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The American Physical Society

Division of Electron and Atomic Physics

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To members of the DEAP:

The Division of Electron and Atomic Physics has organized three symposia for the Washington APS Meeting. The scheduling of these three events and abstracts of the invited papers are enclosed for your convenience in accordance with the wishes of the DEAP Executive Committee.

I. Monday, April 27, 9:00 A.M.

Session AA - AIR POLLUTION (Chairman - Earl C. Beaty)

Photochemistry of Urban Atmosphere. R. STEPHEN BERRY, Department of Chemistry, University of Chicago. Oriented toward clarifying the role of scientific information in determining policies and strategies for air quality management, this discussion reviews the current picture of air pollution with emphasis on its photochemically-activated phases. The problems associated with interacting pollution systems require attention beyond that given to "simple" systems such as automotive pollution. Establishing the connection, now virtually nonexistent, between aerochemistry and dispersion models will presumably be the object of much of that attention.

Man-Made Climate Change. PAUL R. JULIAN, National Center for Atmospheric Research, Boulder, Colorado. Before reviewing the more scientific aspects of the subject of the effects of anthropogenic constituents in the atmosphere on the determination of climate it would be advisable to note the following. First; the word 'climate,' however it is used in discourse, inherently involves a time integration of day-to-day weather. Climate will mean different things to different living organisms because each has its own time integration interval of a more-or-less unique set of meteorological elements. In this regard, it is safe to state that man has without doubt changed some climate by using the atmosphere as a means of waste or residuals disposal. The question, of course, is one of how much and for whom. Second; climate, using a statistical definition involving e.g. probability distribution functions and a particular scale of time integration has a variety of causes. One of the most important of these, if indeed it can be termed a cause, is the autovariability of the atmosphere itself. That is, given no changes in the external boundary conditions (solar radiation, deep ocean circulation) and composition of the atmosphere, a meteorological element averaged over L time units will not be a constant but will have some probability distribution function with finite higher moments. Thus we would not expect the mean temperature at a place, for example, averaged over one period of L years to be the same as in any other period of L years. This fact which is quite well understood by all meteorologists and climatologists is frequently overlooked, particularly in this day of environmental crises. Nowadays, every observed change in timeaveraged meteorological elements must be assigned, it seems a specific man-made cause.

The problem of residuals disposal and climate may conveniently be discussed by noting that the two main physical processes by which the circulation systems of the atmosphere may be affected are first the radiative and second the precipitation processes. The radiative processes in the atmosphere are briefly reviewed and gaps and apparent strengths in our understanding pointed out. Two frequently mentioned man-made large-scale changes in climate arise directly from changes in the so-called radiative balance: these involve secular changes in the anthropogenic CO_2 burden and in the particulate constituents in the atmosphere. The micro-physics and -chemistry of the precipitation process is briefly mentioned. Once, however, these problems are in hand the apparently more formidable problem of the hydrodynamical response of the atmosphere must be solved.

In conclusion, I hope to be able to provide some opinion on the most productive areas for research and on the potentially most serious of the man-induced changes in climate.

Application of Lasers to Air Pollution Research. MICHAEL McCLINTOCK, Space Science and Engineering Center, University of Wisconsin. Several spectroscopic techniques are suggested in which the use of lasers can provide information relevant to air pollution research. The possible contributions of laser-induced resonance fluorescence, laser molecular level crossing spectroscopy, Raman scattering, resonance Raman scattering, laser EPR, and Mie scattering are discussed briefly in relation to molecular and particulate species.

II.

Monday, April 27, 2:00 P.M.

Session BD - ELECTRON-MOLECULE SCATTERING (Chairman - Edward Gerjuoy)

Close Coupling Calculations of Elastic and Rotational-Excitation Cross Sections for Slow Electron Collisions with Hydrogen Molecules. NEAL F. LANE, Rice University. Recent close-coupling calculations of elastic and rotational-excitation cross sections for slow electron- H_2 collisions will be reviewed and detailed comparisons will be made with recent swarm and beam measurements. Special attention will be given to the importance and proper description of polarization and exchange effects. The general formulation of the scattering problem, including excited electronic states of Σ , π , ... character, will also be discussed.

Review of Experimental Techniques and Results in Low Energy Electron-Molecule Scattering. D. E. GOLDEN, Sylvania Electric Products Inc. The various experimental techniques used to obtain differential, total, and momentum-transfer electron-molecule scattering cross sections at low electron energies will be reviewed. The domains of applicability of the different types of cross section measurements will be discussed in the context of their interrelationship. Methods of studying both elastic and inelastic processes will be included. Some of the limitations imposed by finite energy and angular resolutions will be reviewed. The most recent experimental results for the atmospheric gases will be presented and comparison with theory will be given where possible. In this connection, special attention will be given to the hydrogen molecule since it is the simplest molecule to treat theoretically and has been the subject of considerable experimental work.

