

## Joint seminar of the NPI of the CAS

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**Ing. Jakub Vicha, Ph.D., Department of astroparticle physics, FZU CAS: *Do we hear heavy-metal of cosmic rays at the highest energies?***

Abstract:

The origin of the most energetic cosmic rays is a long-lasting mystery that has been mainly obscured by uncertainties in their mass composition arising from the modelling of hadronic interactions in the extensive air showers that these particles induce. For some time now, discrepancies between the model predictions and measured air-shower data have been complicating efforts to find a consistent mass-composition scenario of ultra-high-energy cosmic rays (UHECR, above  $10^{18}$  eV). A deficit of the simulated signal relative to the measured signal in ground detectors is an inconsistency (also known as the muon puzzle) that is usually interpreted as a deficit of the muon signal induced by the hadronic component of a simulated shower. Recent advances in testing models of hadronic interactions revealed a new problem in the predicted depth of the shower maximum, which is usually considered as the best estimator of the cosmic-ray mass.

After brief introduction into UHECR, I will review the tests of models of hadronic interactions using the Pierre Auger Observatory data that imply a very heavy mass composition at the highest energies. Finally, I will introduce an extreme Heavy-metal scenario of UHECR assuming pure iron nuclei in the cosmic-ray flux-suppression region (above  $10^{19.6}$  eV). Surprisingly, such a scenario might be a viable option in the nature given the recent advances in the air-shower modelling.