Atomic Structure and Spectroscopy of Highly Charged Tungsten Ions and Relevance to ITER Diagnostics.

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Outline

Our EBITS

Visible spectroscopy of Tungsten

soft x ray spectroscopy of tungsten

Energy levels

summary

How much is known concerning the spectroscopy of Tungsten

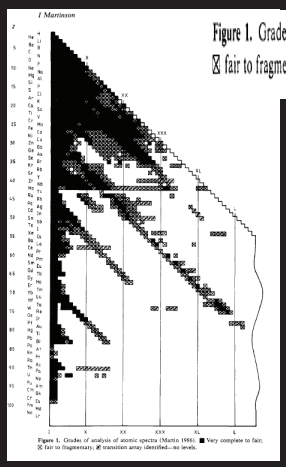
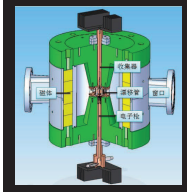


Figure 1. Grades of analysis of atomic spectra (Martin 1986). ▉ Very complete to fair; ▒ fair to fragmentary; ▒ transition array identified—no levels.

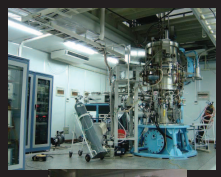
The figure is from 1989 and of course the situation is a little better now.

The Shanghai Electron Beam Ion Traps

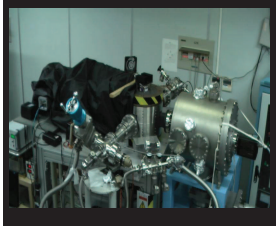


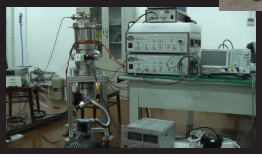
Permanent magnet EBIT

The original



The new one



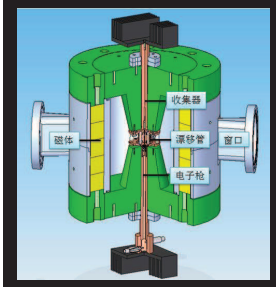


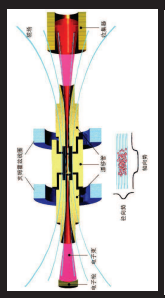
High temperature superconducting EBIT

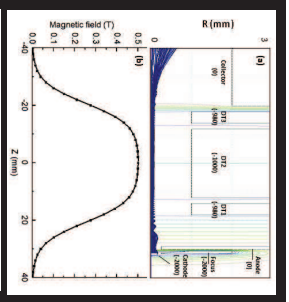
2. SH-PermEBIT装置简介

Shanghai permanent magnet EBIT(永磁EBIT)

设计参数：能量: 250-5000eV 束流: 10 mA 磁场: 0.5T







超低能量EBIT

目标：为ITER

边界等离子体的分解研究服务

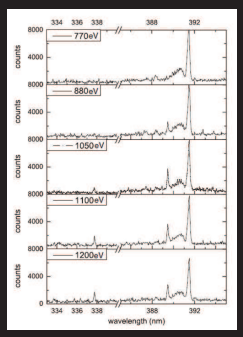
国家	名称	最能极限
日本	Cobit	150eV
德国	FLASH-EBIT	105eV
德国	Berlin-EBIT	190eV
美国	Livermore EBIT	140eV
中国 中国	SH-PermEBIT SH-HtscEBIT	60eV 30eV

Visible spectroscopy

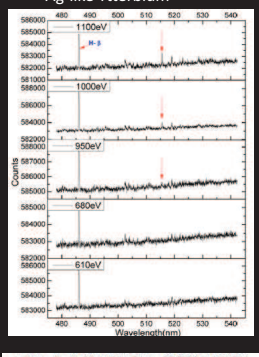
Ag-like Ions

a single 4f electron outside the closed $4d^{10}$ shell, i.e. a ^2F ground term

Ag-like Tungsten



Ag-like Ytterbium



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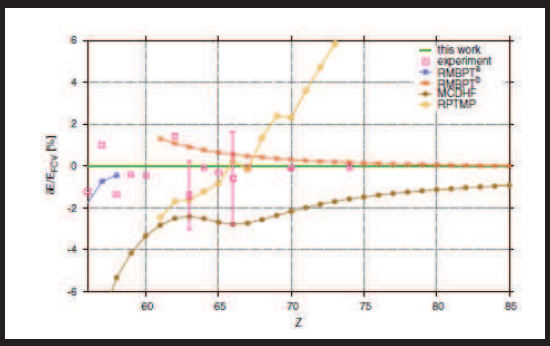
Ground state fine structure M1 transition in Ag-like ions



$\delta E/E_{FCV}^{tot} = (E_{method} - E_{FCV}^{tot})/E_{FCV}^{tot}$

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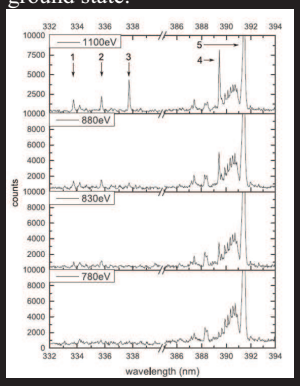
Cd-like Tungsten (W^{26+})

two 4f electrons leading to 13 energy levels making up the ground state.



