

# Comment on "Direct observation of ${}^2D_{3/2} - {}^2D_{5/2}$ ground-state splitting in $\text{Xe}^{9+}$ "

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We have found that xenon in different charge states, namely  $\text{Xe}^{9+}$  and  $\text{Xe}^{31+}$ , can contribute to the radiation in the 598 nm spectral range. Our observation resolves the discrepancy of line identification given by Takács et al. [Phys. Rev. **A** **73**, 052505 (2006)] and Crespo et al. [Can. J. Phys. **80**, 1687 (2002)].

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In a recent publication by Takács et al. [1] from the NIST-EBIT it was claimed that the visible line observed at 598.30 nm corresponds to the  $4d^9 {}^2D_{3/2} - {}^2D_{5/2}$  magnetic dipole (M1) transition within the ground state configuration of  $\text{Xe}^{9+}$ . This was verified by scanning xenon ions confined in an electron beam ion trap (EBIT) over a range of electron beam energies while observing the visible spectrum around the 598 nm region. The line reported previously by Crespo et al. [2, 3] (LLNL-EBIT) at 598.4 nm and assigned there to a  $3d^5 {}^4G_{9/2} - {}^4G_{11/2}$  transition in  $\text{Xe}^{31+}$  was said to have likely been misidentified.

To resolve the question of the disparity between the two identifications, we have performed a series of controlled measurements of the emission from  $\text{Xe}^{9+}$  and  $\text{Xe}^{31+}$  using the Berlin-EBIT [4]. The radiation was observed using a 1m Czerny-Turner spectrometer, which was equipped with a 600 grooves/mm grating and a charge-coupled device (CCD) camera (2048×512 pixels of 13.5  $\mu\text{m}$  width) to record the spectra. The wavelength calibration of the spectrometer was performed using sodium and neon calibration lamps and employing reference wavelengths from the NIST-database [5]. Nine lines from Na I and Ne I between 585 and 610 nm established a linear calibration across the whole region observed with a single CCD image. Spectra were recorded by stepwise variation of the electron beam energy sampling the ranges at which densities of  $\text{Xe}^{9+}$  and  $\text{Xe}^{31+}$  ions are maximal in the trap. Figure 1 shows spectra acquired for 30 min at 200 and 1900 eV beam energy at 1 and 60 mA beam current, respectively. In the low energy spectrum we observe a line at 598.04 nm which we assign to the M1 transition in  $\text{Xe}^{9+}$  reported by Takács et al. [1]. For our measurement we estimate an uncertainty of  $\pm 0.03$  nm resulting from statistical and systematic errors. At electron-beam energies above about 400 eV, we could not any longer observe the line at 598.04 nm due the diminishing abundance of  $\text{Xe}^{9+}$  ions confined in the trap. The higher energy spectrum of Fig. 1 is obtained at 1900 eV, i.e. 65eV higher than the ionization \*Electronic address: Biedermann@ipp.mpg.de

potential of  $\text{Xe}^{30+}$ . As the threshold for ionization of

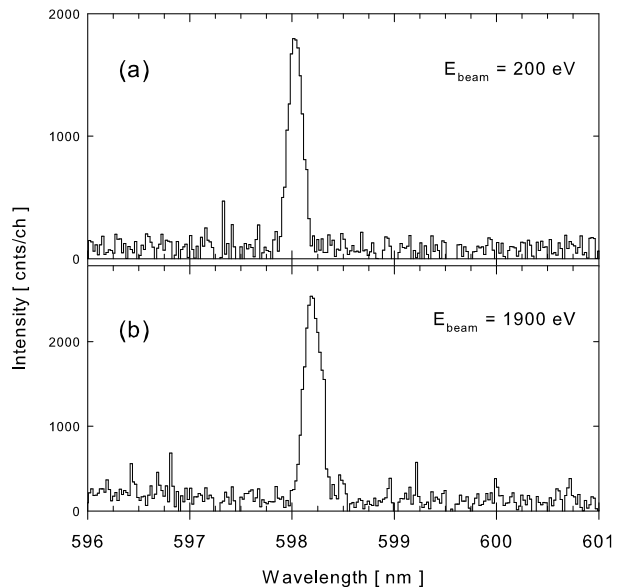


FIG. 1: Spectra of magnetic dipole lines from  $\text{Xe}^{9+}$  (a) and  $\text{Xe}^{31+}$  (b) at two settings of the electron beam energy. Energies are quoted with correction for the electron space charge.

$\text{Xe}^{30+}$  is exceeded, a new line appears in the spectrum at 598.21 nm belonging to the  $\text{Xe}^{31+}$  charge state. This line is displaced from the  $4d^9 {}^2D_{3/2} - {}^2D_{5/2}$   $\text{Xe}^{9+}$  line by 0.17 nm, which is clearly beyond the error limit of our measurement. The  $598.4 \pm 1.0$  nm wavelength of the  $3d^5 {}^4G_{9/2} - {}^4G_{11/2}$   $\text{Xe}^{31+}$  transition reported by Crespo et al. [2, 3] was measured with lower accuracy, but it agrees with our 598.21 nm value to within their experimental uncertainty. In conclusion, we see clear evidence for two lines around the 598 nm region originating from M1 transitions in the  $\text{Xe}^{9+}$  ( $598.04 \pm 0.03$  nm) and  $\text{Xe}^{31+}$  ( $598.21 \pm 0.03$  nm) charge states.

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