knows that he is dealing with living organisms and wants to study all their attributes whether they concern morphology, behavior, ecology, or biochemistry.

An understanding of the biological meaning of variation and of the evolutionary origin of groups of related species is even more important for the second stage of taxonomic activity, the sorting of species into groups of relatives ("taxa") and their arrangement in a hierarchy of higher categories. This activity is what the term classification denotes; it is also referred to as beta taxonomy. No matter how interested a taxonomist is in the evolutionary and ecological aspects of the taxa he studies, he will also devote a major share of his time to alpha and beta taxonomy, not only because so much work still remains to be done, but also because the more interesting biological problems are found only through research in alpha and beta taxonomy.

The Future of Systematics

I would feel rather pessimistic about the future of taxonomy if it were only an identification service for other branches of biology, as is thought by some of our less imaginative colleagues. But he who realizes that systematics opens one of the most important doors toward understanding life in all of its diversity cannot help but feel optimistic. Environmental biology, behavioral biology, and even molecular biology are all moving in our direction. The most exciting aspect of biology is that, in contradistinction to physics and chemistry, it is not possible to reduce all phenomena to a few general laws. Nothing is as typically biological as the never-ending variety of solutions found by organisms to cope with similar challenges of the environment. Nothing is more intriguing than the study of differences between related organisms and the challenge to explain these differences as the result of natural selection. Even in cases where the ultimate solution may come from genetics or biochemistry, it is the systematist who in almost every case is the one who poses the challenging questions. The opportunities for exciting research are virtually unlimited. This is becoming clearer and more widely appreciated every year.

These opportunities are not without obligations. Let us remember at all times that each and every taxonomist is a spokesman for systematics. He must carry out his activities in such a way as to reflect favorably on his field. Let us remember that taxonomy is not a kind of stamp-collecting but a branch of biology. Let us desist from all practices that are injurious to the prestige of systematics, as, for instance, by indulging in nomenclatural practices that lower the value of scientific nomenclature as an information storage and retrieval system. Finally, let us remember that in virtually every taxonomic finding certain generalizations are implicit that are of value and broad interest to biology as a whole. It will help our relations with other branches of biology if we make these findings known. They are sure to have a minor or major impact well beyond the bounds of systematics.

It is my sincere belief, to summarize my discussion, that systematics is one of the most important and indispensable, one of the most active and exciting, and one of the most rewarding branches of biological science. I know of no other subject that teaches us more about the world we live in than systematics, the study of the diversity of life.

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Metastable Atoms and Molecules

Measurements of their unusual properties in highly excited states reveal a new area for investigation.

E. E. Muschlitz, Jr.

An atom (A) or molecule (XY) is generally considered to be in a metastable state of electronic excitation if its lifetime for monomolecular decay is greater than 1 microsecond. Obviously, this is an arbitrary definition, for the entire range of lifetimes may be found. If ordinary electric dipole radiation is allowed, lifetimes of the order of 10^{-9} second are observed for the radiative decay process

$$A^* \rightarrow A + h\nu \qquad (1)$$

where $h\nu$ is Planck's constant times the frequency of the photon. Thus, for an atom or molecule to be in a metastable state, dipole radiation must be a forbidden transition. Chemical reactions of nonmetastable excited species are often not significant in the gas phase, since radiative decay may occur before a reactive collision takes place. On the other hand, a metastable species can survive a number of elastic collisions before reaction occurs. Perhaps the most prominent regions of the universe where metastable excited atoms and molecules play an important role are the upper atmospheres of the earth and other planets. In these regions, the particle density is so low that bimolecular collisions are relatively infrequent, and a significant amount of energy is stored in metastable species. On earth, atoms and molecules in electronically excited states are present in flames, shock waves, and electrical discharges.

