VISIBLE AND INFRARED CONTINUUM RADIATION FROM A LOW TEMPERATURE Cl2-ARC

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INTRODUCTION

Continuum visible and especially infrared emission of plasmas is of interest because of its advantages for diagnostic purposes of dense low temperature plasmas and for the investigation of properties of nonideal plasmas. Continuum radiation has been extensively studied in hydrogen and inert gases and to a lesser extent in other atmospheric gases, alkali metal vapors, mercury and the halogens /1/. In the latter case the measured visible continua were found greater than expected by factors 5-50, but the observed radiation has not been unambiguously identified /1/. It is the aim of the present work to perform quantitative measurements of the visible and infrared continuum radiation of a chlorine arc plasma.

Fig. 1

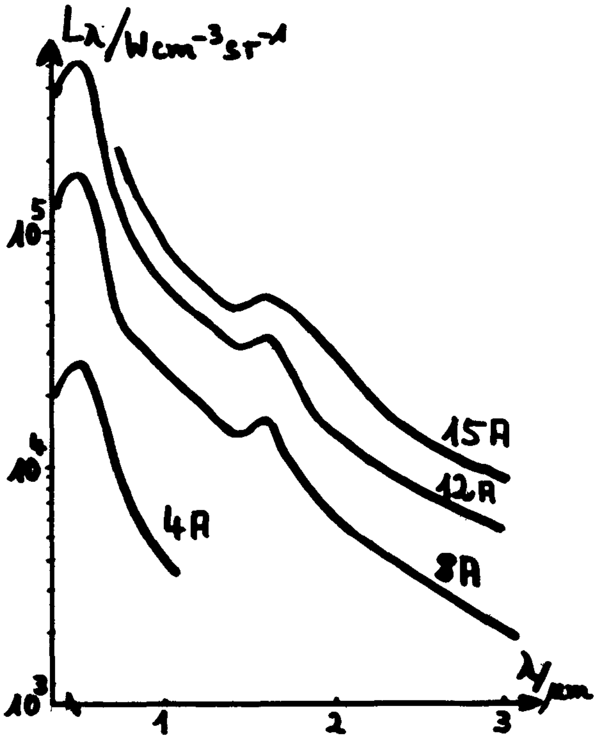
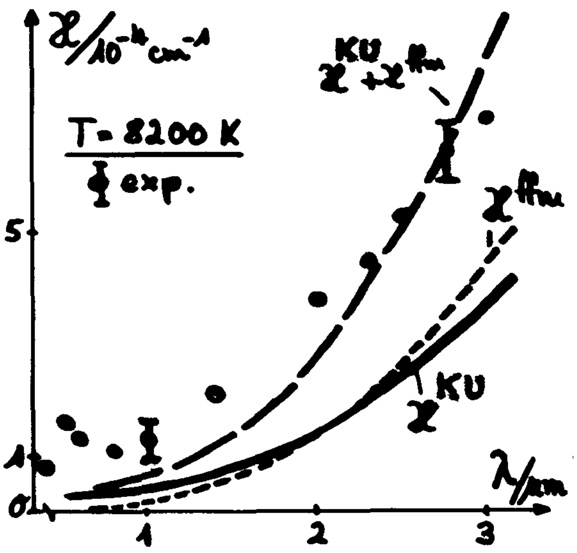


Fig. 2



EXPERIMENT

The Cl_2-arc is operated in a water cooled quartz tube of 8 mm inner diameter and 10 cm length at atmospheric pressure with dc-currents of 4-15 A. Both ends of the arc are submerged in argon gas to prevent reabsorption of radiation by Cl_2-molecules in regions of lower temperature and thus to make possible end-on observation of the arc axis. The detectors used at the exit slit of a McPherson 2051 monochromator are photomultipliers (S20, S1), a PbS - cell and a cooled InSb - photoconductive detector, whose signals are fed into a lock-in detection system. A standard carbon arc is used for absolute intensity calibration.

MEASUREMENTS

Fig. 1 shows absolute spectral continuum intensities emitted end-on from the arc axis in the wavelength range 0.4 μm - 3μm for 4 different arc currents. These curves are composed from those experimental points, which seemed to be unaffected by any atomic line radiation. Simultaneous determination of the axis temperatures as a function of discharge current by absolute intensity measurements of ClI spectral lines allows conversion of the data of Fig. 1 into absolute absorption coefficients via Kirchhoffs law. The experimental points of Fig. 2 show this absorption coefficient $\varkappa(\lambda$, 8200 K).

DISCUSSION

Fig. 2 shows a comparison of absolute magnitudes and λ -dependences of our data with the calculated electron-ion contribution (Kramers-Unsöld, ξ -factor 1) $\varkappa^{KU}$ (solid curve) and the electron-atom bremsstrahlung (free-free-minus) $\varkappa^{ffm}$ (dotted curve), which was calculated according to the Hyman/Kivel approximation /2/. The sum $\varkappa^{KU}+\varkappa^{ffm}$ (dashed curve in Fig. 2) agrees fairly well with our data in the range 2 μm < λ < 3μm. On the other hand, fairly large differences exist for λ < 2μm, especially near $\lambda \approx 1.7\mu$m and $\lambda \approx 0.5\mu$m, where the experimental data lie high by factors 2 and 5 respectively. The maximum at $\lambda \approx 5300$ Å may be interpreted as due to a series of electron-ion recombination thresholds into ClI $3s^2 3p^4 4p$ levels. A ξ-factor /3/ of 5 at maximum, comparable to Xe ξ-factors at 6000 Å /4/, results from this interpretation. Moreover, the dependence $\varkappa$(T, 5300 Å) of our data on temperature, which is shown in Fig. 3 and compared with both $\varkappa^{KU}$ and 5x $\varkappa^{KU}$, is also in agreement with this. Fig. 4 shows experimental data of $\varkappa$(T, 2.9 μm) together with the contribution $\varkappa^{KU}$ (ξ=1) and $\varkappa^{ffm}$ as a function of temperature. The steeper increase, which is observed in experiment, indicates that an additional radiation mechanism becomes important at higher temperatures. A possible process would be strongly broadened ClI spectrum lines from energy levels close to the ionisation threshold which merge into a quasi-continuum.

LITERATURE

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Fig. 3

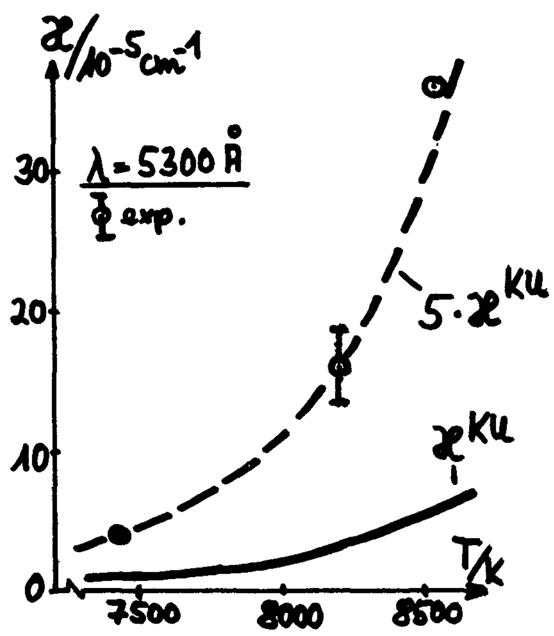

Fig. 4