Low-mass dilepton enhancement

Effects of chain decays, radial flow and $U_A(1)$ restoration

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1. Motivation / problem

Excess in low-mass region ($0.1\ \text{GeV} < m_{ee} < 0.7\ \text{GeV}$)

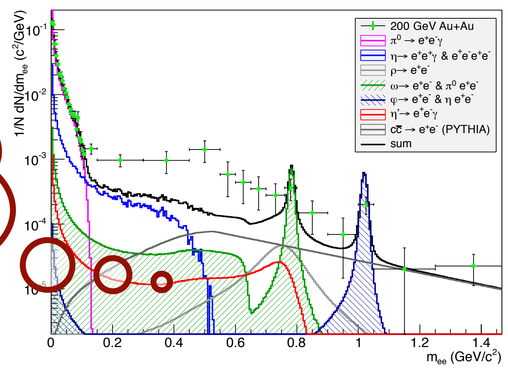
$\chi^2/\text{NDF} = 50.3/12$, CL = 0.01%

(calculated for $0.12\ \text{GeV} < m_{ee} < 1.2\ \text{GeV}$)

The return of the prodigal Goldstone boson - η' mass drop

Kunihiro: Phys.Rev.Lett.B219 (1989) 363-368
Kapusta *et al.* Phys.Rev. D53 (1996) 5028-5033
Zheng *et al.* Phys.Rev. D53 (1996) 5034-5041

A. Adare et al, PHENIX Coll., PRC**81** (2010) 034911



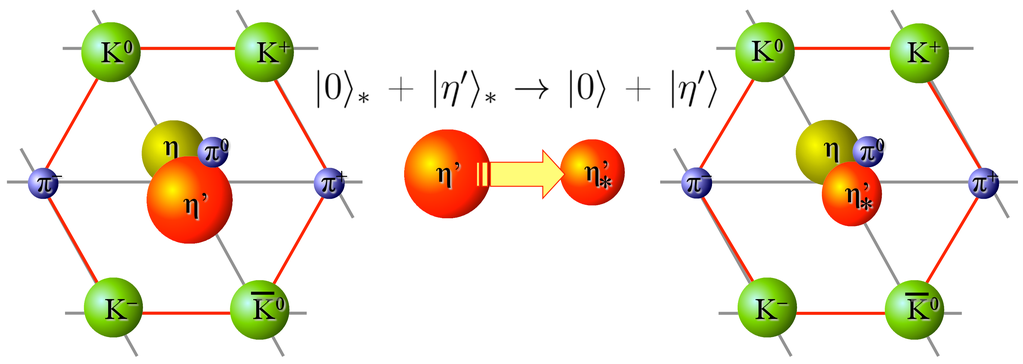
For preliminary dilepton data with HBD see I. Tserruya's PHENIX plenary talk

2. The η' meson in hot, dense medium

Indirect, HBT observation of an η' mass reduction

T. Csörgő, R. Vértesi, J. Sziklai, PRL 105 (2010) 182301, PRC38 (2011) 054903

- In a hot, dense hadronic medium: **vacuum modification**



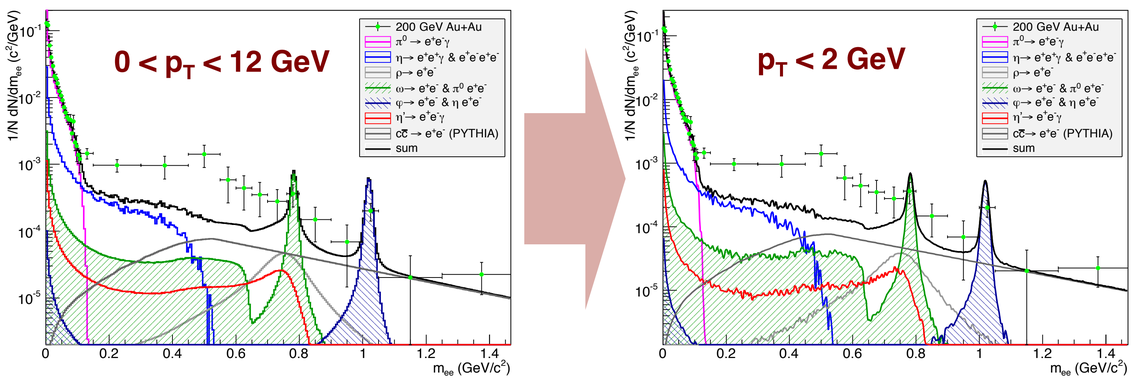
- **In T = 0 QCD vacuum $m_{\eta'} = 958$ MeV. In T > 0 QCD, $m^*_{\eta'} = ?$**
- Hagedorn-estimation: the lighter the η' the larger its production

$$f_{\eta'} = \left(\frac{m^*_{\eta'}}{m_{\eta'}}\right)^{\alpha} e^{\frac{m_{\eta'} - m^*_{\eta'}}{T_{\text{cond}}}}$$

From HBT, indirect measurement:

