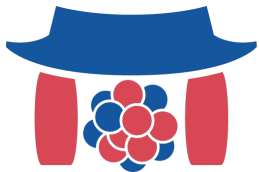


Accessing the internal structure of exotic resonances at the LHC energy



INPC 2025

May 25-30, 2025
DCC, Daejeon, Korea



ALICE

Junlee Kim¹
On behalf of ALICE Collaboration

25–30 May 2025
29th INPC
Daejeon, South Korea

1. CERN

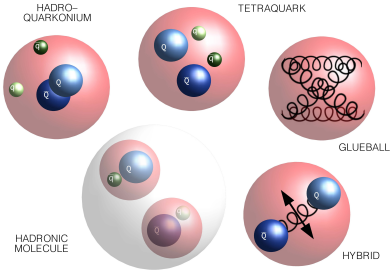
Internal structure of exotic hadrons still under debate

- Tetraquark: $(u\bar{u} + d\bar{d})s\bar{s}$
PRD 103 (2021) 1, 014010, Mod.Phys.Lett. A2 (1987) 771
- Molecular state: KK ($f_0(980)$), KK^* ($f_1(1285)$)
PRD 101 (2020) 9, 094034, PRD 42 (1990) 874
- Conventional meson: $u\bar{u} + d\bar{d}$ (no s quarks)
PRD 67 (2003) 094011, PRD 96 (2017) 5, 054012

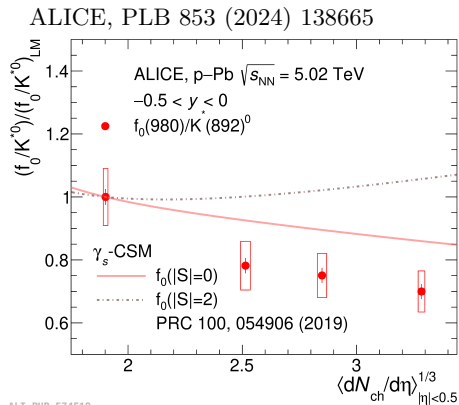
Comparison of particle yield ratios with thermal model calculations to discuss the internal structure of exotic hadrons

	$f_0(980)$	$a_0(980)$	$\kappa(700)$	$f_1(1285)$	$K_1(1270)$	$f_0(1710)$
Mass (MeV/ c^2)	990	990	630–730	1,281	1,253	1,730
Width (MeV/ c^2)	10-100	60–150	500–700	20	15	150
J^P	0^+	0^+	1^+	0^+	1^+	0^+

$K_1 \rightarrow K^* \pi$



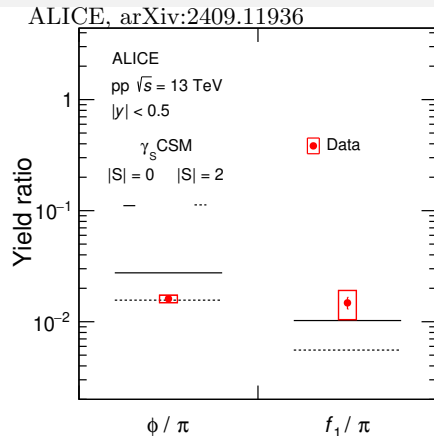
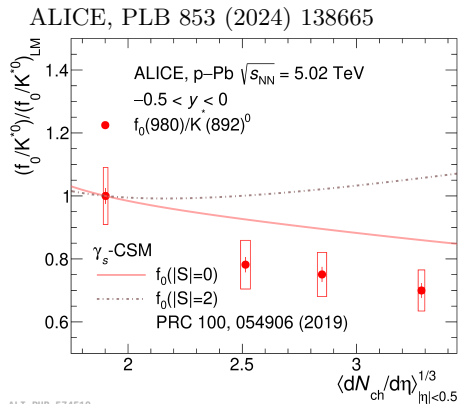
Searching for the nature of $f_0(980)$ with thermal model



ALI-PUB-574510

- Decreasing f_0/K^{*0} with $|S| = 0$ scenario
 - Disclaimer: may have different rescattering effects for f_0 and K^{*0}

