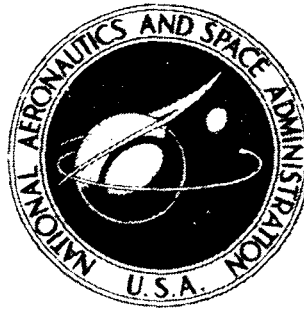


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**VISIBLE AND NEAR-ULTRAVIOLET
SPECTRA OF LOW-PRESSURE RARE-GAS
MICROWAVE DISCHARGES**

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SUMMARY

The spectral emission characteristics of three commercial low-pressure rare-gas discharge lamps have been obtained in the near-ultraviolet and visible wavelength range. All three lamps show a definite continuum over the entire wavelength range from 0.185 to 0.6 micrometer. There is also considerable line emission superimposed on much of the continuum for wavelengths greater than 0.35 micrometer.

These sources have been used to make transmittance measurements on quartz samples in the near-ultraviolet wavelength range.

INTRODUCTION

The spectral emission characteristics of three commercial low-pressure rare-gas discharge lamps have been obtained in the near-ultraviolet and visible wavelength range. Although the usual application of these lamps is as continuum radiation sources for spectrometer studies in the vacuum ultraviolet wavelength region, their output in the near-ultraviolet and visible region also included a continuum that was found to be useful for spectrometer studies.

While the emission spectra of rare-gas discharges are known to extend over the wavelength range from the vacuum ultraviolet through the visible, the useful spectrum is divided into two regimes, which are produced by two distinctly different types of rare-gas discharge lamps. The vacuum ultraviolet spectra of these gases is generally produced by either a spark discharge or a microwave discharge through the gas at low pressures (40 to 300 torr). This type of source is commonly used for spectrometer measurements in the vacuum ultraviolet. On the other hand, the visible and near-ultraviolet emission is commonly generated by a short arc discharge through a high-pressure (5 to 30 atm) rare gas, notably xenon or krypton. These lamps are commonly used for solar

simulation, searchlights, and projection systems.

Johnson (ref. 1), however, has shown that these high-pressure rare-gas discharges can also have a continuum in the ultraviolet. When such a source is equipped with a magnesium fluoride window, it can provide an intense source of radiation for the vacuum ultraviolet wavelength region.

Similarly, low-pressure discharges may have an output in the near-ultraviolet and visible wavelength range. Huffman, Hunt, Tanaka, and Novack (ref. 2) in investigating the low-pressure molecular continuum of helium, which is in the 0.06 to 0.09 micrometer range, found that when the lamp pressure was increased to 150 torr, a second continuum extending from at least 0.105 micrometer to beyond 0.4 micrometer occurred. Both continua became stronger as the pressure was further increased, until at pressures greater than 200 torr, the long-wavelength continuum became much stronger than the 0.06 to 0.09 micrometer continuum.

The fact that commercial low-pressure rare-gas vacuum ultraviolet sources obviously have a visible output suggested the possible use of these lamps as spectrometer sources for the visible and near-ultraviolet regions in which conventional incandescent lamps fall off in intensity. Consequently, the microwave-excited emission spectra of three of these sources were examined in air from the ultraviolet air cutoff through the visible wavelength range.

EXPERIMENT

The spectrometer utilized was a 1-meter, 15° Robin mount, vacuum ultraviolet, scanning spectrometer with a 590-line-per-millimeter concave grating blazed at 1500×10^{-10} meter (1500 Å) in the first order. The photomultiplier detector had an S-13 type response characteristic and was biased at 900 volts. Spectral scans were taken over the wavelength range from 0.16 to 0.72 micrometer. The air path within the spectrometer absorbed the vacuum ultraviolet portion of the spectrum for which the source was designed and consequently eliminated higher order effects from this region. Higher order effects from the radiation between the air cutoff ($\approx 0.185 \mu\text{m}$) and 0.36 micrometer were eliminated with order-sorting filters.

Three sealed vacuum ultraviolet sources with magnesium fluoride windows were investigated. These lamps were excited by a 2450-megahertz microwave generator. The charge gases were argon, krypton, and xenon, which have ultraviolet continua of 0.105 to 0.15, 0.127 to 0.165, and 0.15 to 0.18 micrometer, respectively. All lamps were operated at approximately 80 watts of power.

RESULTS

Figure 1 shows the spectra recorded for the argon, krypton, and xenon lamps. (The spectra have not been corrected for the response of the detection system.) All three lamps show a definite continuum over the entire wavelength range from 0.185 to 0.6 micrometer. There is also considerable line emission superimposed on much of the continuum for wavelengths greater than 0.35 micrometer. The maximum intensity level is approximately the same for all three gases. The wavelength at which the maximum intensity occurs is approximately 0.375 micrometer for all three sources.

The spectra of argon and krypton are similar in shape and structure. Both have a continuum from about 0.18 to 0.65 micrometer with a fairly line-free continuum between 0.2 and 0.32 micrometer.