The physical and chemical properties

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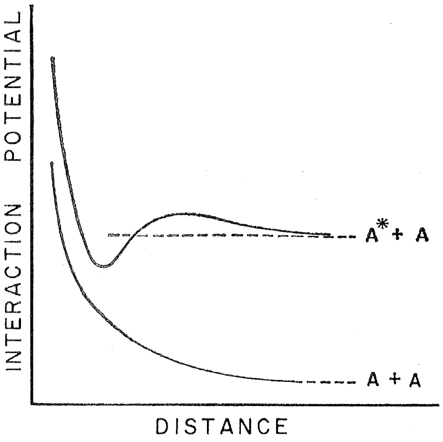

Fig. 1. interaction potential curves for excited and ground-state atoms.

of electronically excited atoms and molecules are quite different from those of the ground state. For example, the 2^1S metastable state of helium has the electronic structure, $1s2s$. The single outer $2s$ electron gives this excited atom properties similar to those of lithium, $1s^22s$, as we shall see later. Measurements of the physical properties of excited species at atmospheric pressure are difficult, if not impossible, for molecular and wall collisions may destroy them at a rapid rate. Other methods are available, however; prominent among them is the use of molecular beams of excited atoms and molecules (*1*).

Table 1 shows that there is a wide variation in both the energy and lifetime of metastable states (*2*). Not all known metastable states even for a single species are listed. For example, three are known for atomic oxygen and five for molecular oxygen.

Electronically excited molecules have, in general, different internuclear distances and geometry. The ground state of the CH_2 radical is linear while the metastable $\tilde{a}^1A_1$ state is bent (*3*). Although the ground state of HCN is linear, three electronic states, each with a different bond angle, are known. The lowest excited states of benzene, two of which are shown in Table 1, are ascribable to excitation of one of the six $2p\pi$ nonlocalized electrons. No difference in the symmetry of the molecule is therefore expected in these states; however, the hexagonal ring is known to be larger for the $^1B_{2u}$ state (*3*). Thus, it is quite reasonable that such basic molecular properties as the polarizability, which is a measure of the extent of distortion of the electron distribution in an electric field, and the dipole moment will exhibit quite different values for excited states than for the ground state.

The dipole moment of carbon monoxide in the $a^3\Pi$ state and the polarizability of argon in the $^3P_2$ state are very good examples. The ground state of CO has a small dipole moment of 0.112 debye, and the molecule may best be described as having a triple bond between the two atoms. Freund and Klemperer (*4*), measuring the dipole moment of the excited state with the molecular-beam electric-resonance method (*5*), found it to be 1.38 debyes. As they pointed out, there is a striking similarity between the excited CO molecule and the carbonyl group in formaldehyde (Table 2).

Table 2. Comparison of physical constants for carbonyl and excited CO.

Species	Bond distance (Å)	Vibrational frequency (cm^{-1})	Dipole moment (debye)
CO $X^3\Sigma^+$	1.128	2170	0.112
CO $a^3\Pi$	1.209	1739	1.38
$>C{=}O$ (H_2CO)	1.225	1744	2.3

Table 1. Some metastable atoms and molecules (*1–3, 8*).

Species	Ground state	Metastable state	Energy (ev)	Lifetime (sec)
H	$^2S_{\frac{1}{2}}$	$2^2S_{\frac{1}{2}}$	10.20	0.12
He	$^1S_0$	2^3S_1	19.82	Very long
He		2^1S_0	20.61	Long
Li	$^2S_{\frac{1}{2}}$	$(1s2s2p)\,^4P_{5/2}$	56	5.1×10^{-6}
N	^4S	^2D	2.38	6×10^4
N		^2P	3.58	13
O	^3P	^1D	1.97	110
O		^1S	4.17	0.78
Ne	$^1S_0$	$^3P_{2,0}$	16.62,16.71	Long
Ar	$^1S_0$	$^3P_{2,0}$	11.55,11.72	Long
Hg	$^1S_0$	$^3P_{2,0}$	5.43, 4.64	Long
H_2	$^1\Sigma_g{}^+$	$c^3\Pi_u$	11.86	Long
N_2	$^1\Sigma_g{}^+$	$A^3\Sigma_u{}^+$	6.16	0.9
N_2		$a^1\Pi_g$	8.54	1.7×10^{-4}
O_2	$^3\Sigma_g{}^-$	$a^1\Delta_g$	0.98	Very long
CO	$^1\Sigma^+$	$a^3\Pi$	6.01	Long
NO	$^2\Pi$	$a^4\Pi$	4.7	Long
CH_2	$^3\Sigma_g{}^-$	$\tilde{a}^1A_1$	<1	Long
C_6H_6	$^1A_{1g}$	$\tilde{A}^1B_{2u}$	4.9	0.59×10^{-6}
		$\tilde{a}^3B_u$	3.8	28