- $m^*_{\eta'} \le m_{\eta'} - 200$ MeV @ 99.9 % confidence level
- $m^*_{\eta'} = 340\ ^{+50}_{-60}\ (\text{stat})\ ^{+280}_{-140}\ (\text{syst}) \pm 45\ (\text{model})$ MeV
- Enhancement factor, $f_{\eta'}$ estimated: 26-68 ➔ **Dileptons?**

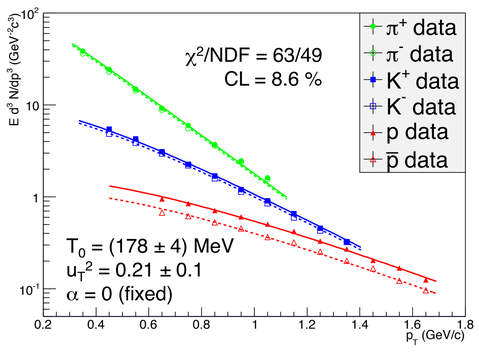
3. Radial flow for dilepton enhancement



- resonance $p_T < 2$ or 12 GeV cut, similar result
- low-p_T part dominant → radial flow important ($m_\eta \approx m_{K^\pm}$, $m_{\eta'} \approx m_p$)

$$E\frac{d^3N}{dp^3} = A\left(\frac{m_T}{m}\right)^{\alpha} e^{-\frac{m_T}{T_0 + m u_T^2}}$$

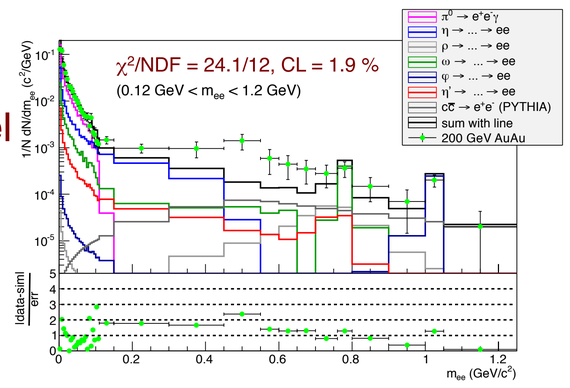
- Hydro with radial flow term simultaneously fitted to min. bias 200 GeV Au+Au data: $\pi^\pm$, $K^\pm$, $p^\pm$



4. Resonance chain decays+radial flow

Dilepton cocktail with hydro

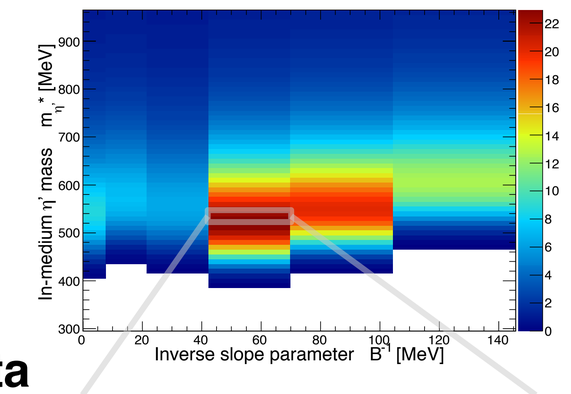
- Chain decays for dileptons ($\eta' \to \eta + 2\pi \to e^+e^-\gamma + 2\pi$)
- Resonance ratio: thermal model (Kaneta and Xu, nucl-th/0405068)
- All chain decays of mesons
- Radial flow included
- Still systematically below data



5. In-medium η' mass + chains + flow

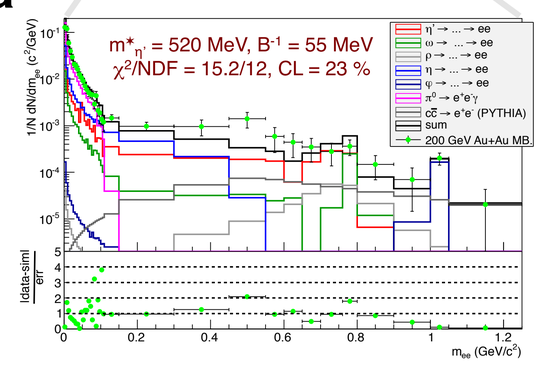
Confidence level map

- Simulations with η' enhancement
- Scanning through η' spectrum parameters
- Region of CL > 0.1% shown



From PHENIX dilepton data

- 480 MeV < $m^*_{\eta'}$ < 600 MeV (at CL ≥ 15 %)
- 400 MeV < $m^*_{\eta'}$ ≤ 958 MeV (at CL ≥ 0.1 %)
- **$m^*_{\eta'}$ is a good control**



6. Conclusions:

- **Radial flow and chain decays are important**
- **PHENIX low-mass dileptons described well with radial flow + chains + in-medium η' mass**
- **400 MeV < $m^*_{\eta'}$ ≤ 958 MeV (CL > 0.1 %)**
- **480 MeV < $m^*_{\eta'}$ < 600 MeV (CL ≥ 15 %)**
- **Consistent with indirect HBT measurements**
- **Error analysis is preliminary**