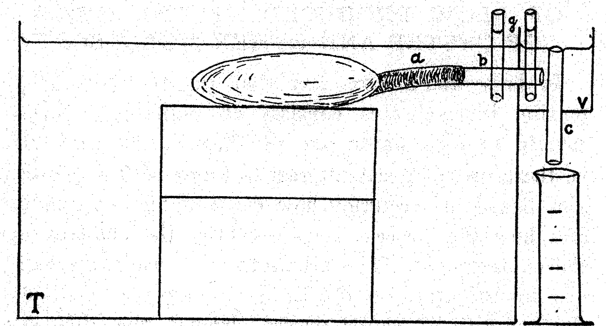
The difference may be maintained as long as the gill epithelium keeps on beating. Under optimum conditions the highest difference observed was 4 mm.



(2) To measure the rate of flow the same oyster is placed into a tray; the end of the rubber tube (a) is attached to a ⊥ tube, the upper end of which is connected to a funnel filled with a fine carmine suspension and the third end is connected with a glass tube of same diameter; the tube is 17 cm long and is graduated into cms. Releasing the clamp a very small amount of carmine suspension is added; it forms a distinct cone moving inside the graduated tube. The rate of movement of the apex of the cone is then measured. Since a distinct cone of carmine suspension is visible it may be assumed that in this case we have "stream line" or viscous flow to which the Poiseuille's formula

$$\mu = \frac{\pi g d^4 p}{128 L q} \qquad (1)$$

is applicable.

In this formula μ = viscosity in poises, g = acceleration of gravity, d = diameter and L = length of capillary tube, q = rate of flow in cc per second, p = difference in pressure between two ends of the tube. The maximum velocity is at the center of the tube; the average velocity of flow throughout the whole sectional area is then one half the maximum velocity. If the viscosity of water and dimensions of tube are known the pressure p may be calculated.

The experiments performed this summer on oysters show that the rate of flow is a function of temperature. It reaches its maximum at 25° C. and slows down with the decrease of temperature. Below 7.6° C. no current is produced, though the cilia are still beating. At 5° C. they come to a standstill. There is a considerable individual fluctuation in the rate of flow depending on the physiological conditions of the organism. A healthy adult oyster, three to four inches long, at temperature about 25° C. may take in water at a rate of 3,000 cc per hour. This is a maximum figure frequently observed during the experiments.

By using the "tank" method the discharged water can be easily collected and analyzed. Counting the microplankton in the tank water and in the discharged water I found that more than 99.5 per cent. of diatoms and dinoflagellates are caught by the gills. Water after having passed the gills contains almost nothing but mucus.

Taking in of water depends not only on ciliary motion of the gill epithelium, but also on opening and closing of the shell. To study this phenomenon the oyster is immobilized and one valve is connected to a recording apparatus with daily clock movement. Observations made during August and September, 1925, on more than twenty oysters show that at temperatures from 15° to 22° C. the daily period when the shells remain open averages twenty hours.

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SPECIAL ARTICLES

DISPLACED SERIES IN THE SPECTRUM OF CHROMIUM[1]

RECENT analyses of the complex spectra of the elements of the first and second long periods have classified hundreds of lines as combinations between numerous groups of terms. In only a few cases, however, have sequences or series of homologous terms been established, which are characterized by different values of the total quantum number. The explanation for this is to be found in the new theory of spectral terms which had its inception in recent work by Russell and Saunders[2] and was later developed into a practical theory by Hund.[3] These new ideas account for the low terms of a spectrum from the various possible ways of adding the azimuthal quantum numbers of the several valence electrons of the atom. The probability of the occurrence of corresponding terms with higher total quantum numbers is much less, with the consequence that the resulting spectrum lines are faint and inconspicuous.

In Fe a sequence of ^5D terms has been indicated by Gieseler and Grotrian,[4] and in Cr and Mo sequences of ^7S and ^5S terms have been used by Kiess[5] and by Catalan[6] for calculating series limits and ionization potentials. It is a striking fact that the

[1] Published by permission of the director of the Bureau of Standards.

[2] H. N. Russell and F. A. Saunders, *Astrophys. Journ.*, *61*, 38, 1925.

[3] F. Hund, *Zs. f. Phys.*, *33*, 345, 1925.

[4] H. Gieseler and W. Grotrian, *Zs. f. Phys.*, *25*, 165, 1924.

[5] C. C. Kiess and H. K. Kiess, SCIENCE, *56*, 666, 1922; C. C. Kiess, *Sci. Papers, Bur. Standards*, *19*, 113, 1923.

