Jet suppression at LHC: theory vs. experiment

Magdalena Djordjevic

Institute of Physics Belgrade, University of Belgrade

Jet suppression at LHC

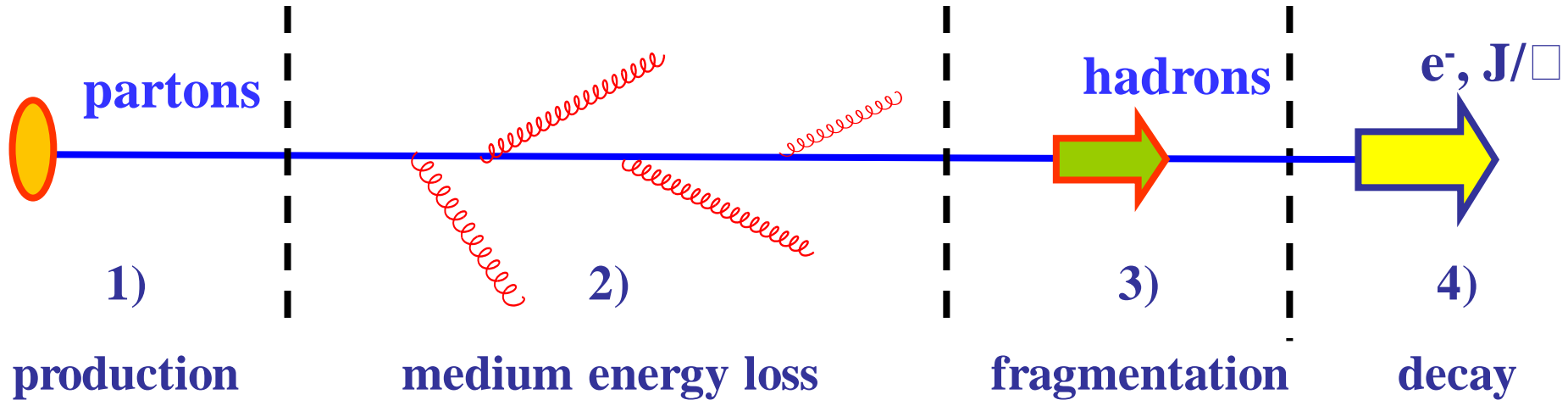**Light and heavy flavour suppressions are excellent probes of QCD matter.**

Suppression for a number of observables at LHC has been measured.

Comparison of theory with the experiments allow testing our understanding of QCD matter.

Jet suppression

1) **Initial momentum distributions for partons**
2) **Parton energy loss**
3) **Fragmentation functions of partons into hadrons**
4) **Decay of heavy mesons to single e^- and $J/\Box$.**

Dynamical energy loss

Computed both collisional and radiative energy loss in finite size **dynamical QCD medium** of thermally distributed massless quarks and gluons.

Abolishes approximation of static scatterers.
M. D. PRC 80:064909 (2009), M. D. and U. Heinz, PRL 101:022302 (2008).

Finite magnetic mass effects.
M. D. and M. Djordjevic, PLB 709:229 (2012)

Includes running coupling
M. D. and M. Djordjevic, arXiv:1307.4098

Numerical procedure

- **Light flavor production** Z.B. Kang, I. Vitev, H. Xing, PLB 718:482 (2012)

- **Heavy flavor production** M. Cacciari et al., JHEP 1210:137 (2012)

- **Path-length fluctuations**

    WHDG, NPA 784:426 (2007), A. Dainese, EPJ C33:495 (2004)

