PAPER ELECTROPHORESIS IN THE STUDY OF THE CHEMICAL EFFECTS PRODUCED DURING β DECAY OF ^{132}Te TO ^{132}I

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^{132}Te (77.7 h)–^{132}I (2.30 h) is an ideal system for the study of the chemical consequences of β decay[1]. It has already been investigated by several authors[1,2] by solvent extraction and precipitation experiments broadly involving the following steps: (1) addition of macroquantities of iodine in its several oxidation states to the solution of ^{132}Te in 0.1 N HNO_3 and allowing the mixtures to stand for 16 h for the growth of ^{132}I, (2) separation and purification of the carriers and (3) determination of the radioactivity of each fraction. The presence of strong oxidising agents, IO_3^- and IO_4^-, as carriers during the growth of iodine is undesirable. Secondly, even in the most recent method recommended for milking ^{132}I from ^{132}Te, a contamination of 0.1 μg of stable tellurium per milliliter of the product solution and $5 \cdot 10^{-3}$ % of radioactive tellurium has been reported[3]. The presence of tellurium is not desirable when iodine is meant for clinical purposes. In view of these problems we were led to search for an alternative method for the separation of the different oxidation states of iodine from one another without use of carriers and also from those of tellurium. The present paper reports the feasibility of paper electrophoresis for this purpose. This technique has already been applied to the study of the products of the Szilard-Chalmers reaction in various compounds[4–7].

EXPERIMENTAL

^{131}I and ^{132}Te solutions used in these studies were supplied by C.E.A. (Saclay, France).

For low voltage electrophoresis the usual glass plate technique described by LEDERER AND WARD[8] was employed. High-voltage electrophoresis was carried out by the method and with the apparatus described by GROSS[9]. Arches No. 302 paper strips were used for the separations.

The position of the ions on the inactive electrophoregrams was located by the help of suitable reagents. Radioelectrophoregrams were scanned by the Frieseke-Hoepfner FH 452 automatic scanner.

RESULTS AND DISCUSSION

Electrophoretic migration on paper of tellurite, tellurate, iodide, iodate, and periodate has been studied by LEDERER[10] and GRASSINI AND LEDERER[11]. The results of these authors as well as those of JACH *et al.*[6] on iodide, iodate and periodate indicate

that the periodate ion gives more than one spot with a comet extending up to the distance moved by iodate under the same conditions. This behaviour of periodate thus hampers the complete separation of iodate and periodate and will complicate the study of the system which interests us with two more ions, namely, tellurite and tellurate. We therefore thought it of interest to investigate first of all the cause of this behaviour of periodate ions and subsequently to develop a method to avoid its many spots and the comet.

(1) *Paper electrophoresis of periodate ion*

Periodate ion is an energetic oxidising agent in an acid medium. Its oxidising action becomes, however, mild and selective in an alkaline medium[12]. The results of our preliminary experiments with low-voltage electrophoresis showed that even in *N* NaOH IO_4^- gives two spots, one at the point of application and the other at the distance traversed by iodate under the same conditions, with a comet in between. This showed that during electrophoresis the periodate ion is partially reduced to iodate ion. In order to verify whether this reduction resulted from the cellulose of the paper as has already been suggested[12], we carried out the electrophoresis of periodate ion, in *N* NaOH, on Whatman GF/A glass-paper strips and on plaster of Paris plates. Electrophoregrams similar to those obtained on cellulose paper were again obtained. The possibility of the cellulose being responsible for the reduction of periodate during electrophoresis was thus eliminated. The other factors that could reduce IO_4^- were the heat generated during electrophoresis and the long duration of the experiment. Periodate ions are known to decompose under the action of heat and by aging in solution[12]. When we eliminated these two factors by using the high-voltage electrophoresis apparatus of GROSS where arrangements for cooling the paper strip had been made and the time of run of the experiment was reduced to about one-fifth of that necessary for low-voltage electrophoresis, the whole of periodate, applied as $^{131}IO_4^-$ or as inactive periodate, remained at the point of application (Fig. 1). Similar electrophoregrams were obtained when the concentration of the electrolyte was varied in the range 0.01–1.0 *N* NaOH.

