

tematically in error; the violet and red components being assigned values, respectively too small and too large.

4. The systematic deviations for lines with violet and red companions found by comparing the Rowland and International wave-lengths go *pari passu* with and are referable to the errors in Rowland wave-lengths. The coefficient of correlation is $+0.55 \pm 0.05$.

5. These systematic deviations, therefore, do not furnish evidence that the relative positions of the Fraunhofer lines are systematically displaced by mutual influence. On the other hand, the sun-arc displacements and the relative separation of the components of close pairs in solar and arc spectra indicate that, within the limits of error, evidence of mutual influence is absent from the solar spectrum, and, in so far as mutual influence is a necessary corollary of anomalous dispersion in the sun, evidence for it also is absent.

¹ A. Einstein, *Leipzig, Ann. Phys.*, 35, 898 (1911).

² W. H. Julius, *Astrophys. J.*, 40, 1 (1914).

³ *Trans. Internat. Union Co-op. Solar Res.*, 4, 74. Charles E. St. John and Harold D. Babcock, 'A Study of the Pole Effect in the Iron Arc,' *Mt. Wilson Contr.*, 106; *Astrophys. J.*, 46, (1915).

⁴ Sir Joseph Larmor, *Observatory*, 497, 103 (1916).

⁵ Sebastian Albrecht, *Astrophys. J.*, 41, 333 (1915).

⁶ W. H. Julius, *Astrophys. J.*, 43, 53 (1916).

⁷ Charles E. St. John and L. W. Ware, *Mt. Wilson Contr.*, —, *Astrophys. J.*, — (1916).

AN ATTEMPT TO DETECT THE MUTUAL INFLUENCE OF NEIGHBORING LINES IN ELECTRIC FURNACE SPECTRA SHOWING ANOMALOUS DISPERSION

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Received by the Academy, July 6, 1916

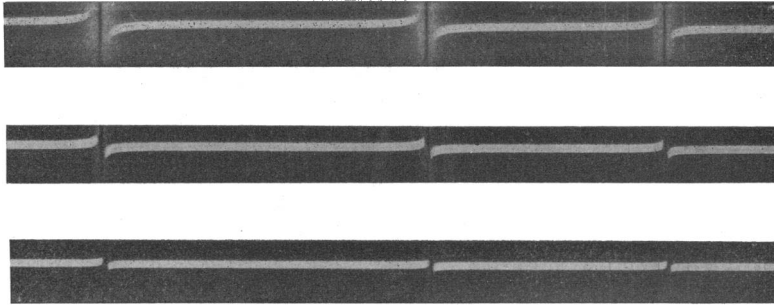
When light traverses a transparent medium, the variation of the index of refraction with the wave-length of the incident light may undergo decided changes if the medium shows selective absorption. If a beam of white light is passed through a mass of vapor which is itself emitting a spectrum, the sudden change of refractive index close to the absorption lines can be shown by suitable optical arrangements. One method of producing this effect is based on the principle of crossed prisms used by Kundt, and consists in making the absorbing medium form a prism whose refracting edge is at right angles to the slit of the analysing spectroscope. An absorption line showing anomalous dispersion will then cause the continuous spectrum to bend sharply in opposite directions

on the two sides of the line. This method was employed by Wood in studying the anomalous dispersion of sodium vapor, the prism being formed by vapor enclosed in a horizontal steel tube heated from below, the upper portion being cooled.

According to a theory advanced by Julius, when anomalous dispersion is active, two vibrations of nearly the same period affect each other in such a way as to cause a mutual repulsion between the corresponding spectrum lines. It seemed possible to make laboratory tests which would set at least an upper limit to the amount of this effect. For this purpose, as well as to study the regular phenomena of anomalous dispersion, the writer has recently adapted the tube resistance furnace for the production of these effects. A beam of white light from a carbon arc outside the furnace chamber was passed through the furnace tube containing the metallic vapor to be studied. A strong density gradient in the vapor was produced by cutting away the upper portion of the tube and passing a water-cooled pipe above it. Examination under high dispersion with a plane-grating spectograph gave a means of studying the relative anomalous dispersion produced by different spectrum lines, and, by the use of mixed vapors in the furnace tube, to test the constancy of wave-lengths of lines when alone and when close to a line showing high anomalous dispersion given by another vapor.