- **Multi-gluon fluctuations**

    M. Gyulassy, P. Levai, I. Vitev, PLB 538:282 (2002).

- **DSS and KKP fragmenation for light flavor**

    D. de Florian, R. Sassot, M. Stratmann, PRD 75:114010 (2007)

    B. A. Kniehl, G. Kramer, B. Potter, NPB 582:514 (2000)

- **BCFY and KLP fragmenation for heavy flavor**

    M. Cacciari, P. Nason, JHEP 0309: 006 (2003)

- **Decays of heavy mesons to single electron and J/☐ according to**

    M. Cacciari et al., JHEP 1210:137 (2012)

- **Temperature T=304 MeV**

    M. Wilde, Nucl. Phys. A 904-905:573c (2013) (ALICE Collab.)

Generating predictions

- **Provide joint predictions across diverse probes**

    charged hadrons, pions, kaons, D mesons,

    non-photonic single electorns, non-prompt J/$\square$

    M. D. and M. Djordjevic, arXiv:1307.4098

- **Puzzles (apparently surprising data)**

    Measured charged hadron *vs*. D meson supression

    M. D., arXiv:arXiv:1307.4702

- **Fine resolution hierarchy**

    Measured pion *vs*. kaon suppression

    M. D. and M. Djordjevic, arXiv:1307.4714

- **All predictions generated**

    ➢**By the same formalism**

    ➢**With the same numerical procedure**

    ➢**No free parameters in model testing**

Comparison with LHC data
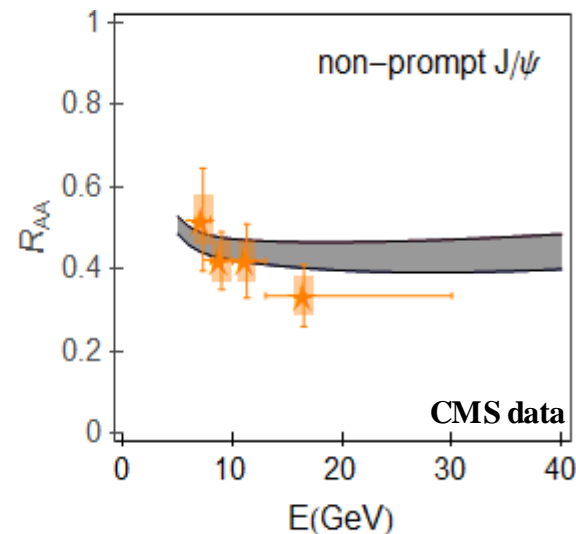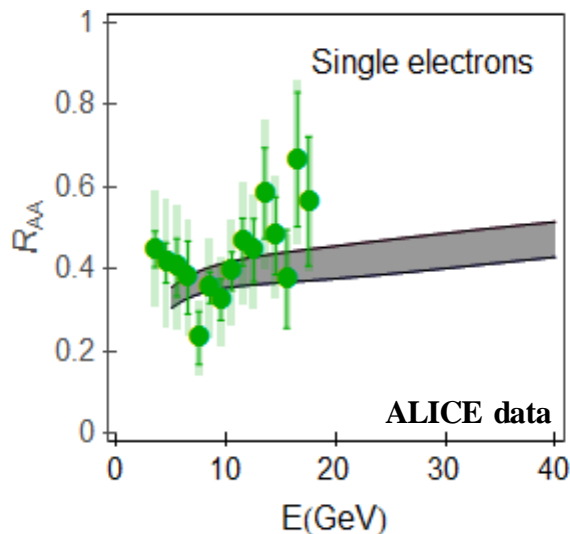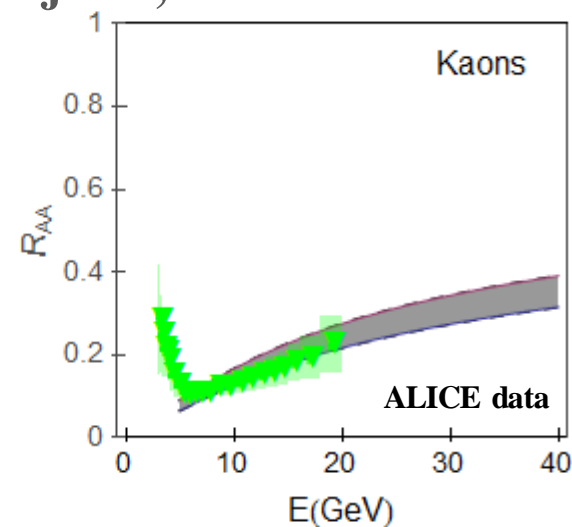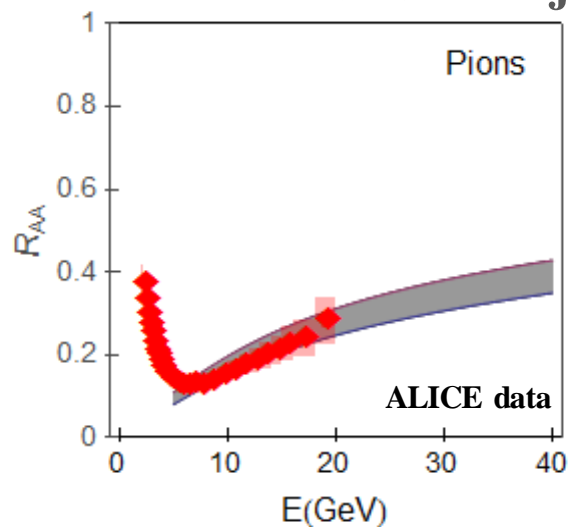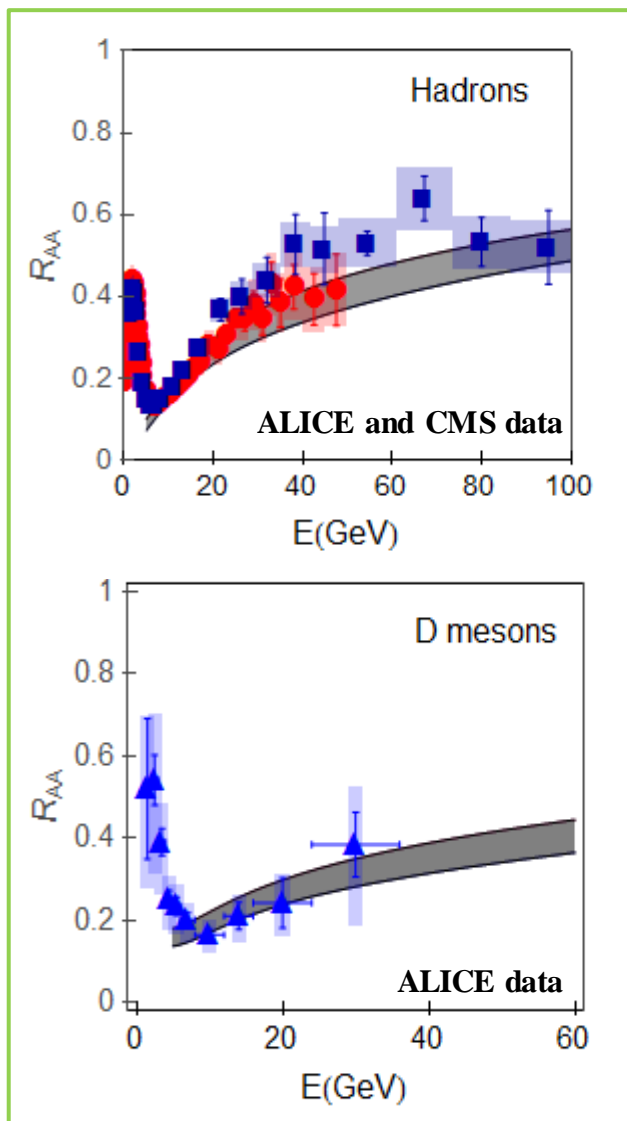
Very good agreement with diverse probes!

