J/Ψ Suppression in QGP

Outline:

- Introduction : charmonium and dense matter
- J/Ψ Suppression as a probe for QGP
- Experimental results
- Summary

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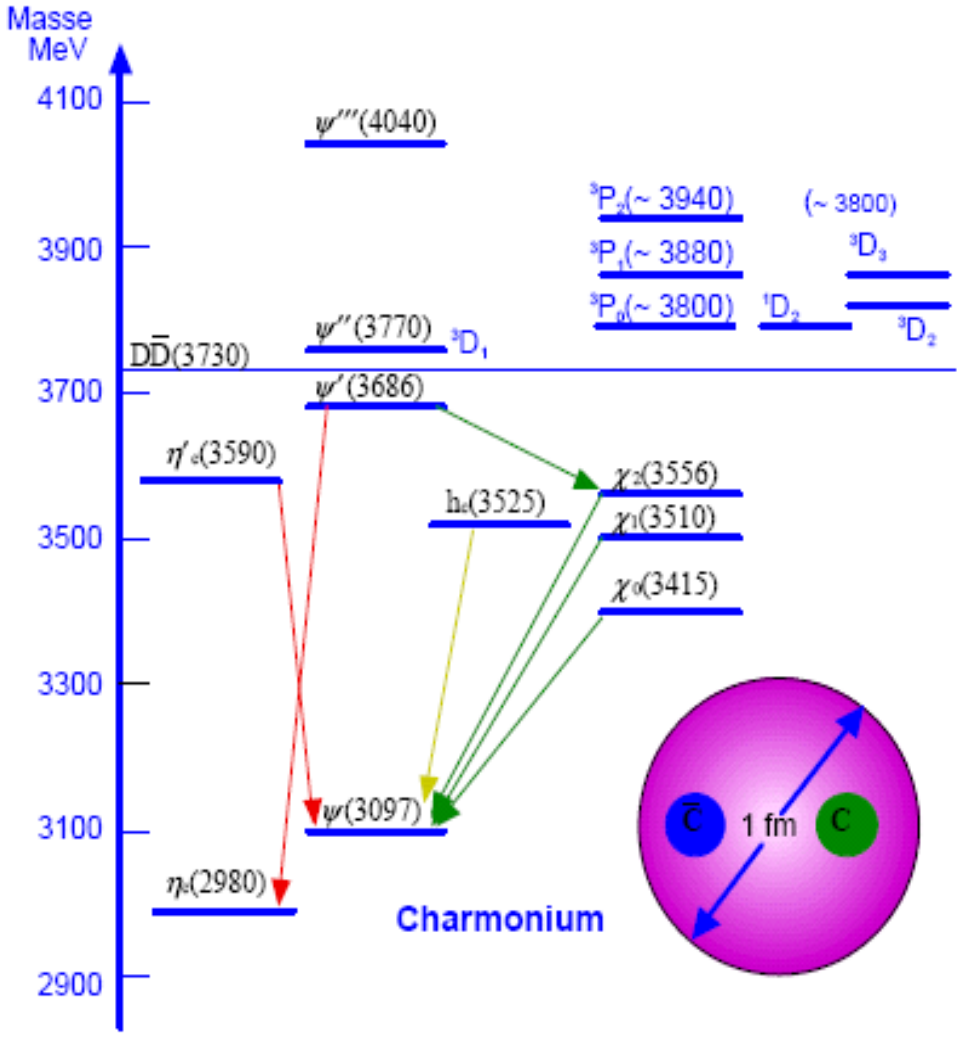
Introduction : charmonium

