Dipole Moment and Microwave Spectrum of Bromo-acetylene

THE electric dipole moments of the mono-halogen acetylenes are known to decrease to very small values as the electronegativity of the halogen decreases. The moment of bromo-acetylene, in particular, was reported to be indistinguishable from zero by Brockway and Coop¹. Although no estimates of possible errors were stated for this molecule, the accuracy of the methods was in general such that the error was not expected to exceed 0.01 D. Tyler and Sheridan² prepared and characterized iodo-acetylene, and were unable to detect its microwave spectrum in sensitive instruments, although the B_0 value assumed was subsequently proved to be correct by rotational Raman spectroscopy³. Hence it was concluded that the dipole moment of iodo-acetylene is not more than 0.05 D, perhaps much less. In view of the improbability that bromo- and iodo-acetylene should both possess such small dipole moments, we have examined the microwave rotation spectrum of bromo-acetylene. This spectrum proved easy to observe and indicated that the dipole moment of the molecule is more than 0.01 D.

The $J = 2 \rightarrow 3$ and $3 \rightarrow 4$ transitions were measured for ⁷⁹BrCCH and ⁸¹BrCCH, and the $J = 2 \rightarrow 3$ transitions for ⁷⁹BrCCD and ⁸¹BrCCD. High electrostatic fields were required, as expected, for the production of resolvable Stark effects in the lines of the molecular ground states, but well resolved splittings were observed at fields of several thousand volts per cm. The nuclear quadrupole fine-structures, which showed the expected second-order perturbations, were analysed to give the following spectroscopic constants.

Table 1

Molecule	B_0 (Mc/s $\pm$ 0.03 Mc/s)	eqQ of bromine (Mc/s $\pm$ 2 Mc/s)
⁷⁹ BrCCH	4,000.05	646
⁸¹ BrCCH	3,978.44	541
⁷⁹ BrCCD	3,655.11	646
⁸¹ BrCCD	3,634.98	541

Spectra caused by molecules excited in the bending-modes ω_4 and ω_5 were also easily observed, and distinguished by their much stronger Stark effects. The analysis of their overlapped fine-structures is in progress. Details of the Stark effects are being analysed to obtain accurate dipole moments in the ground- and vibrational-states. The preliminary indications are that the moment is of the order of 0.1 D.

The values of B_0 yield a substitution bromine-hydrogen distance of 4.051 Å. From the inertial contributions of the carbon atoms, and the mass-centre condition, the bond lengths are derived with less accuracy as: bromine-carbon = 1.784 Å, carbon-carbon = 1.216 Å, and carbon-hydrogen = 1.051 Å. They agree well with the electron diffraction data¹ and expectations based on results for related substances². The nuclear quadrupole coupling constants are very close to those found in methyl bromo-acetylene⁴.

The strength of the spectra indicates that work now in progress on species containing carbon-13 in natural concentration should lead to a more accurate complete set of bond lengths by the substitution method.

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RADIOBIOLOGY

Killing and Mutagenic Efficiencies of Heavy Ionizing Particles in *Arabidopsis thaliana*

THE killing and mutagenic effects of heavy ionizing particles, helium, carbon and argon, accelerated by an energy of 10.4 MeV/nucleon were investigated and compared with the effects produced by caesium-137 gamma-rays. The effects of heavy ions on several biological systems have been discussed by Brustad¹, Tobias² and by Deering *et al.*³.

Arabidopsis thaliana (L.) Heynh. was used in this experiment. Dry F_2 seeds obtained from F_1 hybrids between a hairless mutant (gl^1) and the wild hairy strain of race 'Landsberg' were subjected to gamma-rays and heavy ionizing particles. F_2 seeds were used because it is difficult to obtain many F_1 seeds⁴. Irradiation with heavy ionizing particles was carried out on a 'Hilac' machine¹, and the dose rate for all irradiations was about 4–5 krad/min. The irradiations were carried out in air; before the beam reaches the seeds, it has first to penetrate various absorbers the thickness of which is equivalent to 12.7 mg/cm² of aluminium. Dry seeds were subjected to a surface dose of 1–5 krad of helium-4 and carbon-12 ions and 3 and 5 krad of argon-40 ions with initial particle energies of 41.6, 124.8 and 416 MeV respectively. To compare relative biological effectiveness (RBE) and establish a standard, 27 and 47 krad gamma-ray exposures were given to the same material at an intensity of 10 krad/h using a 6 kc. caesium-137 source. The seeds were sown about 30 h after the gamma-ray treatment.

Germination and survival rates in the control and in the two portions irradiated by gamma-rays were very high, amounting to about 90 per cent. Survival rates decreased markedly with increasing dosage in the portions irradiated by heavy ions, especially those treated with helium ions. Survival rate in the portions irradiated by a 5 krad dose of helium ions was reduced to about half of that in the control portion. The decrease of survival rates in portions irradiated by carbon ions was not so severe, and was about 66 per cent in the portion receiving the highest dosage. On the other hand, 3 and 5 krad treatment with argon ions showed a slight decrease of survival rate (Table 1).

Table 1. SEGREGATION RATIO AND MUTATION RATES IN IRRADIATED F_2 POPULATIONS

Treatment (krad)	No. of seeds	Percentage of survivals	Hairy	Hairless	Expected No. of heterozygotes	No. of plants with hairless sectors (per cent)
Control	1,069	93.2	753	242	290	0
Caesium-137 γ -ray	28 1,878	89.9	1,304	384	869.4	3 (0.34)
"	47 1,498	90.9	1,025	336	683.4	8 (1.16)
Helium ions	1 1,089	72.9	626	168	417.3	0
"	2 992	71.5	521	183	347.3	1 (0.29)
"	3 1,107	56.6	473	154	315.3	0
"	4 1,084	69.2	574	176	382.7	0
"	5 950	47.6	334	118	222.7	0
Carbon ions	1 1,066	74.7	620	176	413.3	4 (0.97)
"	2 696	79.9	424	132	282.7	5 (1.77)
"	3 1,067	77.5	641	186	427.3	8 (1.87)
"	4 1,156	80.4	676	217	450.7	9 (2.53)
Argon ions	3 1,101	87.2	724	236	482.6	1 (0.20)
"	5 1,100	87.5	776	187	517.3	2 (0.38)

About 67 per cent of the hairy plants can be assumed to be heterozygotes for the hairy hairless allele pair, so to find somatic mutation from dominant hairy to recessive hairless we had to look among those plants. The number per individual of mutated hairless leaves or leaf sectors showed a variation. When a leaf or a part of a leaf was hairless it was scored as one mutational event occurring in the dominant hairy allele, without reference to the number of mutated leaves or sectors per individual, in order to compare the relative mutation rates. The rates calculated by this method may not be equivalent to the real mutation frequencies, but they are useful for comparing