The Development of the Fixed-Nuclei Approximation of Electron-Molecule Scattering and the Adiabatic Theory of Rotational Excitation. A. TEMKIN, NASA-Goddard Space Flight Center. A brief history of the fixed-nuclei approximation will be given starting with the separable-spheroidal potential model of Stier and Fisk, the non-separable analysis of Nagahara, the H_2 calculation of Massey and Ridley, leading to the exchange adiabatic H_2 calculation of Hara and the single center polarized orbital calculations of Temkin et al. for H_2^+ . The decomposition in the latter of the scattered amplitude in spherical harmonics leads naturally to a simple evaluation of rotational excitation amplitude in the adiabatic theory. The following properties of the adiabatic amplitude will be demonstrated: (a) its accuracy, (b) its simplicity, (c) its consistency, (d) its clarification of the fixed nuclei cross section averaged over classical orientations of the internuclear axis, and its modification of the same at small impacting energies. We present as yet unpublished results on the rotational and electronic excitation of H_2^+ ; and conclude with remarks on the question of the accuracy of the single center expansion for the fixed-nuclei approximation and the possible applicability of the adiabatic theory for vibrational excitation.

Recent Electron-Molecule Inelastic Collision Studies of Atmospheric Gases. EDWIN N. LASSETTRE, Carnegie-Mellon University. Some recent investigations of inelastic electron scattering by selected atmospheric gases will be discussed. In particular, excitation of the $a^1\Sigma^+$ and $a^1\Pi$ states of nitrogen, N_2 , will be discussed including recent collision cross section measurements. Collision cross section studies on carbon monoxide will also be described and oscillator strengths compared with those calculated by other investigators from lifetime measurements. The current status of differential cross section studies on atmospheric gases will be discussed.

III.

Tuesday, April 28, 9:00 A.M.

Session DB - D-REGION IONOSPHERE CONSTITUENTS AND REACTIONS
(Chairman - K. S. W. Champion)

Measurements of Positive and Negative Ions in the Lower Ionosphere. R. S. NARCISI, Air Force Cambridge Research Laboratory. Rocket-borne cryogenically pumped mass spectrometers have been used for measurements of positive and negative ions in the D and E regions. Positive ion composition results have been obtained from 20 rocket flights. These results show that the D region composition is dominated by water cluster ions, $H^+(H_2O)_n$, from 60 to about 85 km. Other D region species are present and will be discussed. Near 85 km, within the space of two kilometers, a very sharp transition in ion composition occurs, marked by the complete disappearance of the water cluster ions and the abrupt appearance of meteoric atomic ions. The meteoric ions are typically found in a broad layer with a peak near 93 km. At higher altitudes, the meteoric ion layers are very thin and these vary markedly in amplitude and altitude. The role of meteoric ions in sporadic E and their enhancements during meteor showers will be discussed. Above 85 km, NO^+ and O_2^+ are the major E region ions. A comparison of the observational data for NO^+ and O_2^+ with a diurnal model of the E region which includes both ion chemistry and ion transport will be presented to show clearly when and how transport processes are effective in redistributing the ionization. Negative ion composition measurements have been obtained from 6 rocket flights. These results show a preponderance of large cluster ions concentrated entirely below 90 km and identified as $NO_3^-(H_2O)_n$ with $n = 0$ to 5. Negative ion concentrations above 90 km are very small and consist of such ions as O^- and NO_2^- .

Laboratory Measurements of D-Region Ion-Neutral Reactions. E. E. FERGUSON, Environmental Science Services Administration. The primary positive and negative ions produced in the D-region are rapidly converted to different ionic species by a series of ion-neutral reactions. Laboratory studies indicate that the major D-region positive ion produced, NO^+ , will lead to production of the heavy water cluster ion, H_7O_3^+ , by a long sequence of reactions. The significant concentration of O_2^+ ions produced in the D-region by photoionization of $\text{O}_2(^1\Delta_g)$ molecules leads to $\text{H}_5\text{O}_2^+ + \text{HNO}_2$ production by a very rapid reaction sequence. The primary negative ion produced in the D-region, O_2^- , suffers electron detachment and also undergoes a very complex series of reactions which lead to the stable negative ion NO_3^- . The NO_3^- , like all other stable ions of the D-region, can then become hydrated. The status of the various types of laboratory measurements available on these processes will be discussed.

Ion-Ion Mutual Neutralization Reactions. J. R. PETERSON, Stanford Research Institute. Reactions of the type $\text{A}^+ + \text{B}^- \rightarrow \text{A} + \text{B}$ constitute one of the essential mechanisms in the final removal of charge from the D-region of the ionosphere. Experimental difficulties have prevented the measurement of their cross sections under controlled conditions until the fairly recent development of the superimposed beams technique. Measurements have now been made on combinations of N^+ , O^+ , N_2^+ , NO^+ , O^- , O_2^- , and NO_2^- and the reaction $\text{H}^+ + \text{H}^-$ over a large dynamic range extending from about 0.1 to several hundred eV. Because the low energy regime is controlled by Coulomb forces, these data can be extrapolated to still lower energies, and thermal rate coefficients can be deduced with reasonable accuracy. Experimental results will be compared with theory, and estimates will be made for rates among species other than those that are experimentally tractable.

The Ionizable Minor Constituents NO and $\text{O}_2(^1\Delta)$. DONALD M. HUNTEN, Kitt Peak National Observatory. The only ultraviolet wavelengths that penetrate well into the D region are those greater than 1027 Å, which cannot ionize the major constituents. The presence of $\text{O}_2(^1\Delta)$, which has a threshold of 1118 Å, is established by dayglow observations and its distribution can be understood as a consequence of ozone photolysis. NO is ionized primarily by Lyman-alpha; it too is observed in dayglow, but an explanation of its high concentration requires consideration of downward transport and reactions of metastable precursors.