Spectroscopy of Highly Charged Ions in Magnetic Fusion Plasmas: Research Opportunities and Diagnostic Necessities

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Highly charged ions play a crucial role in magnetic fusion research as diagnostics of, for example, electron and ion temperatures, transport, and bulk motion, and as contributors to the radiative plasma cooling [1],[2]. In order to develop specific spectral diagnostics a large amount of atomic data are needed. For example, there is a need for highly accurate wavelengths as references for measurements of bulk plasma motion, for accurate line excitation rates that encompass both electron-impact excitation and indirect line formation processes, for accurate position and resonance strength information of dielectronic recombination satellite lines that may broaden or shift diagnostic lines or that may provide electron temperature information, and for accurate ionization balance calculations.

Conversely, magnetic fusion plasmas are excellent sources for studying highly charged ions and their atomic properties as well as the collisional processes involved in their excitation. These studies include x-ray production by charge exchange, line identifications and accurate wavelength measurements, benchmark data for ionization balance calculations, and the calibration of astrophysical density diagnostics. An overview of opportunities for highly charged ion research with magnetic fusion plasmas was given recently [3].

We point out that the ions of several elements are of special current interest, notably the highly charged ions of argon, iron, krypton, xenon, and, foremost, of tungsten [3]. The electron temperatures thought to be achievable in the near future may produce W^{70+} ions and possibly ions with even higher charge states. This means that all but a few of the most highly charged ions are of potential interest as plasma diagnostics or are available for basic research.

This talk will give an overview of various research opportunities and diagnostic needs involving highly charged ions in magnetic fusion plasmas.

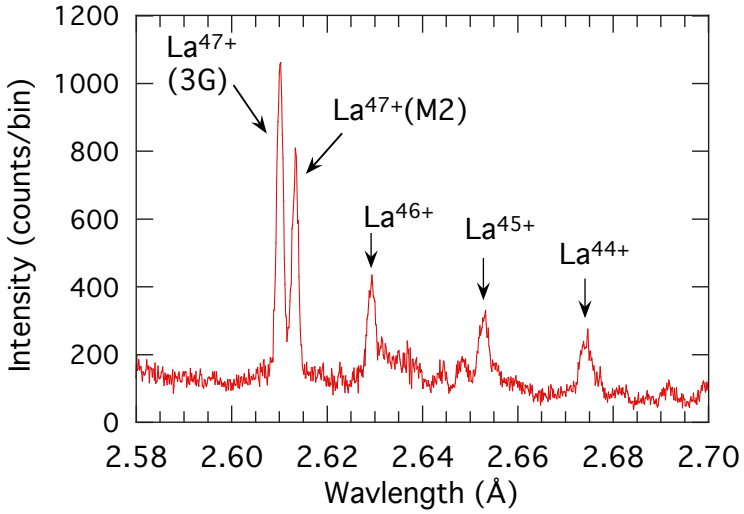

Fig. 1: Emission from highly charged lanthanum observed from a tokamak plasma. Lines $3G$ and $M2$ are $3s \rightarrow 2p$ transitions in neonlike La^{47+}.

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References

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