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An novel method for plasma optical emission spectroscopy based on artificial neural network

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Optical emission spectroscopy (OES) has been widely used in plasma etching, material processing, plasma equipment and technology development, as well as plasma propulsion. Based on a collisional-radiative (CR) model, the emission spectrum could be translated into plasma parameters such as electron temperature and electron density.

However, OES method is restricted by several factors. On the one hand, The collisional-radiative model used in OES is affected by the deviation of fundamental data such as collision cross sections, which will lead to the error of diagnostic results; On the other hand, the uncertainties of the experiment due to the process of photoelectric conversion, signal readout and signal transmission will be transferred to the diagnostic results; The quantum randomness of particle collision, radiation and other processes in plasma will be transferred to the emission spectrum, which shows as the fluctuation of spectrum, will also affects the diagnostic results.

In this work, a novel method based on spectroscopy neural network (SNN) for OES is developed. The neural network is trained based on a database generated by a CR model. In order to improve the anti-noise ability of the method, random noise factors are introduced into the database to simulate the uncertainties of measurement and deviation of the CR model. Error characteristics of the SNN method and traditionally used least-square fitting (LSQ) method are compared. It is found that the SNN method can reduce the errors transferred to the diagnostic results. Experimental results also support this argument. The near real-time data processing ability of SNN method makes it a competitive online diagnostic method. It can also support feedback control of plasma devices.

References
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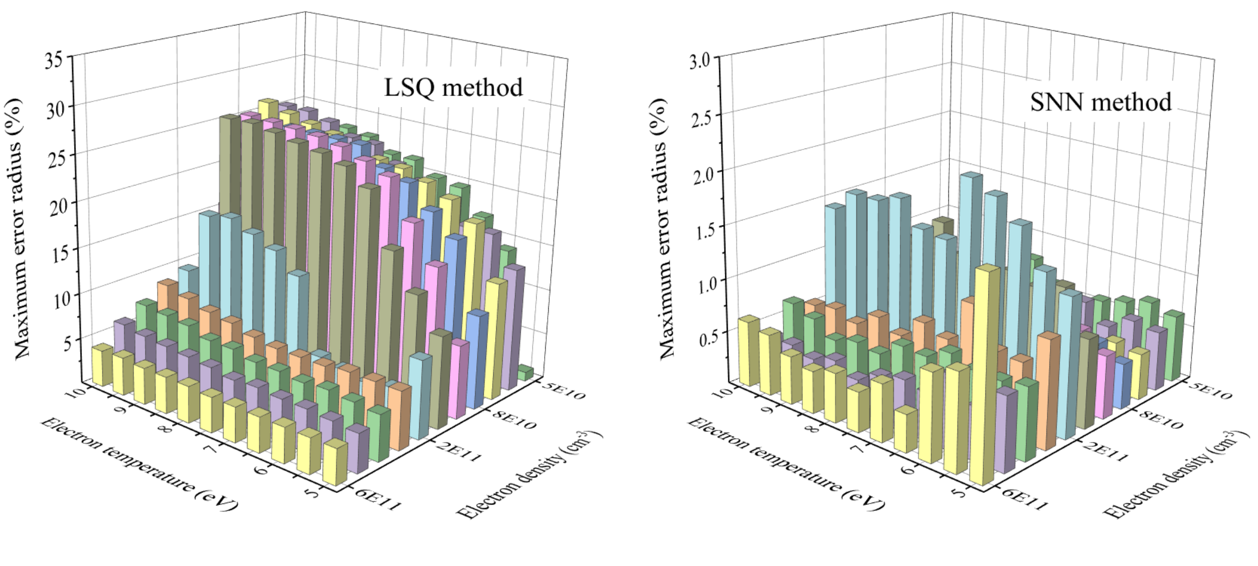

Figure 1 a) The maximum error radius of the diagnosis result of the least square method; b) the maximum error radius of the diagnosis result of the neural network method.