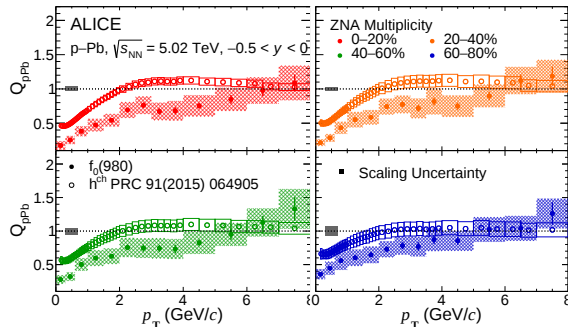
Searching for the nature of $f_1(1285)$ with thermal model



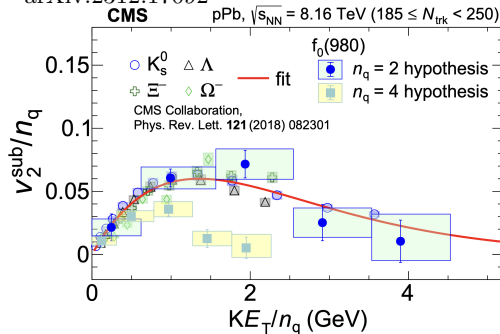
- Decreasing f_0/K^{*0} with $|S| = 0$ scenario
- Alignment of particle yield ratio for $f_1(1285)$ with $|S| = 0$ scenario
 → Measurement suggests both particles have no (anti-)strange quarks and probably are conventional mesons

Constituent quarks of $f_0(980)$ resonances

PLB 853 (2024) 138665



arXiv:2312.17092



No Cronin-like enhancement for $f_0(980)$ R_{pPb}

- Enhancement expected for tetraquark state: PLB 645 (2007) 138

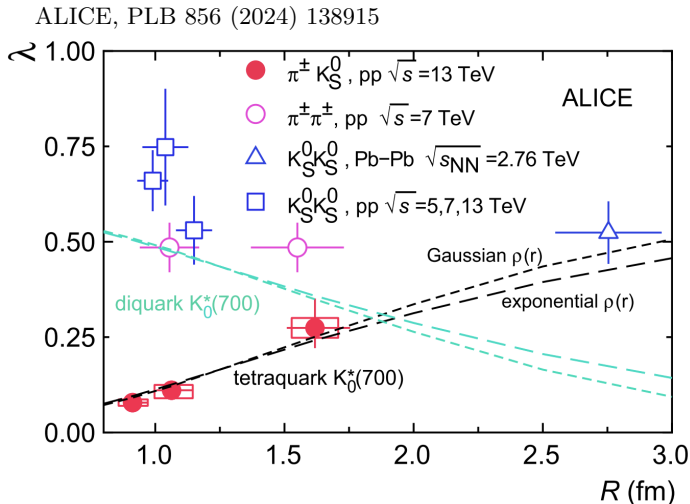
The origin of flow from constituent quarks $\rightarrow f_0(980)$ flow aligned with conventional meson
Important input to understand chiral symmetry for the lightest pseudoscalar mesons

Internal structure of $\kappa(700)$ via femtoscopy

Correlation strength (λ) increases with increasing source size (R), supporting tetraquark structure scenario

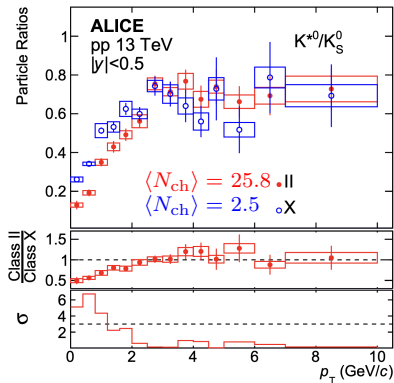
- Tetraquark scenario: less $d\bar{d}$ annihilation for longer source size
- Diqurk scenario: more $d\bar{d}$ creation for shorter source size