When sodium chloride solution was used as electrolyte for high-voltage electro-

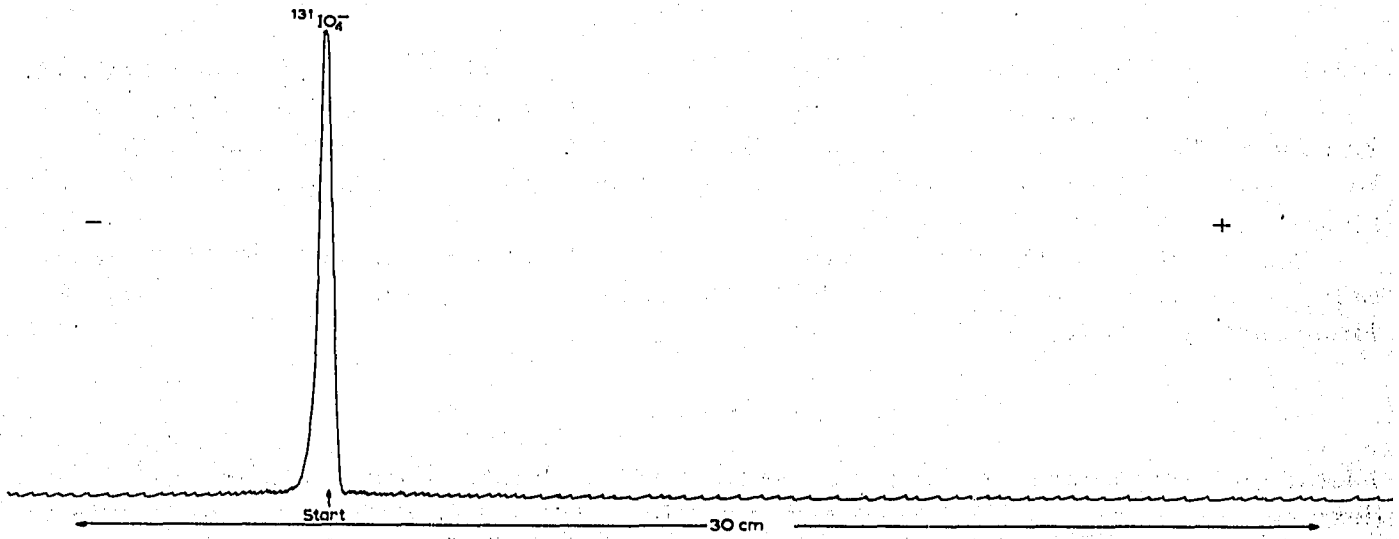

Fig. 1. High-voltage electrophoregram (1250 V, 15 min; *N* NaOH) of $^{131}IO_4^-$ on 4 cm wide paper.

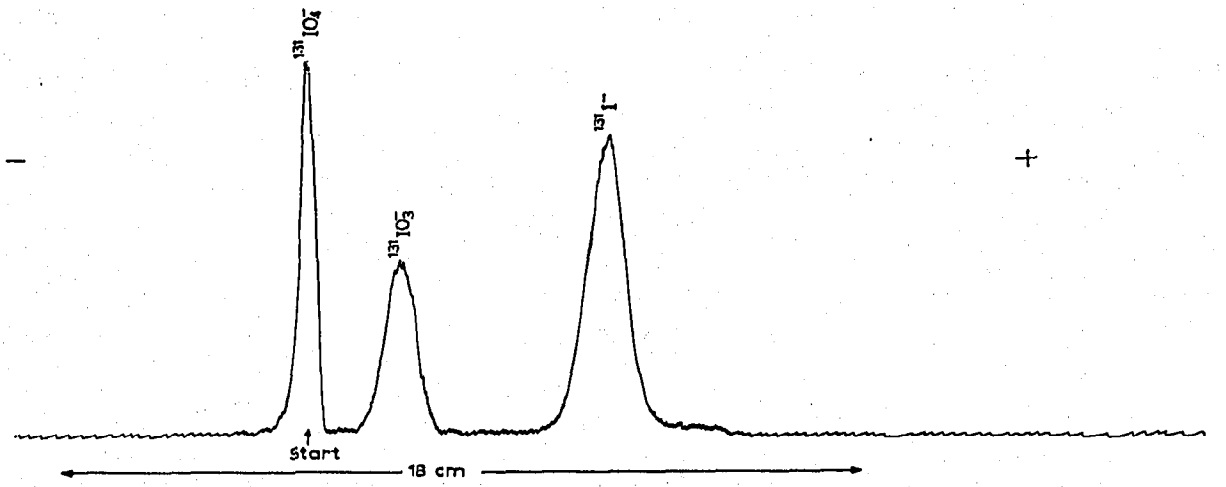

Fig. 2. High-voltage electrophoregram (1250 V, 15 min; N NaOH) of $^{131}I^-$, $^{131}IO_3^-$ and $^{131}IO_4^-$ on 4 cm wide paper.

phoresis, periodate ion remained at the starting point for concentrations lower than 0.5 N. In higher concentrations, and specially in 1.0 N NaCl, electrophoresis showed a faint anionic comet with its origin at the point of application where the major portion of the IO_4^- lay.