Heavy flavor puzzle at LHC
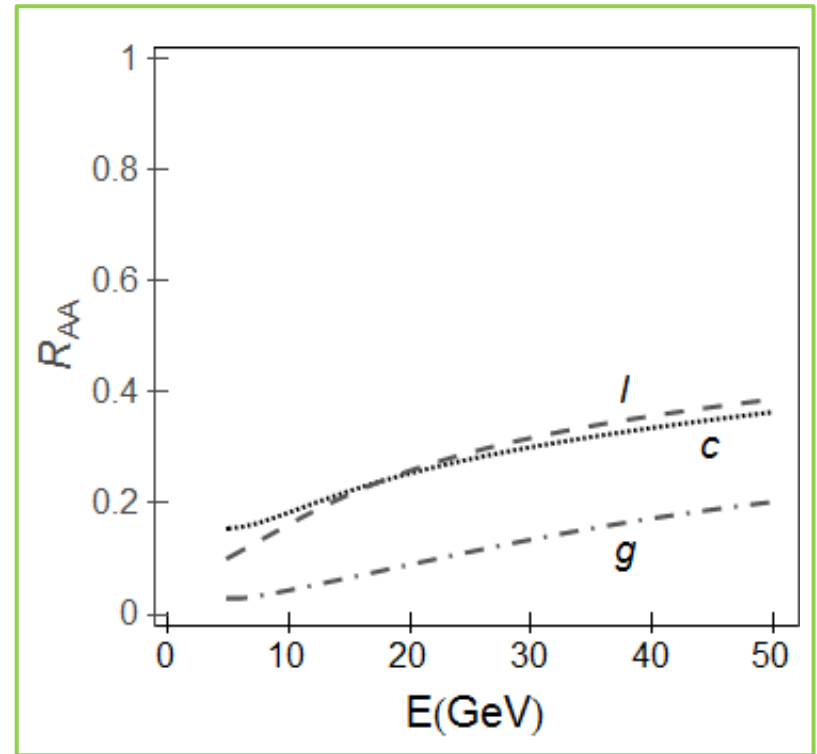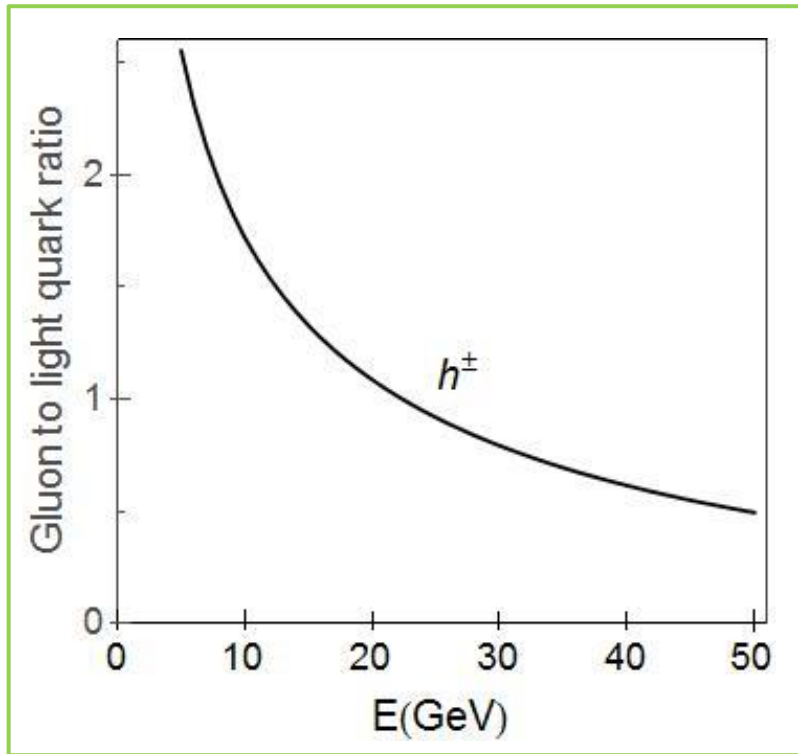
Significant gluon contribution
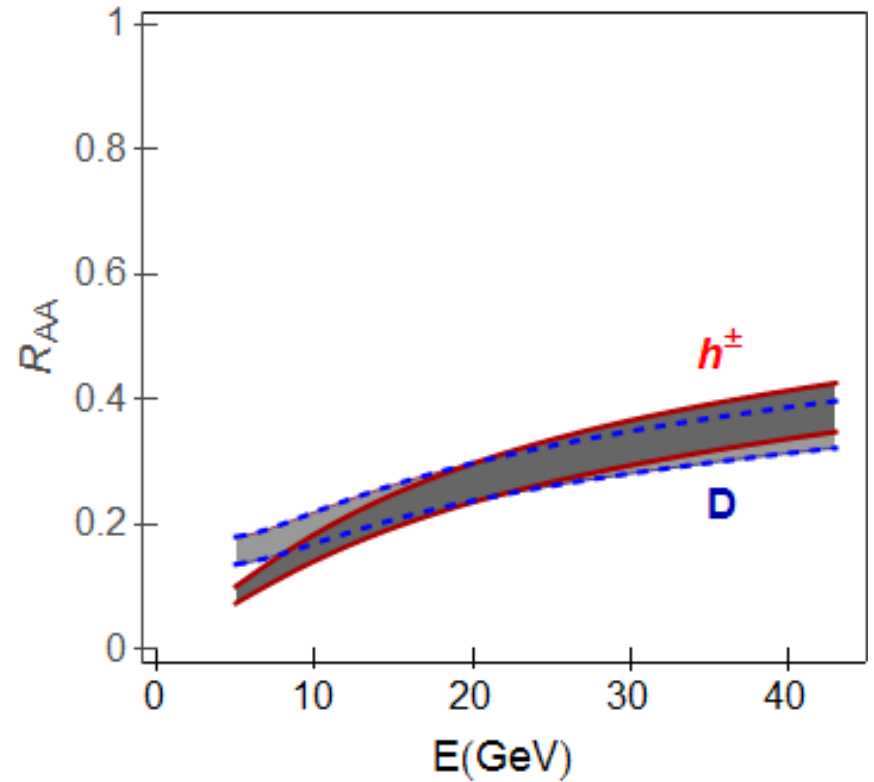in charged hadrons

