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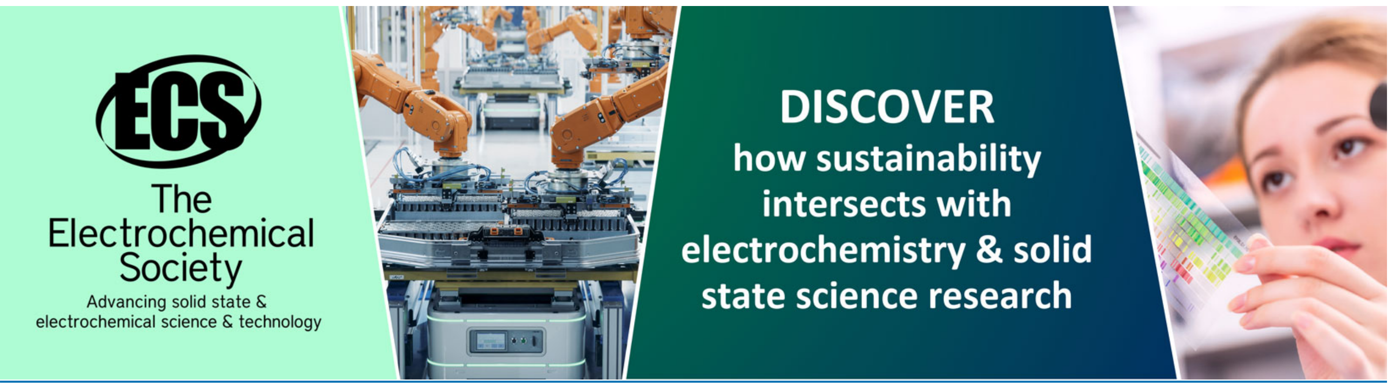

Combined MCDHF-CI and MBPT calculations for n=4 to n=3 x-ray transitions in Ni-like tungsten

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Synopsis The $4d \to 3p$, $4p \to 3s$, and $4f \to 3p$ x-ray transitions in Ni-like tungsten ions have been studied theoretically. The Multiconfiguration Dirac–Hartree–Fock method and the large-scale relativistic Configuration Interaction and Many Body Perturbation Theory methods have been employed in order to take into account electron correlation effects on the lines wavelengths.

Tungsten is chosen as a plasma facing material in modern large tokamaks, such as JET and ITER. Therefore, spectroscopic studies of tungsten ions are a tool for diagnostics relevant for a wide range of electron temperatures [1].

Table 1. Wavelengths of Ni1, Ni2, and Ni3 transitions (Å) for various theoretical approaches.

	Ni1	Ni2	Ni3
AMBIT:			
MCDHF	5.1986	5.2528	4.6394
+CI	5.2007	5.2537	4.6420
+CI+MBPT	5.2011	5.2543	4.6424
GRASP2K (cited from Ref. [2]):			
MCDHF	5.1947	5.2486	4.6367
+CI(FCI)	5.1994	5.2517	4.6519
+CI(FCI*)	5.1988	5.2510	4.6413
+CI(CV)	5.2010	5.2541	4.6318
+CI(CV*)	5.2004	5.2532	4.6417
Experiment:			
Ref. [3]	5.2008(3)	5.2540(3)	
Ref. [4]	5.2002(9)	5.2520(16)	4.6372(10)

In our previous paper [3] the x-ray transitions in Ni- and Cu-like tungsten ions in the 5.19–5.26 Å wavelength range that are relevant as a high-temperature tokamak diagnostic have been studied. In our next paper [2] various Multiconfiguration Dirac–Hartree–Fock (MCDHF) plus Configuration Interaction (CI) approaches (named FCI, FCI*, CV, and CV* in Table 1; see [2] for detailed description), employing GRASP2K [5] code, have been tested in order to reproduce and predict experimental wavelengths of $4d \to 3p$ transitions in Ni- and Cu-like tungsten ions.

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In the present work the calculations of the wavelengths of the $4d \to 3p$, $4p \to 3s$, and $4f \to 3p$ x-ray transitions in Ni-like tungsten ions have been carried out by means of the AMBIT [6] code, based on MCDHF method with CI and Many Body Perturbation Theory (MBPT) approaches in order to take into account electron correlation effects on the lines wavelengths. Applying both the MCDHF-CI and the MCDHF-CI + MBPT approaches instead the "pure" MCDHF approach allowed to reduce substantially the experiment–theory gap in wavelengths. Results of this study provide an important benchmark for x-ray measurements in tokamaks.

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