The polarizability of argon in the $^3P_2$ state has been determined by Pollack, Robinson, and Bederson (*6*) with a new molecular-beam method in which the transverse forces on the atoms in the beam due to parallel electric and magnetic field gradients are balanced. They found the mean polarizability to be 48 Å^3 which may be compared with 1.6 Å^3 for argon in the ground state and 36 Å^3 for potassium. Both potassium and the ^3P metastable states of argon have a single $4s$ electron in the outermost shell. The method is a very powerful one, in that the anisotropy in the polarizability may also be determined. This arises in ^3P argon since the inner $3p$ subshell is incomplete and not spherically symmetrical. The resulting anisotropy is only about 10 percent, however, for the major contribution to the polarizability comes from the outer $4s$ electron which has a spherical probability distribution.

Lifetimes of Metastable Atoms and Molecules

For nearly all species listed in Table 1, there is a difference in the multiplicity of the ground state and that of the excited state. This is a result of the selection rule, $\Delta S = 0$, for dipole radiation, that is, the total electron spin must be the same in the initial and final states. This rule becomes less rigorous as the nuclear charge increases. For example, the $^3P_1$ states of neon, argon, and mercury are not metastable, but the $^3P_2$ and $^3P_0$ states are, because of the rigorous selection rules, $\Delta J = 0$ or $\pm\ 1$ and $J = 0 \nleftrightarrow J = 0$, on the total angular momentum. If electric dipole radiation is forbidden, the less probable processes, electric quad-

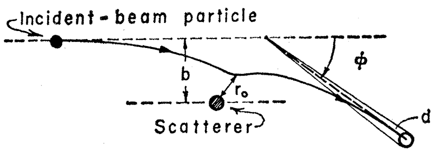

Fig. 2. Scattering path for an elastic collision.

rupole or magnetic dipole radiation, may be allowed. An example is the $^1\Pi_g$ state of N_2 which decays by magnetic dipole radiation. Even if all single photon processes are forbidden, the metastable species may decay by double photon emission. This is a rare event, but it does put a final upper limit on the lifetime. A complete discussion of selection rules has been given by Garstang (*7*).

The lifetime of a metastable atom or molecule in a gas is appreciably decreased by inelastic collisions and by other perturbing influences, such as electric or magnetic fields. Field-free space lifetimes of excited particles have been measured by various optical methods —for example, by observation of the decay of fluorescence (*8*) (extrapolation of the results to zero pressure is necessary), as well as by the use of molecular beams (*1*). In the latter method, a beam of molecules is excited by electron impact, and the intensity of excited atoms in the beam is measured as a function of distance from the point of excitation; thus, the free-space lifetime is obtained directly. Metastable molecules of sufficient energy will eject electrons on impact with metal surfaces. This process provides a convenient method of detecting them in the presence of ground-state molecules (*1*), and it has been used in most molecular-beam experiments with metastable species.

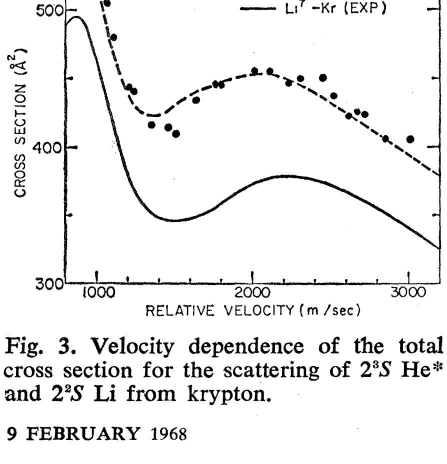

Fig. 3. Velocity dependence of the total cross section for the scattering of 2^3S He* and 2^2S Li from krypton.

