Reviewer report for "Transport coefficients in standard Kappa distributed plasmas"

by Mahmood J. Jwailes, Imad A. Barghouthi, *et al.*

This manuscript (MS) presents a derivation of transport coefficients relevant to a hydrodynamic formulation of a superthermal plasma, when the plasma species are modelled by the Standard Kappa (SK) velocity distribution function. This MS is a follow-up from a previous paper (Jwailes *et al.*, 2025), where the same transport coefficients were derived for a suprathermal plasma modelled by the Modified Kappa (MK) distribution.

The problem that this MS and the previous paper tackle is relevant to the evaluation and measurement of transport coefficients such as electric and thermal conductivities in the Solar Wind, which is rarely in a state close to the thermal equilibrium. Hence, it is of interest to the space plasma community. The paper is well written and the mathematical formalism seems sound. Therefore, in my opinion the MS can be accepted for publication in Annales Geophysicae. I just have a few remarks and suggestions to the Authors.

1. The MS generalizes previous results by including the effects of collisions evaluated from the Boltzmann collision integral (18). The results are obtained employing different collision processes such as Coulomb collisions, hard-sphere interactions and Maxwell-molecule collisions. As in the previous paper, the MS describes these different approaches rather tersely and it would be interesting if the Authors could include a short paragraph right before Eqs. (20) - (25) explaining the main differences of the considered processes.

2. I find puzzling the behavior displayed by Eq. (57) and Fig. 3 for the effective collision rate occurring in a plasma described by the SK distribution, as compared with the behavior of the same quantity in a plasma described by the MK model. Whereas the former goes to zero at $\kappa = 1/2$, the latter goes to infinity at $\kappa = 3/2$. Does that result mean that a plasma described by a SK distribution has negligible collision rates at small kappas?

3. Related to the previous remark, it would be also interesting if the Authors could compare their results (here or in future publications) with locally measured transport coefficients in the plasma of the Solar Wind. Which one of the most commonly-employed models of the Kappa distribution (SK or MK) is the more adequate to describe the suprathermal plasma in space environments has been a subject of debate for quite some time. Comparing the theoretical results derived from either model with local measurements of the transport coefficients can shed some light on this problem.

4. Finally, I second the Authors's intentions to derive the transport coefficients employing the regularized Kappa distribution (RKD), as mentioned in line 505. The RKD corrects inconsistencies in the behavior of the Kappa distribution for very small kappas and provides results for the extreme suprathermal case ($\kappa \to 0$). In this case, the Authors should compare their results with those from Husidic *et al.*, ApJ, 927:159, 2022 (doi: 10.3847/1538-4357/ac4af4), which were obtained employing a Krook-type collision integral.

Minor Points

I have found some typos on the text, which can be corrected with a thorough revision. I mention here only a few points, emphasized with a blue fount.

1. Page 4, paragraph starting at line 113: I think that the sentence will make sense introducing an "and", as follows:

   > Decades later, inspired by the principles of non-extensive statistical mechanics introduced by Tsallis (2012), Livadiotis (2017) developed a new theoretical perspective **and** reformulated the Kappa distribution into what is now known as the modified Kappa distribution (MK).

2. Figures 1 and 2: I suggest using logarithmic scale on the y axis in order to salient the differences between the suprathermal distributions and the Maxwellian.

3. Line 350: "... low values of $\varkappa$ correspond to a ~~reduced~~ reduction (?) in the population of particles near the core..."

4. Figure 6: the value of the kappa-index for the bottom cases is $\kappa = 4$ or $\kappa = 5$? There is a discrepancy between the caption and the figure label.

5. Line 500: please verify if the sentence "Additionally, the standard Kappa distribution..." really applies to the SK distribution. The kinetic temperature (T_κ), as evaluated from (1), indeed becomes undefined when $\kappa = 3/2$; however, the distribution exists for $\kappa > 1/2$. The MK distribution (6), on the other hand, is clearly undefined for $\kappa \leqslant 3/2$.

A few other typos were found in the text. The Authors should perform a thorough review on the text.