(2) *Separation of iodide, iodate and periodate*

Figs. 2 and 3 show the typical electrophoregrams obtained for $^{131}I^-$, $^{131}IO_3^-$ and $^{131}IO_4^-$ applied to the same strip. These ions could be separated very well by using sodium hydroxide as electrolyte in the range 0.01 to 1.0 N. In lower concentrations of the electrolyte the bands were somewhat wider but they were still far apart.

(3) *Separation of iodide, iodate and periodate from tellurite and tellurate*

The results of GRASSINI AND LEDERER[11] indicate that in 0.1 N NaOH, tellurate and periodate, and tellurite and iodate have electrophoretic mobilities of the same order. We found that increase in concentration of the electrolyte does not improve the

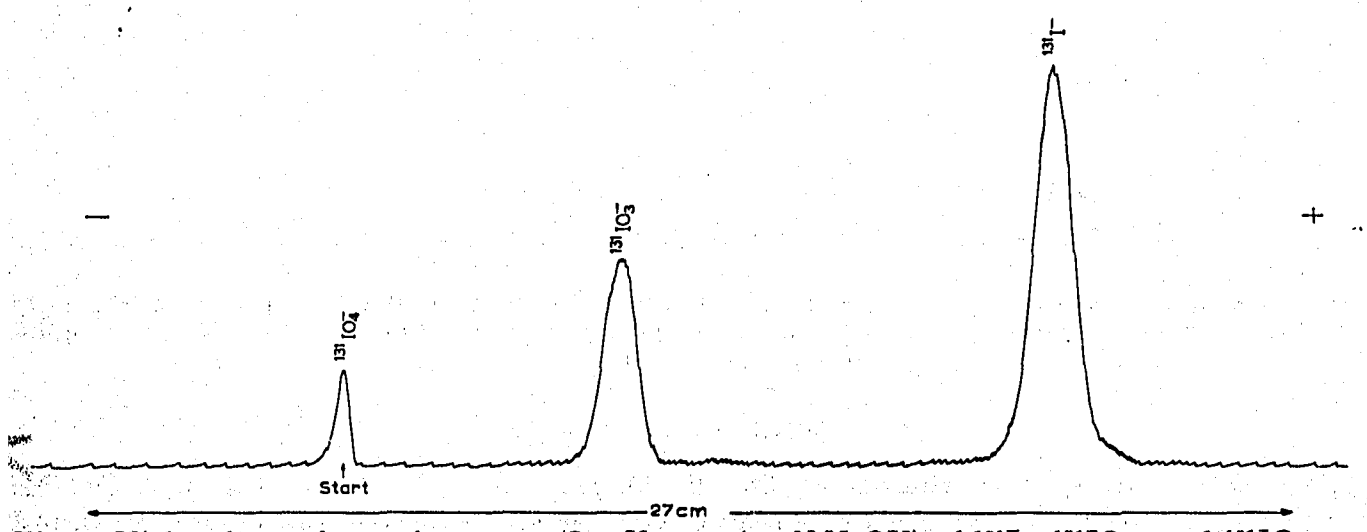

Fig. 3. High-voltage electrephoregram (800 V, 30 min; N NaOH) of $^{131}I^-$, $^{131}IO_3^-$ and $^{131}IO_4^-$ on 4 cm wide glass paper.

