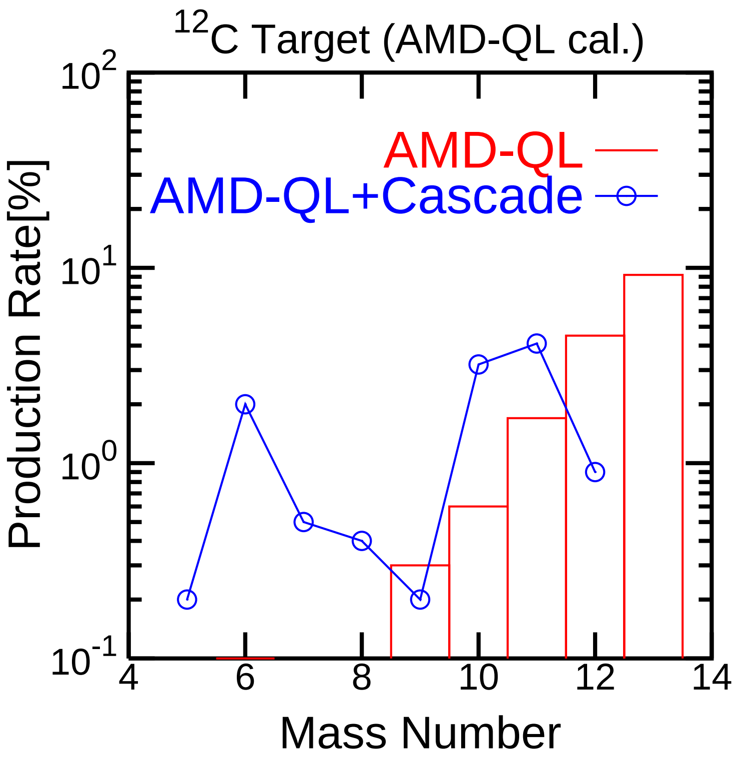


Dynamical Formation of Double Hypernuclei
is enhanced due to Langevin Force.

