# Measurement and analysis of EUV emission spectrum from laser produced Pr plasma

**S. Q. Cao, M. G. Su[1], Q. Min, D. X. Sun and C. Z. Dong[1]**

Key laboratory of Atomic and Molecular Physics & Functional Materials of Gansu Province, College of Physics and Electronic Engineering, Northwest Normal University, Lanzhou, 730070, China

**Synopsis** We report a spectral measurement of laser-produced Pr plasma and corresponding calculation results for 4d excitations of $Pr^{3+}$ to $Pr^{7+}$ ions with the Hartree-Fock method, in which the importance of configuration interaction effects has been evaluated. The plasma parameters have been obtained by comparison of experimental and simulated spectra based on a steady-state collisional-radiative (CR) model.

The spectrum of laser-produced plasmas (LPPs) of middle- and high-Z elements is of great interest for plasma diagnostic studies about fusion plasma, astrophysical and laboratory plasmas, as well as the interpretation of conversion efficiencies and radiative transport in plasmas. In past years, numerous spectra of highly charged ions of middle- and high-Z elements have been studied both in theory and experiment. Especially, the 4d inner-shell excited spectra with increasing ionization have been the subject of intense interest due to their striking spectral features resulting from the 4*d*-ε*f* shape resonance [1].

In this work, the EUV spectrum of laser produced Pr plasma in the 7.5-14.5 nm wavelength range has been measured. In order to identify the structures of the experimental spectrum, a series of calculations were performed with the Hartree-Fock method by Cowan codes [2]. It is found that all of the observed resonance structures which arises from the 4*d*-4*f* transition arrays of $Pr^{3+}$ to $Pr^{7+}$ ions. The important configuration interaction effects lead to a strong expanding of the distribution of 4*d*-4*f* transition array to longer wavelengths, and with increasing ionization the bands are only slightly shifted as shown in Figure 1.

In order to estimate the parameters of plasma, two theoretical simulations have been f based on a steady-state collisional-radiative (CR) model as shown in Figure 2. Comparisons between the experimental and simulated spectra shows that a single electron density and temperature cannot fully describe the ion populations in present calculations due to the wide gate width of detector and the highly inhomogeneous and transient nature of laser produced plasmas.

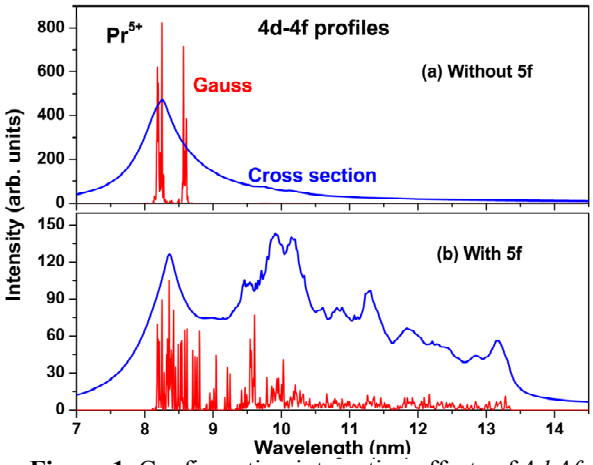


**Figure 1.** Configuration interaction effects of 4*d*-4*f* transition of $Pr^{5+}$ ion.

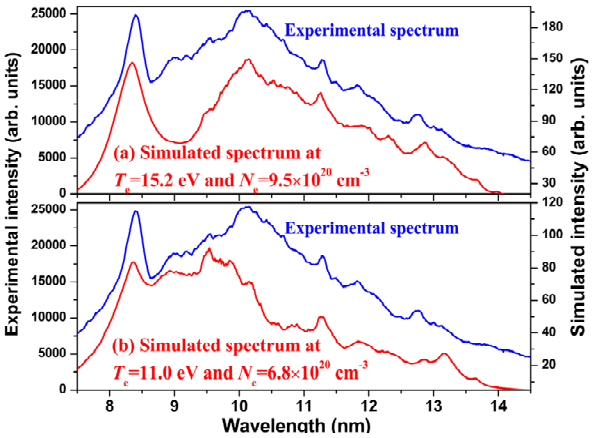


**Figure 2.** Comparisons between the experimental spectrum and simulated spectra.

This work is supported by the National Natural Science Foundation of China (Grants Nos. U1332206, 11364037, and 11564037)

## References

[1]G. O'Sullivan, and P. K. Carroll, 1981 J. Opt. Soc. Am. **71**, 227

[2] R. D. Cowan 1981 *The Theory of Atomic Structure and Spectra* (Berkeley: University of California Press)

[1] E-mail: dongcz@nwnu.edu.cn, nwnu_sumg@163.com