undergo the same spontaneous strain and, therefore, the same spontaneous polarization as macroscopic domains do.

These effects can be accounted for by the assumption of a critical domain size between 1500A and 4000A (probably nearer to the lower limit). If a crystal of these linear dimensions is cooled below the Curie point, it could only polarize as a single domain.

If it is nonconducting and imbedded in a nonconducting medium of not too high permittivity, the depolarization factor is larger than the Lorentz correction. Therefore, no spontaneous polarization can take place. (This result is in contrast to the behavior of small ferromagnetic particles, where the depolarizing field is less effective, since the magnetic dipoles are aligned by interactions which are about 10^4 times larger than the ordinary dipole-dipole interaction.)

If, however, the ferroelectric crystal or the imbedding medium is a conductor (KD_2PO_4-colloid), the depolarizing field breaks down and the normal spontaneous polarization results.

Large crystals ($D \geqq 4000$A) can split up in two or more domains with a consequent reduction of the depolarizing field. Hence also in the nonconducting case spontaneous polarization is observed.

A full account of the present investigations will appear in the *Helvetica Physica Acta*. Similar experiments with ferroelectrics of $BaTiO_3$-type are in progress.

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Search for Natural Radioactivity of Calcium 48*

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It has been noted on several occasions[1,2] that Ca^{48}, which occurs to the extent of 0.18 percent in natural calcium,[3] has an exceptionally low proton-neutron ratio in comparison with stable nuclides in this region and accordingly, might be unstable. If this is the case, the absence of readily detectable natural radioactivity in calcium[4] would indicate a very long lifetime. On the other hand, empirical and theoretical indications that 20 protons and 28 neutrons both form closed-shell configurations would make the stability of ${}_{20}Ca_{28}{}^{48}$ plausible.

One of us[2] has pointed out that if Ca^{48} is beta-labile, it would transform to the well-known 44-hour Sc^{48} and that chemical extraction of the daughter from a large quantity of calcium would provide a sensitive method of detecting the activity of the parent. Negative results of such a test indicated that the half-life for decay of Ca^{48} to Sc^{48} must be at least 5×10^{15} years.[5]

Collins, Nier, and Johnson[6] have recently determined the mass of Ca^{48} as 47.96778 ± 10. There have been several measurements of the Ti^{48} mass[7,8] the latest[8] giving 47.96313 ± 6. Sc^{48} is reported to emit a simple beta-spectrum of 0.64-Mev maximum energy[9] and gamma-rays of 0.98 and 1.33 Mev in series.[10] Although there is a possibility of other gamma-radiation of lower energy,[10] this has not been reported by others,[11] and it is unlikely that its intensity could be sufficient for it to be assigned to the main mode of disintegration. Thus we take the $Sc^{48}\rightarrow Ti^{48}$ disintegration energy to be 2.95 ± 0.05 Mev. The $Ca^{48}-Sc^{48}$ mass difference is then $+0.00148\pm13$, whence the $Ca^{48}\rightarrow Sc^{48}$ transition is exoergic by 1.38 ± 0.12 Mev. Other Ti^{48} mass values[7] give energies between -1.8 and $+1.2$ Mev for this transition but with larger uncertainties. Both of the masses used above were obtained with the same instrument and the same reference ion, $C^{12}(H^1)_4{}^+$. A direct comparison of Ca^{48} and Ti^{48} would be desirable; since the packing fraction separation is nearly 0.9×10^{-4}, this should be feasible.

With this new indication of the instability of Ca^{48}, we have undetaken a more intensive search for the $Ca^{48}\rightarrow Sc^{48}$ transition. One hundred pounds of calcium nitrate, containing 9 kg of Ca, was dissolved to make a 45 percent aqueous solution. A small amount of $CaCO_3$ was precipitated with $(NH_4)_2CO_3$, filtered out, and dissolved in HNO_3. After refiltering, the solution was made alkaline with NH_4OH, which formed a visible precipitate, presumably because of small amounts of silicates leached from the glass vessels and carried down by the $CaCO_3$. This precipitate was separated on a sintered glass filter and dissolved in HNO_3. Barium was added and removed as the sulfate, and finally a small amount of calcium was added and precipitated as the oxalate. In separate experiments using Sc^{46} as a tracer, 80–90 percent recovery of Sc was obtained in the CaC_2O_4 precipitate.

The activities were measured by filtering the precipitates onto filter paper disks and mounting beneath the mica window of a conventional lead-shielded counter having a background of 25 counts per minute. Alternate sample and background counts were made for a week following separation. In several experiments no detectable amount of 44-hour activity was found. Small and variable amounts of shorter-lived activity were found in both the $BaSO_4$ and CaC_2O_4 fractions, but this could easily be accounted for by entrainment of natural radio-elements from the air during filtration of the large volume of initial solution.

We calculate a minimum half-life of 2×10^{16} years for the decay of Ca^{48} to 44-hour Sc^{48}. Accordingly,[12] if the energy available for this transition is 1 Mev or more, the logarithm of the comparative lifetime ft in seconds must be at least 24.8. This is greater than that for any observed beta-ransition, the largest known value being that of In^{115}, 22.6. The $Ca^{48}\rightarrow Sc^{48}$ transition is quite similar in both atomic number and energy to the $K^{40}\rightarrow Ca^{40}$ transition, for which the spin change is 4, but the lifetimes differ by a factor of at least 10^7. Thus the spin of Sc^{48} must be at least 5 and possibly greater; this is in agreement with the absence[9] of observable transitions from Sc^{48} to the ground state of Ti^{48}. Nordheim[13] has indicated that odd-odd nuclides commonly have large nuclear spins, as is the case for Lu^{176}, whose spin has been measured as $\geqslant 7$. A possible configuration for ${}_{21}Sc_{27}{}^{48}$ according to Nordheim's scheme involves a $f_{7/2}$ orbital for each odd nucleon, coupled so as to give a net spin equal or close to the maximum possible value of 7.

We plan to continue these experiments with larger amounts of calcium and more sensitive counters. We are also investigating the possibility that Ca^{48} might decay to Ti^{48} via a metastable excited state of Sc^{48}, by-passing the ground state of the latter. Unless this occurs with a half-life much shorter than the ground-state transition, it would appear that Ca^{48} possesses no geochronological value.[2]

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