The Energy Spectrum of the Ion Beam in a Double-focussing Mass Spectrometer used for the Study of Organic Compounds

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IN order to separate the various unimolecular ion decompositions which give rise to the peaks in a mass spectrum "metastable peaks" are studied. A convenient and sensitive way of doing this is to study the spectrum of ion energies emerging from the electrostatic sector of a double-focussing mass spectrometer. The main beam of ions which have been formed within the ionization chamber enters the electrostatic sector with the full acceleration energy; ions which decompose after acceleration in the field-free region preceding the electrostatic sector possess only a fraction F of this energy. If m_1/e is the mass-to-charge ratio of the decomposing ions and m_2/e the mass-to-charge ratio of the fragment ions formed from them, then: $F = m_2/m_1$.

These ions can be made to pass through the energy resolving slit (the so called β-slit) by reducing the voltage across the electrostatic sector from its original value V to a new value FV. If the electrostatic voltage is continuously varied from V to zero, a spectrum of ion energies can be made to pass through the β-slit and the intensities of the ion beams of various energies recorded on a suitable collector.

We have constructed a device whereby an ion multiplier can be lowered into the ion beam passing through the β-slit of a Hitachi Perkin–Elmer type RMH-2 mass spectrometer.[1] The main ion beam in this instrument has a spread of ion energies of only about $\pm 0{\cdot}6$ ev at an accelerating voltage of 5 kv and with a narrow β-slit good energy resolution can be obtained. Source conditions are unaltered during scanning of the electrostatic sector voltage, so that good focussing is obtained throughout.

The fractional energy loss (and hence the fractional mass loss) for each focussed beam of ions passing through the β-slit is obtained directly. It should also be noted that if only part of the ion beam is intercepted by the ion multiplier, the remaining beam can be used to provide a mass analysis of the daughter ions of the decompositions by allowing them to pass through the magnetic sector and be collected in the usual way.

Complete abundance/mass/energy plots by this method will give much more detailed information about fragmentation processes than either the mass spectrum or the "metastable" peak spectrum alone and should extend still further the use of the mass spectrometer for structural diagnosis and for understanding the processes taking place during the decomposition of complex ions.

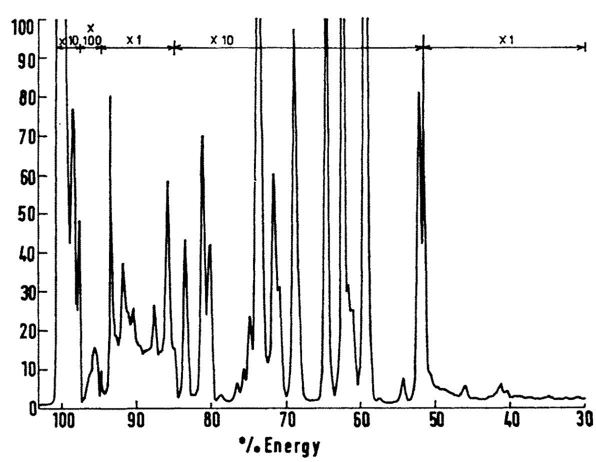

FIGURE. *Ion intensity against ion energy for n-decane. Over the regions of the spectrum marked* $\times 10$, $\times 100$ *the sensitivity has been reduced* 10 *and* 100 *times, respectively.*

An early spectrum of ion beams at the β-slit (that of n-decane) is shown in the Figure. It illustrates the wealth of detail apparent in the spectrum.

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[1] J. H. Beynon, W. E. Baitinger, J. W. Amy, and T. Komatsu, *Internat. J. Mass Spectrometry and Ion Phys.*, to be published.