Interaction Forces

The interaction between two atoms or molecules is changed considerably if one of them is excited. For example, the A*–A interaction may lead to the formation of a stable excited molecule, whereas the A–A interaction may be purely repulsive (Fig. 1). This is the case for both metastable states of helium, the $^3\Sigma_u$ and $^1\Sigma_u$ excited molecules having binding energies of 1.1 and 1.6 ev, respectively (*9*). Figure 1 illustrates another feature common to a number of interaction curves for excited atoms, namely, a maximum in the potential at large distances, which is often large enough to obliterate the van der Waals' attraction normally found at these distances.

The use of molecular-beam techniques for the investigation of intermolecular forces has proved to be very fruitful. In these experiments, velocity selected beams are used, so that measurements of molecular scattering as a function of the relative velocity of the colliding particles are obtained. The data are expressed in terms of scattering cross sections. The number of beam particles elastically scattered by a single molecule per second into an element of solid angle, $d\omega = \sin \phi d\theta d\phi$, from a beam of unit intensity is $I(\phi)d\omega$, where $I(\phi)$ is the differential elastic scattering cross section, a function of the scattering angle ϕ. Figure 2 shows a scattering event in the plane $\theta = 0$, during which both attractive and repulsive forces operate. Relative coordinates are used which are centered on the scatterer and move with it. At large distances, attractive forces predominate, and the beam particle is drawn toward the scatterer; at closer distances, the particles are repelled. The distance b is called the impact parameter, and the distance r_0 is the closest distance of approach. The scattering angle ϕ will therefore depend upon b, the relative velocity, and the interaction forces. All particles in an incident beam of unit intensity with impact parameter lying between b and $b + db$ will scatter at angles between ϕ and $\phi + d\phi$ if the potential is isotropic, thus:

$$2\pi b db = I(\phi) 2\pi \sin \phi d\phi \qquad (2)$$

The total elastic scattering cross section is given by

$$Q = \int\int I(\phi)\, d\omega = 2\pi \int_0^\pi I(\phi) \sin \phi d\phi \qquad (3)$$

and represents the total scattering at all angles.

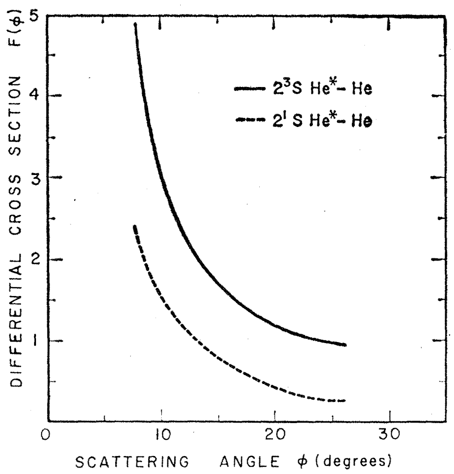

Fig. 4. Differential cross section (polar angular scattering coefficient) as a function of angle for the scattering of metastable helium atoms from ground-state atoms.

Total elastic-scattering cross sections are determined by measuring the attenuation of the beam as it passes through a gas at sufficiently low pressures to insure single collisions. Two crossed molecular beams may be used for the determination of the angular distribution of the elastic scattering. Intermolecular forces affect both the velocity dependence of the total scattering and the angular distribution. For example, a total cross section which varies only slightly with relative velocity indicates a "hard" interaction potential, one that varies very rapidly with distance between the colliding particles. Bernstein (*10*) has reviewed the determination of intermolecular potentials from molecular-beam scattering data.

