

# Langmuir Probe In Theory And Practice

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Electric Probes in Stationary and Flowing Plasmas  
Electrical Probes for Plasma Diagnostics  
Fundamentals of Plasma Physics  
Langmuir Probe Theory and Analysis  
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Theory of Spherical and Cylindrical Langmuir Probes in a Collisionless, Maxwellian Plasma at Rest  
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Probe Measurements on the P-4 System in Single Cathode Operation  
Theory of the Resonance Probe  
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U.S. Government Research & Development Reports  
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The Stagnation-point Langmuir Probe in a Shock Tube--theory and Measurements  
Radio Science Documentation of Plasma Physics. Pt. 1, Experimental Plasma Physics [and] Theoretical Plasma Physics  
A Theoretical and Experimental Investigation of Langmuir Probes in a Collision Dominated Quiescent Discharge  
Langmuir Probe and Optical Emission Diagnostics for Low Pressure DC Discharges  
Journal of Thermophysics and Heat Transfer  
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from flat panel televisions to thermonuclear fusion for energy production plasmas currently have numerous and wide applications in sciences and industry a diversity of plasma diagnostics is available to physicists and engineers to measure and control plasma parameters among them the langmuir probe is the most inexpensive and most popular instrument and method the langmuir probe is a small electrode which is submerged in plasma in order to measure the probe current voltage characteristic the same characteristic is processed further to derive the electron and ion concentration the electron distribution function and the plasma potential at the probe location langmuir probe diagnostics afford rapid measurements of the electron distribution function and plasma potential at a good time resolution 10<sup>-8</sup> seconds in a wide range of plasma densities 10<sup>3</sup> 10<sup>14</sup> cm<sup>-3</sup> and the electron energy from the room temperature to hundreds of electron volts qualities which are essential for researchers in view of these facts langmuir probe diagnostics are applied very frequently to measuring plasma parameters this book will be useful in teaching plasma diagnostics to undergraduate and graduate students in plasma physics courses and it will also serve as a practical reference manual for physicists and engineers working in the growing area of plasma physics the reader of this book will learn what kind of plasma parameters the langmuir probe can measure how to develop the probe diagnostics for specific cases and how the probe data obtained should be processed to deduce reliable plasma parameters in this book the reader can find not only the basic physics information important to understanding the principles of probe operation but also how the real probe disturbs plasma and how it is possible to reconstruct undisturbed plasma parameters with available probe data

the electric probe has long been used as a fundamental diagnostic tool for measuring the local properties of a plasma since langmuir first developed the electric probe technique in 1924 probes have been used to measure electron densities and temperatures in a wide variety of gaseous ionized media such as electric discharges afterglows ionizing shock waves flames mhd and plasma jet flows reentry

vehicle flow fields and atmospheric and space plasmas the first systematic account of modern theories of electric probe behavior was given by chen 1965 who also provided practical information on experimental techniques a subsequent survey by swift and schwar 1970 which was representative of results contained in the literature through 1969 included additional information on some of the modern theories and on practical details of probe utilization the purpose of this volume is to supplement the previously mentioned two works by providing an account of a large body of the up to date information available on electric probes particularly in the areas of transitional and continuum flow phenomena and by offering for all domains of probe application a critical appraisal of the more significant probe theories and experimental investigations in the literature

this rigorous explanation of plasmas is relevant to diverse plasma applications such as controlled fusion astrophysical plasmas solar physics magnetospheric plasmas and plasma thrusters more thorough than previous texts it exploits new powerful mathematical techniques to develop deeper insights into plasma behavior after developing the basic plasma equations from first principles the book explores single particle motion with particular attention to adiabatic invariance the author then examines types of plasma waves and the issue of landau damping magnetohydrodynamic equilibrium and stability are tackled with emphasis on the topological concepts of magnetic helicity and self organization advanced topics follow including magnetic reconnection nonlinear waves and the fokker planck treatment of collisions the book concludes by discussing unconventional plasmas such as non neutral and dusty plasmas written for beginning graduate students and advanced undergraduates this text emphasizes the fundamental principles that apply across many different contexts

