PiAI Seminar Series: Physics informed AI in Plasma Science
9:30-10:30, 22 January 2024 (CET)
17:30-18:30, 22 January 2024 (JST)
Web Seminar

Numerical Strategy for Solving the Boltzmann Equation with variable E/N using Physics-informed Neural Networks

Jinseok Kim[1], Kazuki Denpoh[1], Satoru Kawaguchi[2], Kohki Satoh[2], Masaaki Matsukuma[1]

[1]Tokyo Electron Technology Solutions Limited
[2]Muroran Institute of Technology

Tokyo Electron Technology Solutions Limited, Yamanashi, Japan

In this study, we introduce a novel strategy to solve the Boltzmann equation with varying the reduced electric field *E/N* by using an artificial neural network (ANN), where *E* is the electric field and *N* is the gas number density. In the method, the ANN learns the electron velocity distribution function (EVDF) for a range of *E/N* in the Boltzmann equation. Thus, the ANN can calculate the EVDFs in the training range of *E/N* without additional training. The trained ANN was used to calculate the EVDFs in both Ar and SF6 gases for validating the ANN. The electron energy distribution function (EEDF), electron transport coefficients calculated from the EVDF quantitively agree with those from another ANN for a single *E/N* [1, 2]and those from a Monte Carlo simulation [3, 4], proving the validity of the present method.

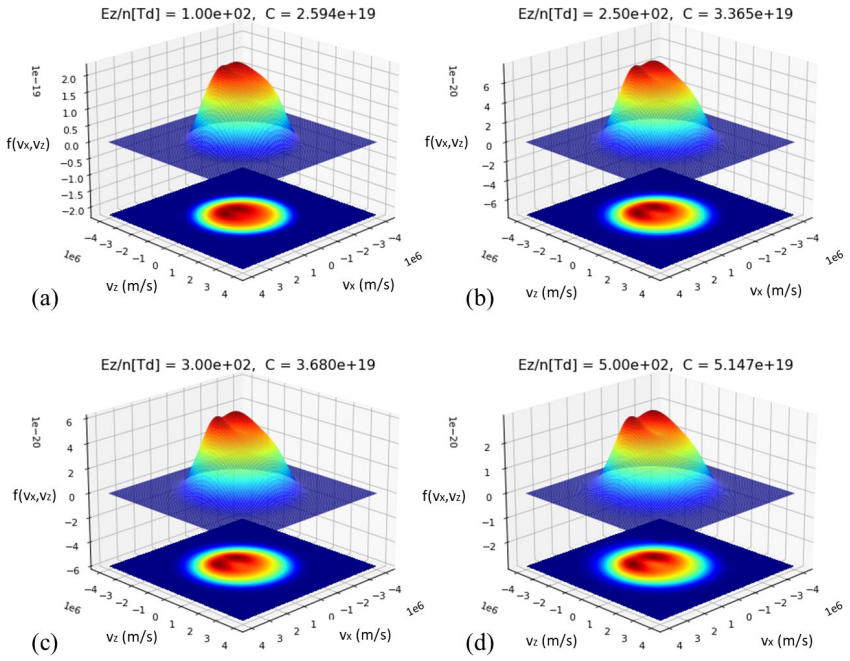

Fig. 1 Electron velocity distribution function in Ar gas from the trained ANN at (a) 100, (b) 250, (c) 300, and (d) 500 Td.

References

[1] Kawaguchi S, Takahashi K, Ohkama K, and Satoh K 2020 Plasma Sources Sci. Technol. 29 025021

[2] Kawaguchi S and Murakami T 2022 Jpn. J. Appl. Phys. 61 086002

[3] Kawaguchi S, Takahashi K, Satoh K, and Itoh H 2016 Jpn. J. Appl. Phys. 55 07LD03

[4] Kawaguchi S, Takahashi K, and Satoh K 2021 *Plasma Sources Sci. Technol.* **30** 035010