Transition energy measurements of highly-charged Xe and W in support of ITER's XRCS and SPARC's XRS

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High-resolution x-ray crystal spectroscopy diagnostics continue to be an indispensable tool for determining important plasma parameters such as ion temperature, plasma flow, and impurity abundances in tokamak devices. However, both the design and successful operation of these diagnostics require accurate transition energies for the diagnostic lines themselves, for line emission from nearby charge states of the same Z, and for line emission from other relevant impurity ions present in the device. ITER's X-Ray Crystal Spectrometer, Core Viewing (XRCS-Core) is a key diagnostic that will utilize high-resolution spectroscopy to measure time-resolved profiles of plasma parameters such as ion and electron temperature for the ITER tokamak. Line surveys and accurate reference energies are the first critical step to identify suitable lines for these diagnostics. XRCS-Core is designed to observe the Ne-like Xe^{44+} $2p^5_{1/2}3d_{3/2}(J = 1) \rightarrow 2p^6$ emission line known as 3C and a nearby N-like Xe^{47+} emission line. SPARC is a planned commercial D-T tokamak fusion device. SPARC's XRS-HR-Xe high-resolution x-ray crystal spectrometer is designed to observe the Ne-like Xe^{44+} $2p^5_{3/2}3d_{5/2}(J = 1) \rightarrow 2p^6$ line known as 3D. For both the XRCS-Core and XRS-HR-Xe diagnostics, a complete set of measured transition energies from highly-charged xenon and from highly-charged impurity ions, such as tungsten, which may limit the Xe diagnostics, is needed. In order to address these atomic data needs, we have used the LLNL EBIT-I electron beam ion trap and EBIT calorimeter spectrometer (ECS) to measure the transition energies of x-ray line emission from highly charged Xe and W ions.

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