[6] M. A. Catalan, *Anal. Soc. Esp. Fis. Quim.*, *21*, 84, 1923.

few series-forming P and D terms of Cr and Mo are characterized by small term separations as compared with the much larger $\Delta\nu$'s separating the components of the many other terms which give rise to the ordinary multiplet groups found in Cr and other complex spectra. But small separations of arc terms can occur only when the generating spark term is single. The analysis of the spark spectrum of Cr, which is being made at the Bureau of Standards, has indicated the existence, among others, of a low and widely separated ^6D term and a somewhat higher ^4D term. But these could not be made responsible for the series-forming terms of Cr I.

Theoretically the following low terms may be expected in Cr II:[7]

three 3_3 and two 4_1 electrons: ^4F, ^4P, . . .
four 3_3 and one 4_1 electrons: ^6D, ^4D, ^4H, . . .
five 3_3 electrons: ^6S, ^4G, . . .

Since the two series-forming terms ^7S and ^5S of Cr I must be accounted for by the configuration of five 3_3 and one 4_1 electrons, the assumption seems justified that the higher terms of the series result from the configuration of five 3_3 and one 5_1 electrons; or, in other words, that they are built up on a ^6S term.

Since these terms of Cr I which are built up on the hypothetical ^6S term lie lower than those built up on ^6D, we concluded that ^6S would lie lower than the known ^6D term. A preliminary search through the known wave lengths of Cr II for a strong triplet showing the characteristic $\Delta\nu$'s, 141.0 and 92.2, of ^6P (known from the multiplet ^6D–^6P already published[8]) was without success.* We then estimated the position of ^6S as follows: Since $\infty\ ^7S$ and $\infty\ ^5S$ coincide with ^6S, we must find a series which converges to ^6D, that is, we must find a term ^5D (five 3_3, one 4_1, and one 5_1 electrons) which is the second member of the series beginning with the very prominent low ^5D term (five 3_3 and two 4_1 electrons). Such a term has been recognized from its position and $\Delta\nu$'s among the several unprimed ^5D terms, which the analysis of Cr I has yielded.[9] The following numerical values will suffice, calling the normal state of the atom zero:

$$4\,^7S_3 = 0$$
$$\infty\ ^7S_3 = 56000$$
$$4\,^5D_4 = 8308$$
$$5\,^5D_4 = 48824$$

From Rydberg's table of the function $R/(m+a)^2$ we find that

$$4\,^5D_4 - \infty\ ^5D_4 = 60420$$

whence $4\,^7S_3 - \infty\ ^5D_4 = 60420 + 8308 = 68730$

and $\infty\ ^7S_3 - \infty\ ^5D_4 = 68730 - 56000 = 12730$

or, stated in words, the limits of the ^7S series and the ^5D series differ by 12730 cm^{-1} ($\pm$1000 cm^{-1}). This means that $^6S_3$ of Cr II lies 12730 ν units lower than ^6D. The group $^6D-{}^6P$ lies at wave length 2750A or $\nu = 36400$. The resonance triplet should, therefore, lie at $^6S-{}^6P = 49130$, or at approximate wave length 2035A.

The spectrum of the Cr spark was photographed by Mr. D. D. Laun, of this laboratory, with a large type E Hilger quartz spectrograph, the plate being an Eastman 33 coated with Nujol. An intense triplet was found in the region indicated. Measurement of the plate using as standards the Cu spark spectrum gave the following wave lengths:

λ. I A.	ν	Δν
2055.51 (8)	48634.08	
		141.29
2061.50 (7)	48492.79	
		92.26
2065.43 (6)	48400.53	

The $\Delta\nu$'s are identical, within the errors of measurement, with those resulting for ^6P from the multiplet $^6D-{}^6P$. Hence the normal state of Cr^+ is ^6S (five 3_3 electrons), thus necessitating a correction of an earlier tentative statement[10] that this state is represented by ^6D. The difference between $^6S_3$ and $^6D_5$ proves to be 12498 cm^{-1}.

It appears to be a general rule, which we have verified in several other spectra, that in all the relatively prominent series it is the s-electron that is excited and thrown to higher n_1 states. The s-electrons penetrate even into the K-shell without undergoing such irregular disturbances as may affect n_3 electrons and may cause anomalies similar to Wentzel's "broken series."[11] The fact that the Rydberg series formula is usually so well represented is evidently a consequence of this. As a further consequence we

[7] Compare Hund's paper, *l.c.*, esp. page 354.

[8] W. F. Meggers, C. C. Kiess and F. M. Walters, *J. O. S. A.*, and *R. S. I.*, *9*, 355, 1924; esp. page 368.

[9] We do not agree with the series arrangement for Cr, which was published by H. Gieseler, *Zs. f. Phys.*, *22*, 228, 1924. A second ^5D term, which is regarded as a higher series member, is apparently unreal.

