

"PROPERTIES OF EXCITED $A = 40$ NUCLEAR SYSTEMS WITH VARYING MATTER COMPOSITION

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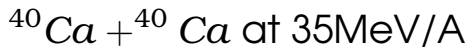
Nuclei are composed of fermions. In collisions both, fermions and bosons are emitted.

Is the fermionic or bosonic nature of ejectiles manifested in the emission?

Hua Zheng and Aldo Bonasera Phys. Rev. C **86**, 027602

Hua Zheng, Gianluca Giuliani, and Aldo Bonasera Phys. Rev. C **88**, 024607

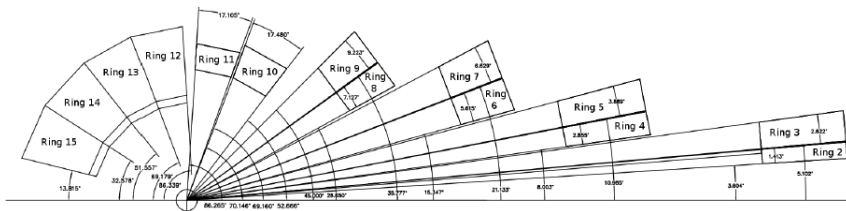
When two alpha-conjugate nuclei collide, bosonic properties might control important features of the reaction dynamics and the evolution of the excited system...



the results for the experimental data and AMD simulations will be shown

EXPERIMENT

NIMROD - Neutron Ion Multidetector for Reaction Oriented Dynamics
Cyclotron Institute, Texas A&M University, US

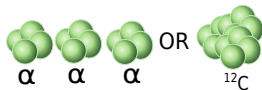


- 14 concentric rings ranging from 3.6° to 176°
- Single telescope: $150\mu\text{m}$ ($300\mu\text{m}$) silicon placed in front of CsI(Tl)
- Supertelelescope: $150\mu\text{m}+500\mu\text{m}$ silicons placed in front of CsI(Tl)
- Neutron Ball

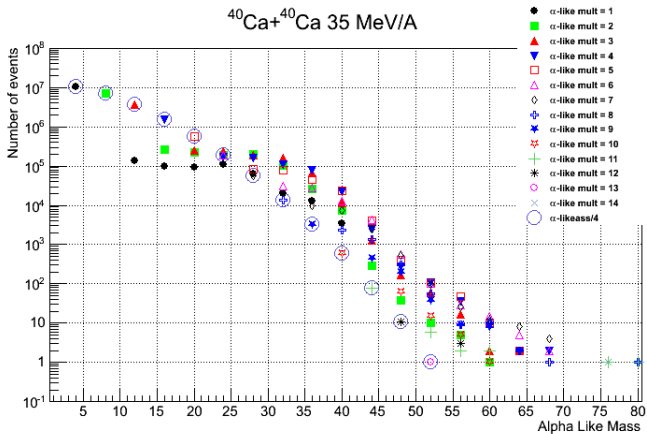
OBSERVABLES DEFINITION

$$\begin{aligned}\text{AlikeMass} &= 4\text{Mult}_{\alpha} + 12\text{Mult}_{^{12}\text{C}} + \dots + 40\text{Mult}_{^{40}\text{Ca}} \\ \text{DlikeMass} &= 2\text{Mult}_d + 6\text{Mult}_{^6\text{Li}} + \dots + 30\text{Mult}_{^{30}\text{P}}\end{aligned}$$

AlikeMass = 12:

