DISCUSSION AND CORRESPONDENCE

EXPERIMENTAL CONFIRMATION FOR SOMMERFELD-FERMI-DIRAC DEGENERATE GAS THEORY OF CONDUCTION ELECTRONS

SOME preliminary results of a study of the Compton modified line structure at this institute confirm the Sommerfeld theory of conduction electrons in metal crystal lattices.

This theory based on the Fermi-Dirac theory and the Pauli exclusion principle predicts a much broader range of velocities for the conduction electrons than is to be expected on the classical kinetic theory. A very appreciable proportion of the conduction electrons in this theory should indeed have speeds considerably exceeding the orbital speeds of the outer electrons in isolated atoms of the same metal. This is a result of the application to the conduction electron gas of the Pauli exclusion principle originally conceived to apply to electrons in single atoms. According to this principle the phase space is to be divided into cells of volume h^3 in each of which the presence of one electron precludes the entrance of any other electron. In other words for a one dimensional case the fact of an electron possessing a velocity, v, prevents neighboring electrons from possessing any adjacent velocity, the range of exclusion in velocity being inversely proportional to the separation in space of the electrons. For a completely degenerate gas (*i.e.*, one in which all the lowest phase cells are filled with electrons) it is evident that even at low temperatures this exclusion principle requires high velocities for some of the electrons. The electrons are uniformly distributed as to velocities up to a maximum velocity beyond which there are no electrons if one neglects a slight shading at this velocity boundary due to temperature. This critical velocity boundary is shown by Sommerfeld to be proportional to the cube root of the electron density in space.

The breadth and structure of the Compton modified scattered X-ray line is intimately connected with the speeds of the electrons which scatter the X-radiation in much the same way as the Doppler broadening of optical lines. A line structure can be computed for any given distribution of electron velocities. It has been found in the interpretation of our experimental results that a line structure computed on the basis of the above-mentioned Fermi-Sommerfeld theory accords with the experimentally found line structure much better than one computed on the assumptions either that the conduction electrons have classical thermal equipartition of energy or that they have the velocities they should have in the external orbits of free atoms far removed from neighboring atoms. Aluminium and beryllium have been studied, the results being most striking in the case of beryllium, where probably two out of the total of four electrons per atom are in the above-mentioned degenerate gas state.

JESSE W. M. DUMOND
NORMAN BRIDGE LABORATORY OF PHYSICS,
CALIFORNIA INSTITUTE

A READILY DETECTABLE SIGN OF OVULATION IN THE MONKEY

IT appears certain from the work of Corner[1] that a female monkey may menstruate with or without ovulating. There are, therefore, two types of menstruation: namely, one that is preceded by ovulation, the formation of a corpus luteum, and the building up of a typical "premenstrual" endometrium; and the second type (which R. Schröder wishes to designate as "pseudomenstruation") consisting of a similar periodic bleeding not preceded by ovulation or corpus luteum formation and issuing from a uterus in the resting stage. Hitherto it has been possible to differentiate between these two types only by removal of the organs and studying them histologically or by inspection of the ovaries and uterus during laparotomy.

A sign of ovulation, readily applied to the living intact animal would, therefore, be welcome—not only for differentiating the two types of menstruation and furthering the study of menstrual phenomena in other ways, but also for aid in securing timed embryological material. Such a test we believe we have found in the recovery of small numbers of red blood cells in lavages or douches made from the monkey vagina after a technique described in April, 1928.[2] The procedure consists of washing out the vagina with a pipette containing a standard quantity of physiological salt solution, diluting the lavage with six times the quantity of 1:12,000 methylene blue made up in salt solution instead of distilled water, and studying this final mixture in a blood-counting chamber under the microscope. The observations upon which this new sign of ovulation is based are the following:

For some time it was noticed that on the day after copulation in certain animals, when the vagina of the mated female was examined for spermatozoa, a few red blood cells were found among several thousand cornified cells and leucocytes recovered from the lumen of the vagina. The number of red blood cells thus recoverable are so few that they would never be discovered in smear preparations made in the usual way.

[1] Geo. W. Corner, 1923, *Contrib. to Embryol.*, Vol. 15; also 1927, *Jour. Am. Med. Assn.*, 89: 1838–40.

[2] Carl G. Hartman, 1928, *Am. Jour. Obst. and Gyn.*, 38: 61–71.