Response to Reviewer's Comments for SQM 2024

Coleridge Faraday

November 28, 2024

I would like to first thank Dr. Maire for his valuable feedback on my submitted proceedings for Strangeness in Quark Matter 2024. I address all the reviewer comments below, and indicate the changes that were made to the manuscript in this document.

Referee's comment:

Abstract: small system-size corrections or small-system size corrections ? better use an hyphen and place it where it matches your message.

My response:

Thanks for your comment; we had not considered this alternative framing. After careful consideration we have chosen to keep the phrase as "small system size corrections" in this context, as "small system size" here is operating as a noun phrase and hence does not require any hyphenation. That is, we do not wish for the reader to misinterpret "small-system" as an adjective acting on "size corrections" for instance. Perhaps this is just stylistic preference.

Referee's comment:

p.1: "... [3]—typically associated with large heavy-ion collisions—ha" spaces missing before and after long hyphens ? Same logic is also consistently found twice on p.2. To be checked.

My response:

My understanding, and confirmed by looking it up, is that em-dashes (long hyphens) do not have spaces before and after them. Some author's choose to use en-dashes (shorter dashes) in which case spaces are used, however em-dashes without spaces is the more standard style for journals. As such, we keep the text the same.

Referee's comment:

p.1: "energy loss [9]" (one line)

p.2: "these terms [10]" (one line)

p.2: "elastic energy loss model [12] as" (one line)

My response:

We have ensured that the noun proceeding the citation is on the same line as the citation itself.

Referee's comment:

p.2: HTL notation is used in section 1 already but is never properly introduced. You may specify it at its first occurrence (either in the abstract already or in section 1 p.2)

My response:

We now specify that HTL stands for hard thermal loops on page 2 in sec. 1.

Referee's comment:

p.2: "... while the HTL result uses HTL propagators for all momentum transfers." The usage of HTL as a generic naming and as a specific model name creates some ambiguity, you may use temporarily in section 1 HTL in quotes ("HTL") for naming the specific model of your reference [11], if no better name appears. (Pois. HTL used in section 2 when it becomes relevant to discuss Gauss Vs Poisson)

My response:

We refer to this model as “HTL-only” to distinguish it from HTL more broadly where appropriate. Later, when it becomes necessary to distinguish between Gaussian and Poisson we refer to these as “Gauss. HTL” and “Poiss. HTL” respectively, as in the original manuscript.

Referee’s comment:

p.2: (major) “We observe that the SPL correction greatly reduces the suppression for pions in both Pb+ Pb and $\mathrm{p}+\mathrm{Pb}$ collisions; however, it is negligible for D mesons in both $\mathrm{p}+\mathrm{Pb}$ and $\mathrm{Pb}+\mathrm{Pb}$ collisions as well as pions in $\mathrm{Au}+\mathrm{Au}$ and $\mathrm{d}+\mathrm{Au}$ collisions.”

I believe the sentence convey a unwanted message:

Do you imply that the SPL corrections should be different between Pb and Au nuclei ?

Do you imply that the SPL corrections should be very different between RHIC and LHC energies (at a fixed pT , for a given hadron) ?

Do you imply that SPL correction matters a lot for $h\pm$ but not for pion?

The sentence is maybe implicitly biased : you seem to match the pT range covered by experiments in your theoretical tests, in particular up to 90GeV/c for h± at LHC but “only” up to 25GeV/c for pio at RHIC.

Visually, one can get spontaneously bothered by why the RAA(h ±) at LHC appears so much changed by SPL. e.g. $0-5\%$ $\mathrm{Pb}-\mathrm{Pb}$ (top left Fig.1; Delta up to 0.3 unit of RAA !) while much more moderate (Delta < 0.1 unit of RAA) for pio in central Au-Au (top right Fig.1).

Comparing apple with apple between RHIC and LHC (h vs piO, on pT in [0,25] GeV/c only), the outcome may be consistent.

My intuition speaking, I would expect more logically a very similar behaviour between ht and pio (be it at RHIC or LHC, it should not matter much) than between DO and piO.

Am I completely wrong?

If not, you may rephrase your sentence and hint at such aspect in your text sentence.

My response:

Thank you for pointing out the ambiguity in this sentence. Your intuition is largely correct: the SPL correction does not differ between Pb and Au nuclei, or between $h^{\pm}$ and π^0. There are two reasons that the SPL correction is much larger for p/Pb + Pb at LHC compared to d/Au + Au at RHIC. Firstly, as your correctly point out, the larger experimentally accessible p_T range leads to the SPL correction being larger over the entire accessible range. At the same p_T, the effects of the short pathlength correction are more similar. However, one need only compare, say, $R_{AB}^{h^{\pm}}$ for 0–5% centrality $p+\mathrm{Pb}$ to $R_{AB}^{\pi^0}$ for 0–5% centrality $d+\mathrm{Au}$ at 20 GeV. The SPL correction at LHC in this case leads to $R_{AB} \simeq 1$ compared to the uncorrected of 0.8, while at RHIC the SPL correction leads to $R_{AB} \simeq 0.9$ compared to the uncorrected of 0.8. One may observe similar effects when comparing $\mathrm{Pb}+\mathrm{Pb}$ and $\mathrm{Au}+\mathrm{Au}$. The second reason, then, *is* a $\sqrt{s}$ dependence. This is from the breaking of color triviality (C_A/C_F scaling of energy loss) which leads to the SPL correction being much larger for gluons compared to light quarks. The larger fraction of gluons at LHC compared to RHIC then leads to the large SPL correction.

