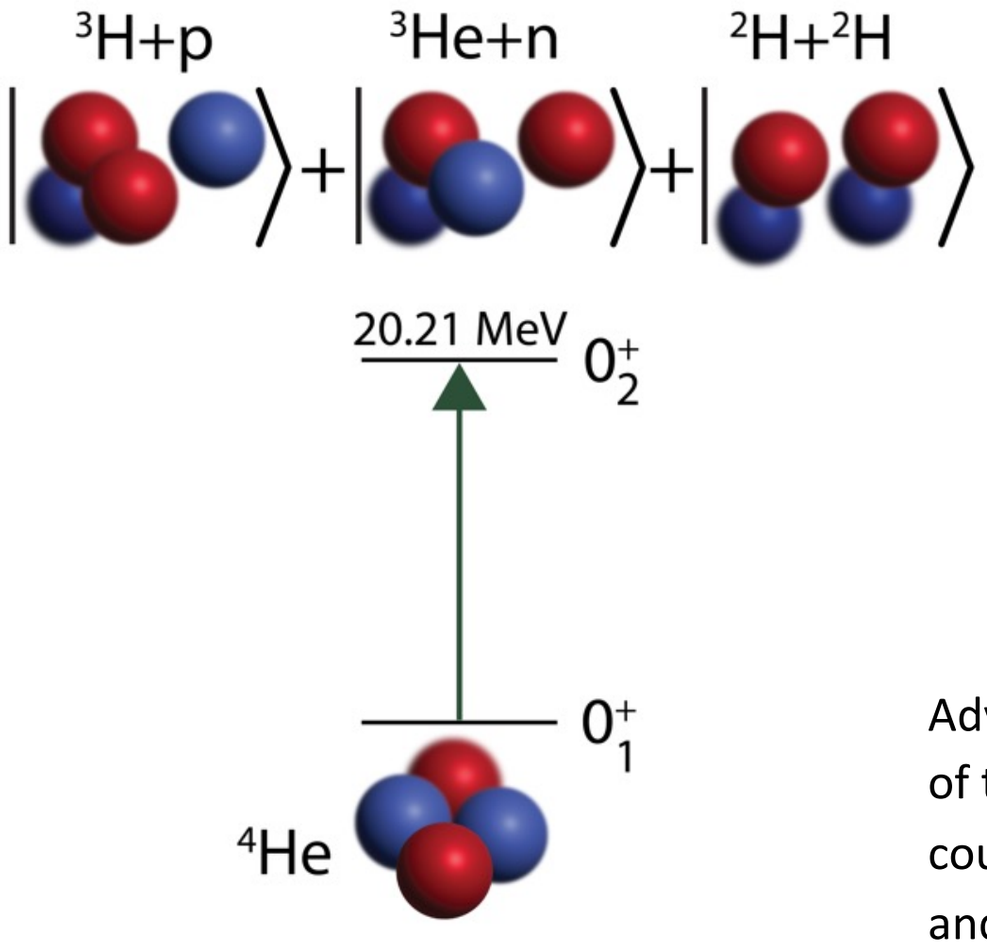
Fine-tuned 0^+ resonance of the α particle: puzzle solved!

U.S. DEPARTMENT OF ENERGY | Office of Science

NUCLEI Nuclear Computational Low-Energy Initiative

Objectives

- The open-quantum-system no-core Gamow Shell Model was used to explain the results of recent precise experimental determination of the monopole transition form factor from the ground state of ^{4}He to its 0^+ excited state via electron scattering at Mainz. According to our analysis, the structure of the 0^+ resonance involves an intricate coupling between three binary cluster configurations: ^{3}H + p, ^{3}He + n, and ^{2}H + ^{2}H.



Impact (as of now)

- This is the fist application of the ab-initio no-core coupled-channel GSM to a system involving several mass partitions.
- The claims made in the experimental paper, suggested a "puzzle, which is not due to the applied few-body method, but rather to the modeling of the nuclear Hamiltonian." These claims were consecutively amplified by alarming articles in popular press, which suggested a crisis in nuclear theory. Our calculations fully explain the experimental findings and demonstrate that the reports indicating the nuclear theory crisis have been greatly exaggerated.
- The interplay of several reaction channels corresponding to the different mass partitions related to an interplay of several particle emission thresholds is essential for solving the mystery of the 0^+ α particle resonance.

Accomplishments (as of now)

- Published in Phys. Rev. Lett. 131, 242502 (2023)
- Featured in Physics 16, 207

Advanced theoretical calculations predict a rather complex character of the excited 0^+ state of the α particle at 20.21 MeV that involves a coupling between three binary cluster configurations: ^{3}H + p, ^{3}He + n, and ^{2}H + ^{2}H.