

Search for higher mass resonances via KK decay channel in pp collisions with ALICE at the LHC

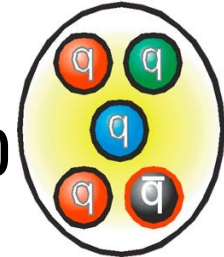
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Normal baryon



Normal meson



Pentaquark



Tetraquark



Glueball



Hybrid meson



Motivation:

Lattice QCD predicts the possible existence of glueballs [1],[2].

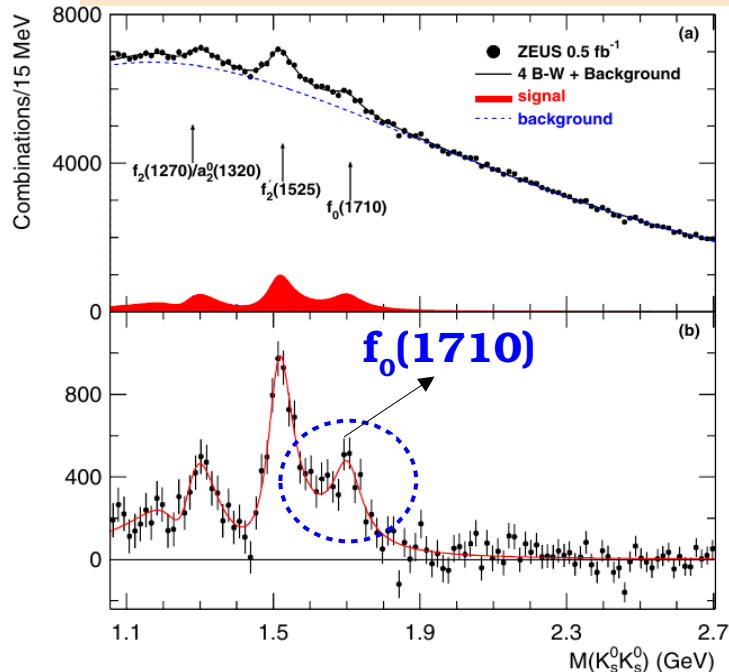
[1] PRL101, 112003 (2008)

[2].P.A. Zyla et al. (Particle Data Group)

Candidates:

- Mass range : 1550-1750 MeV/c²
- Total angular momentum, charge and parity : J^{PC} (0⁺⁺)

K_s^0 - K_s^0 resonance in ep collisions



Structure, quark content and nature yet not understood

$f_0(980)$, $f_2(1270)$,
 $f_2(1525)$, $f_0(1710)$
???

Candidates for tetra-quarks, molecule, composite structure, or glueball

$f_0(1710)$ is the lightest glueball candidate

In the present study we look for resonances decaying in K_s^0 - K_s^0 and K^+K^- pairs via invariant mass reconstruction in pp collisions at LHC energies

can we see these states in pp collisions with the ALICE detector ??

K_s^0 selection and reconstruction of resonances:

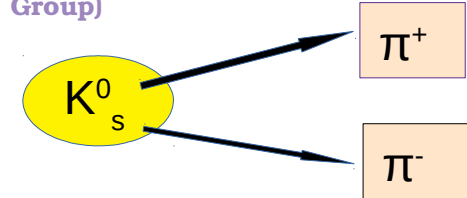
Data set

Collision system : pp
Center-of-mass energy : 13 TeV
Events analyzed : 1.52×10^9

Invariant mass method:

$$M_R = \sqrt{(E_1 + E_2)^2 - (\vec{p}_1 + \vec{p}_2)^2}$$

[1] PRL101, 112003 (2008)
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Relativistic Breit-Wigner function (rBW) (for signal) :
$$\frac{M_R \Gamma_0 M_0}{(M_R^2 - M_0^2)^2 + M_0^2 \Gamma_0^2}$$

For residual background function (Res.Bkg) :

$$A(M_R - 2m_0)^B \exp(-C(M_R - 2m_0))$$

Fit function used for this study[1] :

For K_s^0 - K_s^0 pair : **Coherent Breit-Weigner function + Res.Bkg :**

$$c1 * |5 * rBW\{f_2(1270) - 3 * rBW\{a_2(1320)\} + 2 * rBW\{f_2(1525)\}|^2 + c3 * |rBW\{f_0(1710)\}|^2,$$

