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## A comprehensive search for the $\theta^+$ pentaquark on the lattice

**Prof. Ferenc Csikor**  
Institute for Theoretical Physics  
Eötvös Loránd University Budapest  
Budapest, Madžarska

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### Abstract:

We study spin 1/2 isoscalar and isovector, even and odd parity candidates for the  $\Theta^+(1540)$  pentaquark particle using large scale lattice QCD simulations. Previous lattice works led to inconclusive results because so far it has not been possible to unambiguously identify the known scattering spectrum and tell whether additionally a genuine pentaquark state also exists. Here we carry out this analysis using several possible wave functions (operators). The cross correlator matrix we compute is  $14 \times 14$  with 60 non-vanishing elements. We can clearly distinguish the lowest scattering state(s) in both parity channels up to above the expected location of the pentaquark, but we find no trace of the latter. We conclude that there are most probably no pentaquark bound states at our quark masses, corresponding to  $m_\pi = 400 - 630$  MeV. However, we cannot rule out the existence of a pentaquark state at the physical quark masses or pentaquarks with a more exotic wave function.

Voditeljica seminara:

Dr. Blaženka Melić  
([melic@thphys.irb.hr](mailto:melic@thphys.irb.hr))