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PLASMA BROADENING AND SHIFTING OF NON-HYDROGENIC SPECTRAL LINES: PRESENT STATUS AND APPLICATIONS

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Abstract. The present status of the experimental studies of plasma broadening and shifting of non-hydrogenic neutral atom and positive ion spectral lines will be discussed with an emphases to the plasma diagnostic applications. Short overview of the available theoretical results will be followed by the description of experimental techniques for the line shape and shift measurements. The influence of other broadening mechanisms to the Stark width and shift determination will be considered and typical experimental procedure described. The results of comparison between theory and available experimental data for neutral atoms and positive ions will be discussed.

Plasma broadened and shifted spectral line profiles are used for a number of years as a basis of an important non-interfering plasma diagnostic method. The numerous theoretical and experimental efforts have been made to find solid and reliable basis for this application. This technique became, in some cases, the most sensitive and often the only possible plasma diagnostic tool. In the early sixties a number of attempts have been made to improve and to check experimentally the existing theories of spectral line broadening by plasmas. Most of these early works were concerned with the Stark broadening of hydrogen lines. Owing to the large, linear Stark effect in hydrogen, these studies were very useful for plasma diagnostic purposes. However, it is not always convenient to seed plasma with hydrogen, and sometimes this is not possible. Furthermore, due to the large Stark effect, hydrogen lines or the lines of hydrogen like ions are sometimes inconvenient for plasma diagnostic purposes, since they become so broad at high electron densities that, due to the interference with other neighboring lines, it is difficult to determine their shape correctly. Therefore, from the early starts of this field of research, there was an interest for the plasma broadening of isolated non-hydrogenic lines of neutral atoms and positive ions. Due to the quadratic Stark effect, these lines can be used for plasma diagnostic purposes at high electron densities and, in particular, at high electron temperatures when hydrogen is fully ionized. Here the word "isolated" is used for the lines originating from isolated energy levels in the sense that l levels are not degenerate and do not overlap one another.

The aim of this talk is to present results of recent experimental studies of the Stark broadening and shifting of spectral lines and to discuss the comparison of these data with theory. On the basis of this comparison, the attention will be drawn to some systematic discrepancies which may be used as a guideline for future work. From the point of view of applications, the estimated accuracies of data will be given and some experimental difficulties underlined. The measurements of line parameters and estimation of the influence of other broadening mechanisms will be discussed in detail. Since line widths and shifts depend also upon electron temperature T_e, for accurate electron density N_e plasma diagnostics, T_e measurements are required and they will be discussed also. Finally, the typical experimental procedure for N_e plasma determination will be described also.