



Spectra of moderately charged tungsten ions in the region below 350 Å

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According to recent compilation

.A.E.Kramida, T.Shirai. Energy levels and spectral lines of tungsten, W III through W LXXIV. - At. Data and Nucl. Data Tables, 2009, v.95, p.305-474

experimental data on wavelengths and energy levels in moderately charged tungsten are available up to W VIII. Spectra W VIII – W XXVII are not known

There is one publication

J.Verés, J.S.Bakos, B.Kardon. Energy levels and the vacuum ultraviolet spectrum of W VIII. – JQSRT, 1996, v.56, p.295-301

where tokamak spectrum taken at 5 Å resolution was reported. Two wide maxima in the regions ~190 and ~230 Å were attributed to W VIII. Such low resolution did not permit any reliable interpretation of this spectrum.

W VIII is next expected extension in a study of tungsten ion spectra



Experimental technique at the Institute of Spectroscopy in Troitsk

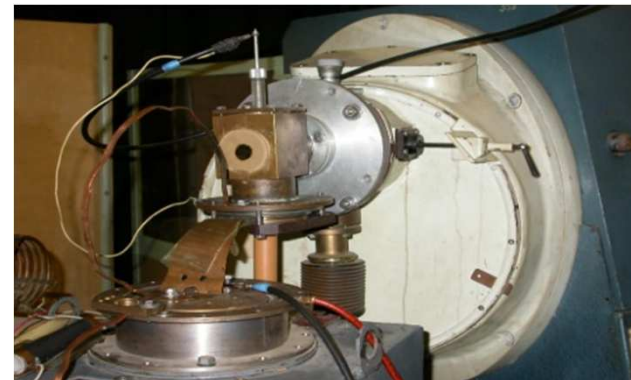
VACUUM SPECTROGRAPH

Grating radius 3m, 3600 l/mm
Angle of incidence 85°
Resolving power at 200 Å $\sim 8 \cdot 10^3$
Region 100-350 Å