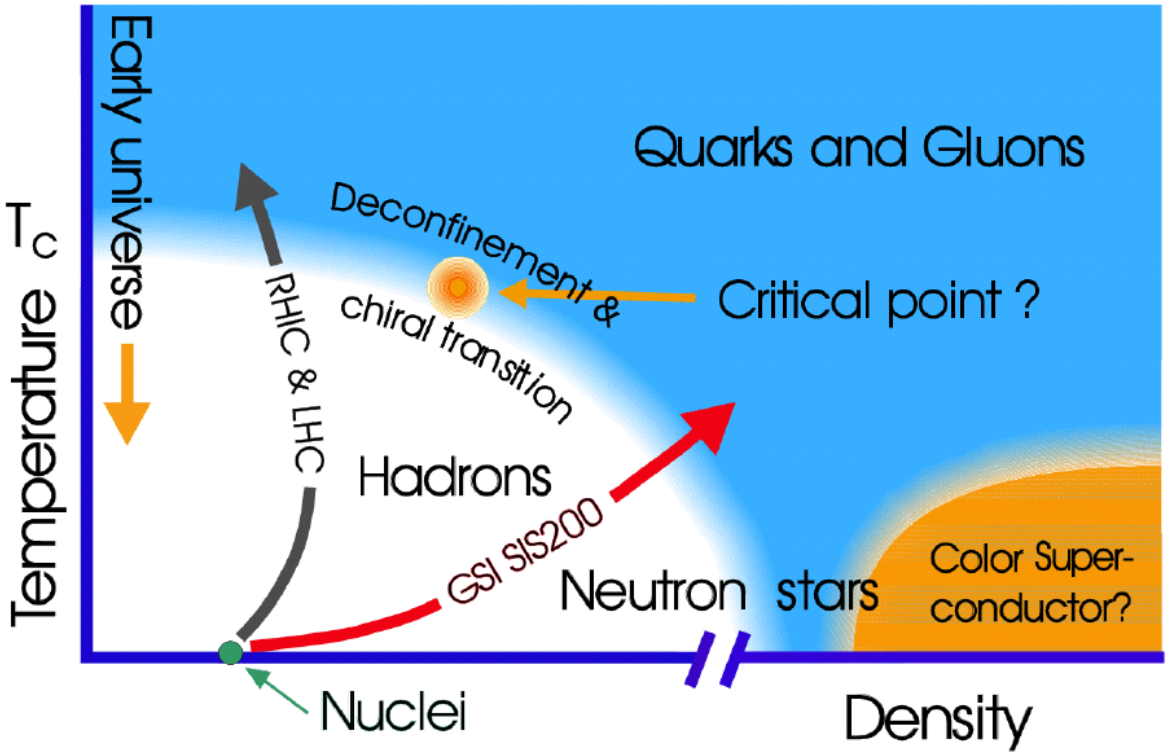
J/ψ spectroscopy



- J/Ψ (1S) is a **c$\underline{\mathbf{c}}$** bound state
  m = 3.097 GeV
  <r> ≈ 0.4 fm