this report develops a unified theoretical representation of the spherical langmuir probe in a collision dominated weakly ionized gas the analysis is performed by numerically integrating poisson's equation and a set of moment equations derived from the boltzmann equation that conserve mass momentum and energy for electrons and ions the theory provides for the continuous description of langmuir probes from collisionless through collision dominated conditions numerical techniques are developed to carry out the analysis the numerical results show that the theoretical model satisfies all known theoretical limits for collisionless and collision dominated operating conditions a new model for langmuir probe data analysis is developed the model provides for the description of sheaths of finite thickness and is found to meet all known theoretical limits in the collisionless and collision dominated extremes and

provides a continuous description of operating conditions between these extremes systematic data analysis procedures employing the new data analysis model are developed the feasibility of performing a langmuir probe experiment in a thermodynamic equilibrium cesium plasma for the purpose of validating theoretical probe models under experimental conditions where plasma properties are known from thermodynamic relations is investigated

a method was developed and used to obtain theoretical predictions of the current collected from a collisionless fully maxwellian plasma at rest by an electrically conducting langmuir probe having spherical or cylindrical symmetry the probe characteristic or functional relation between current and probe potential was determined for both geometries for probe radii up to 100 times the debye shielding distance of the hotter species of charged particle for a complete range of ion to electron temperature ratios and for probe potentials from 25 to 25 times the thermal energy of the hotter species each current collection result is computed to a relative accuracy of 0.002 or better in an average time of approximately two minutes on the ibm 7094 explicit comparison is made between the results for a completely maxwellian plasma and those for a plasma mono energetic in attracted particles as treated by bernstein and rabinowitz lam and chen it is shown that in certain cases the mono energetic plasma does not adequately simulate the maxwellian plasma

conical electrostatic probes of lengths 0.153, 0.393 and 1.0 cm were placed in partially ionized argon flows in the laboratory in order to study the use of their current voltage characteristics in the measurement of ion number densities over a wide range the ion densities and electron temperatures of the flows were measured with thin cylindrical electrostatic probes and the neutral properties were determined from impact pressure stagnation pressure and stagnation temperature measurements the current voltage characteristics of the ion attracting conical probes were measured and compared to thin and thick sheath theories over the whole range of ion densities the measurements agreed reasonably well with the thin sheath theories of chung and blankenship 1966 and denison 1967 which yield explicit expressions for the ion densities in terms of measurable quantities modified author abstract

a model of the ion electron flow in the stagnation region between the detached shock and the wall of a langmuir type probe is proposed for ionized air in a shock tube at ion mass fractions less than 1/10,000 based on the close agreement between numerical

calculations and measurements of the probe wall ion current density the proposed model gives an accurate description of the ion electron flow in the stagnation point boundary layer when negative potentials are applied at the stagnation point of the probe the procedure is indicated to be applicable also in the region between the detached probe shock and the edge of the boundary layer the ion and electron densities in the boundary layer are shown to be strongly dependent on the equilibrium conditions for the high temperature gas behind the shock hence the ion and electron number densities in the undisturbed incident flow ahead of the detached shock cannot be obtained unless it is possible to calculate the changes in the number densities across the shock author

the langmuir probe theories of su and lam and of self and shih for collisional plasmas were examined theoretically and compared with experimental results probe measurements were made in helium in nitrogen and in argon discharges for which the pressures were between 480 and 1 200 torr three discharge tube configurations and both spherical and cylindrical probes were used to analyze measurements from cylindrical probes an approximate ellipsoidal geometry theory was formulated and used spherical geometry probe data was analyzed with a technique derived from the self and shih theory it was found that probe currents were not always large enough author

this journal is devoted to the advancement of the science and technology of thermophysics and heat transfer through the dissemination of original research papers disclosing new technical knowledge and exploratory developments and applications based on new knowledge it publishes papers that deal with the properties and mechanisms involved in thermal energy transfer and storage in gases liquids and solids or combinations thereof these studies include conductive convective and radiative modes alone or in combination and the effects of the environment

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