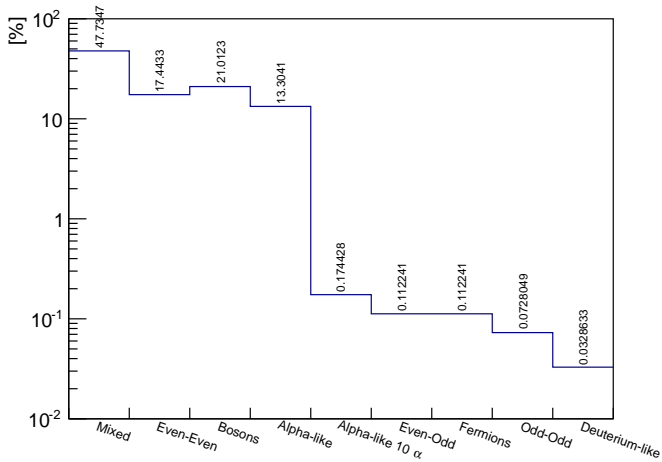


EVENTS COMPOSITION

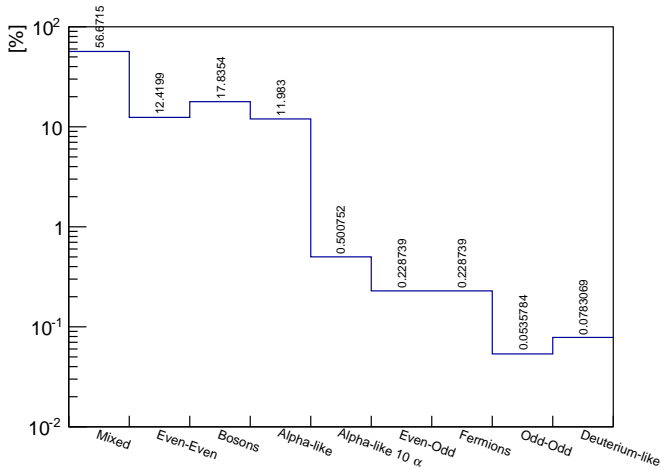


- 1 $A_{tot} = 40 + A_{LCP}$
 - Even-Even Matter or LCP
 - Odd-Odd Matter or LCP
 - Even-Odd Matter or LCP
 - Mixed Matter or LCP
 - Boson Matter or LCP
 - Fermion Matter or LCP
- 2 AlikeMass=40 and EvenEven and Z=N or LCP: Alpha-like Matter
- 3 AlikeMass=40, 10 α or LCP: Alpha-like Matter 10 α
- 4 DlikeMass=40 and OddOdd and Z=N or LCP: Deuterium-like Matter

EVENT SELECTION - EXPERIMENTAL DATA



EVENT SELECTION - AMD SIMULATIONS



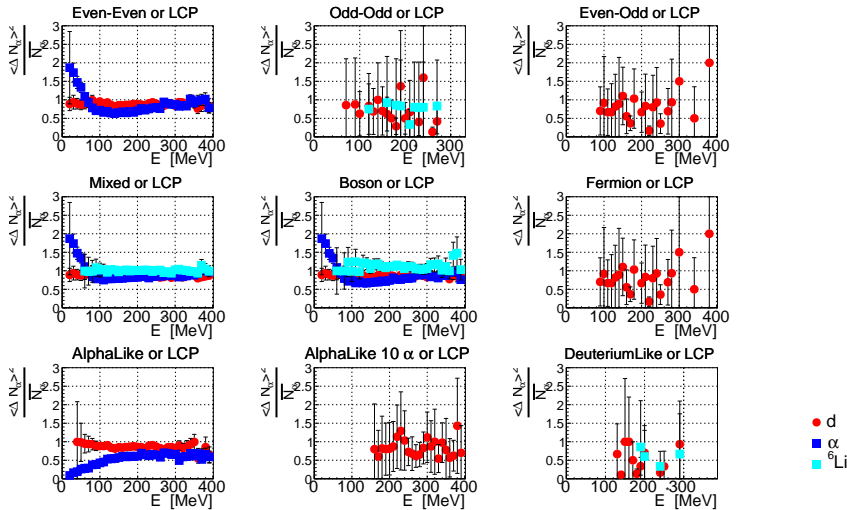
NUMBER FLUCTUATIONS

For a classical gas, the multiplicity of a specific cluster size follows Poissonian distribution where $\sigma_N^2/\bar{N} = 1$

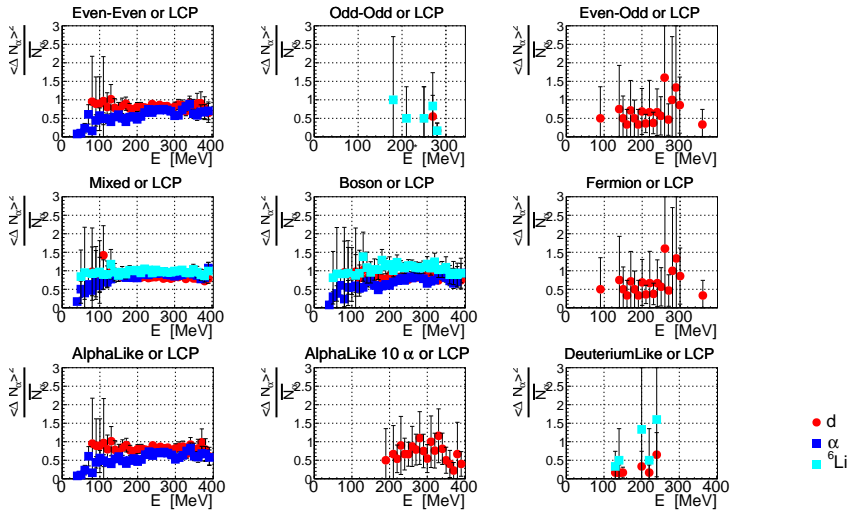
Fermions emitted from a nucleus are subject to the Pauli exclusion principle which may block certain emission channels (Pauli blocking), leading to suppression of the multiplicity fluctuation.

