density vector. The effect of temperature nonequilibrium effects can change the magnitude and direction of the current density vector. The effects of temperature nonequilibrium on the electrical current distribution of a low pressure arc discharge in the presence of a transverse magnetic field is also presented. Qualitative theoretical considerations indicate that temperature nonequilibrium in the cathodic arc region of the low pressure arc discharge induces a reversal of radial current on the retrograde side of this region. High-speed films are presented on the magnetically induced motion of a low pressure arc discharge between concentric cylindrical electrodes. The observed changes in arc shape, arc rotational speed, and the phenomenon of the arc progressing from Lorentz to retrograde rotation with reduction in chamber pressure can be understood as the results of the interaction between the applied magnetic field and the electrical currents induced by temperature nonequilibrium.

* Work supported in part by National Science Foundation Grant GK-904.

EC5. Free-Space Microwave Scattering by a Plasma Cylinder with Time-Dependent Electron Density.* S. C. BLOCH and J. E. TURBEVILLE, *University of South Florida*—Experimental results are presented for the scattering of low-power, continuous wave, electromagnetic waves at X-band from Hg-vapor plasma cylinders with time-dependent electron density. The plasmas were contained in quartz or pyrex tubes and sustained by a 14.14 MHz field which could be amplitude-modulated from 200 Hz to 2 KHz. The electric fields of the incident microwave and discharge fields were parallel to the cylinder axis, in order to avoid Tonks-Dattner resonance phenomena. The phase and amplitude of several spectral components of the transferred modulation on the microwave signal were studied as functions of scattering angle and modulation frequency, and correlated with the phase and amplitude of the modulation on the 5460.74 Å emission line from neutral Hg atoms; plasma diagnostics were performed with a microwave interferometer and double Langmuir probes.

* Research supported by the National Science Foundation under Grant GA-667, and by the University of South Florida Research Council.

EC6. Langmuir Probe Measurements in a N_2-CO_2-He Laser. CHARLES CASON, *U. S. Army Missile Command, Redstone Arsenal*—Single Langmuir probe current-vs-voltage characteristic curves have been collected from a flowing N_2-CO_2-He CW laser. A 2 inch ID tube supporting a 10 feet long dc discharge was used with hole output coupling. Total gas pressures were always below 1 Torr. Output power-vs-component gas composition and discharge tube current curves were taken. Electron temperatures obtained by the semi-log plot method were compared at optimum and off optimum output power points. At a mixture ration of 0.1 Torr N_2 and 0.1 Torr CO_2 and 0.07 Torr He, the electron temperature remains consistent at 2.5 eV while the electron density, of the order of $10^{10}/cm^3$, increased as the tube current was increased from 15 to 150 ma. For this gas mixture, the optimum output power of 3 W was obtained at 100 ma. Large excursions in the probe current, of the order of 20%, were noted when the laser was loss-modulated at about 8 cps with a rotating sector disk. The author wishes to acknowledge Dr. T. E. Horton's valuable discussions and Mr. Herb Ruge's and Mr. Bill Gurley's assistance in performing the experiments.

EC7. The Interaction of S-band Microwaves with Plasmas Contained in Microwave Noise Tubes. JACK COPELAND and STANLEY T. NOLAN, *University of South Alabama*—An experimental investigation of the interaction of S-band microwaves with plasmas contained in microwave noise tubes has uncovered a complex absorption spectrum in hydrogen and helium discharge tubes with variations of several db as a function of frequency, with definite maxima and minima some tens of megacycles apart. There is also a frequency sensitive interaction whereby the microwave energy passing through the plasma causes a marked variation of the plasma conductivity. The experimental arrangement and results will be presented.

EC8. Discussion of Microwave—Noise Tube Interaction. STANLEY T. NOLAN and JACK COPELAND, *University of South Alabama*—A discussion of the experimental results of the preceding paper will be presented. Exact mechanisms for the production of such spectra are apparently unknown at present. Comparison of the results will be made between the experimental results and plasma oscillations, Dattner[1] resonances, and high quantum transitions[2] for the various gases.

[1] A. Dattner, Phys. Rev. Letters, *10*, No. 6, 205 (Mar. 1963).
[2] N. S. Kardashev, Astro. Zhurnal, *36*, No. 5, 838-844 (Sept.-Oct. 1959).

EC9. Stabilization of a Curved Guiding Plasma for Relativistic Electron Beams. THOMAS A. BARR, JR., THOMAS G. ROBERTS, *U. S. Army Missile Command, Redstone Arsenal,* **and WILLARD H. BENNETT,** *N. C. State University at Raleigh*—A curved linear pinch has been used to produce a plasma column for guiding very intense pulses of relativistic electrons. To perform these experiments it was necessary to produce a curved plasma column which was stable during the time of passage of the beam, and for future work it was required that the plasma column remain stable after the passage of the beam. A simple method for producing such a plasma column was devised by arranging the return conductors so that the discharge is partially back-strapped. The experimental results of the improvement in stability obtained by properly arranging the return conductors about the pinch tube and the results of theoretical calculation of the magnetic fields in the curved portion of the pinch tube will be given.