M_R = mass of reconstructed pair

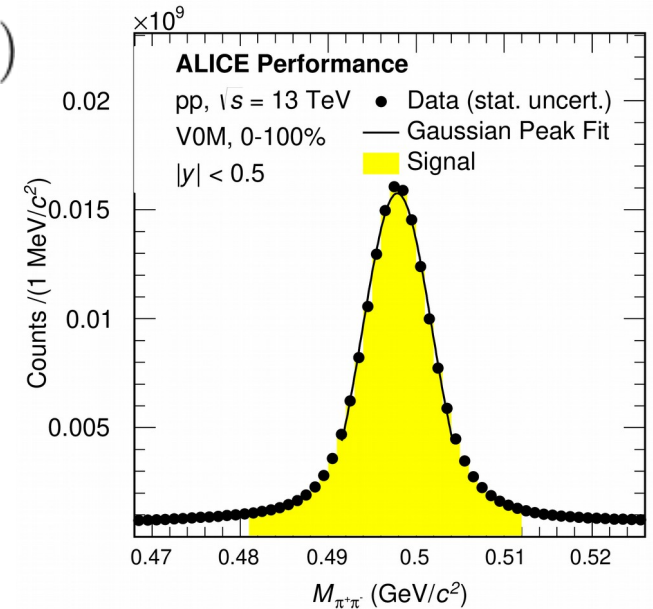
M_0 = PDG mass of resonance[2],

m_0 = PDG mass of decay daughter of resonance

Γ_0 = PDG width of resonance [2] ,

$c1, c3, A, B, C$ are free fit parameters

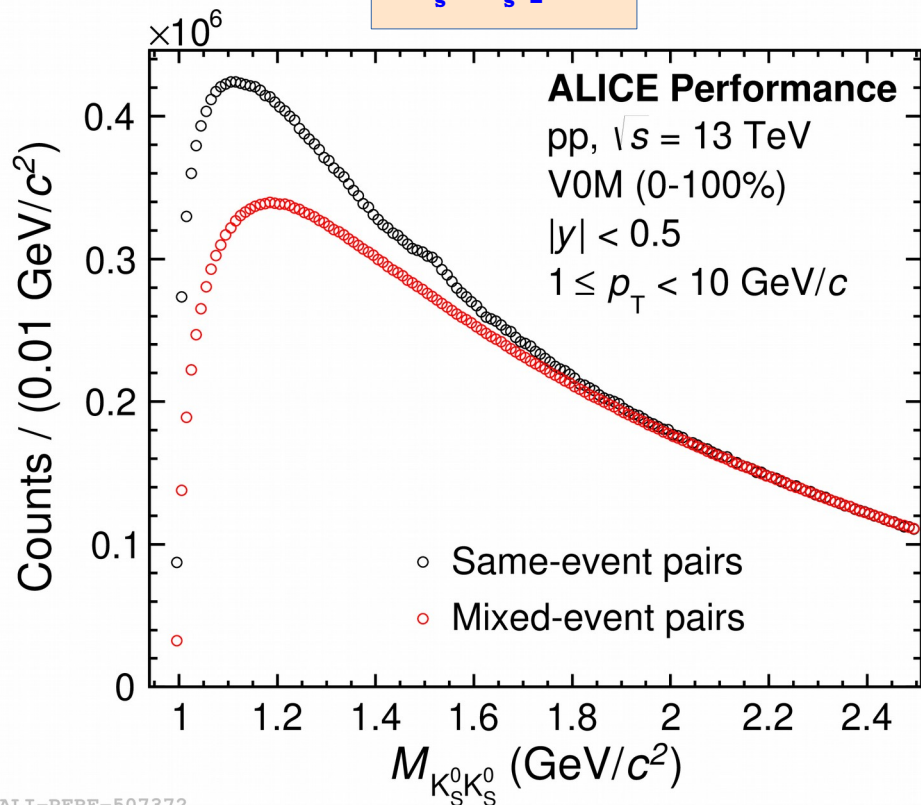
For K^+K^- pair : **Non-coherent Breit-Weigner function + Res.Bkg**



ALI-PERF-507360

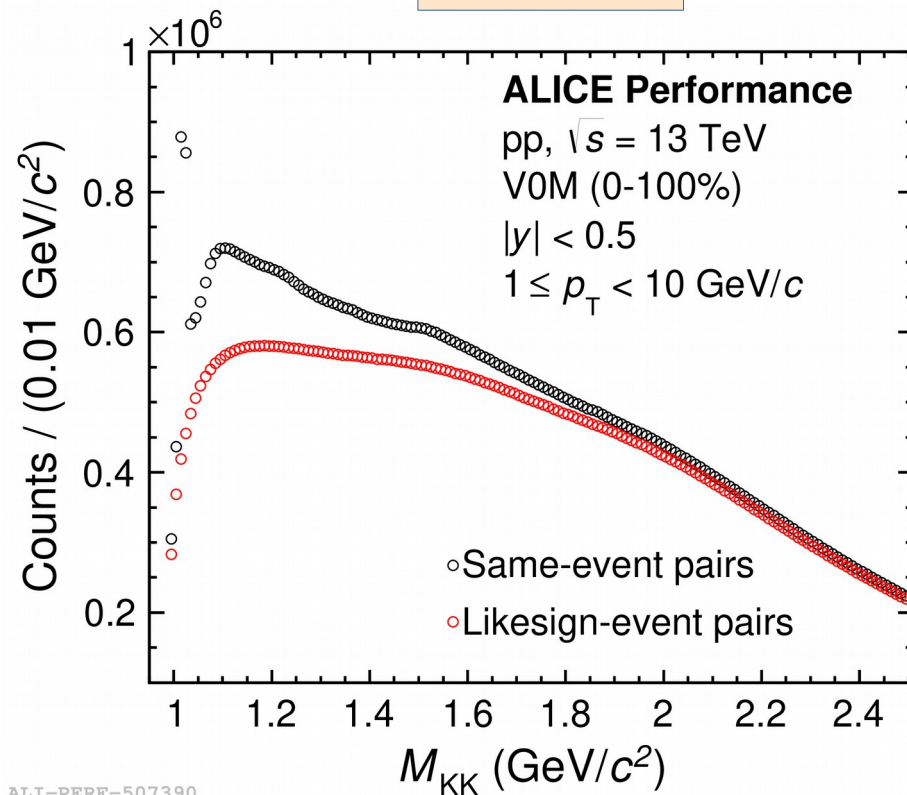
K_s^0 - K_s^0 and K^+K^- invariant mass distributions