* NOTE.—Since this paper was written we have found that approximate wave lengths for these lines have been measured by McLay; *Trans. Roy. Soc. Canada*, *17*, 137, 1923.

[10] Meggers, Kiess, Walters, *l.c.*

[11] G. Wentzel, *Zs. f. Phys.*, *19*, 53, 1923.

may predict in the following tables the normal states for the neutral and ionized atoms of the first and second long periods, by taking away successively one n_1 electron.

Our table for the first spark spectra deviates from that of Hund,[12] but it is a consequence of our general principle. Experiments extending these principles to Mo and W are being carried on.

NORMAL STATES OF ELEMENTS OF THE FIRST AND SECOND LONG PERIOD

	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn
I	${}^2D$	${}^3F$	${}^4F$	${}^7S$	${}^6S$	${}^5D$	${}^4F$	${}^3F$	${}^2S$	${}^1S$
II	${}^3D$	${}^4F$	${}^5F$	${}^6S$	${}^7S$	${}^6D$	${}^5F$	${}^4F$	${}^1S$	${}^2S$
III	${}^2D$	${}^3F$	${}^4F$	${}^5D$	${}^6S$	${}^5D$	${}^4F$	${}^3F$	${}^2D$	${}^1S$

	Y	Zr	Cb	Mo	EkaMn	Ru	Rh	Pd	Ag	Cd
I	${}^2D$	${}^3F$	${}^6D$	${}^7S$	${}^6D$	${}^5F$	${}^4F$	${}^1S$	${}^2S$	${}^1S$
II	${}^3D$	${}^4F$	${}^5D$	${}^6S$	${}^5D$	${}^4F$	${}^3F$	${}^2D$	${}^1S$	${}^2S$
III	${}^2D$	${}^3F$	${}^4F$	${}^5D$	${}^6S$	${}^5D$	${}^4F$	${}^3F$	${}^2D$	${}^1S$

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THE PERFECT STAGE OF CYLINDROSPORIUM POMI[1]

DURING the spring of 1924 an ascomycete was discovered upon overwintered apple leaves in Adams County, Pennsylvania. When cultured it showed the characteristic conidial fructification of *Cylindrosporium Pomi* Brooks, the cause of apple fruit spot. The similarity in growth of the two organisms on agar media was so striking that plans were at once made to determine by inoculation experiments whether they were the same.

Single ascospore isolations were made and the resulting conidia were used as inoculum on Stayman, Winter Banana, Baldwin and Grimes Golden varieties of apples, and also upon quince. Atomized inoculations were made both within special chambers attached to the twigs and in the open, from three to six exposures being made successively on different fruits at varying intervals from June 26 to July 28. The results were successful upon Baldwin, Grimes Golden and Stayman but inconclusive upon Winter Banana and Quince, since on the former only three spots developed and the quinces rotted on the tree. The check apples were free of the disease. Isolations made from the artificially infected fruits resulted in all cases in the recovery of the identical organism used as the inoculum.

In 1925 more extensive studies were planned. Fresh isolations from ascospores were again made and the development and formation of the conidia studied confirming further the proposition that we were dealing with the organism described by Brooks and Black.[2]

A series of inoculations at two-week intervals were made upon Grimes Golden apples, beginning June 17 and continuing to October 1, using five conidial cultures from different sources. Another set of inoculations were made upon quince fruits. The check fruits were atomized with sterilized water at the same time and under the same conditions that the inoculum was applied. The results upon the apple have been most satisfactory in confirming the positive results obtained in 1924. Up to September 28 positive infection resulted from the first four series of inoculations on apples. The first infections occurred within the chambers about six weeks subsequent to the first inoculation, while those made outside the chambers took nearly three months, indicating that moisture may hasten infection and the subsequent development of the disease. Re-isolation of the organism has been made in all cases, and its cultural characters check with the original cultures used as inoculum. The check apples, those not atomized with the inoculum, were perfectly free from the disease.

The results on quince are somewhat doubtful, since a few of the checks showed considerable spotting. However, since the infected checks were close to the inoculated fruits, while those more removed were free, it seems probable that the questionable checks were accidentally atomized with the inoculum. The fruit spot organism was recovered from both infected checks and inoculated fruits.

The writers believe they have discovered the perfect stage of *Cylindrosporium Pomi.* The perithecia are abundant on both surfaces of overwintered leaves. They are frequently but not always grouped: black in color, measuring 70–100 microns in diameter. The asci are approximately 8–10 by 40–66 microns, containing eight 2-celled spores measuring 2.8–4.2 by 12.6–26.6, averaging 3.5 by 18.8 microns. It is quite certainly a Mycosphaerella agreeing most nearly with the description of *M. Pomi* Passer.

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[12] *l.c., vide* page 361.

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[2] *Phytopath.,* 2: April, 1912.