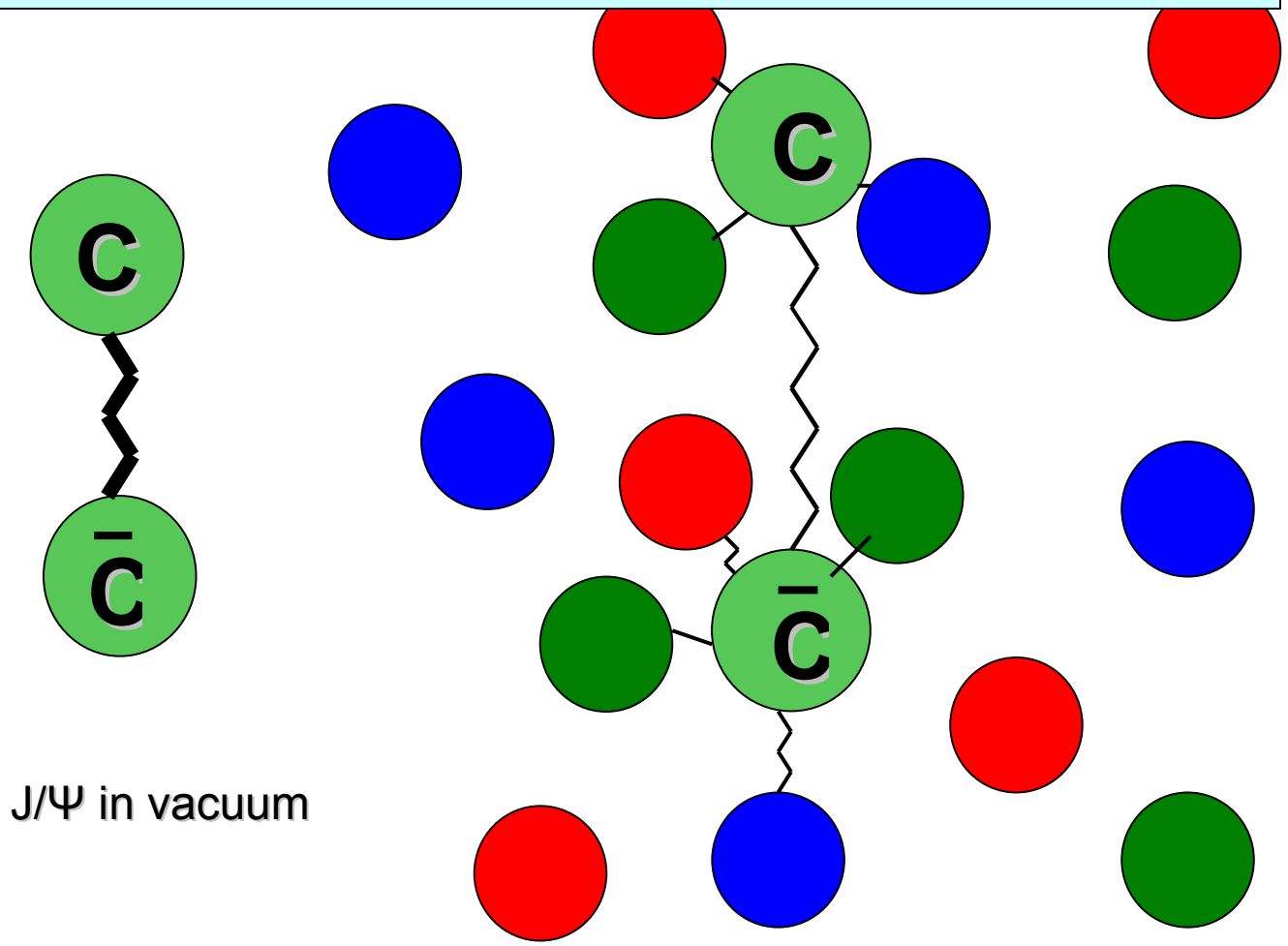
- J/Ψ threshold production for p-p collision ≈ 15 GeV

Introduction : Heavy-ion collision



- High-energy heavy-ion collision can create the QGP
- Different ways around the critical point : high temperature or high density
- Need observables to distinguish hadron medium from QGP : J/Ψ suppression ?

Why do we expect a suppression ?