K_s^0 - K_s^0 pair



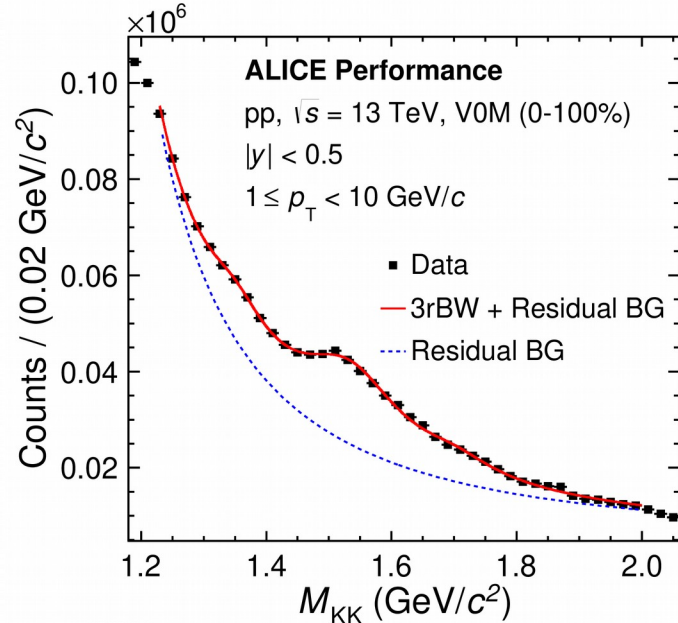
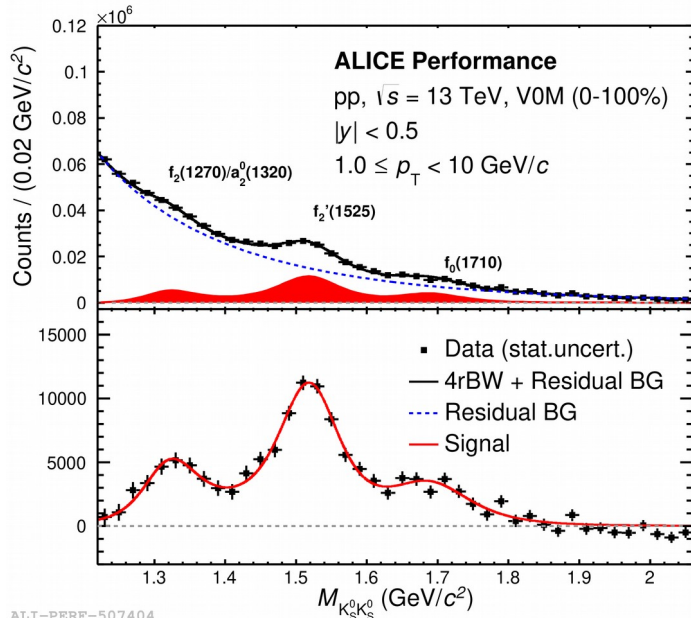
Combinatorial background: Mixed-event pairs

K^+K^- pair



Combinatorial background: Same event,
like-sign pairs

Signal after combinatorial background subtraction



Summary:

- First look to the invariant mass distributions of K_S^0 - K_S^0 and K^+K^- pairs in pp collisions at 13 TeV.
- Higher mass resonance states are observed and a prominent signal peak is seen for $f_2(1525)$ in both of the decay channels.

Outlook:

- Extract mass, width and p_T distributions of the observed high mass resonances.
- High statistics collected in Run 3 and Run 4 is mandatory for precise measurements.

K_S^0 - K_S^0 channel: 3 invariant mass peaks are seen -> consistent with the observation in ep collisions at HERA[1].

K^+K^- channel: 2 invariant mass peaks are visible.

A prominent $f_2(1525)$ signal is observed in both the decay channels.