

indicated by the measured shift. Provisionally we are inclined to ascribe these displacements to increase of density, but the effects of other conditions are still under investigation.

The following table shows the results in the case of a few typical lines:

Negative Pole minus Center of the Arc.

Group <i>a</i> .		Group <i>b</i> .		Group <i>d</i> .		Group <i>e</i> .	
λ	$P-C$	λ	$P-C$	λ	$P-C$	λ	$P-C$
5,323	-0.0060 $\text{\AA}$.	6,136	+0.0007 $\text{\AA}$.	5,281	+0.018 $\text{\AA}$.	5,364	-0.022 $\text{\AA}$.
5,332	-0.0002	6,137	-0.0004	5,283	+0.019	5,367	-0.026
5,341	-0.0006	6,213	+0.0003	5,324	+0.022	5,369	-0.020
5,497	-0.0003	6,219	+0.0010	5,339	+0.016	5,383	-0.024
5,501	-0.0004	6,230	+0.0004	5,393	+0.017	5,400	-0.024
5,506	+0.0004	6,252	+0.0000	5,653	+0.014	5,410	-0.024
Mean.....	+0.0002 $\text{\AA}$.		+0.0003 $\text{\AA}$.		+0.018 $\text{\AA}$.		-0.023 $\text{\AA}$.
Displ. per atm....	+0.0036		+0.0094		+0.015		-0.018

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ON THE GROWTH AND DECAY OF COLOR SENSATIONS IN FLICKER PHOTOMETRY.¹

BY M. LUCKIESH.

IT has been well established that photometric measurements obtained by the direct comparison and flicker methods do not agree in most cases. Under favorable conditions this disagreement is only a few per cent., but where there is a large color difference such as obtains when red or green lights are compared with "white" light or with each other the results by the two methods often differ by many per cent. A comparative study has been made of the two methods and a further study has been made of the phenomena involved in the flicker method in order to account for the difference between the results by the two methods. The results by both methods are of course primarily effected by the variations in the color vision of various observers. For instance observers having so-called normal color vision on comparing red or blue with "white" light obtain results differing by as much as 100 per cent. But the fact that the two methods give different results indicates that the different phenomena underlying these two methods are of importance.

When flickering lights are observed it is at once obvious that the rates of growth and decay of the color sensations are liable to be involved. Broca and Sulzer have shown that there is an overshooting of luminous sensation varying with the intensity and color of the light. The writer has used complementary colors, red and blue-green, in studying the phenomena involved in flicker photometry. These have been intercompared in various ways and also com-

¹ Abstract of a paper presented at the Washington meeting of the Physical Society, April 24-25, 1914.

pared with "white" light. It has been verified that the ratios of the intensities of these two lights differ by many per cent. by the direct comparison and flicker methods.

The maximum values of sensation produced by these colored lights differ considerably at all frequencies of flicker up to vanishing-flicker frequencies. The speed at which flicker disappears is always lower for the blue-green light for equal intensities as measured by the direct comparison method. When blue-green light is flickered upon a steady red field the speed at which flicker disappears is much lower than for the case of red light flickering upon a steady green field. In these cases the illuminations on the photometer screen are balanced for equality by the direct comparison method. The speed or frequency at which a balance is made with the flicker photometer is found to be lower than the speeds of vanishing flicker for the two lights. There is a considerably greater overshooting of luminous sensation in the case of the red light flickering upon a steady blue-green field than in the case of blue-green light flickering upon a steady red field.

It is also found that the vanishing flicker frequency depends upon the shape of the "illumination wave," that is upon the contour of flicker. This suggests a possibility that flicker photometers differing in principle may give different results. The results indicate that the importance of the different rates of growth and decay of color sensations have not been considered seriously enough in connection with flicker photometry. It seems that the differences between the results by the direct comparison and flicker methods can be largely accounted for in the above phenomena.

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REVERSIBLE TRANSITIONS BETWEEN SOLIDS AT HIGH PRESSURES.¹

BY P. W. BRIDGMAN.

A LARGE number of substances have been examined over the range from 0° to 200° and from atmospheric pressure to 12,000 kgm. per sq. cm. The reversible transitions from one solid to another which occur within this range have been studied, and the relation between pressure and temperature along the transition lines, the difference of volume between the different forms, and the latent heat of transition have been determined. Data have been obtained for the following substances: AgI, NH₄NO₃, HgI₂, C₂Cl₆, KNO₃, KClO₃, AgNO₃, KSCN, NH₄SCN, KNO₂, and CsNO₃. Of these NH₄NO₃, KClO₃ and KNO₂ have each one new form not known before, and KNO₃ has two new forms. Particularly striking are the very rapid curvature of the AgNO₂ line, and the fact that there is a maximum temperature of transition between the red and the yellow modifications of HgI₂. The results for these various substances show nearly all possible kinds of behavior. This is different

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