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VISUAL OBSERVATION OF INFRARED LASER EMISSION

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Radiation at 0.95, 1.11, 1.15, and 1.18 μ from a gas laser was observed with the unaided eye. Radiation with $\lambda = 0.95\ \mu$ is observed as red light and radiation with $\lambda = 1.11$, 1.15, and 1.18 is observed as light of half the wavelength.

THE present communication describes experiments on the visual detection of intense coherent infrared emission. It was found that infrared light in the wavelength region from 1.11 to 1.18 μ is seen as yellow-green or orange light; that is, as light of half the wavelength.

In these experiments we used a gas laser using a hollow cathode discharge in an Ne-H_2 mixture[1]. Laser action took place on the following spectral lines in Ne: 9486, 11177, 11143, 11525, and 11790 Å. The most intense of these was the emission at 11143 Å. The laser was pulsed with a pulse length of 5 μsec, and the pulse power was of the order of hundreds of milliwatts. The laser beam had a diameter of about 5 mm and an angular divergence of 3′.

The beam of the gas laser was passed through an IKS-3 infrared color filter (opaque to visible light) and then through a lens which focused the beam on the slit of a monochromator. The monochromator was adjusted to the wavelength of the infrared emission. The eye of the observer was placed in the path of the infrared beam leaving the monochromator. A different method was used to observe the relatively weak lines at 11525 and 11790 Å: after the laser beam was passed through the IKS-3 filter, it fell directly on the eye of the observer; in this case the laser beam was dispersed with a prism.

Radiation in all of the above five wavelengths was observed with the unaided eye. The color perceived depended on the wavelength as follows: 9486 Å was seen as red light, 11177 and 11143 Å were seen as yellow-green, 11525 Å as yellow, and 11790 Å as orange. If a color filter transparent to visible light but opaque to infrared was held in front of the eye, the laser flashes were not seen. This shows that the visual sensations are due to infrared radiation. The flashes were rather bright, especially at the four shorter wavelengths.

It is of some interest to establish the correspondence between the wavelength of the infrared light and the observed color of the flashes. These observations were complicated by the fact that the color sensation for a given wavelength was variable and clearly changed from pulse to pulse (except for the red color seen at $\lambda = 9486$ Å. To obtain quantitative results we used a group of 8-10 observers. Each observer looked at the radiation for ten flashes and then compared the color observed with the spectrum of an incandescent lamp seen through a monochromator. The table shows the results of these measurements together with the mean squared error calculated on the basis of

Wavelength Å	Color observed, Å	Second harmonic of the infrared emission, Å
11177 and 11143	5600±40	5588 and 5571
11525	5760±70	5762
11790	5840±130	5895

the spread in the experimental points.

Consideration of this data leads to the rather firm conclusion that the light seen by the eye in observing infrared emission corresponds to the harmonic of the given radiation. The present experiment may be useful in elucidating the nonlinear properties of the eye.

[1] V. P. Chebotaev and L. S. Vasilenko, JETP 48, 779 (1965), this issue, p. 515.

Translated by J. A. Armstrong
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