When the angle ϕ is zero, the classical value of $I(\phi)$ becomes infinite (*11*), provided that $d\phi/db$ remains finite (Eq. 2). This phenomenon is known

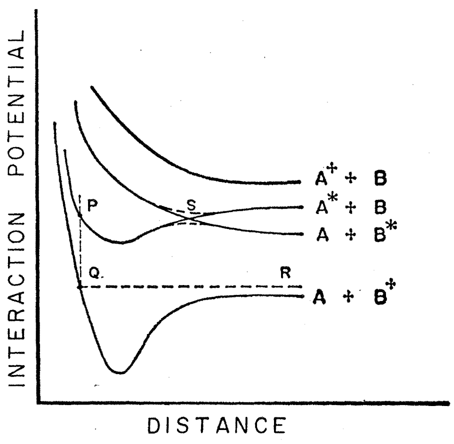

Fig. 5. Interaction potential curves illustrating two mechanisms for Penning ionization.

as forward glory scattering. Now $\phi \rightarrow 0$ as $b \rightarrow \infty$, and also ϕ will become zero for any realistic potential function (containing both attractive and repulsive terms) at a particular impact parameter such that the effects of attraction and repulsion on the scattering angle cancel. These scattered waves interfere with each other at very small scattering angles. Since the critical impact parameter for glory scattering is a function of relative velocity, undulations are observed in the velocity dependence of the total cross section. Excited atom scattering is shown in Fig. 3 from data obtained by Rothe *et al.* (*12*). The measured total cross sections for the scattering of both 2^3S helium atoms and lithium atoms from krypton are shown as a function of relative velocity. The similarity in the behavior due to the similarity in structure of the beam particles is evident. Rothe has determined the parameters ϵ and σ which give the best fit of his data to a Lennard-Jones potential

$$V(r) = 4\epsilon[(\sigma/r)^{12} - (\sigma/r)^6] \qquad (4)$$

For the Li–Kr interaction, he finds the quantity $C = 4\epsilon\sigma^6$, the constant factor in the van der Waals inverse sixth-power attractive term, to be 28×10^{-59} erg cm^6 which may be compared with 38×10^{-59} erg cm^6 for He*–Kr. These results are consistent with a larger polarizability for 2^3S He than for lithium (*6, 13*) and are in accord with theoretical calculations (*14*).

Measurements of the angular distribution of 2^3S and 2^1S helium metastable atoms scattered from ground-state atoms have been made by Richards and Muschlitz (*15*). A beam of helium atoms excited by electron impact is used. Such measurements are possible because the ratio of singlet to triplet metastable atoms in the beam is a function of the energy of the electron beam used for excitation. This ratio has been determined by several methods, in particular by deflection experiments with an inhomogeneous magnetic field (*16*). By making measurements of the scattering as a function of the energy of the exciting electrons and thereby the composition of the beam, separate cross sections for the scattering of both metastable species may be obtained. The results are shown in Fig. 4, in which the polar angular scattering coefficient $F(\phi) = 2\pi I(\phi) \sin \phi$ is plotted against the scattering angle ϕ. The small angle scattering is uniformly greater for the triplet metastable atoms. The maxima in the He*–He interaction potentials (Fig. 1) are sufficiently great to prevent thermal energy particles from approaching each other closely, so that the scattering is determined by repulsive forces. Calculations of the height of these maxima give 0.29 ev for the triplet interaction and 0.26 ev for the singlet (*9, 17*). The greater repulsion for triplet atoms leads to a greater cross section. Because quite accurate theoretical interaction curves are now available (*17*), more experimental data on the scattering of metastable helium atoms is needed, particularly at higher relative energies to sample the potential energy in the region of the minimum. The existence of both a maximum and a minimum in these curves should produce some interesting interference effects in the scattering.