Both of these points are presented in the original proceedings submission: "The larger correction for pions at LHC is due primarily to the larger proportion of gluons which fragment to pions at LHC compared to RHIC" and "Furthermore, the SPL correction scales as $\Delta E_{\mathrm{SPL}} \sim E$ while the uncorrected DGLV result scales as $\Delta E_{\mathrm{DGLV}} \sim \ln E$, which explains why the SPL correction grows as a function of p_T." These quoted lines appear immediately after it is pointed out that the SPL correction is larger in $\mathrm{Pb}+\mathrm{Pb}$ compared to $\mathrm{Au}+\mathrm{Au}$. However, we do agree that this could be phrased more clearly.

In order to avoid any confusion, we rephrase the offending paragraph from (original):

"From Fig. 1, we first compare the R_{AB} calculated with the DGLV and DGLV + SPL radiative energy loss models to understand the impact of the SPL correction. We observe that the SPL correction greatly reduces the suppression for pions in both $\mathrm{Pb}+\mathrm{Pb}$ and $p+\mathrm{Pb}$ collisions; however, it is negligible for D mesons in both $p+\mathrm{Pb}$ and $\mathrm{Pb}+\mathrm{Pb}$ collisions as well as pions in $\mathrm{Au}+\mathrm{Au}$ and $d+\mathrm{Au}$ collisions. The large correction for pions at LHC is due primarily to the large proportion of gluons which fragment to pions at LHC compared to RHIC, while D mesons fragment from charm quarks. The SPL correction is significantly larger for gluons compared to quarks, breaking the usual $C_A/C_F = 9/4$ colour scaling [10, 14]. Furthermore, the SPL correction scales as $\Delta E_{\mathrm{SPL}} \sim E$ while the uncorrected DGLV result scales as $\Delta E_{\mathrm{DGLV}} \sim \ln E$, which explains why the SPL correction grows as a function of p_T [10]. We also observe that the SPL correction is fractionally larger in small systems compared to larger systems due to the $e^{-\mu L}$ scaling of the SPL correction [10, 14]. "

to (revised)

"From Fig. 1, we first compare the R_{AB} calculated with the DGLV and DGLV + SPL radiative energy loss models to understand the impact of the SPL correction. Including the SPL correction greatly reduces the π^0 and $h^\pm$ suppression, but only mildly reduces D meson suppression. This flavor-dependence is due to the SPL correction being significantly larger for gluons compared to quarks, over and above the usual $C_A/C_F = 9/4$ colour scaling [10, 14]. We also observe that the magnitude of the SPL correction grows in p_T, which is due to the different asymptotics of DGLV and DGLV + SPL: $\Delta E_{\text{DGLV}} \sim \ln E$ and $\Delta E_{\text{DGLV + SPL}} \sim E$ respectively [10]. The $\sqrt{s}$ dependence of the SPL correction is due primarily to the larger proportion of gluons which fragment to pions at LHC compared to RHIC [15] and the larger experimentally accessible p_T range. Finally, we observe that the SPL correction is fractionally larger in small systems compared to larger systems due to the $e^{-\mu L}$ scaling of the SPL correction [10, 14]."

We believe that a large portion of the confusion was from trying to address too many effects at the same time, leading to ambiguity. In the revised manuscript we have now tried to address each effect and its cause one-by-one.

Referee's comment:

p.2: The next sentence may then rather read "the largER correction for pions at LHC..."

My response:

This is addressed by our changes according to the previous comment.

Referee's comment:

"the largeR proportion of gluons which fragment to pions". My ignorance : at RHIC there is no large proportion of gluons around in any case compared to quark population ? Isn't it just that it is even larger at LHC ?

My response:

Yes, you are correct that the important point is the fraction of gluons is larger at LHC compared to RHIC. We have changed the text as you suggest.

Referee's comment:

p.2: Poiss HTL Vs Gauss HTL "We observe that this effect is $O(5\text{–}10)\%$ in large systems and $< 2\%$ in small systems."

I understand that we need to compare the red and the blue curves.

The effect seems more (factor 2?) pronounced for pi0 at RHIC in Au-Au (Fig.1 top right) than for h± at LHC (Fig.1 top left), be it in large or small systems, AA or dA.

Any additional comment on this sqrt(s) dependence ? (Mmm, maybe not enough space anymore...)

My response:

Indeed there is a $\sqrt{s}$ dependence to the difference between the Gaussian and Poisson HTL elastic energy loss. This is related to the moment expansion of the R_{AA} discussed at the end of page 2, and discussed in detail in reference [15] of the proceedings. We introduce this sentence at the end of the last paragraph of page 2: "The Poisson and Gaussian results are more similar at LHC energies because the steeper production spectrum at RHIC makes higher-order moments more important than at LHC." I believe that this clarifies the point.