J/Ψ in vacuum

J/Ψ in the QGP

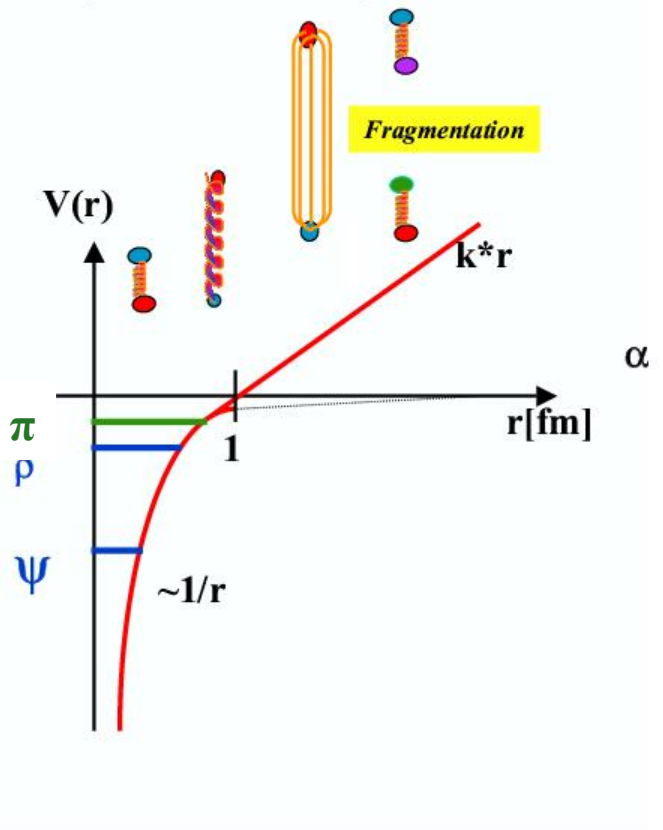
→ Debye Screening of colour charge

Charmonium model and lattice QCD

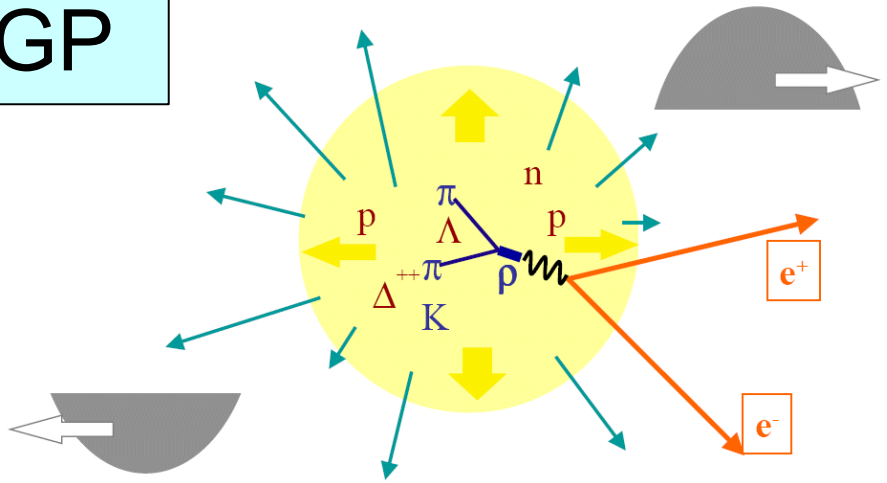
Find the temperature dependance of the screening radius

- $V(r) = \sigma r - m\alpha_{eff}/r$ σ: string tension

($\sigma \approx 0.16\ GeV^2$ for isolated system, i.e T=0)



J/Ψ suppression in QGP



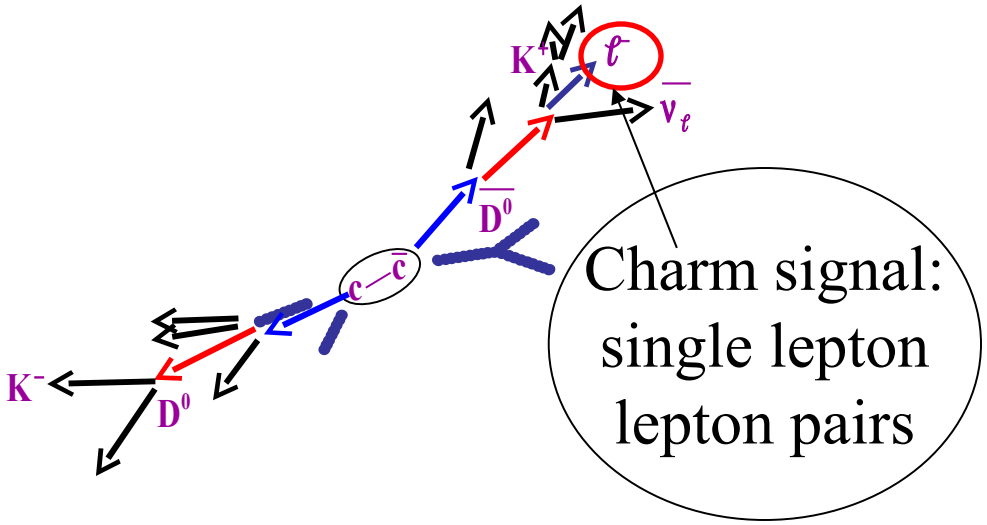
- At what T does $r_D(T)$ fall below $r_{J/}$ (T) ?
- Are there competitive non-plasma suppression mechanisms ?
- Could the suppression in the QGP be compensated in the transition or hadronization stage ?
- Could enhanced non-resonant production of lepton pairs (“thermal dileptons”) prevent the observation of the ?

