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Continuum Processes in High and Ultra High Pressure Lamps[1]

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The growing use of Ultra High Pressure (UHP) lamps for projection applications has motivated studies of thermal or LTE Hg plasmas in a peculiar region of parameter space. These UHP lamps, which are now commonly found in conference room projectors and large screen TVs, operate with Hg pressures $>$ 200 bar, electron densities $\sim$1.0E18 / cc, and power densities $>$ 1.0E5 W/cc. Such lamps were developed to couple the maximum amount of light into small etendue LCD projection systems. Unlike most other plasmas in similar parts of parameter space, the plasmas in UHP lamps are steady-state. A greater variety of diagnostic techniques and more accurate measurements are possible in UHP lamp plasmas. Continuum processes are much more important in both the opacity and power balance of UHP lamps than they are in typical ($<$ 20 bar) High Intensity Discharge (HID) lamps. Electron + Hg atom bremstrahlung dominates ($\sim$90%) the near IR emission from UHP lamps [1]. Quasi-molecular absorption at $>$ 200 bar yields substantial opacity and results in minimal UV emission from UHP lamps [2, 3]. There are additional physics issues in the 200 bar to 1 kbar range: e.g. (1) spectral line broadening of the few remaining Hg transitions including the breakdown of the single perturber approximation of line broadening theory, (2) free electron continuum processes including the breakdown of the binary collision approximation, and (3) the effect of strong coupling of the plasma on radiative processes. A more quantitative understanding of electron + Hg atom bremsstrahlung in UHP lamps has resulted in a better understanding of near IR losses from widely used, lower pressure metal-halide HID lamps.

[1] Lawler JE, Koerber A, and Weichmann U 2005 J. Phys. D: Appl. Phys. 38, 3071.
[2] Wharmby D 2008 J. Phys. D: Appl. Phys. in press.
[3] Kato M, Kane J, and Lawler JE 2008 J. Phys. D: Appl. Phys. submitted.

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