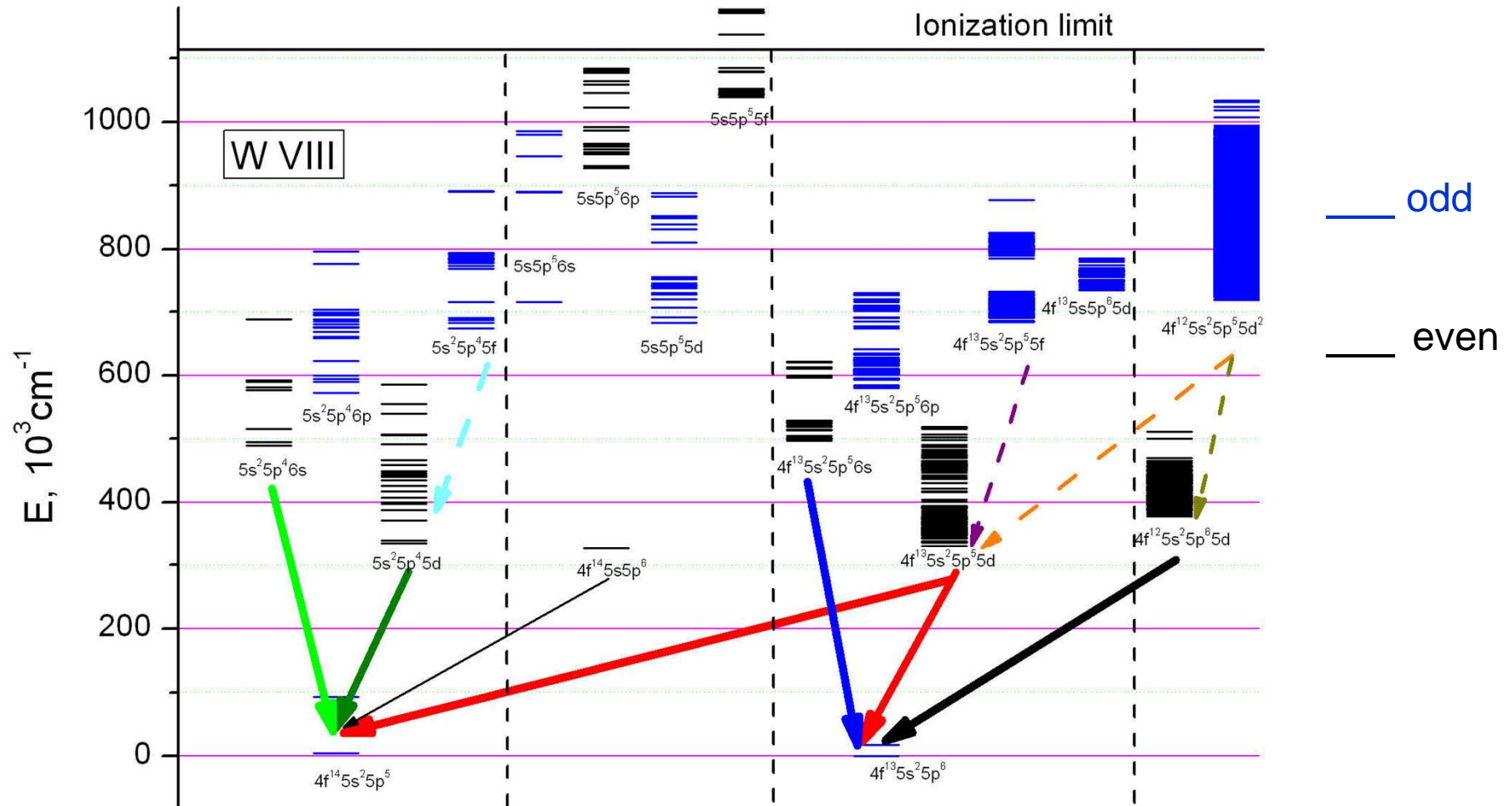


VACUUM SPARK

C=10 - 7500 μ F
L=0.08 – 1.0 nH
U=0.2 – 5.0 kV
I up to 30 kA



W VIII energy levels according to HF calculations



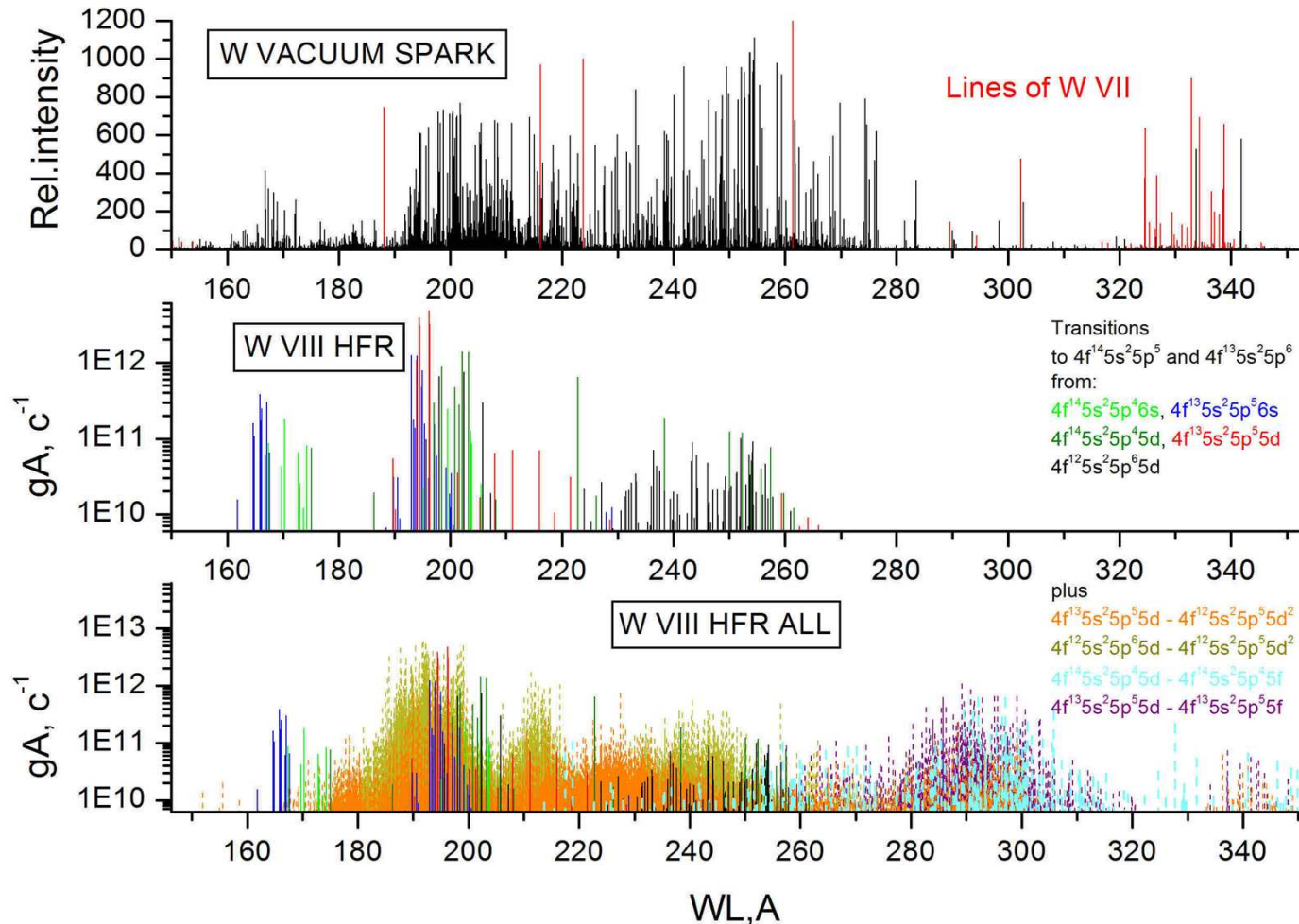
Resonance transitions are expected below 350 Å



