# Estimating Theory-Side Uncertainties in Classical Transport Coefficients for Multi-Component Plasmas

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Classical transport coefficients and collisional forces for multi-component plasmas has been provided by Zhdanov et al[1], equivalent to the first-order Chapman-Enskog approximation. However, the method assumes that the temperatures of all colliding species are near each other. However, different plasma species being at different temperatures is a common phenomenon in both fusion and industrial plasmas. Therefore, we have generalized the Zhdanov closure for the multi-temperature case, and have provided a general derivation method for the multi-temperature collision coefficients[2, 3].

In doing so, we find $\sim 10\%$ variation in transport coefficients for small temperature differences for multi-component plasmas with ions of comparable mass (D-T plasmas) and for heavy ions (W) at trace density levels. However, for light impurities like argon and neon, significant differences are found to persist between the single-temperature and multi-temperature schemes for transport coefficients (up to 80%) and friction/thermal forces (up to 40%).

Furthermore, we also put such differences in context by checking against use of different collision operators, e.g. Boltzmann (with different potentials of interaction) and Landau operators to quantify the differences in such operators. Furthermore, a Monte-Carlo approach towards temperature and density variations will be used to quantify final standard deviations in transport coefficients for typical plasma compositions. The two aforementioned uncertainties together are termed as "theory-side" uncertainties.

## References

[1] Zhdanov V M 2002 *Transport processes in multicomponent plasma* (London: Taylor and Francis) ISBN 0-415-27920-8

[2] Raghunathan M, Marandet Y, Bufferand H, Ciraolo G, Ghendrih P, Tamain P and Serre E 2021 *Plasma Physics and Controlled Fusion* **63** 064005

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