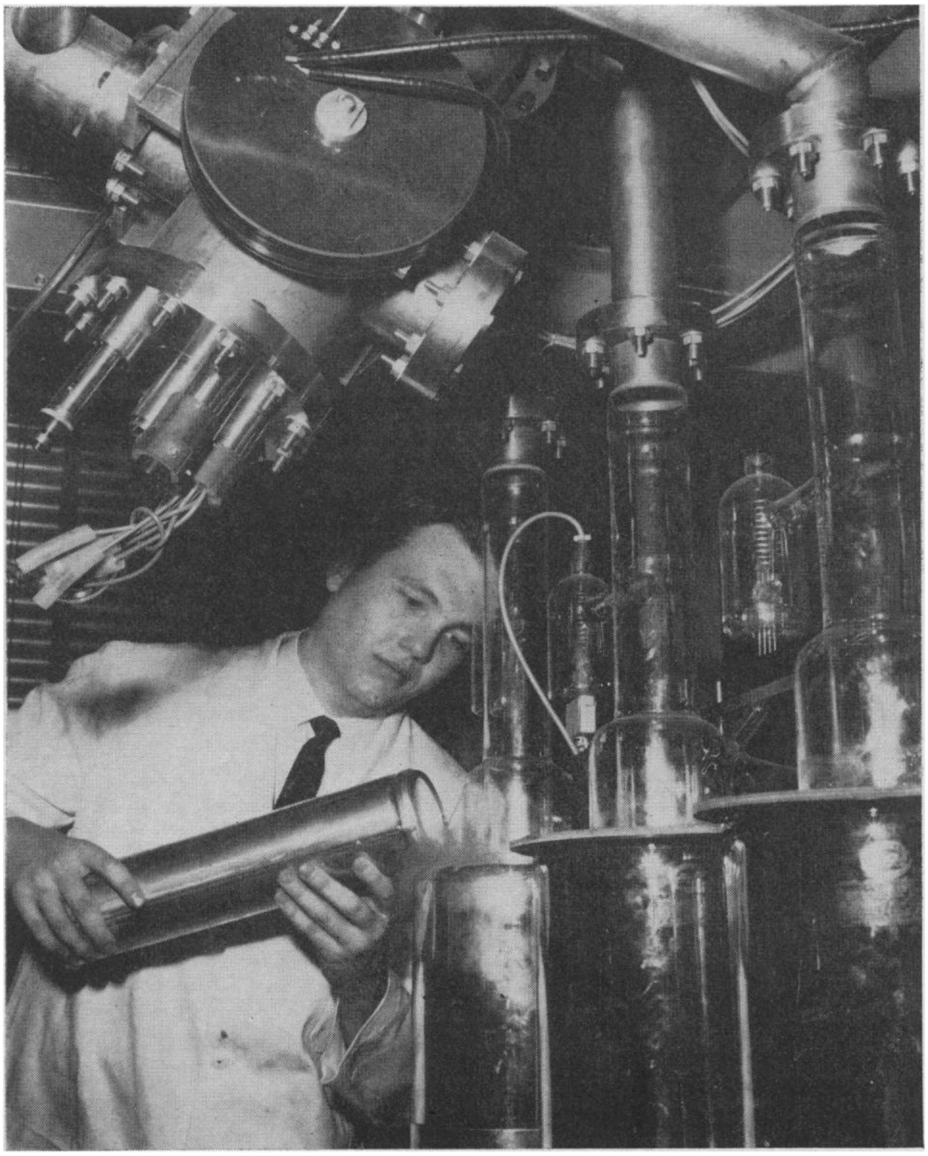

Fig. 6. Ion source region of the mass spectrometer (60° radial magnetic deflection, 30.5-cm radius) used for investigations of Penning ionization at the University of Florida.

Reactions

Much of our knowledge of the chemical reactions of excited species has come about through investigations of such macroscopic phenomena as flames, electrical discharges, photolysis, and radiolysis (*18*). A number of basic inelastic collision processes involving excited atoms have been identified:

$$A^* + XY \rightarrow A + XY^* \qquad (5)$$

$$A^* + XY \rightarrow A + XY \qquad (6)$$

$$A^* + XY \rightarrow A + X + Y \qquad (7)$$

$$A^* + XY \rightarrow AX + Y \qquad (8)$$

$$A^* + XY \rightarrow A + XY^+ + e \qquad (9)$$

$$A^* + XY \rightarrow A + X^+ + Y + e \qquad (10)$$

$$A^* + XY \rightarrow AX^+ + Y + e \qquad (11)$$

$$A^* + XY \rightarrow AXY^+ + e \qquad (12)$$

Table 3. Ionization cross sections for collisions of metastable helium atoms (*23*).