Bosons, following the Bose - Einstein statistics, can all occupy the same state, what can lead to a larger multiplicity fluctuations than the Poissonian limit.

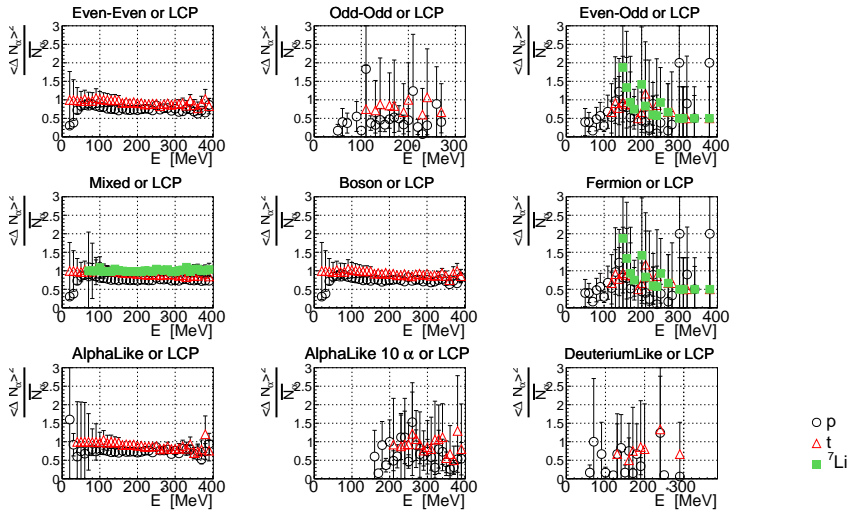
NUMBER FLUCTUATIONS OF BOSONS - EXP



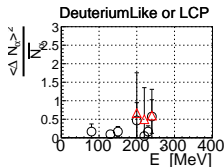
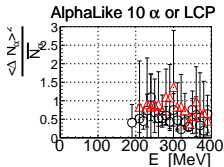
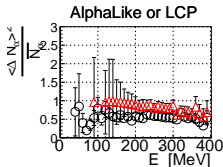
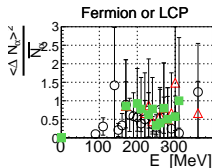
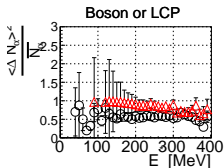
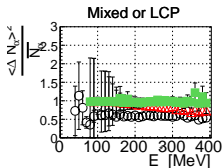
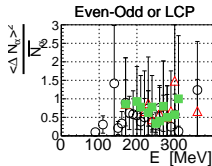
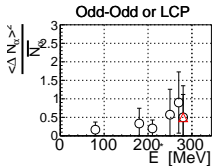
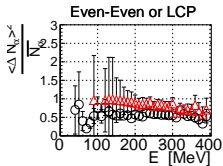
NUMBER FLUCTUATIONS OF BOSONS - AMD



NUMBER FLUCTUATIONS OF FERMIONS - EXP

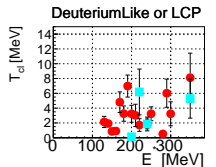
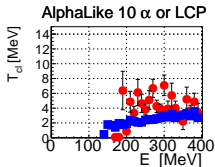
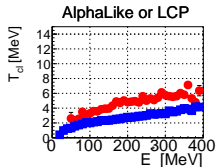
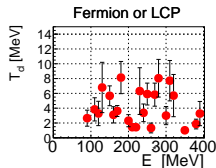
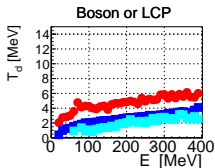
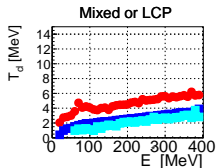
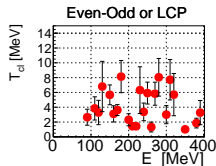
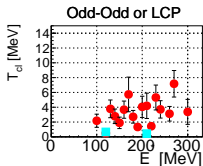
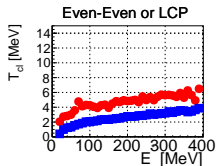


