

Peer Review

# Review of: "Exploring QGP-Like Phenomena with Charmonia in p+p Collisions at $\sqrt{s}=13$ TeV"

Joerg Aichelin<sup>1</sup>

1. Laboratoire de Physique Subatomique et des Technologies Associées, Nantes, France

The authors present a model to explore QGP-like phenomena in pp collisions.

It is very difficult to appreciate this article because it is a sum of many approaches, parametrizations, and assumptions, whose relation to the claim of the abstract "can serve as a robust probe for determining the possible existence of a thermalized QCD medium in such a small collision system" remains obscure.

This model contains preequilibrium and equilibrium contributions to charmonia, all only referenced without any statement about the approximations made to obtain these formulas and how they are obtained.

It contains as well an ad hoc hydrodynamical model and interactions with the medium, which do, however, neither include detailed balance nor energy conservation.

Therefore, the referee is not able to understand the conclusions and, especially, why the systematic error, implied by all the involved approximations, is sufficiently small to render the conclusions reasonable.

The problems start already with the fact that the authors are convinced that something like a primordial charmonium distribution can be obtained, without making reference to the different pQCD contributions, which produce  $c\bar{c}$  pairs, and that the fluctuations in pp collisions are that small that they can be treated by a collision-averaged mean field, contrary to what Monte Carlo-based approaches, like EPOS, state. They continue with the introduction of formulas, whose origin is cited but whose applicability (and limitations) are not elucidated, like 1,2,7, 8,10,... Statements like "The time dependence of the Hamiltonian arises from the temporal variation of temperature" remain unexplained (are the wave functions time-dependent or only a function of T?) and that gluon

dissociation cross sections are non-vanishing for small gluon energies (although the energy difference between the singlet and octet states is large) needs at least an explanation.

In short, in the present version, the article cannot be published because it is not even clear how the authors substantiate their claim that charmonia data can be used to establish the existence of a QGP in pp data.

The authors have to organize the article in a way that a thread of arguments is visible, to demonstrate that the many approximative formulas remain valid for pp and what they imply physically. They have also to clearly state how they come to their conclusions based on the approximations which are introduced. Only then will a judgement of the model be possible.

## **Declarations**

**Potential competing interests:** No potential competing interests to declare.