nosity of the vapor travels away from the anode at the rate of 1.7 (10^5) cm per second during the first 2 (10^{-7}) sec after breakdown. We also have obtained actual photographs of the initial stages of single sparks *with exposure times as short as* 4 (10^{-8}) sec. These snapshots of the beginnings of single sparks show that a current of 1600 amperes is carried by a filament of cross-section 5 (10^{-4}) sq. cm at the anode which gradually widens out to a cross-section of 2 (10^{-3}) cm at the cathode. *Thus the current density in the discharge attains the enormous magnitude of* 3 (10^6) *amps per sq. cm.* This great current density produced the great brilliance of the spark as a light source which made possible the photography of the spark with the short exposures mentioned above.

It seems probable that the above recorded velocity of spreading of the spark luminosity from the anode really measures the velocity of the positive ions. Assuming this to be the case and that the positive ions carry one half the discharge current, *it is calculated from the cross-section of the discharge that about 30 percent of the molecules and atoms in the discharge are ionized.* This result is in striking agreement with the above estimate of the ionic density evaluated from the broadening of the spectrum lines. These calculations have not taken into account certain factors and therefore are approximate but certainly right in order of magnitude. Perhaps it does not seem valid to assume that the positive ions carry as much of the discharge current as the electrons because of the greater speeds of the latter carriers. This objection appears less serious when it is pointed out that the magnetic field produced by the discharge itself reaches the magnitude of 40,000 Gauss and therefore that the electrons are confined to spiral paths of very small radii in such a manner that their velocity of migration to the anode is diminished considerably.

Finally, we should like to mention that two of our photographs of early stages of sparks show off-shoots from the main filament of the discharge which remind one of Wilson cloud photographs of alpha-particle tracks. Because the off-shoots in both cases are bent towards the cathode the possibility is suggested that they are due to regions of ionization initiated by high velocity positive ions ejected from the main filament of the discharge.

Ernest O. Lawrence
Frank G. Dunnington
University of California,
December 11, 1929.

The Effect of Second Order Zeeman Terms on Magnetic Susceptibilities: Errata.

Due to a previous arithmetical error, the theoretical Bohr magneton numbers given in Table I of our note in the preceding (December 1) issue should read 3.68, 2.83, 1.66 and 3.53 for Nd^{+++}, Ill^{+++}, Sm^{+++}, and Eu^{+++} respectively instead of 3.69, 2.87, 1.83 and 3.56. There is no change in the balance of this Table or in Table II. This revision is seen to be appreciable only for Sm^{+++}, and here improves the agreement with experimental values (1.54, Cabrera, or 1.32, St. Meyer) so that the situation for the whole rare earth group is now quite satisfactory. The first sentence of the last paragraph in our previous note obviously relates to the iron rather than rare earth group.

J. H. Van Vleck
A. Frank
University of Wisconsin,
December 13, 1929.

Electron Emission by Metastable Atoms

It has been shown recently by Oliphant [Proc. Roy. Soc. **A124,** 793 (1919)] that helium metastable atoms cause a secondary electron emission when they strike a negatively charged target. Uyterhoeven [Proc. Nat. Acad. Sci. **15,** 32–37, (1929)] has observed that the currents to a negative probe in neon are greater than those calculated from the observed sheath thickness. This could be accounted for by the assumption that a portion of the current measured was due to secondary emission by metastable neon atoms. The writer (Science **68,** 598, 1928) has also reported observations with a negative probe in neon which can be accounted for by a secondary electron emission from the probe. More recent experiments in this laboratory (which will be reported shortly by Found and Lowe) indicate this secondary emission is due to metastable atoms.

There is considerable difficulty in separating the currents due to positive ions from that