Measurement of charm and lepton/lepton pairs

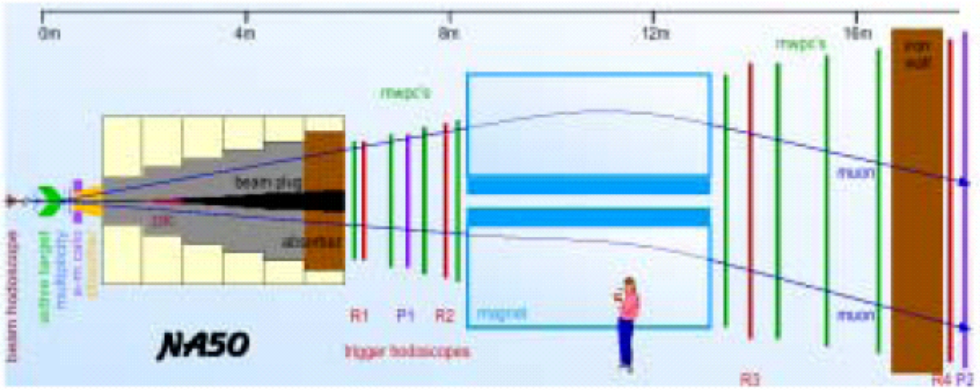
Charmonium:
lepton pairs

$J/\Psi \rightarrow e^+e^-, \mu^+\mu^-$
$\Psi(2S) \rightarrow e^+e^-, \mu^+\mu^-$
$\chi_c \rightarrow J/\Psi + \gamma$

Open charm:
single lepton and lepton pairs

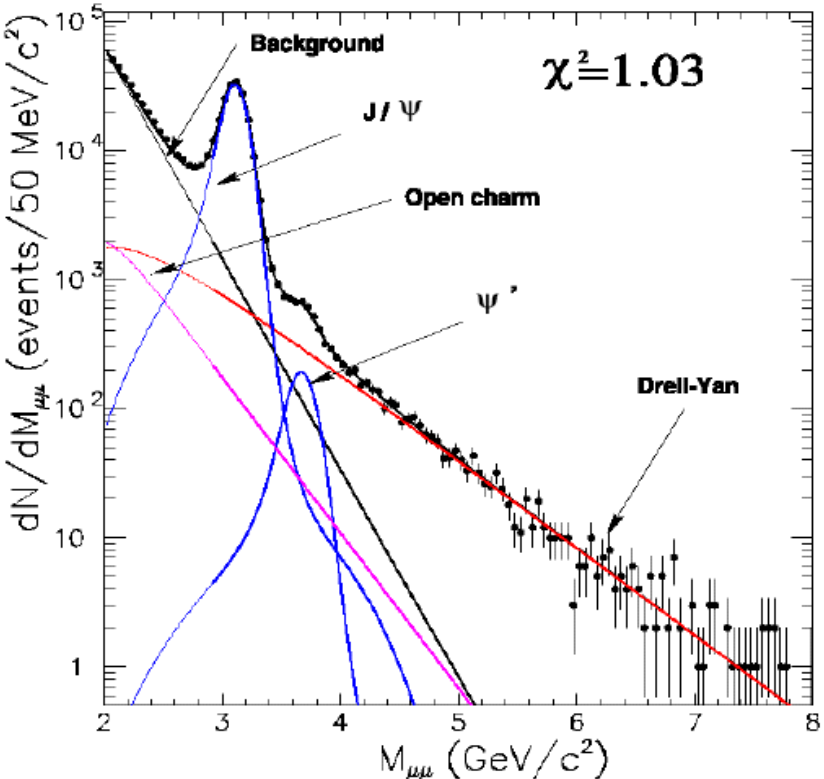


- J/Ψ has a large branching ratio (6%) to lepton pairs, and it is almost exclusively measured by lepton pair decay.
- Charmed mesons has a large leptonic branching ratio (D^0: 7 %, D^+:17%). Charm production can be measured indirectly by single lepton in 0.5< pt<3 GeV/c (RHIC/PHENIX) and lepton pairs in 1<M<3 GeV (SPS/NA50).
  - More direct measurement of D-meson reconstruction is difficult without a precision vertex detector