Much larger gluon suppression

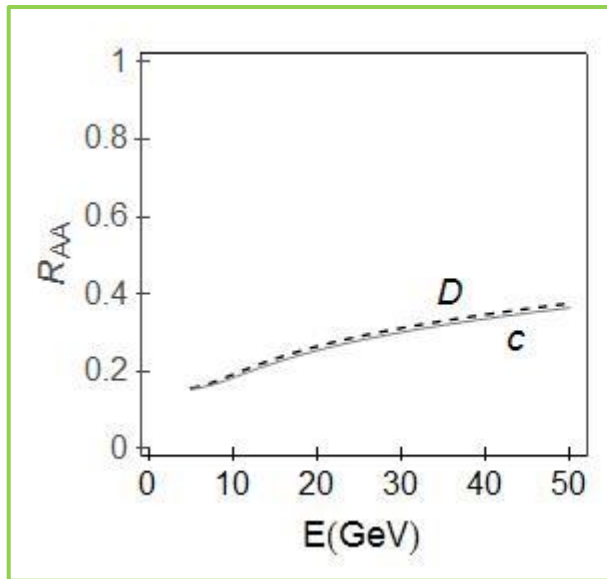$R_{AA} (h^{\pm}) < R_{AA} (D)$

Charged hadrons vs D meson R_{AA}

ALICE data

$h^{\pm}$

D
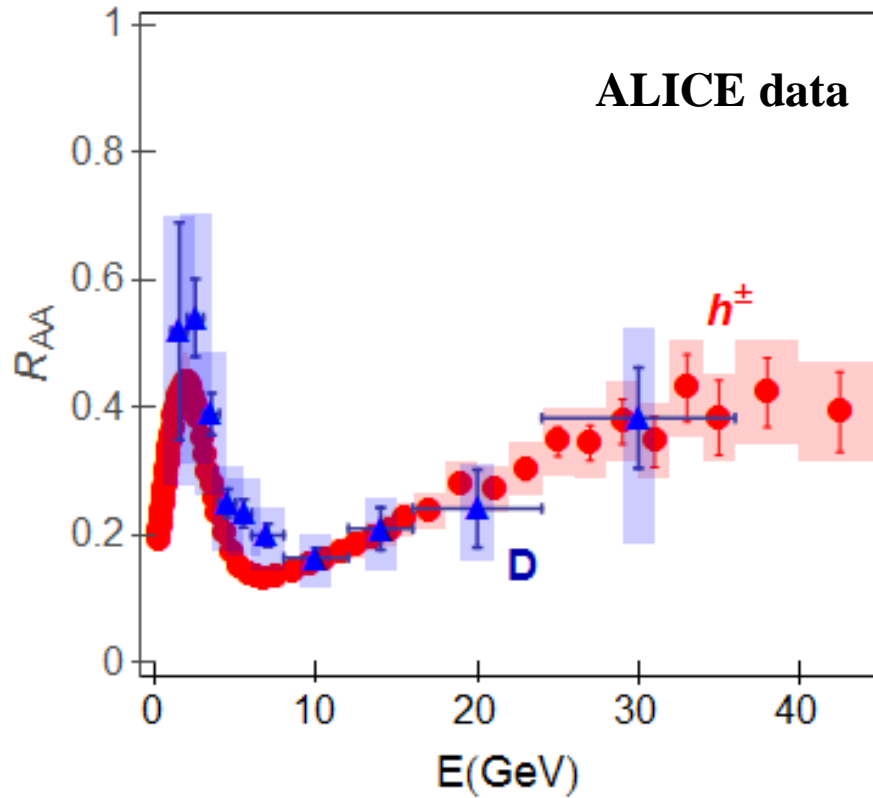
$R_{AA} (h^{\pm}) = R_{AA} (D)$

**Excellent agreement
with the data!**

Disagreement with the qualitative expectations!

M. D., arXiv:arXiv:1307.4702

Hadron R_{AA} *vs.* parton R_{AA}

D meson is a genuine probe of bare charm quark suppression
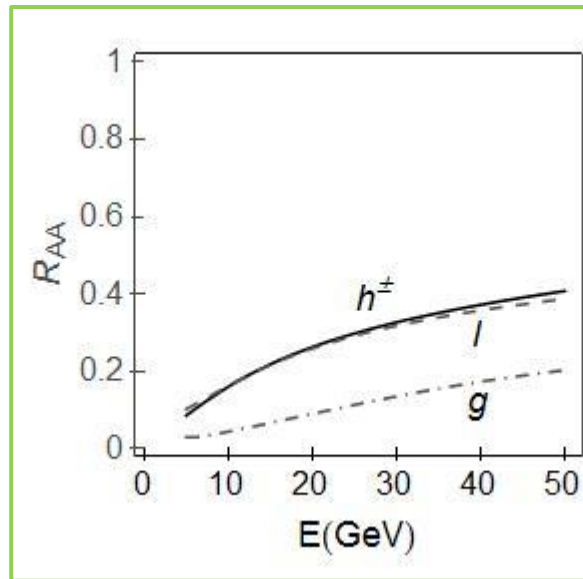
Distortion by fragmentation

Charged hadron R_{AA} = light quark R_{AA}

M. Djordjevic 10

M. D., arXiv:arXiv:1307.4702

Puzzle summary

$R_{AA}(h^{\pm}) = R_{AA}$ (light quarks)