System	Product ion	Ion abundance (%)		Cross section Å^2	
		$(2^1 S_0)$He*	$(2^3 S_1)$He*	$(2^1 S_0)$He*	$(2^3 S_1)$He*
He* — Ar	Ar$^+$	91.5	87.1	7.0	6.6
He* — Ar	HeAr$^+$	8.5	12.9	0.6	1.0
He* — Kr	Kr$^+$	92.6	88.6	8.3	8.0
He* — Kr	HeKr$^+$	7.4	11.4	0.7	1.0
He* — O_2	O_2^+	85.4	93.9	12.0	13.1
He* — O_2	O$^+$	14.6	6.1	2.0	0.9
He* — N_2	N_2^+	100.	100.	7.0	7.0

Equation 5 represents a transfer of electronic energy. If XY* subsequently radiates, the phenomenon is called sensitized fluorescence; it was first discovered by Cario and Franck (*19*). Such a process comes about by a "crossing" of potential energy surfaces. The atoms A* and B approach along the indicated curve (Fig. 5) and separate after a radiationless transition along the lower curve corresponding to A + B*. The crossing can take place at *S* as the atoms are approaching or receding from each other. The reaction indicated is exoergic, with the excess energy appearing as kinetic energy of the separating atoms, A and B*. If B is a molecule, part of the excess energy may appear as vibration or rotation. Equations 6 to 8 are quenching processes, variations of Eq. 5, in which the electronic excitation is lost. Many examples are known from photochemical studies. The last four reactions, where ionization is produced, occur only for highly excited atoms, but it is in these cases that mass spectrometer and molecular-beam techniques can be applied most readily.

Collisions represented by Eqs. 9 and 10 are collectively known as Penning ionization (*20*). Cross sections for some of these processes are shown in Table 3, as measured by Shollette (*21*), Weiss (*22*), and Herce (*23*) who used a beam of metastable helium atoms. In Penning ionization, the metastable atom must return to the ground state, since there are no intermediate states. By varying the exciting electron energy and therefore the 2^1S to 2^3S population in the beam, they were able to obtain cross sections for both metastable helium species. There is good evidence both from beam experiments (*24*) and from measurements of the electron energy (*25*) that the N_2^+ ion is formed not only in the ground state but in several excited states. When the metastable atom has sufficient energy, ionization is accompanied by dissociation, as with O_2. Here, both the atomic and molecular ions are formed. Penning ionization is a highly probable process, the cross sections being an order of magnitude (or more) larger than for ionization of the gas by electrons or by photons of the same energy. Equation 12 is an example of associative ionization (chemionization) first observed by Hornbeck and Molnar (*26*). They found that the mass spectrometer appearance potential for the rare gas molecular ions, such as He_2^+, was lower than the ionization potential of the rare gas. Associative ionization in the rare gases involves not only highly excited states with lifetimes of 1 μsec or less (*27*), but also the metastable states (*23*). In the case of the metastable helium-rare gas interactions, both Penning and associative ionization occur as parallel reactions, with the former predominating (see Table 3).

Mass spectra of a number of compounds ionized on impact of metastable atoms have been obtained (*22, 23, 28*). The usual electron beam in the mass spectrometer ion source is replaced by a molecular beam of the excited species (Fig. 6). The relative abundances of the fragment ions produced are quite different from those observed in electron impact, with more fragmentation usually found in Penning ionization.

The mechanism of Penning ionization is not completely understood. Two possibilities arise. There may be an exchange of excitation energy as described above; this leaves B* in a preionizing state (see Fig. 5). Such states with lifetimes long enough ($>10^{-13}$ second) to survive the collision are well known. The excited molecule B* may then either lose an electron or dissociate into two neutral fragments. Thus, there should be an isotope effect, because there are two competing steps and the rate of dissociation will depend on the isotopic composition of B (*29*). The isotope effect was first observed by Jesse (*30*) in his experiments on the total ionization in gas mixtures subjected to α-particle radiolysis. Using a beam of helium metastable atoms incident on H_2, HD, and D_2, Penton and Muschlitz (*24*) measured the relative cross sections for the formation of the molecular ions and found them to be 1.00, 1.18, and 1.26, respectively. This is the order expected, since the rate of dissociation of these molecules decreases from H_2 to D_2. Analysis of the ion-extraction voltage data obtained from the mass spectrometer showed that these ions were formed with kinetic energy of about 0.2 ev, or about 10 times thermal energy. This means that the excess energy in the initial energy transfer step must be small, and thus there must be a highly excited state of H_2 with an energy nearly 5 ev above the ionization potential. However, the known preionizing states in H_2 lie within 0.5 ev of the ionization potential (*31*).