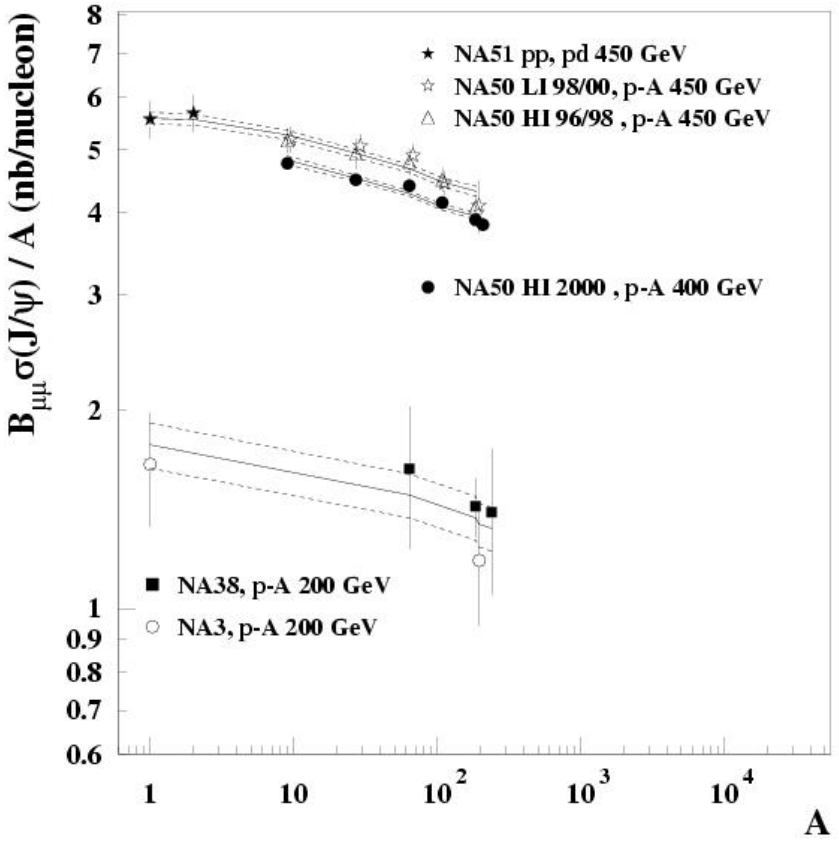


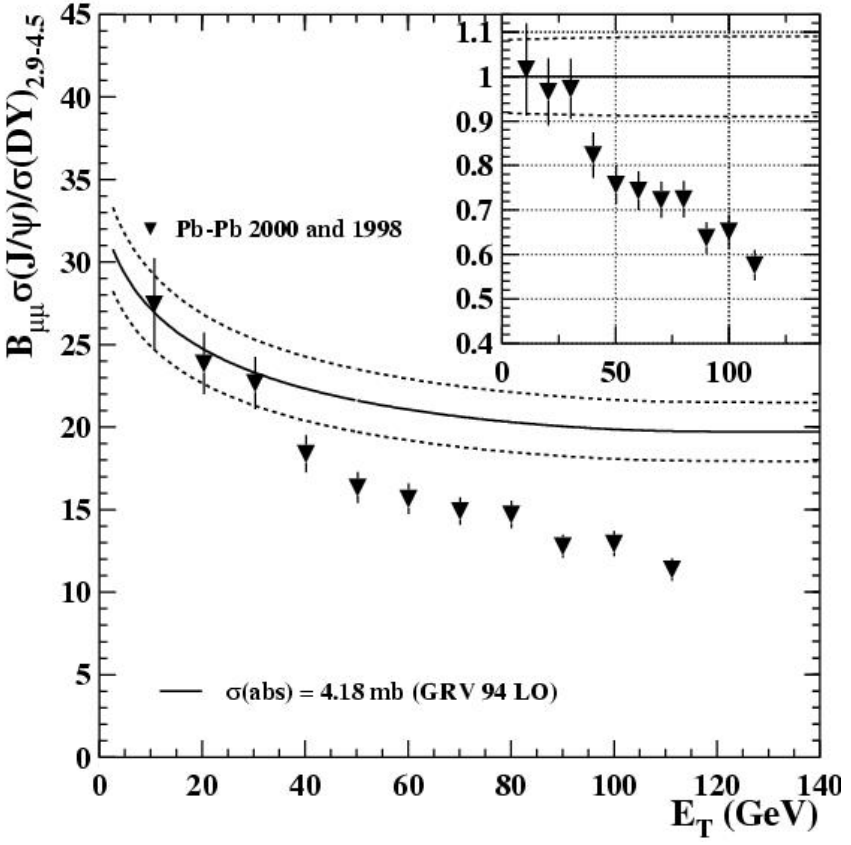
NA50 Collaboration at CERN:

$J/\psi\ (c\bar{c}) \rightarrow \mu^+\mu^-$ (6%)

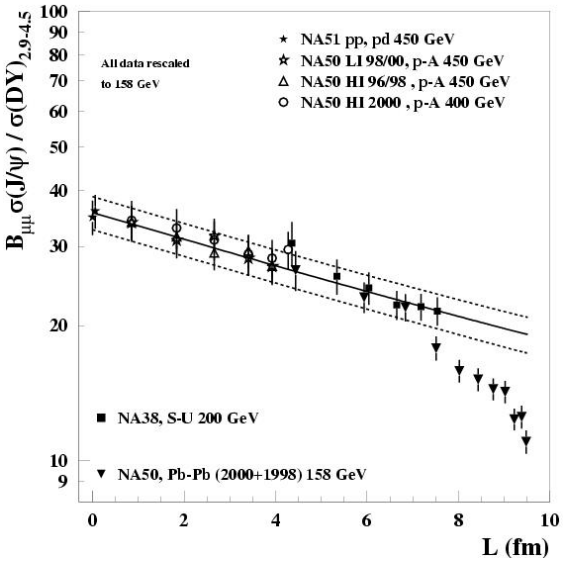


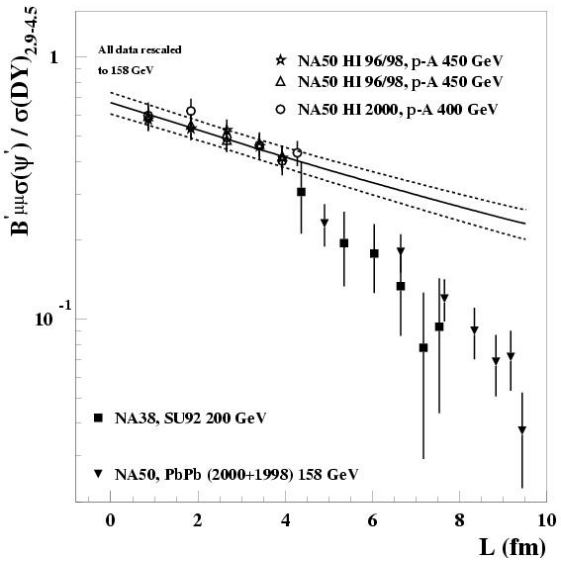
NA50 Results

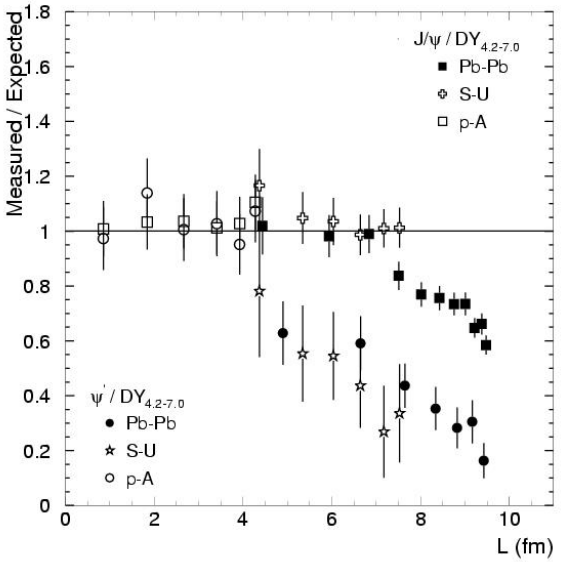




NA50 Results







Experimental results

- NA50 observed anomalous suppression of J/Y in Pb+Pb collisions at 158 GeV, deviation from the nuclear absorption model
- If J/Ψ suppression is due to QGP formation, almost all of initially produced J/Ψ should be suppressed at RHIC energy
- PHENIX observed excess of single electron yield over the contribution from light meson decays and photon conversions

Summary

- Quarkonium suppression has been observed at SPS
- The gross features are consistent with the idea of colour charge screening, but :
- It seems to be specific to the kinematic conditions in these experiments : the enhanced charm creation at RHIC and LHC may lead to an enhancement of the yield
- Evidence of charmonium production by coalescence in QGP
- No suppression observed at RHIC