Comparison

of vacuum spark spectrum with calculated W VIII spectrum

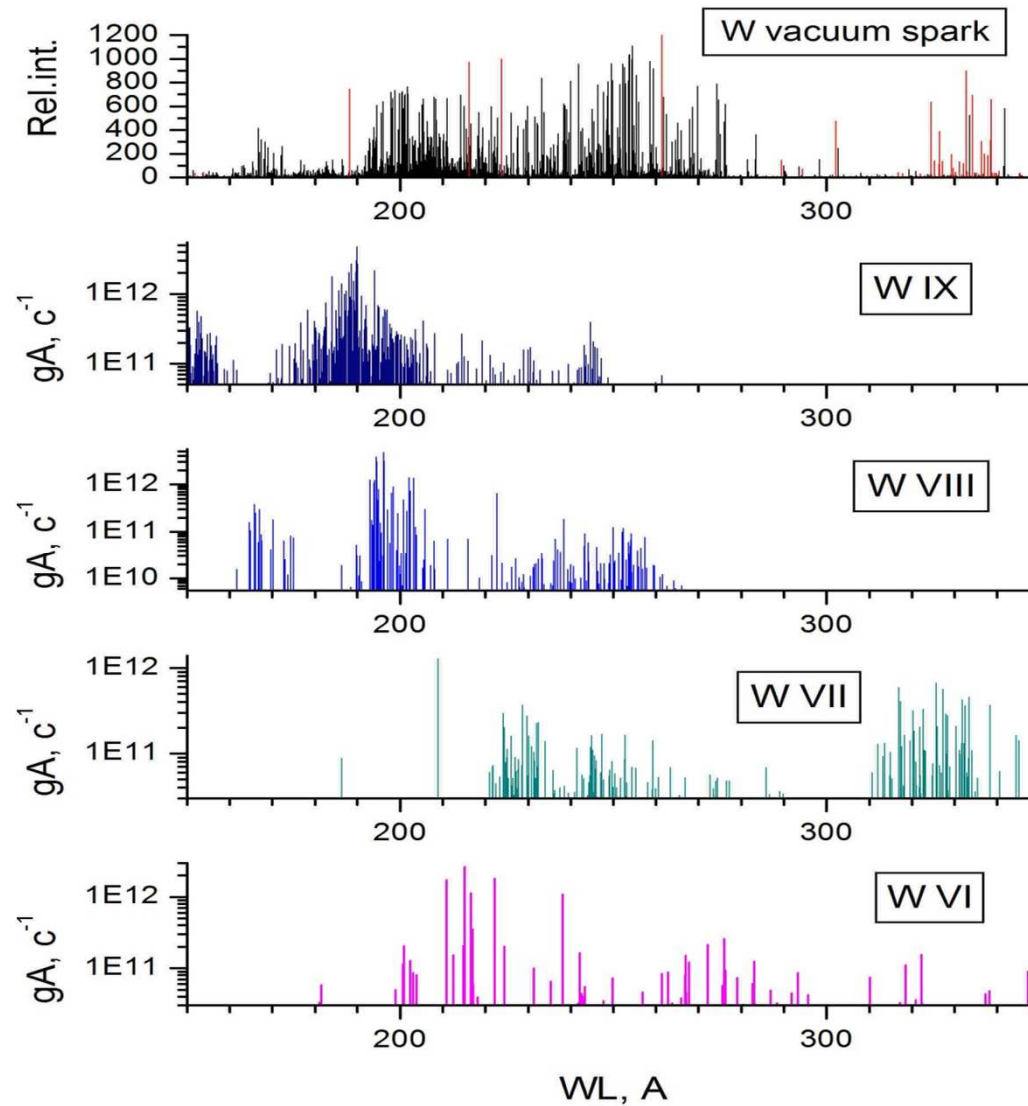
W VII lines identified by J Sugar and V Kaufman (Phys. Rev. A, 1975, v.12, p.994-1012) and Wyart J.-F., Kaufman V. and Sugar J. (Phys.Scripta, 1981, v.23, p.1069-1078) are shown by red.





