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Chairman's Introduction

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The first significant experiment using the technique of accelerator mass spectrometry (AMS) was reported by Alvarez & Cornog in 1939. It was widely thought at the time that tritium, and not ^{3}He, was stable, and with that in mind Rutherford had asked Aston to search for hydrogen of mass three in a specially prepared water sample. The result was negative and Rutherford reported this in the last paper he wrote, which was published in *Nature* a few months before his death in 1937.

Alvarez realized that if ^{3}He, and not tritium, were stable then it should be present in ordinary helium, presumably at a low abundance level. He therefore fed helium into the ion source of the Berkeley 60 inch† cyclotron and soon demonstrated the existence of a 24 MeV beam corresponding to mass three and charge two, a unique combination. This identification was confirmed by a measurement of the range of the accelerated particles. Subsequently, Alvarez & Cornog showed that the abundance of ^{3}He in atmospheric helium was about ten times greater than in well helium, although their absolute abundances were rather lower than the currently accepted values.

In 1977, Muller pointed out explicitly the advantages of AMS in ^{14}C and ^{3}H dating and in particular the very high sensitivity that was possible. However, he also pointed out the difficulties that would arise from background contamination e.g. of ^{14}N ions when positive ions were used in conventional cyclotron operation. This background proved to be very difficult to overcome in the case of ^{14}C, but as shown later by Raisbeck, naturally abundant ^{10}Be could readily be detected with the help of a cyclotron.

The advantages of mass-spectrographic methods over the detection of the decay radiation from long-lived isotopes are well known, and it was pointed out in 1969 by Oeschger *et al.* that 'a more sensitive ^{14}C determination technique based on ... mass spectrometric detection' should be developed. Although attempts were made in 1972 to exploit the instability of negative ions containing nitrogen, success was not achieved until 1977 when a group of physicists from the Universities of Toronto and Rochester and from the General Ionex Corporation, and almost simultaneously a group from McMaster University, demonstrated, with the use of tandem accelerators, that the nitrogen negative ion was too unstable to interfere with the detection of ^{14}C at natural abundance levels.

The advantages of the tandem accelerator are as follows.

1. Because the first stage of acceleration requires negative ions, elements that do not form such ions are automatically eliminated.

2. Molecular complexes having the same mass as the ion it is desired to detect e.g. $^{12}CH_2^-$, which has the same mass:charge ratio as $^{14}C^-$, are broken up in the terminal stripper and eliminated.

† 1 inch = 2.54 cm.

3. The final ion energies are sufficiently high for the well-established single particle detection techniques well known in nuclear physics to be employed. Hence the high sensitivity.

These advantages have proved to be crucial, and almost all AMS work since 1977 has employed tandem accelerators.

Although large tandem Van de Graaff accelerators were used in the pioneering work, it was immediately apparent that a smaller accelerator could be used for ^{14}C dating. It was established experimentally at Oxford that a $^{14}C^{3+}$ beam could be readily detected for a terminal voltage in the range 2.0–2.5 MV, and this led to the construction of Tandetron accelerators by the General Ionex Corporation that are now in use in many different countries.

The advantages of AMS are not restricted to ^{14}C dating. Evidently, the longer the lifetime of the isotope concerned, the smaller is the specific activity and the greater is the advantage to be gained from a mass-spectrographic technique. We shall learn at this Meeting of many applications of AMS to the detection of long-lived isotopes that provide a time scale for many natural processes.

Following the talk on the fundamentals of the method by Professor Litherland, we shall hear from Professor Harris of the impact of these new techniques on archaeology and from Professor Oeschger of the impact on the Earth sciences. Dr Hedges will follow, and will tell us about recent Oxford results on ^{14}C dating and Dr Brown will discuss the importance of ^{10}Be measurements in the Earth sciences. Then Dr Henning will tell us about the application of AMS to the heavy elements where larger accelerators are needed.

Tomorrow, Dr Raisbeck will tell us about recent measurements with the dedicated tandetron at Orsay and Professor Gove will discuss results with ^{36}Cl and ^{129}I. Then Professor Middleton, whose important work on negative ion sources has laid the foundation for so much of AMS, will talk about ^{26}Al. We shall hear from Professor McKeown on a totally different topic, the attempts to detect fractionally charged particles such as quarks in Nature. Finally Dr Hurst, the inventor of resonance ionization spectroscopy, another very sensitive form of mass spectrometry, will tell us about recent results in that field, and Professor Hall will briefly summarize the outcome of this Meeting.

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