NUMBER FLUCTUATIONS OF FERMIONS - AMD



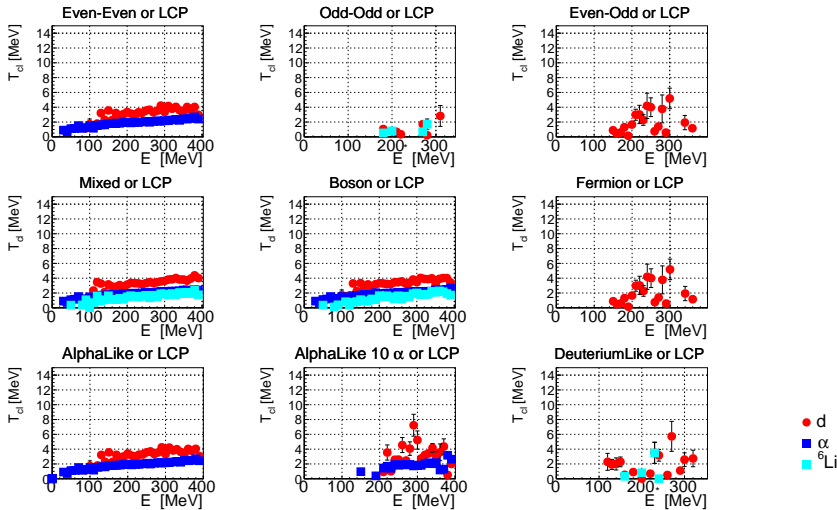
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TEMPERATURE CLASSICAL OF BOSONS - EXP

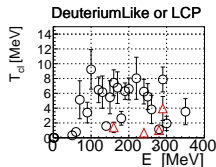
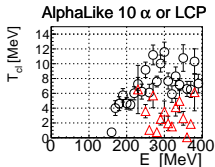
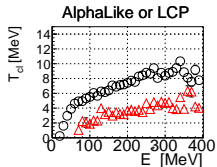
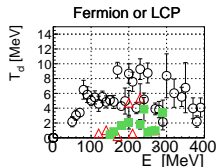
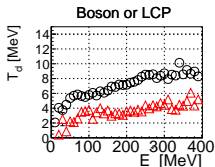
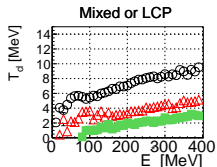
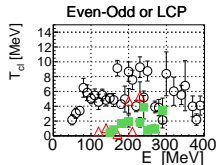
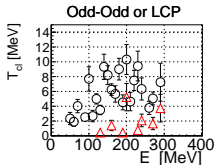
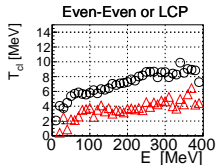


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■ ${}^6\text{Li}$

TEMPERATURE CLASSICAL OF BOSONS - AMD

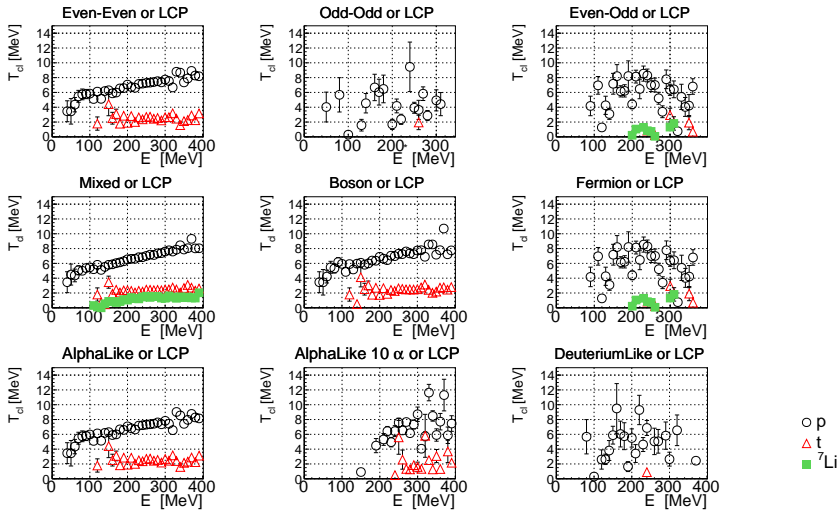


TEMPERATURE CLASSICAL OF FERMIONS - EXP



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TEMPERATURE CLASSICAL OF FERMIONS - AMD



- 1 the number and momentum fluctuations have been studied for different matter compositions formed in excited $A = 40$ system
- 2 the enhancement of multiplicity fluctuations of α' s has been noticed (BEC?) in the experimental data, not present in the AMD calculations.
- 3 differences in momentum fluctuations have been noticed between the data and simulations - caused by the classical approach in the model?
- 4 quantum corrections to the temperature, densities and volumes will be studied in the future (bosons seem to condense, experiencing smaller mean volumes and smaller relative distances)

α multiplicity of Even - Even Matter