Comparison

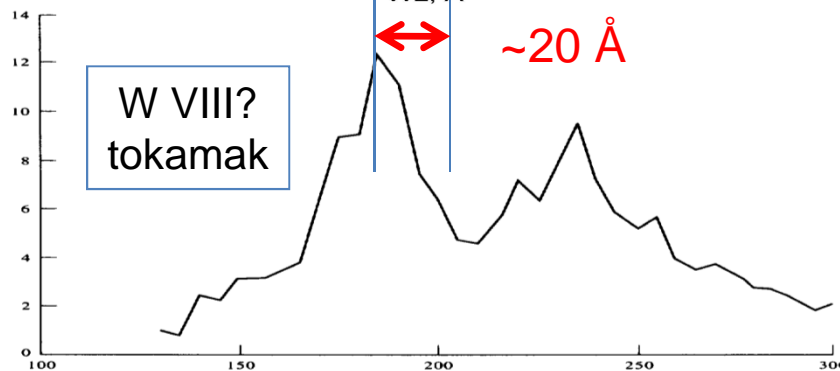
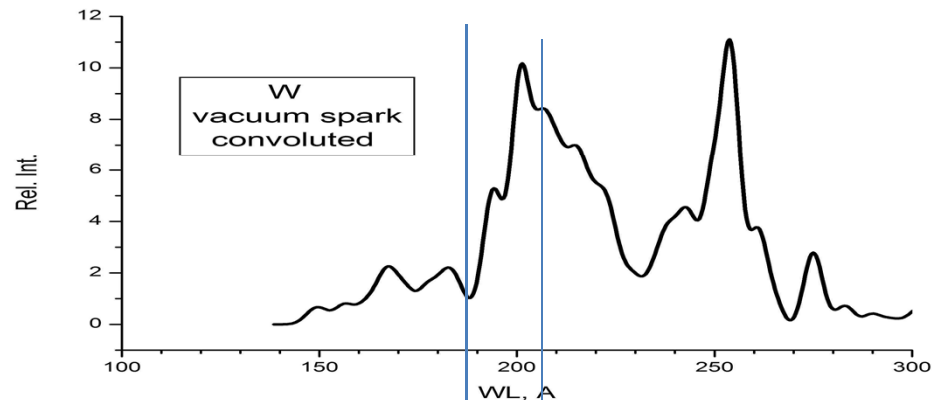
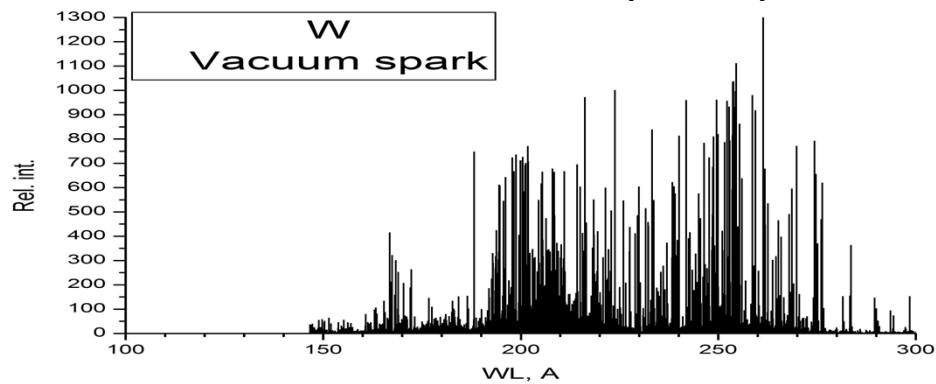
of vacuum spark spectrum with calculated W VI – W IX spectra





Comparison

of vacuum spark spectrum with tokamak spectrum



Vacuum spark spectrum is
Convoluted with 5 Å resolution

Tokamak VIII spectrum (*J. Veres,
J.S.Bakos and B.Kardon, 1996*),
5 Å resolution



Conclusion from the vacuum spark and tokamak spectrum comparison

Or W VIII lines are absent in tokamak spectrum, or some fatal error occurred in wavelength calibration of their spectrometer

In any case this tokamak spectrum is not suitable for any diagnostic purposes.