A study of the iron spectrum over a considerable range of wave-length gave strong anomalous dispersion effects for those of the stronger lines which reverse easily in the arc and other sources. This feature appears to be general for the spectra which have been examined. It was found further that a certain temperature of the absorbing vapor is required to give the most efficient prism for a particular type of line. Thus the calcium line λ 4227 and the chromium lines λ 4254, 4275, 4290 can all be made to show very strong anomalous dispersion, but the best temperature for the calcium prism is lower than that for chromium. This can be well shown by mixing the two vapors and causing each in turn to show anomalous dispersion. When the temperature is adjusted to give maximum anomalous dispersion for chromium, the effect usually disappears for λ 4227 of calcium, leaving only a wide absorption line. In several experiments, however, a high temperature condition has given a curvature of the spectrum adjacent to λ 4227 in the opposite direction to that prevailing for the chromium lines at the same time, and also the reverse of what the calcium line itself shows at a lower temperature. This indicates an inversion of the prism of vapor producing λ 4227, due probably to the cooler vapor above giving the line more strongly than the highly heated region below.

The density of the absorbing vapor is necessarily a function of the temperature when plenty of the material is present. At a given temperature, the amount of anomalous dispersion is proportional to the vapor density, which alters the width of the absorption line, so that for special purposes the effect can be regulated by changing the amount of vapor. The reproduction shows the anomalous dispersion for the chromium lines λ 4254, 4275, 4290, the temperature being approximately 2500°C. in each case, with varying vapor densities.



ANOMALOUS DISPERSION OF CHROMIUM LINES WITH VARYING VAPOR DENSITY.

The tests on the mutual influence of spectrum lines were carried out by mixing titanium and calcium vapors with that of chromium. By this means, a titanium line was obtained separated by 0.21 Å from λ 4275 of chromium, while a calcium and a titanium line occur 0.36 Å and 0.65 Å respectively from λ 4290 of chromium. The titanium and calcium lines were thus well within the curved spectrum given by the strong anomalous dispersion of the chromium lines. The wave-lengths of the former, given as absorption lines under these conditions, were compared with their values when produced by the furnace as emission lines.

Twenty-seven spectrograms showing varying degrees of anomalous dispersion were measured. The titanium line separated by only 0.21 Å from the chromium line λ 4275 gave consistent measurements indicating an approach to the chromium line in the anomalous dispersion plates, the mean difference between the two sets of measures being 0.006 Å. It is questionable, however, whether this displacement is genuine, as the spreading of the strong chromium line weakened the continuous spectrum on one side of the titanium absorption line, which would probably affect the micrometer settings. The calcium line separated by 0.36 Å from λ 4290 of chromium showed an apparent approach amounting to 0.002 Å, to which the same source of error may apply. The line

of the set most favorable for accurate measurement was λ 4289.237 of titanium, 0.65 Å from λ 4289.885 of chromium. Measurements of this line from three different standards gave no difference larger than 0.001 Å and usually agreed exactly. It may be said, therefore, that the measurements have given no evidence whatever of a mutual repulsion between close lines when anomalous dispersion is active, such small apparent differences as were found being in the opposite direction.

The same lines were tested in the regular furnace spectrum under a dispersion of 1 mm. = 0.6 Å to see whether the presence of the strong chromium lines affected the wave-length of the close line of titanium and calcium. The latter were photographed with and without the mixture of chromium vapor. The calcium and one titanium line gave differences of 0.002 Å but these were opposite in direction and probably within the errors of measurement, while the other titanium line, closest of the three to a chromium line, agreed within 0.001 Å when titanium was used alone and when mixed with chromium.

The material in this investigation has been limited by the scarcity of suitable pairs of lines, as in addition to being separated by a small interval, the lines must be given strongly in the furnace spectrum and one of them must show high anomalous dispersion. The lines tested have filled these requirements and the measurements have at least shown no tendency toward a repulsion between such close lines under these conditions.

SYNTHESIS OF THE BASE $C_8H_{10}ON_2$ DERIVED FROM METHYL-AMINOMETHYL-3,4-DIHYDROXYPHENYLCARBINOL

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Received by the Academy, July 3, 1916

Some thirteen years ago Abel¹ found that when methylamino-methyl-3,4-dihydroxyphenylcarbinol, $3,4-(HO)_2C_6H_3CH(OH)CH_2NHCH_3$ (epinephrine, suprarenine, adrenaline, the substance known as the active principle of the medullary portion of the suprarenal capsules) is slowly added to nitric acid (density 1.2) an energetic reaction takes place and there are obtained as chief products oxalic acid and an unstable nitrogenous base in the form of a hygroscopic salt (probably the oxalate). With iodine trichloride this base gives a crystalline double compound which, although relatively stable, is also very hygroscopic, but with gold chloride is obtained a stable, beautifully crystalline chloroaurate. Abel analyzed this salt for carbon, hydrogen, nitrogen, gold and chlorine