$R_{AA}(D) = R_{AA}$ (charm)
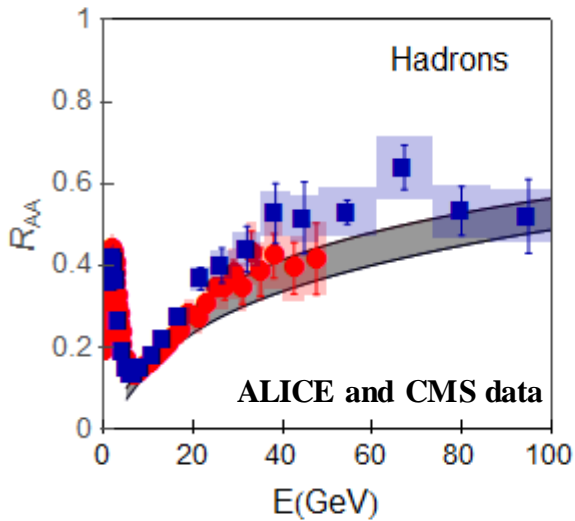
R_{AA} (light quarks) $= R_{AA}$ (charm)
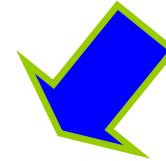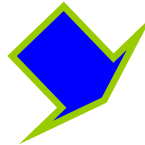
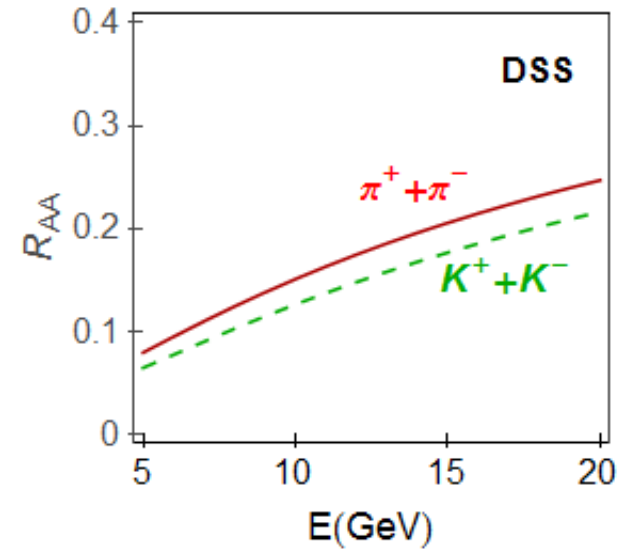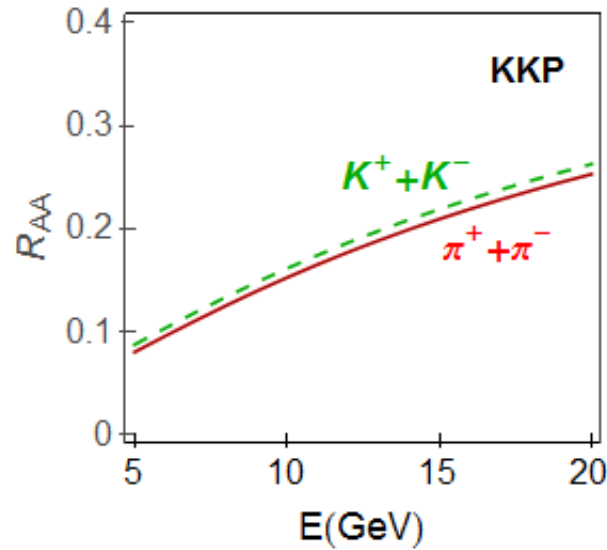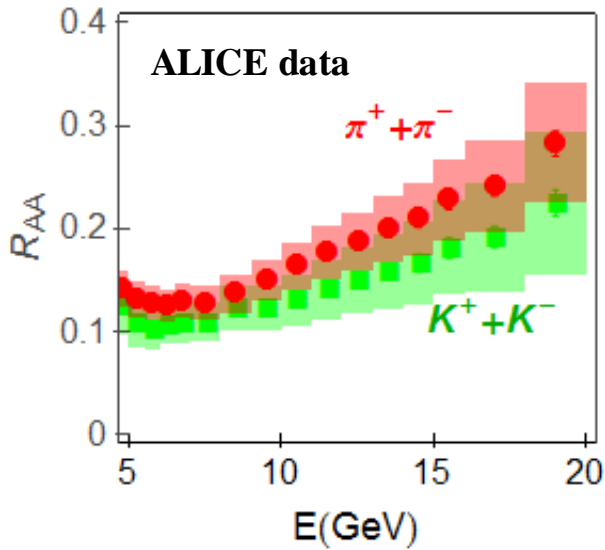$R_{AA}(h^{\pm}) = R_{AA}(D)$

Puzzle explained!

