Nuclear Physics at VMU

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The ab-initio algebraic model for nucleus

- Small Theoretical Nuclear Physics group at Research Institute of Natural Sciences and Technology VMU
- The ab-initio algebraic model for nucleus
- No Core Shell Model - All the nucleons are active in the model space
- Intrinsic coordinates for the explicit center of mass coordinate removal

Jacobi coordinates!

- Traditional No Core Shell Model approach with **intrinsic** coordinates $N \leq 4$
- New interest in $N \geq 4$ using intrinsic coordinates[1] [2] [3]

[1] A.Gnech, Theoretical calculation of nuclear reactions of interest for Big Bang Nucleosynthesis, Thesis, 2020.
[2] H.L. Thi, Jacobi No-Core Shell Model for P-shell Hypernuclei, Thesis, 2020
[3] S. Liebig, Antisymmetrisation in a Jacobi coordinate based no-core shell model approach, Thesis, 2013

The goal and the tasks

- Develop an **algebraic model** for the nucleon systems.
  - Formulate **a systematic treatment of the transpositions of the Jacobi coordinates** and their representations in the HO basis (Applicable for large systems).
  - Create a **computationally efficient** approach for the accurate state vector construction (High performance computing).
  - **Develop** generic computational **tools** for the construction of the antisymmetric state vectors (Reusability).

  Construct antisymmetric model space using group theory as a language of symmetry.

Activities with CERN

- **2021:**
  - Became member of CERN Baltic Group
  - Participation in 1st CERN Baltic Conference (CBC 2021) : *An algebraic approach for the six nucleon systems* (A. Stepšys, S. Mickevičius, D. Germanas, R. K. Kalinauskas)
- **2022:**
  - CERN Baltic Group Meeting in Tallinn (A. Stepšys)
- **2023:**
  - CERN Baltic Group Meeting in Kaunas (A. Stepšys)
  - Participation in organizing 3rd Baltic School of High-Energy Physics and Accelerator Technologies 2023. Scientific committee member A. Stepšys
  - Participation in workshop *Particle therapy - future for the Baltic States? State-of-play, synergies and challenges* in May (S. Mickevičius)
  - Application for joint scientific projects of research in CERN research topics (with KTU) (*A new generation carbon optoelectronic sensor for the Compact Muon Solenoid detector"*)
  - Participation in organizing 3rd CERN Baltic Conference (CBC 2023) Scientific committee member A. Stepšys
  - Participation in 3rd CERN Baltic Conference (CBC 2023) *Ground state energy for a few-body systems in an algebraic framework* (A. Stepšys, S. Mickevičius, D. Germanas, R. K. Kalinauskas)

Ongoing Research

- Chiral nuclear interaction application for the algebraic few- body system model
- Algebraic model for six and eight nucleon systems