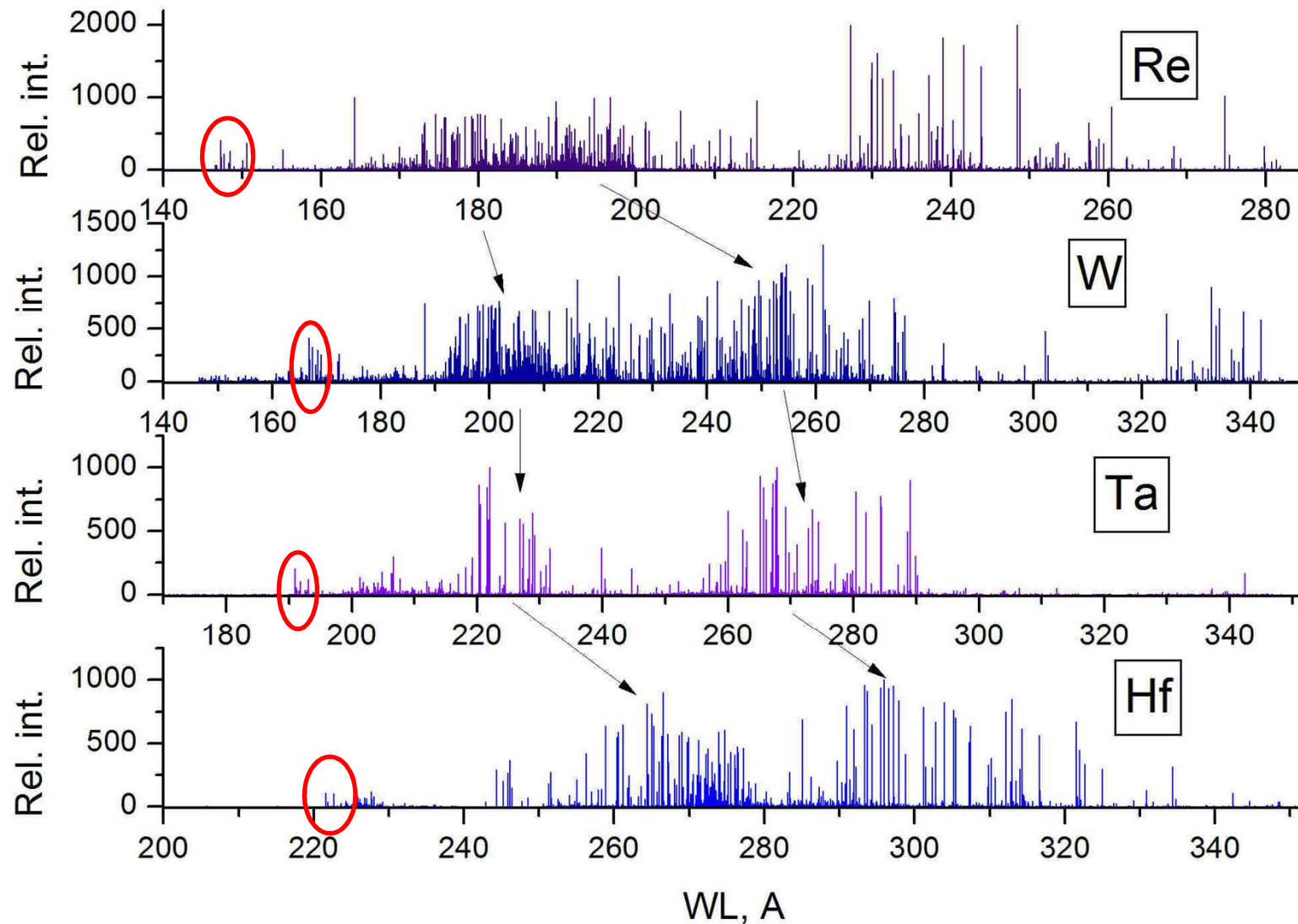
About 3000 lines were measured in the vacuum spark spectrum with estimated error 0.005 Å. Spectrum is very complex. It consists from at least 5 overlapping W VIII transition arrays formed by excitation of different electrons from $4f^{14}5s^25p^5$ and $4f^{13}5s^25p^6$ configurations. W VI, W VII and W IX can also give large contribution to the spectrum.

