

**Joint seminar of the NPI of the CAS**

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**Alexander Turbiner (ICN-UNAM, Mexico and Stony Brook University, US):**  
***Helium atom and helium-like ions - where we are today***

**Abstract:**

Z-Helium atom is the simplest atomic, 3-body system in Nature after hydrogen atom. As a result of enormous computational efforts during the last 90 years (~150 calculations) unprecedented accuracy in 35-44 figures is reached for non-relativistic ground state energies (in static approximation). It looks like we approached to a moment to ask a famous question by Lev Landau: "...and so what!?" (what we have learned out of all that, what is the physics behind?)

After the brief review of contemporary situation it will be shown that the physics extracted from perturbation theory at small and large nuclear charges  $Z$  allows us to get easily 12-13 figures in the energy for  $Z \leq 20$ . Furthermore, the domain of applicability of non-relativistic Quantum Mechanics of Coulomb Charges (no photons; no relativistic, QED, mass corrections) of 4-5 figures is described by the 2nd degree polynomial in  $Z$  (it is from the recently recovered E. Majorana formula, c. 1930). First 3 figures of (mass+rel+QED) corrections vs  $Z$  contribute to 5-6-7 figures of the ground state energy: they are described by 4th degree polynomial in  $Z$  (!) for  $Z \leq 20$ . Similar situation holds for excited states of helium-like and lithium-like ions. Generalizing Hylleraas-Kinoshita-Harris it will be presented the ultra-compact, 7-parametric trial function leading to 5 figures in the energy.