Session ED

THURSDAY MORNING AT 9:00

Conference 3
(J. MILLER, presiding)

General Physics and Lasers

ED1. Energy Straggling by Alpha Particles, Protons, and Other Heavy Charged Particles in Homogeneous Absorbers. M. G. PAYNE, *Berea College*—Theories by Vavilov and Symon enable one to calculate the energy spectrum of heavy charged particles until the mean energy is reduced to about one-half of its initial value. At larger pathlengths all previous theories begin to fail. In the present work a theory has been developed which enables one to calculate the spectrum accurately for partlengths which are large enough so that Vavilov's parameter κ is larger than .5. At non-relativistic energies this means that alpha particles must have their mean energies reduced by more than .5% and K-mesons must have theirs reduced by more than 3% for the theory to apply. The theory neglects multiple scattering and charge exchange, but makes only general assumptions about the functional form of the energy loss cross section. If one uses a form of the energy loss cross section which neglects both inner shell corrections and relativistic effects he can extend the theory to arbitrarily small pathlengths at the expense of losing some accuracy at large pathlengths. Another theory has been developed for alpha spectra with mean energy below 1 Mev. This theory includes electron capture and loss and agrees with experimental data collected by Bortondi and Geiger.

ED2. Magnetic Suspension Microbalance.* J. W. BEAMS, *University of Virginia*—The force on a ferromagnetic body freely suspended in an axial magnetic field H is equal to the magnetic moment M of the body multiplied by the gradient of the field. In a magnetic suspension balance previously described[1] both M and the gradient of H are varied simultaneously. In this experiment M is held constant and the gradient of H alone is varied. Two methods of accomplishing this are described. One employs three air core solenoids and the other two solenoids and permanent magnets. The change in the mass of or force on the suspended body is a linear function of the change in the current through two of the solenoids which are connected in series in such a way as to produce only the gradient of H. Changes in the mass of or force on the suspended body of one part in 10^6 can be measured. Its uses for determining small masses of or forces on a body suspended in a vacuum, under liquids etc. are described. A possible use for the accurate determination of the electron charge is discussed.

* Supported by Army Office of Research—Durham and U. S. P. H. Grant GM 10522-06.
[1] J. W. Beams, C. W. Hulburt, W. E. Lotz, Jr. and R. Montague, Jr., Rev. Sci. Instr. *26*, 1181 (1955).

ED3. Mass Discrimination At Low Energies In Ilford G-5 Emulsions. DUANE ALLEN LARSON, *Auburn University*—The merits of a new method of mass discrimination at low energies in Ilford G-5 emulsion are investigated experimentally. The method consists of using a filar micrometer to measure the maximum deviation of the particle track from a straight line of constant length forming a chord at the end of the track. It is shown that the experimental data taken may be closely approximated by two Maxwell-Boltzmann distributions. This suggests that on a statistical basis alpha particles and singly ionizing particles may be distinguished.

ED4. Energy Loss of Alpha Particles through Gases. J. J. RAMIREZ, R. M. PRIOR,* and R. A. BLUE, *University of Florida*—Measurements of the energy straggling of alpha particles through helium, air, argon, krypton, and xenon have been made for incident alpha energies between 2 MeV and 4 MeV. These measurements were compared with the thoretical results of Bohr, Lewis, and Titeica. None of the theories give satisfactory fits to the data, giving at best predictions within an order of magnitude of the experimental results. Capture and loss of electrons is a significant effect at these energies. The neglect of this effect and of the exact energy shell corrections, as opposed to an average shell correction, is believed to be the reason for the failure of these theories. Values of the stopping power for the alpha particles were also obtained. These were found to be in good agreement with the proton energy loss measurements after the usual corrections for mass and charge difference were made.

* Present address: University of Notre Dame.

ED5. Analysis of Response Data for Organic Scintillators. R. L. CRAUN and D. L. SMITH, *Redstone Arsenal*—Previously measured P/B ratios (anthracene, stilbene, NE-213, NE-102, and pilot B) and d/B ratios (NE-230)[1] have been analyzed using the "exciton" theory of Birks.[2] A computer search code was developed to permit study of least-square fits of the function:

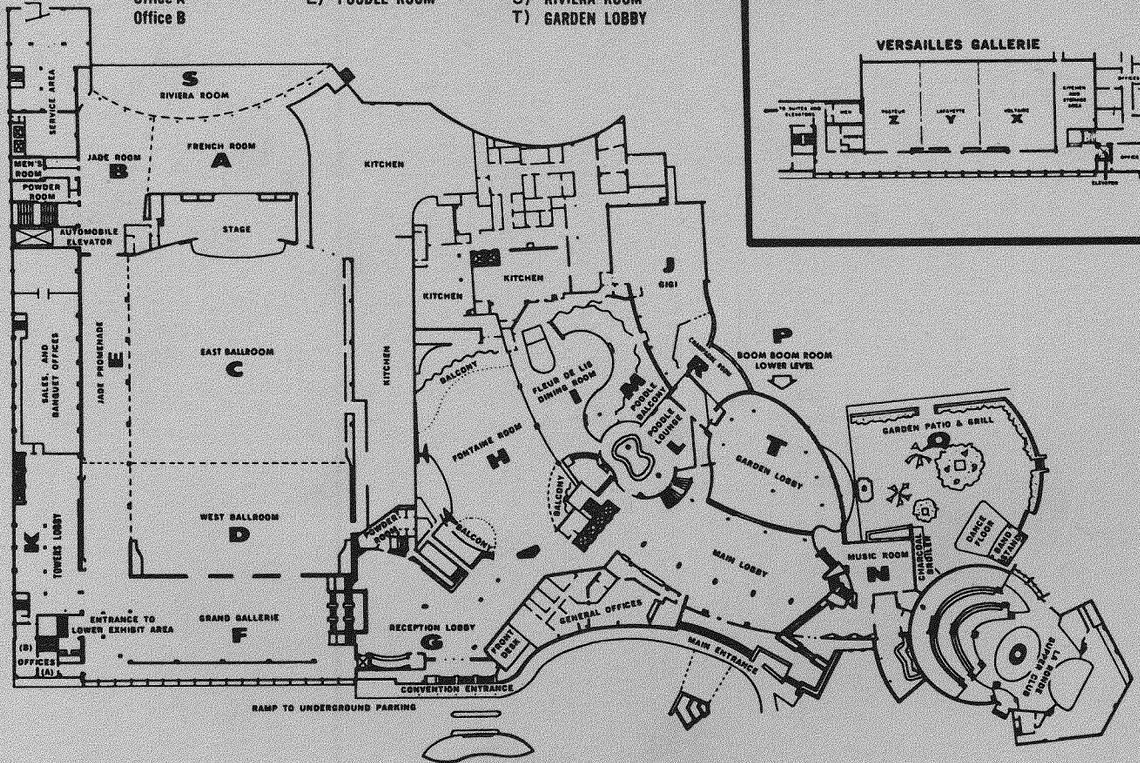
$$S(E) = \int^{E}_{0} \{ A/[1 + \lambda(dE/dx) + C(dE/dx)^2] \} d\epsilon$$

where A, λ and C are adjustable parameters and values of dE/dx were computed from available data.[3] The scaling parameters A were deduced from electron data for which $dE/dx \approx 0$. The best fits to the data were obtained by permitting the code to search λ and C

bulletin
OF THE AMERICAN PHYSICAL SOCIETY

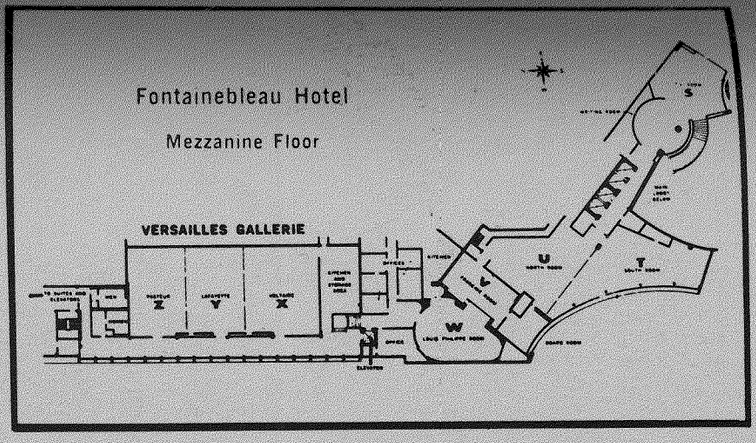
INCLUDING THE PROGRAM OF THE
1968 WINTER MEETING IN SAN DIEGO
18-20 DECEMBER 1968

A) FRENCH ROOM
B) JADE ROOM
C) EAST BALLROOM
D) WEST BALLROOM
E) JADE PROMENADE
F) GRAND GALLERIE
Office A
Office B
G) RECEPTION LOBBY
H) FONTAINE ROOM
I) FLEUR DE LIS DINING ROOM
J) GIGI
K) TOWERS LOBBY
L) POODLE ROOM
M) POODLE BALCONY
N) MUSIC ROOM
O) LA RONDE
P) BOOM BOOM ROOM
Q) GARDEN PATIO
R) CHAMPAGNE ROOM
S) RIVIERA ROOM
T) GARDEN LOBBY



COLLINS AVE. AND FONTAINEBLEAU YACHT BASIN

PUBLIC SPACING – MAIN FLOOR
FONTAINEBLEAU
MIAMI BEACH
ROOMS, LOBBY LEVEL



ROOMS, MEZZANINE

S) T.V. ROOM
T) SOUTH ROOM
U) NORTH ROOM
V) FRANCINE ROOM
W) LOUIS PHILIPPE ROOM
X) VOLTAIRE ROOM
Y) LAFAYETTE ROOM
Z) PASTEUR ROOM