derived from a (+) and from a (−) mycelium respectively.

6. When two sporidia of the *same* sex—that is, two (+) sporidia or two (−) sporidia—are sown close together on a Sunflower leaf so that the two pustules arising from the two infections soon coalesce, the two monosporous mycelia come into contact but do not interact sexually, and therefore do not give rise to any aecia.

7. The belated aecia, which appear at the end of about three weeks on pustules of monosporidial origin or on pustules of bisporidial origin where presumably the two sporidia are of one and the same sex, probably arise without any hyphal fusions.

8. In any heterothallic Rust fungus that behaves like *Puccinia helianthi* there is a possibility of two strains of the same species being crossed by means of the union of their monosporidial mycelia within the tissues of one and the same host-plant.

A few experiments have already been made by sowing the sporidia of *Puccinia graminis* on the leaves of the Barberry. The results, so far as they have gone, appear to be similar to those already described for *Puccinia helianthi*.

In conclusion, I desire to acknowledge valuable assistance derived from consultation with Prof. A. H. Reginald Buller.

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The Dominion Rust Research Laboratory,
Winnipeg, May 25.

Eigenvalues and Whittaker's Function.

AMONG those who are trying to acquire a general acquaintance with Schrödinger's wave-mechanics there must be many who find their mathematical equipment insufficient to follow his first great problem —to determine the eigenvalues and eigenfunctions for the hydrogen atom. I do not think it is generally realised that Schrödinger's differential equation for this problem is one which is fully treated in a standard text-book, Whittaker and Watson's "Modern Analysis," Chapter xvi. (I quote from the second edition). It would seem that advantage may be taken of this to make the treatment easier for English readers. I realise that the following is only a slight redressing of Schrödinger's method; but I think it will be intelligible to some who have been unable to appreciate the original, and that it gives a useful idea of the genesis of eigenvalues.

Having set $\psi = \chi(r)S_n$, where S_n is a spherical harmonic of integral order n, Schrödinger shows that his wave-equation gives:

$$\frac{d^2\chi}{dr^2} + \frac{2}{r}\frac{d\chi}{dr} + \left(\frac{8\pi^2 mE}{h^2} + \frac{8\pi^2 me^2}{h^2 r} - \frac{n(n+1)}{r^2}\right)\chi = 0, \quad (1)$$

and he seeks solutions which shall be finite for all values of r including 0 and ∞.

Writing $u = r\chi$, this becomes:

$$\frac{d^2u}{dr^2} + \left(\frac{8\pi^2 mE}{h^2} + \frac{8\pi^2 me^2}{h^2 r} - \frac{n(n+1)}{r^2}\right)u = 0.$$

Change the unit of r by writing:

$$r_1 = r\sqrt{\left(\frac{-32\pi^2 mE}{h^2}\right)}.$$

The equation then takes the standard form:

$$\frac{d^2u}{dr_1^2} + \left(-\tfrac{1}{4} + \frac{l}{r_1} + \frac{\tfrac{1}{4} - (n+\tfrac{1}{2})^2}{r_1^2}\right)u = 0, \quad . \quad (2)$$

where

$$l = \sqrt{\left(\frac{-2\pi^2 me^4}{h^2 E}\right)}. \quad . \quad . \quad . \quad (3)$$

The general solution of (2) is (W. and W., § 16·31):

$$u = AW_{l,n+\frac{1}{2}}(r_1) + BW_{-l,n+\frac{1}{2}}(r_1),$$

where W is Whittaker's function. It is here sufficien to consider the solution $u = W_{l,n+\frac{1}{2}}(r_1)$. The asymptotic expansion for W (*loc. cit.* § 16·3) gives:

$$u \sim e^{-\frac{1}{2}r_1}r_1^{l}\left\{1 + \sum_{p=1}^{\infty}\frac{\{(n+\frac{1}{2})^2-(l-\frac{1}{2})^2\}\{(n+\frac{1}{2})^2-(l-\frac{3}{2})^2\}\ldots\{(n+\frac{1}{2})^2-(l-p+\frac{1}{2})^2\}}{p!\,r_1^p}\right\}. \quad (4$$

We see at once that u vanishes at $r_1 = \infty$, and the only danger of divergence is at $r_1 = 0$. We notice further that the cases in which

$$n + \tfrac{1}{2} = l - \tfrac{1}{2}, \quad l - \tfrac{3}{2}, \quad l - \tfrac{5}{2}, \ldots$$

i.e. when

$$l = n+1, \quad n+2, \quad n+3, \ldots \quad . \quad . \quad (5$$

present an exceptional feature. For if $n + \frac{1}{2} = l - p + \frac{1}{2}$, the last factor in the numerator of $1/r_1^p$ vanishes, and this zero factor is repeated in every succeeding term. The series thus terminates, and the expansion accordingly becomes exact. The final term in u is then $e^{-\frac{1}{2}r_1}r_1^{l-p+1}$ or $e^{-\frac{1}{2}r_1}r_1^{n+1}$, so that the final term in χ is $e^{-\frac{1}{2}r_1}r_1^{n}$. Hence χ is finite at the origin, and the values (5) are the required eigenvalues. The corresponding energy values $-E$ are then given by (3). The expression (4) gives the eigenfunctions.

A. S. EDDINGTON.

Use of Carbon Dioxide in a Mercury Interrupter.

IT is customary to use coal gas as a dielectric in the mercury interrupter and it has generally been found to be quite satisfactory in action. There are, however, places in the country where coal gas is not available, and the following experiments were undertaken with the view of examining the possibility of employing carbonic acid gas used in connexion with X-ray work carried out in hospitals at such places.

Carbonic acid gas is available in cylinders at many places, and, being an inert gas, it naturally suggests itself as a very useful substitute for coal gas. It is, however, necessary to examine the efficiency of the interrupter using carbonic acid gas by comparing it with that using coal gas and also hydrogen. Since the most important function of the dielectric is to extinguish the flame, it is necessary to examine its action when it is employed in an interrupter in two different circumstances; in one case, when the primary of the induction coil is connected up straight to the source of electric power which gives just sufficient potential difference in the primary to obtain the desired E.M.F. in the secondary, and in the second case, when the primary draws current from the supply mains through a large rheostat which regulates the current in the primary to yield the desired E.M.F. in the secondary.

It is obvious that the two cases are different. In the first case, the sparking inside the interrupter is considerably less than in the second case, where the whole potential difference of the supply mains is effective in producing the spark at the break.

The experimental work for each gas was consequently divided up into two parts. In the first part the power to the primary was supplied from a potentiometer device connected up to the 230 volts D.C. mains, and in the second, the primary was connected to the mains through a rheostat.

The length of the spark-gap was taken to indicate the magnitude of the voltage generated in the secondary. The current drawn by the primary could be read off from an ammeter placed in series with it (see Fig. 1). The same experiments were repeated with an X-ray tube connected up with the secondary with a milliammeter in series (see Fig. 2).

In the second part of the experiment the primary