Fine resolution hierarchy

M. Djordjevic 12
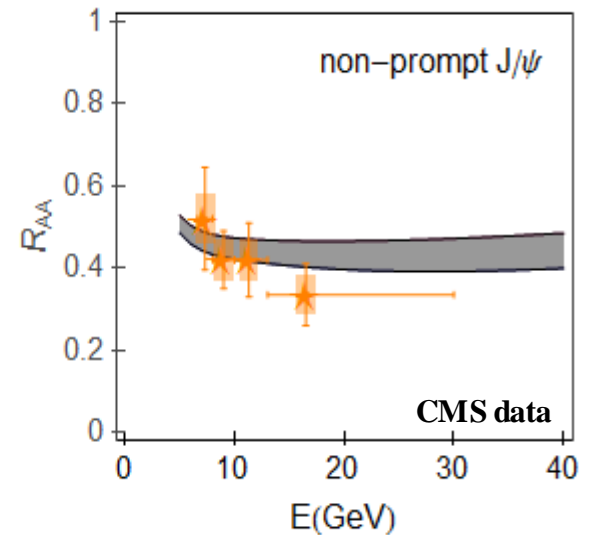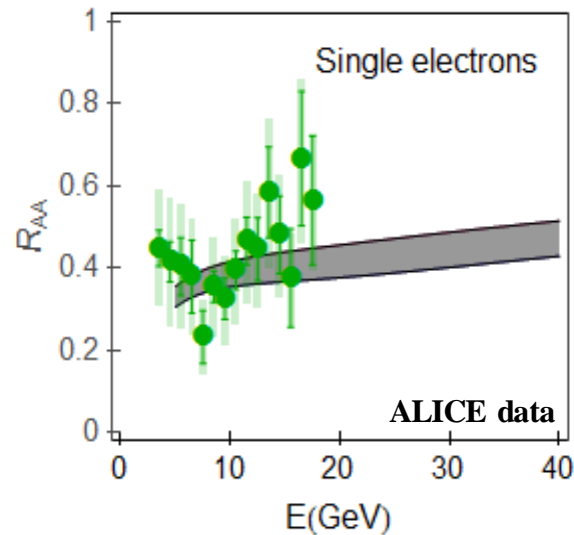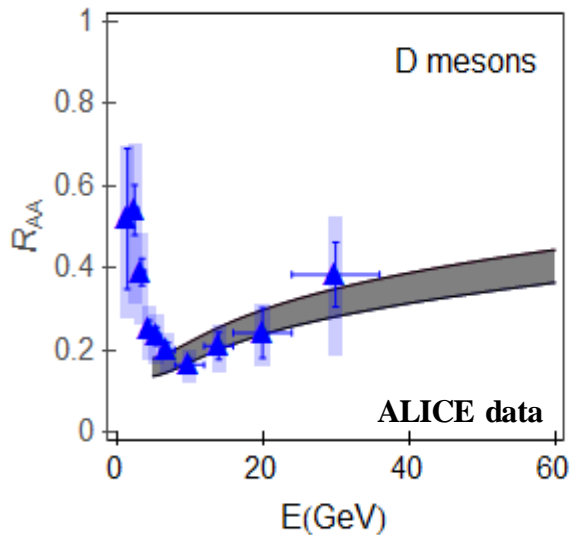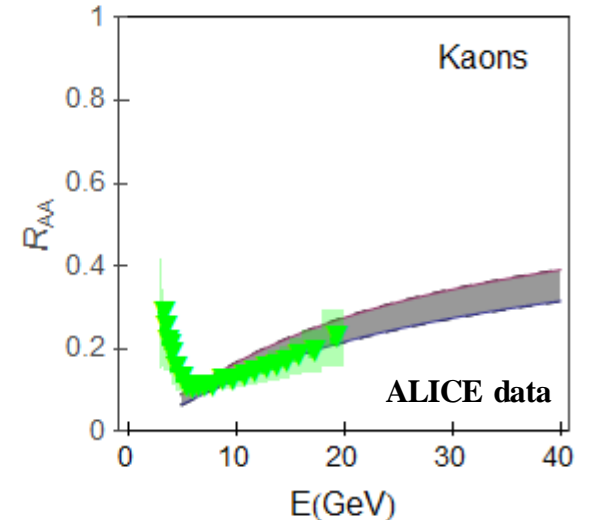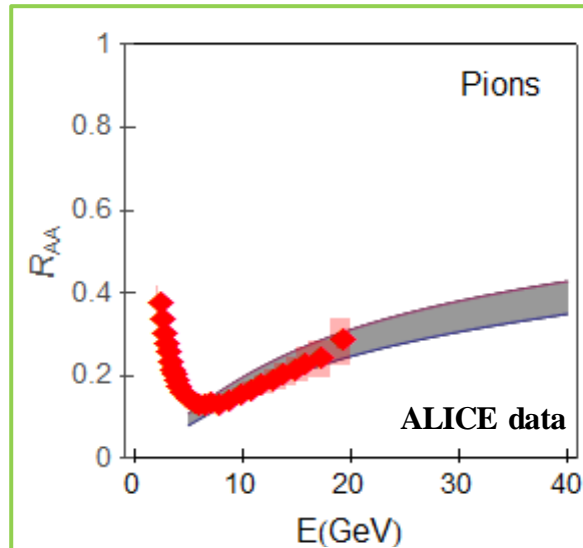
Pion *vs.* kaon R$_{AA}$

