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A TEST OF TIME REVERSAL INVARIANCE THROUGH DETAILED BALANCE OF THE REACTION $^{12}C(\alpha,\gamma)^{16}O$

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The angular distributions of $^{12}C(\alpha,\gamma)^{16}O$ and its inverse $^{16}O(\gamma,\alpha)^{12}C$ have been measured at an excitation of 13.1 MeV where there is a strong asymmetry favouring the forward direction due to E1/E2 interference. The asymmetries for (α,γ) and (γ,α) were the same within one standard deviation, and reveal no evidence of a failure of time reversal invariance.

Evidence concerning time reversal invariance, T, has been sought through the detailed balance of the reaction

$$^{12}C + \alpha \rightleftharpoons {}^{16}O + \gamma \qquad (1)$$

at a γ-ray energy of 13.1 MeV. At this energy the angular distribution exhibits a strong back-forward asymmetry [1] due to the interference between overlapping resonance of opposite parity. A failure of T-invariance could appear as a difference between the back-forward asymmetry for $^{12}C(\alpha,\gamma)^{16}O$ and $^{16}O(\gamma,\alpha)^{12}C$.

This experiment provided a novel test of time-reversal invariance in a reaction involving the strong and electromagnetic interactions. The alpha-particle beam was provided by the Oxford Tandem and for the inverse reaction the photons were supplied by the AERE electrostatic accelerator IBIS.

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LETTERS TO NATURE

A new kind of natural radioactivity

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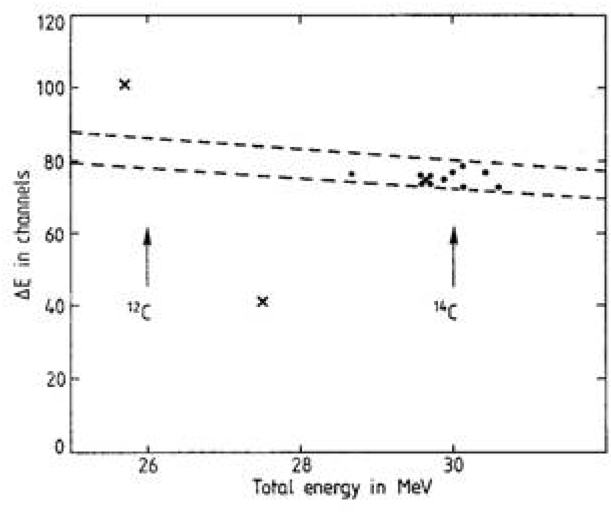
From a systematic study of the properties of nuclei heavier than lead, we have concluded that, in one or two cases, radioactive decay by emission of a particle heavier than the α-particle might be observable in competition with the latter. We have observed such decay in ^{223}Ra which occurs in the natural radioactive series emanating from ^{235}U. Two 'by-pass' modes seem likely: emission of ^{14}C, to ^{209}Pb, with a *Q*-value of 32 MeV; and of ^{12}C, to ^{211}Pb, with a *Q*-value of 28 MeV. (Emissions of ^{13}C and ^{15}C from the same nucleus have *a priori* emission rates similar to that of ^{12}C, but the emission of α-like nuclei seems more likely.) In this study we have used a solid-state counter telescope to identify the charge of the particle emitted, and, for greater convenience, a source of ^{227}Ac (half life 21 yr), with which the lower members of the series, including ^{223}Ra, are in secular equilibrium. We have observed particles identifiable as carbon ions and, from their energy and emission rate, they are ^{14}C rather than other carbon isotopes. The branching ratio for emission of ^{14}C nuclei relative to α-particles from ^{223}Ra is $8.5 \pm 2.5 \times 10^{-10}$, corresponding to a reduced width (preformation probability) smaller by a factor of $\sim 10^5$ to 10^6.



Measurement of the energy and energy loss in a thin detector confirms the signal as Carbon-14.

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Search for superheavy elements in Monazite by Rutherford backscattering

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Following publication of evidence suggesting that super-heavy elements with Z= 116, 124 and 126 may exist in monazite, this experiment searched for their presence in monazite down to the 1ppm atomic level using the technique of Rutherford back-scattering.

A beam of ^{32}S ions accelerated to 42MeV in the Oxford tandem van de Graaff bombarded samples of monazite sand and the back-scattered ^{32}S ions were detected at 165°.

Scattering from the primary constituents Ce, La, Th. and U is evident. The authors deduced an upper limit of 2 ppm for any super-heavy nuclei of A ≥ 354, corresponding to Z ~ 126.

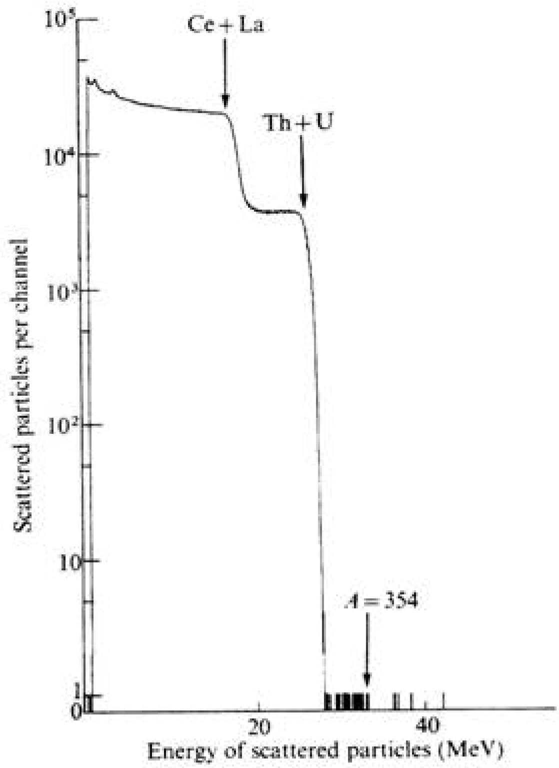

Fig. 1 Energy spectrum of ^{32}S ions of incident energy 42 MeV scattered from a target of powdered monazite sand observed at an angle of 165°. The edges correspond to scattering from the various constituents of the target (see text). An energy of ~24.5 MeV corresponds to channel 500 and there are an average of < 0.2 counts per channel in the region between the Th + U edge and the calculated position of the edge for *A* = 354.