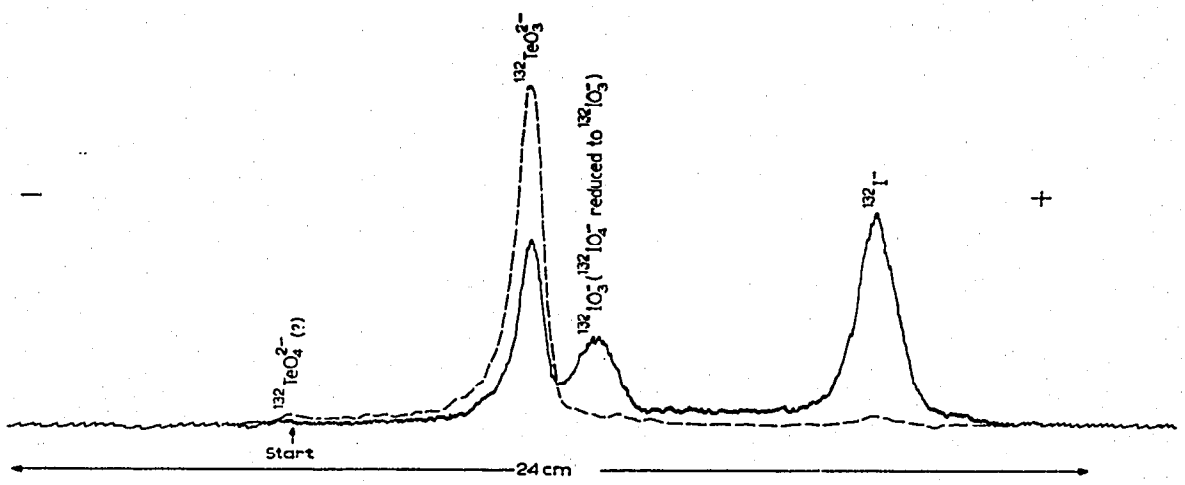

Fig. 4. Low-voltage electrophoregram (300 V, 1 h; $N/2$ NaCl) of alkaline solution of $^{132}TeO_3^{2-}$ in radioactive equilibrium with ^{132}I, on 2.7 cm wide paper. ——— after electrophoresis; – – – – – after 24 h.

separation of these two groups of ions. Electrophoresis in ammonium carbonate solution also does not show promise of their separation[10]. We attempted a separation by using sodium and potassium chloride solutions. Figs. 4 and 5 show the separations obtained with low- and high-voltage electrophoresis respectively. In low-voltage electrophoresis, periodate ion is reduced and moves as iodate while tellurate remains at the point of application. Therefore low-voltage electrophoresis can be used to separate tellurite, tellurate, (periodate + iodate), and iodide. In high-voltage electrophoresis, as we have already mentioned, periodate remains at the point of application. High-voltage electrophoresis in sodium or potassium chloride ($< 0.5\ N$) can therefore give the separation of tellurite, iodide, iodate and periodate in solution. It does not permit the separation of tellurate from periodate and is therefore not suitable for the study of the chemical effects of β decay when the starting substance is tellurate.

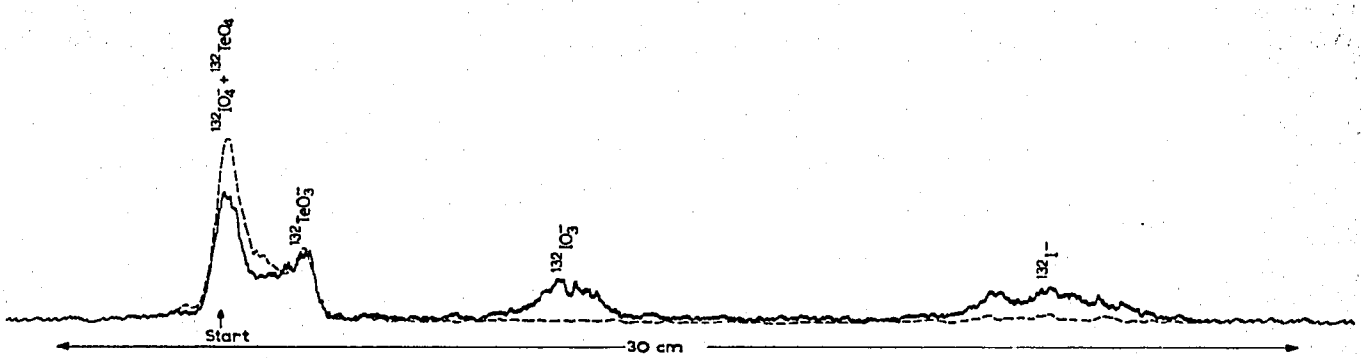

Fig. 5. High-voltage electrophoregram (3000 V, 15 min; $N/2$ NaCl) of alkaline solution of ($^{132}TeO_3^{2-}$ + $^{132}TeO_4^{2-}$) in radioactive equilibrium with ^{132}I, on 2.7 cm wide paper. ——— after electrophoresis; – – – – – after 24 h.

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SUMMARY

The low-voltage and high-voltage paper electrophoretic behaviour of iodide, iodate, periodate, tellurite and tellurate ions has been studied in sodium hydroxide and sodium chloride solutions used as electrolyte. Iodide, iodate and periodate can be very well separated in 0.01–1.0 *N* NaOH or in sodium chloride solutions of concentration less than 0.5 *N*. Simultaneous separation of iodide, iodate. periodate, tellurite and tellurate could not be realised. One could, however, obtain the following separations: tellurate, tellurite, (iodate + periodate), and iodide in NaCl by low-voltage electrophoresis, periodate, tellurite, iodate and iodide by high-voltage electrophoresis in sodium chloride (< 0.5 *N*).

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