# ADVANCES **TOWARDS THE** SUREMENT OF **TRANSTIONS** FROM CLUSTERED STATES IN 160°

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LIGHT CLUSTERS IN NUCLEI AND NUCLEAR MATTER: NUCLEAR STRUCTURE AND DECAY, HEAVY ION COLLISIONS, AND ASTROPHYSICS





## **AIMS AND MOTIVATION**

### Aim

Measure enhancement in electromagnetic transition probabilities on the <sup>16</sup>O nucleus to associate rotational levels built on cluster configurations.

### **Motivation**

- Enhance gamma-ray data link different nuclear states to the same underlying nuclear structure.
- ${}^{12}C(\alpha, \gamma){}^{16}O^*$  reaction can be archived with the MC40 cyclotron at the University of Birmingham.
- Compare our measurements with theoretical predictions.

### THEORY

#### **Nuclear clustering**

- Clustered nuclei can be seen as αconjugates.
- Relation between clustering and excitation energy.

#### Why alpha particles?

- High binding energy (28.3 MeV).
- Alpha emission is one of the possible decay channels.



Kokalova Wheldon, Tzany. (2015). Over half a century of studying carbon-12. Journal of Physics: Conference Series. 639. 10.1088/1742-6596/639/1/012003. Ikeda K et. Al 1968 Prog. Theor. Phys. (Suppl.) extra number, 464

### THEORY

#### **Rotational band**

- The nucleus can deform due to an excess of energy.
- States with similar deformed structures and energies proportional to J(J+1) are a rotational band.
- Rotational band energy given by:

 $\overline{E(J)}=rac{\hbar^2}{2\Im}J(J+1)+\overline{E_0}$ 

#### Rotational bands in <sup>16</sup>O

- W. Bauhoff, H. Schultheis and R. Schultheis discuss the experimental data and different models.
- They propose different configurations including: **Tetrahedral**, bent rhombus, kite and chain structures in <sup>16</sup>O.

Bauhoff W, Schultheis H and Schultheis R 1984 Phys. Rev.C 29 1046





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#### **Gamma transitions**

- Deformed nuclei will have a deformed electromagnetic field due to the rearrangement of components.
- This can be modeled using the multipole description.
- By measuring the angular distribution we can infer the shape of the nucleus.
- By measuring the energy we can associate states with transitions.
- ...But it comes with a price...
  - In light nuclei the branching ratio of gamma to alpha emission tends to be very low( $\sim 10^{-6}$ ).

## **EXPERIMENTAL SET-UP**





BALTI (Birmingham Array LaBr, Timing)



### **AUTO CALIBRATION**











# **GAIN SHIFT**







### BALTI no gate









Substraccion 4.4 - GS







 $E-\Delta E$  Telescope to particle identification



Improved collmation system

# **CURRENT WORK & CONCLUSIONS**

#### Conclusions

- Feasibility test is completed.
- Automated energy and drift calibration.
- Completed Monte Carlo simulation.

#### **Current Work**

- Running experiment.
- Beam time schedule for next weeks.

## **COLLABORATOR S**

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