based on overlap probability between K and π

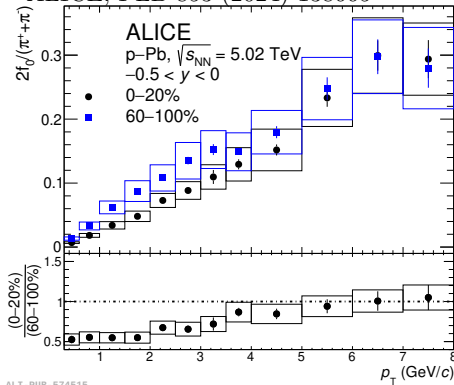


Rescatterings for the $f_0(980)$

ALICE, PLB 807 (2020) 135501



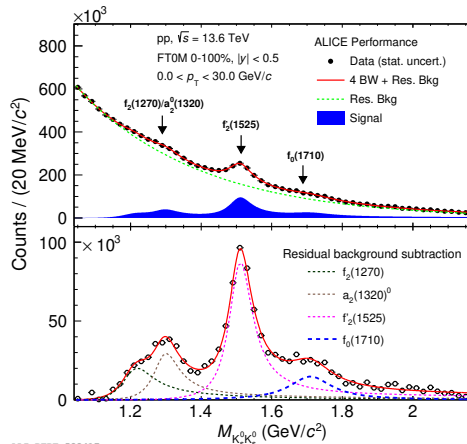
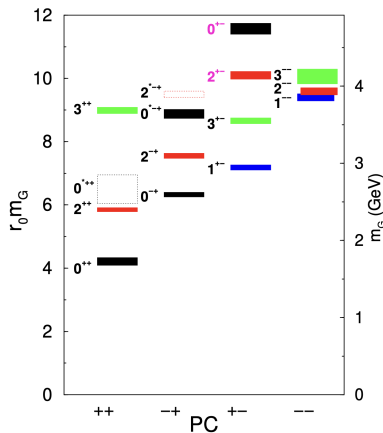
ALICE, PLB 853 (2024) 138665



- $f_0(980)$ yields suppressed at low p_T in higher multiplicity events
→ $f_0(980)$ resonances significantly affected by **interactions with the hadron gas even in small collision system**

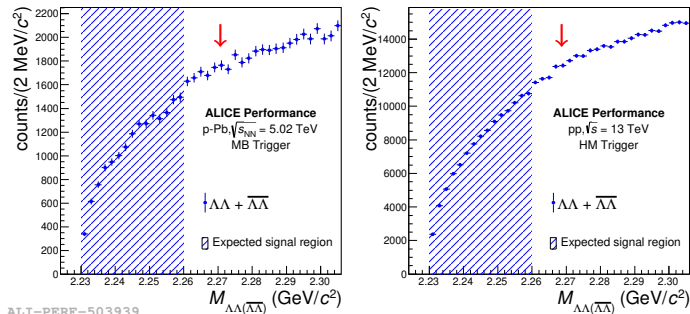
Glueball candidates via KK channels

Colin J. et al. PRD 60 (1999) 034509



- The lightest 0^{++} glueball candidates searches via $K_s^0 K_s^0$
- Signal identification with high significance thanks to improved Run 3 data statistics
- Measurement of flow or nuclear modification factor would be crucial to get insights on internal structure

Promising exotic candidates?

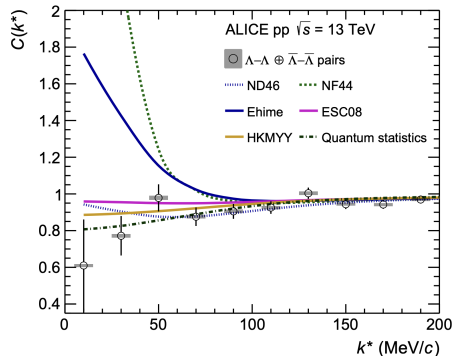


ALI-PERF-503939

- H -dibaryon to be resonant state? PRC 75 (2007) 022201
- Little bump: statistical fluctuation?
- Repulsive interaction?

A new results with high statistics in Run 3?

PLB 797 (2019) 134822



The internal structure of exotic resonances is being probed through high-precision measurements at the LHC, contributing to a deeper understanding of their nature and providing valuable insight into the non-perturbative regime of QCD

Comparison of particle yield ratio between experimental data and thermal model calculations

- $f_0(980)$ and $f_1(1285)$ resonances are expected not to have strange quarks
→ Not likely to have tetraquark structure, probably conventional mesons

Other exotic resonant states in ALICE

- The observed source size dependent correlations strength for $K^0\pi^\pm$ supports $\kappa(700)$ to be a tetraquark
- Promising baseline measurement of Glueball-candidate resonances
- Searches for other interesting resonance states ongoing in ALICE

Backup