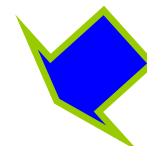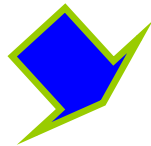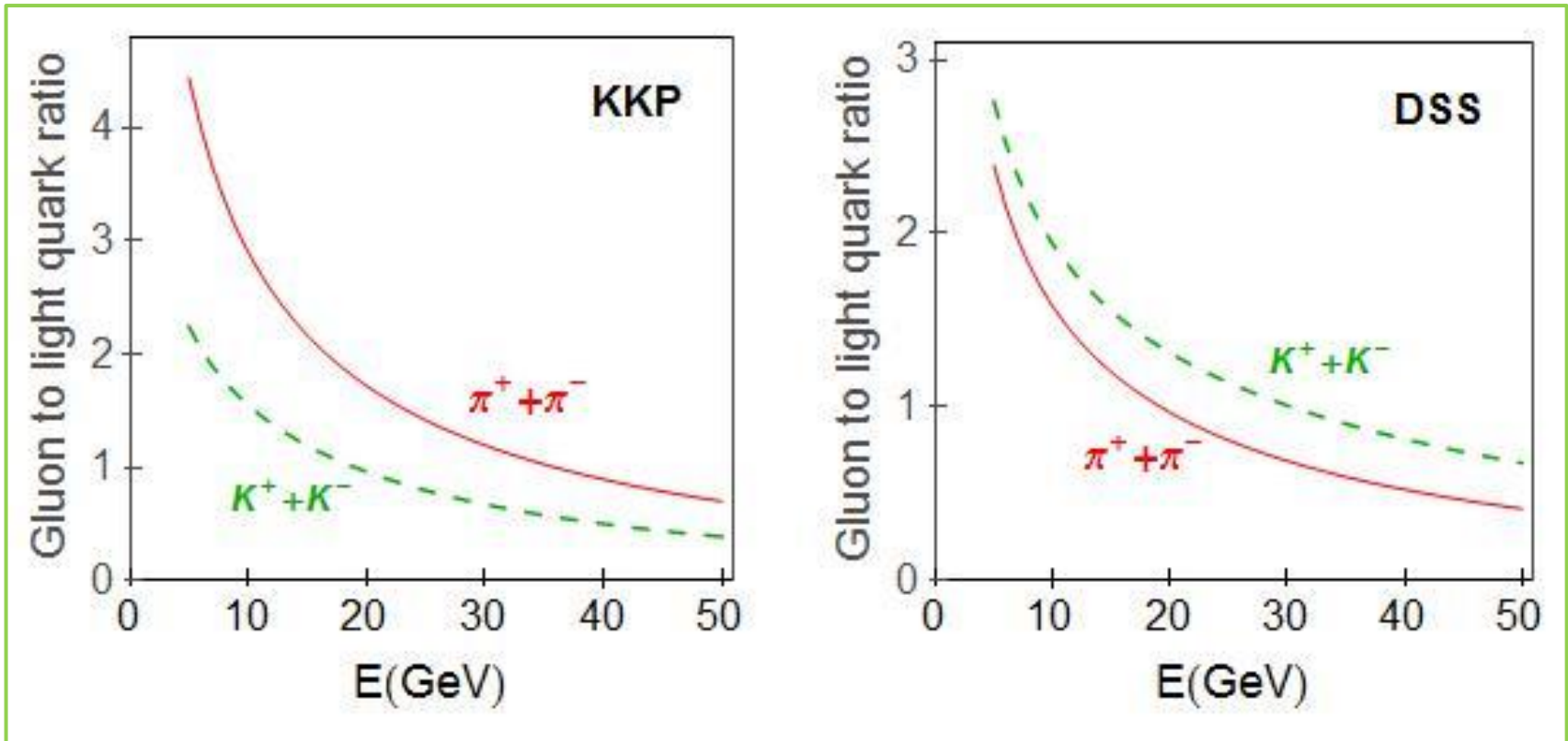**Clear (fine resolution) hierarchy between pion and kaon R$_{AA}$s.**

Disagreement

Agreement

M. Djordjevic 13

M. D. and M. Djordjevic, arXiv:1307.4714

KKP *vs.* DSS

A reversed hierarchy in gluon to light quark contributions!

M. D. and M. Djordjevic, arXiv:1307.4714

Summary

The dynamical energy loss can simultanuously explain measurements for a diverse set of probes at LHC.

The formalism can explain puzzling data ("the heavy flavor puzzle at LHC").

Charged hadron suppression is a genuine probe of light quark suppression, which can considerably simplify interpretation of the relevant data.

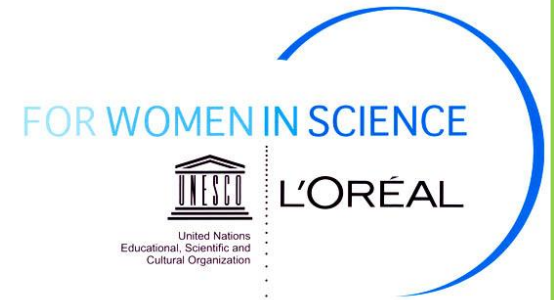**Can explain fine resolution hierarchy.**

Acknowledgement

Ministry of Science and Education in Serbia

FP7 Marie Curie International Reintegration grant

L'Oreal UNESCO For Women in Science Serbia