The spectrum of the xenon lamp is somewhat different in that part of the vacuum ultraviolet continuum below 0.21 micrometer is not absorbed by the air path and can be detected. This output in the fairly narrow range from 0.185 to 0.21 micrometer is quite intense compared to the visible output, as would be expected from an ultraviolet source. The longer wavelength continuum for xenon extends from about 0.24 to 0.6 micrometer, with a line-free continuum occurring between 0.25 and 0.35 micrometer.

The output of the argon lamp between 0.2 and 0.3 micrometer was particularly useful for our application in that a line-free continuum at a reasonable intensity level ($\approx 10^{-7}$ A) was available. Directional transmittance measurements of various quartz samples were being obtained with a 1-kilowatt tungsten filament lamp as the radiation source. Scattered light levels had generally limited these measurements to wavelengths longer than 0.25 micrometer. With the argon discharge lamp as the source, transmittance measurements could be made in air down to 0.2 micrometer.

CONCLUSIONS

In addition to their use in the vacuum ultraviolet region, low-pressure rare-gas microwave sources can also be used to provide radiation that is suitable for spectrometer measurements in the visible and near-ultraviolet wavelength range. Thus, in the absence of other sources for covering this range or simply for the convenience of not changing sources, these sources would be adequate as spectrometer sources in the visible and near-ultraviolet range if judiciously applied.

Lewis Research Center,
National Aeronautics and Space Administration,
Cleveland, Ohio, September 2, 1971,
113-31.

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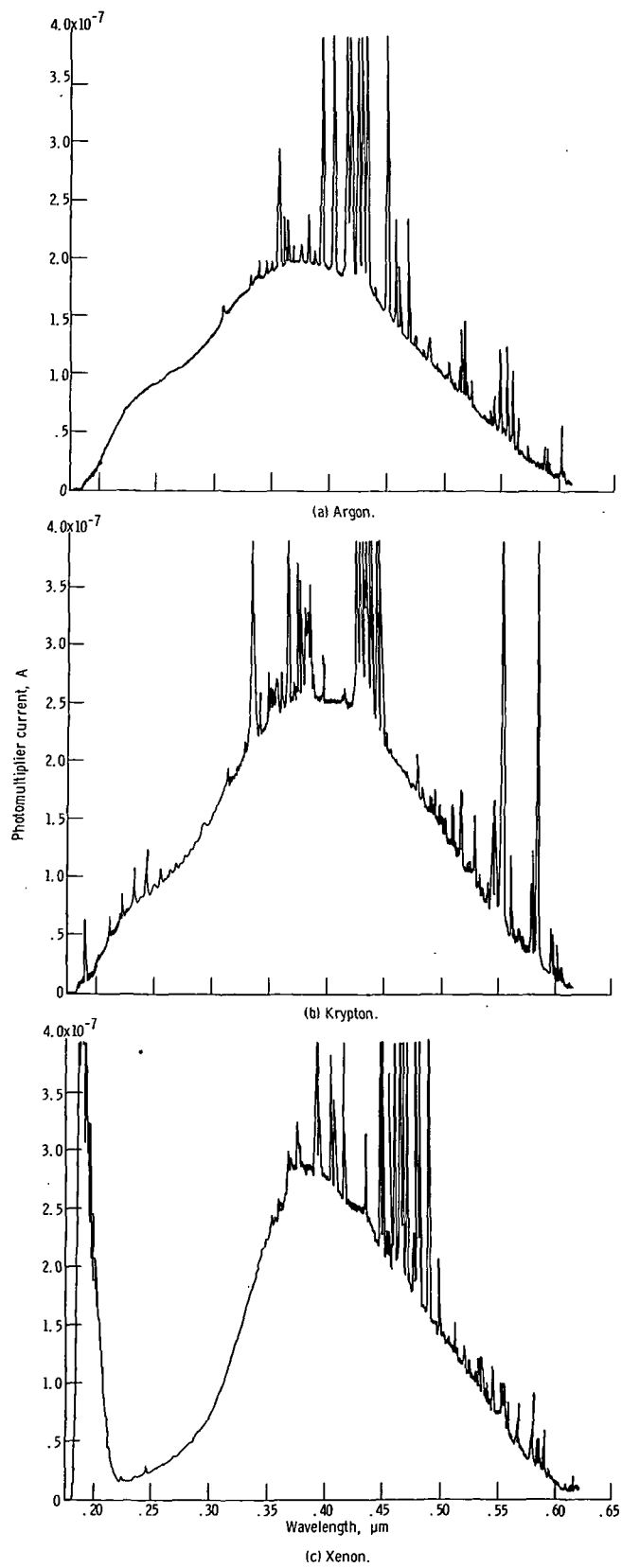


Figure 1. - Visible and near-ultraviolet emission spectra.



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