For reliable identification of tungsten vacuum spark spectrum isoelectronic spectra of neighboring chemical elements should be also studied. Vacuum spark spectra of Re, Ta and Hf excited in the same conditions were taken and shown on the next slide.

Line groups can be traced in these spectra as it is shown by arrows and red circles.

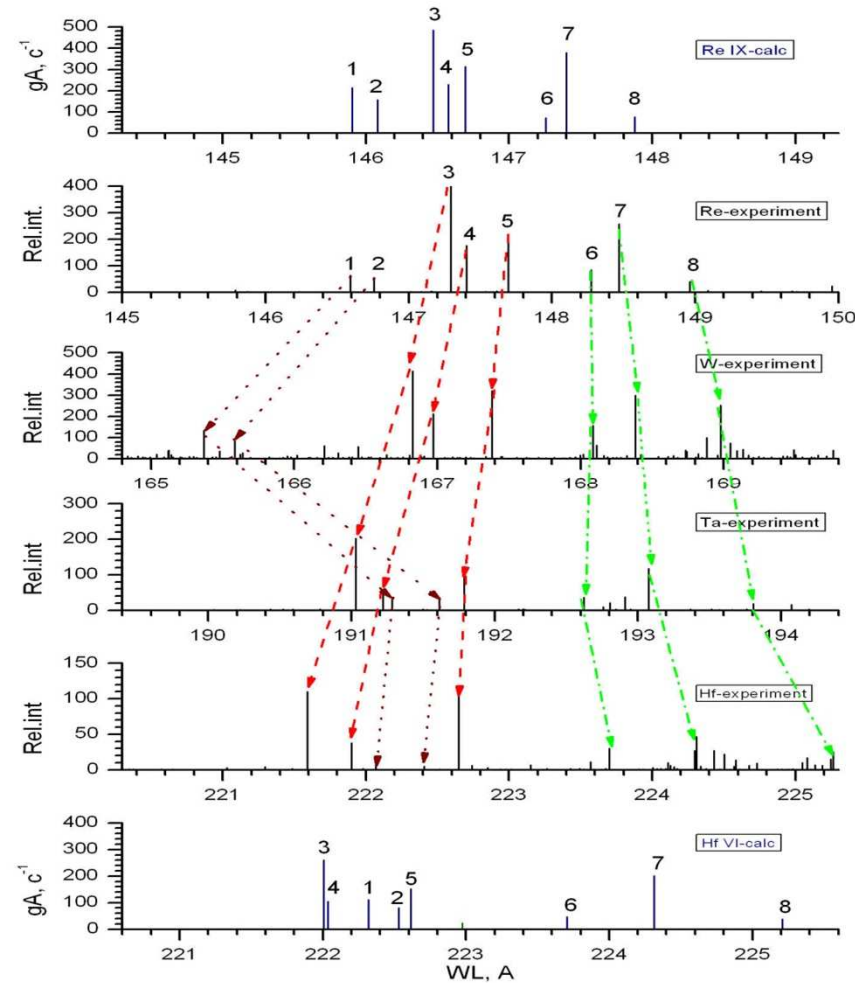


Vacuum spark spectra of Re, W, Ta and Hf





Short wavelength part of the $4f^{13}5s^25p^6 - 4f^{13}5s^25p^56s$ transition array in Hf VI - Re IX spectra can be isoelectronically traced and identified





First spectral data for W VIII spectrum

Identified $4f^{13}5s^25p^6 - 4f^{13}5s^25p^56s$ transitions in W VIII spectrum.

$\lambda, \text{\AA}$	ν, cm^{-1}	I	$gA, 10^9 \text{c}^{-1}$	Transition
165.369	604707.5	133	335	2F 2.5 -(2F)2Da 1.5
165.583	603927.1	86	224	2F 2.5 -(2F)2Da 2.5
166.827	599421.9	414	801	2F 3.5 -(2F)2Ga 4.5
166.972	598904.6	212	360	2F 3.5 -(2F)2Ga 3.5
167.382	597434.7	321	523	2F 3.5 -(2F)2Db 2.5
168.084	594941.0	158	126	2F 3.5 -(2F)4D 3.5
168.381	593890.9	300	627	2F 2.5 -(2F)2Gb 3.5
168.980	591787.4	252	138	2F 2.5 -(2F)4G 2.5



Contribution by my colleagues

E.Ya.Kononov

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to this work is greatly appreciated

The work is performed in valuable cooperation with

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