EPJ Web of Conferences **132**, 03043 (2017) DOI: 10.1051/epjconf/201713203043
SPECTROSCOPY.SU 2016

New laboratory spectra of the Fe^{6+} and Fe^{7+} ions

A.N. Ryabtsev*

Institute for Spectroscopy RAS, 108840 Troitsk, Moscow, Russia

Abstract. The Fe^{6+} and Fe^{7+} ion spectra excited in a vacuum spark were recorded and investigated in the 120 - 350 Å region. Previous identification is corrected and extended. A comparison with the Sun spectrum obtained from Hinode satellite was performed and identification of new lines was suggested.

The spectra of iron ions are of great value for the astrophysics because of large abundance of iron in the universe. Contemporary astronomy shows tremendous progress due to development of new instruments for ground-based as well as extra-atmospheric observations. The instruments are characterized by large spectral and spatial resolution. In particular, Extreme Ultraviolet Imaging Spectrometer (EIS) on board of the solar observatory Hinode provided unprecedented spectra of the upper transition solar region [1] containing intense Fe VII and Fe VIII lines. These spectra were studied previously in 80-th of the last century but the analyses of new solar spectra [2-4] showed that there is insistent necessity in new laboratory study of the Fe^{6+} и Fe^{7+} ion spectra.

The spectra in the vacuum ultraviolet region 120 - 350 Å were recorded at the Institute of Spectroscopy RAS on a high resolution grazing incidence spectrograph with a 3 м diffraction grating. The spectrograph has a plate factor from 0.30 through 0.46 Å/mm respectively in the 120 - 350 Å region. The instrumental width of the spectral lines was about 0.04 mm, what corresponds to 0.015 Å resolution at registration on the photoplates. A three-electrode low-inductance vacuum spark was used for the excitation of the spectra. A discharge circuit contained a capacitor C=10 or 150 mkF, charged to up to 5 kV voltage. New type of radiation-measuring instrument - the FUJI Imaging Plate- was used for spectrum recording. The spectra recorded on the Imaging Plate were scanned by Typhoon FLA 9500 scanner and digitized using the codes ImageQuant TL 7.0 and GFit , resulting in a table of line center positions and intensities. The signal linearity in the range of several orders of intensity magnitude offers a great advantage of an Image Plate in a comparison with a photographic plate. This gives an opportunity for more accurate measurement of the line intensities and their variations with a change of the excitation conditions what provided more reliable differentiation of the lines belonging to transitions in the different iron ions.

By a variation of the spark discharge conditions the iron spectra favorable for the Fe VII and Fe VIII lines were obtained. They show also differences in a behavior of the lines belonging to these spectra.

A part of the spark spectrum from the ~191 – 198 Å region recorded at two excitation conditions is represented in Fig.1 in comparison with the similar region in the solar

* Corresponding author: ryabtsev@isan.troitsk.ru

spectrum [1]. First, it is seen that the laboratory Fe VII и Fe VIII lines reproduce the solar spectrum quite well but with higher resolution, second, there is quite distinct differentiation of the lines of different stages of the ionization.

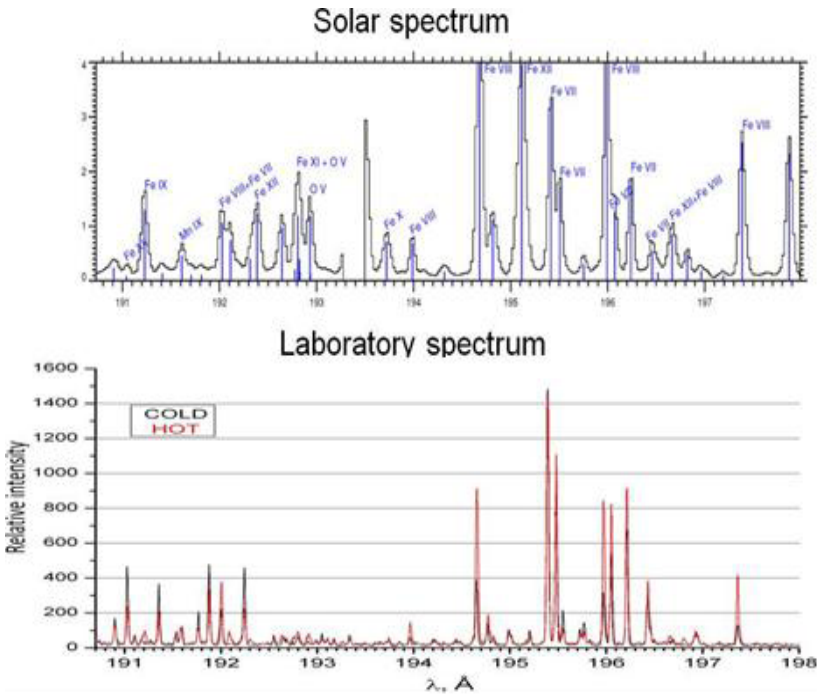

Fig. 1. Vacuum spark spectrum of iron in comparison with the solar spectrum [1].

As a result of the analysis of the Fe VII $3p^63d^2$ – ($3p^63d4p$ + $3p^53d^3$) transitions 185 lines from the region 158 – 266 Å were identified, 55 lines being new. In Fe VII now 65 energy levels are known.

The laboratory Fe^{7+} spectrum consists now of 31 reliably identified lines.

The wavelengths and intensities measured in laboratory spectra of $Fe^{6+}$and Fe^{7+} together with the calculated transition probabilities are used for elimination of the uncertainties in the solar spectrum interpretations. It was found, that the Fe VII line identifications in the solar spectrum performed in [4] are quite questionable. Many new Fe VII lines suggested in this article are absent in our laboratory spectra, or show other properties than Fe VII or the other more intense lines from particular levels are absent. On the other hand, almost all Fe VII analysis in the solar spectrum in [2] is supported by our laboratory spectrum. New identifications are added to the solar spectrum.

The work has been performed in the framework of the research program of the RAS Physical Science Division “Basic optical spectroscopy and its applications”.

References

1. P.R. Young, E. Landi, Ap. J. **706**, (2009)
2. P.R. Young, E. Landi, Ap. J. **707**, 173 (2009)
3. G. Del Zanna, A&A **508**, 501 (2009)
4. G. Del Zanna, A&A **508**, 513 (2009)