Totally we identified 7 lines to be from Cd-like W

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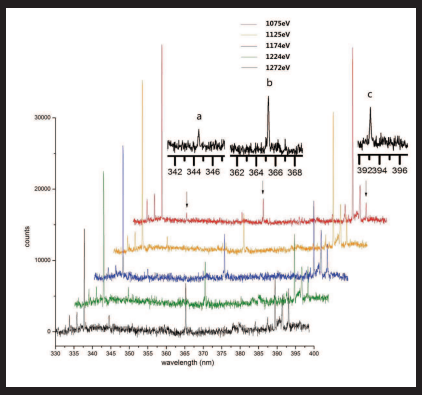
Pd-like Tungsten (W^{28+})



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soft x ray spectral region

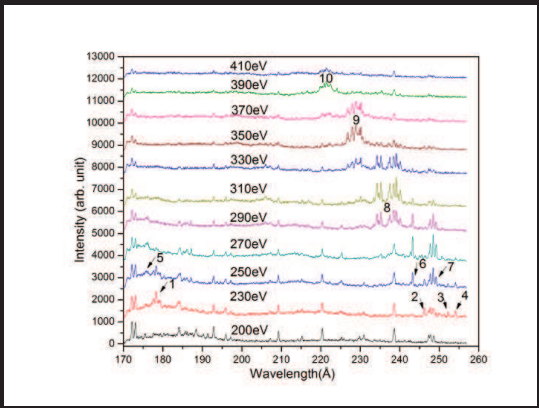
NIST data base 108 lines in region 200 – 400 Å

ITER soft x ray spectrometer

We have investigated the soft x ray spectra of $W^{(11-15)+}$ and identified a number of lines/spectral features in the region 200 – 400 Å.

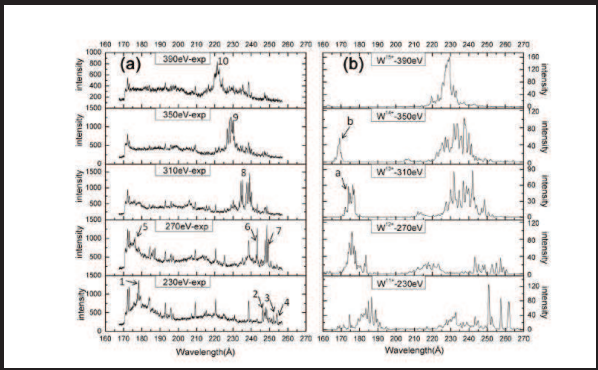
Also down to W^{7+}

Soft x ray tungsten spectroscopy



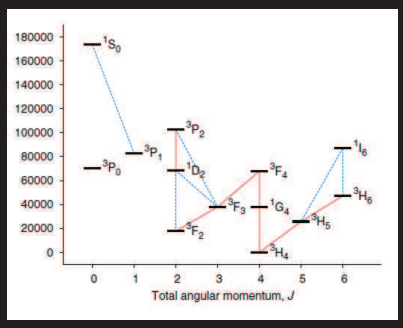
In preparation for publication

Soft x ray tungsten spectroscopy, experiment vrs. simulation

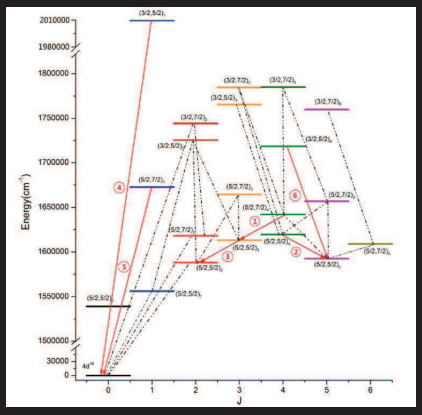


Energy Levels

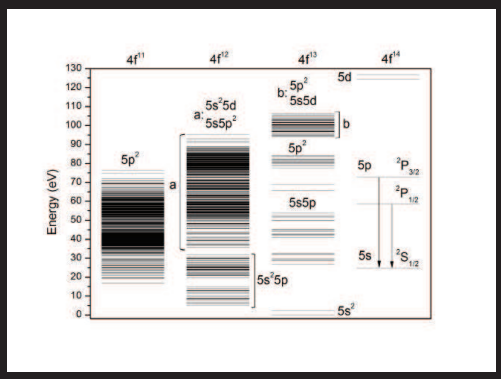
W^{26+}

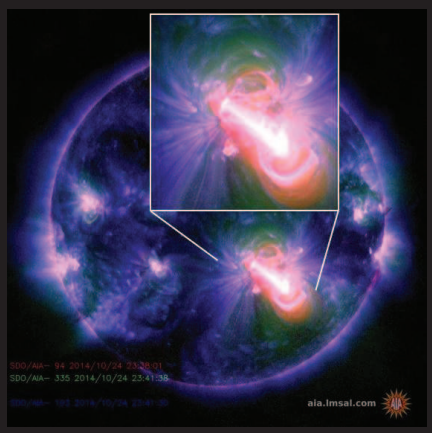


W^{28+}

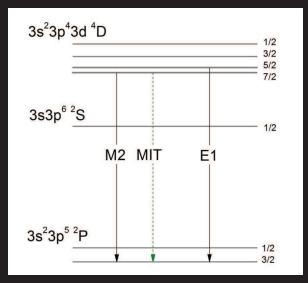


W^{13+}





Proposal of a Unique Method to Measure Magnetic Fields in the Solar Corona Facilitated Through an Accidental Degeneracy of Quantum States in the Fe^{9+} Ion



Please see the poster presentation by Yang Yang for more details on this