An alternate mechanism is illustrated in Fig. 5. At the point *P*, in the collision of A* with B, a Franck-Condon transition takes place to the point *Q* on the A + B+ interaction curve, with the electron carrying away the difference in energy. Since *Q* is above the dissociation energy, the final products are A and B+, each with a small amount of kinetic energy. Associative ionization occurs by this mechanism, for if the vertical transition took place at somewhat larger distances, AB+ would be formed. On the other hand, the observed isotope effect is not as readily explained on the basis of this mechanism. Our knowledge of the reactions of excited atoms and molecules is obviously still in a primitive state. Accurate theoretical calculations of excited atom interaction potentials, as well as new experiments to resolve many interesting questions, are needed.

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Government, Medical Research, and Education

National health needs demand reappraisal of support for biomedical research and education.

Alexander Leaf

All are aware of the rapid expansion of biomedical knowledge in the past 20 years and the changes that this has produced in medicine. Few would deny that this was made possible by generous governmental support of the biomedical sciences, largely through project-related research grants. The success of this support for research, on the one hand, and the need for more and better medical care in the country, on the other hand, have resulted in progressive annual increases in the governmental contribution. Today the very magnitude of the support for research has brought it into competition with other demands on the tax dollar: expanded military needs, Medicare and Medicaid, antipoverty programs and urban renewal, to name a few. It is therefore timely to pause and consider whether the government's support is being utilized to best advantage in stimulating the productivity of the biomedical sciences and in meeting the health needs of our country.

Federal legislation has made comprehensive medical care the birthright of all United States citizens. We may expect to see increasing inadequacies in the ability of present systems to deliver the health services promised by this legislation. Many have foreseen a number of bottlenecks which are certain to impede the best-laid plans and intentions of policy-makers:

1) A shortage of qualified physicians and ancillary health personnel is apparent. Some 20 percent of all physicians being licensed to practice in this country are graduates from medical schools of foreign countries, which can ill afford to export this costly product. The shortage of nurses is so acute that many existing medical care facilities have had to reduce their operations. We have hardly begun to define the ancillary medical personnel necessary to extend the arm of the physician in caring for the health needs of the community; even less has been done to organize their training.

2) The distribution of health services and physicians in the community bears little relation to the distribution of health needs of the country. High-quality medical care tends to be concentrated around university-affiliated medical centers, while away from such centers the quality of care often lags considerably.

3) Insufficient understanding of the causes of major illnesses limits the ability of the medical profession to prescribe effective cures or prevention.

Since our medical schools and universities train our physicians and other medical personnel, since most of the research in the health sciences is performed in their laboratories, and since their affiliated teaching hospitals set standards of excellence for medical care in the community, these national health problems are closely related to the activities of our universities, their medical schools, and affiliated teaching hospitals. Because of the expense of research, education, and patient care, we may expect governmental support to assume an increasing share in the costs of our national health programs. An important question today is, therefore, how can we use and support our educational and research resources to best serve our national health needs?

Support of Basic and Applied Research

The practice of medicine is clearly the application of knowledge toward practical ends. There is no clear dividing line between applied and basic research; basic research is aimed at increasing understanding, and applied research at utilizing this understanding to solve specific practical problems. The latter cannot long proceed without advances in the former. We are dealing with a continuum of understanding. Emphasis only on basic research would be a denial of the social value of knowledge. Emphasis only on applied research in medicine would quickly exhaust the present level of understanding and yield only inadequate solutions to major health problems.

At a time when the health needs of our entire nation are being rationally considered, it seems reasonable to expect a larger contribution by our biomedical scientists toward the solution

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