Double Hypernuclei Production Mass Distribution

- ^{12}C Target

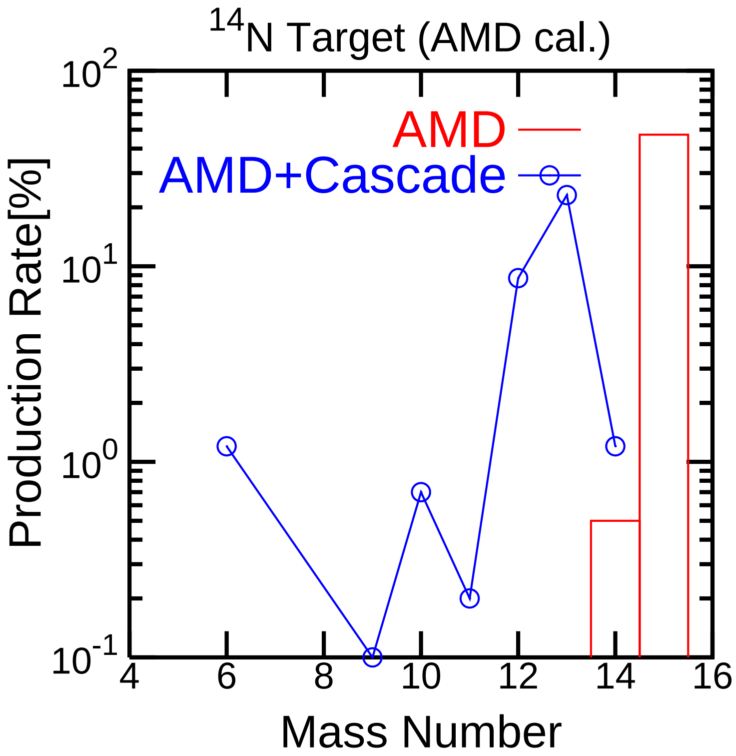


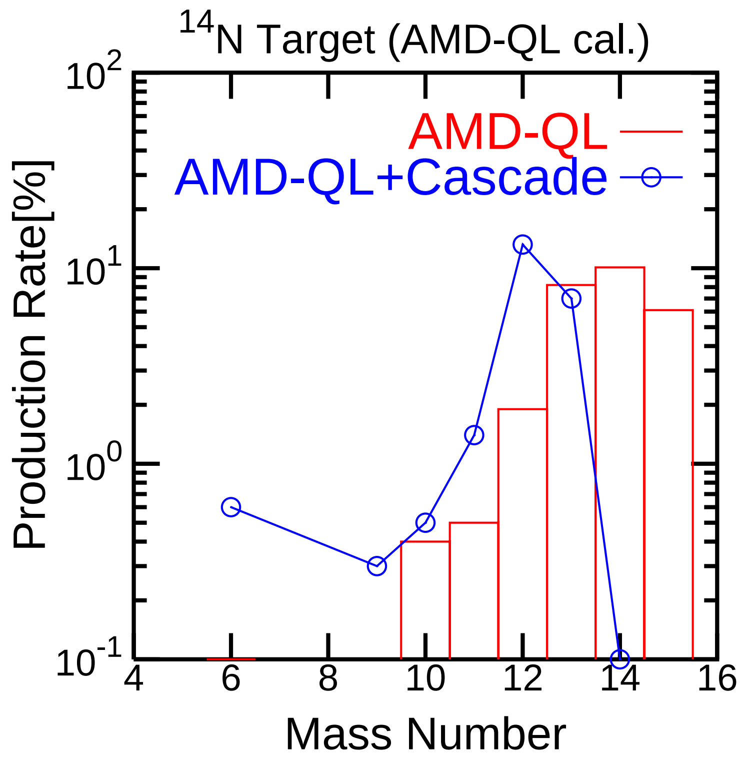


Dynamical Formation of Double Hypernuclei
is enhanced due to Langevin Force.

Double Hypernuclei Production Mass Distribution

- ^{14}N Target





Dynamical Formation of Double Hypernuclei
is enhanced due to Langevin Force.

Target Dependence of Hypernuclear Formation Probability

Target	^{9}Be BNL E906	^{12}C BNL E885 KEK E373	^{14}N
Total $_{\Lambda\Lambda}$Z	6.4 %	11.4 %	23.0 %
Main $_{\Lambda\Lambda}$Z	$^{7}_{\Lambda\Lambda}$He 1.7 % $^{6}_{\Lambda\Lambda}$He 3.6 % $^{5}_{\Lambda\Lambda}$H 0.3 %	$^{12}_{\Lambda\Lambda}$B 0.6 % $^{11}_{\Lambda\Lambda}$B 1.0 % $^{11}_{\Lambda\Lambda}$Be 3.0 % $^{10}_{\Lambda\Lambda}$Be 3.2 % $^{6}_{\Lambda\Lambda}$He 2.0 %	$^{13}_{\Lambda\Lambda}$C 2.3 % $^{13}_{\Lambda\Lambda}$B(E176) 4.5 % $^{12}_{\Lambda\Lambda}$B 7.9 % $^{12}_{\Lambda\Lambda}$Be 4.7 %
Total $_{\Lambda}$Z+$_{\Lambda}$Z	1.6 %	1.2 %	0.6 %
Main $_{\Lambda}$Z+$_{\Lambda}$Z	$^{5}_{\Lambda}$He + $^{4}_{\Lambda}$H + n 1.5 %	$^{8}_{\Lambda}$Li + $^{5}_{\Lambda}$He 0.3 % $^{5}_{\Lambda}$He + $^{5}_{\Lambda}$He+t 0.3 % $^{5}_{\Lambda}$He + $^{4}_{\Lambda}$H+α 0.4 %	$^{9}_{\Lambda}$Be + $^{5}_{\Lambda}$He+n 0.2 % $^{5}_{\Lambda}$He + $^{5}_{\Lambda}$He+α+n 0.3 %

Mass Number of Target increase.

$\rightarrow$

- Double probability increase due to more binding of Λ.
- Twin probability decrease due to larger stability of the system.

· Summary and Conclusions

The Analysis of Stopped Ξ^- Reaction based on
Microscopic Simulation with quantal fluctuation

· $\Xi^- + {}^{9}\mathrm{Be}, {}^{12}\mathrm{C}, {}^{14}\mathrm{N}$

(1)Mass Number of Target increase.
$\longrightarrow$ Double probability increase due to more bindeing of Λ.

(2)Present Model predicts the formation probability
of each Double Hypernuclei $\approx 1 \sim 8$ %

(3)Although Present Model predicts the Twin Hypernuclear
formation is possible, its probability is small.(0.2 $\sim$ 1.5 %).
This is not consistent with KEK-E176 report [4, 5, 6].
(roughly 6 $\sim$ 18 % Twin formation)
$\longrightarrow$ anomalous mechanism? poor statistics(Stopped $\Xi^- \approx 30$)?
(open future problem)

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