The Isotopic Constitution of Lithium in the Sun

Recent experiments on the disintegration of Li^7 nuclei by impact with comparatively slow protons (possible disintegration has been observed at as low as 13,000 volts) suggest that this process might occur thermally at the temperature of the interior of the sun. If the temperature were 100,000,000°C, the mean kinetic energy of agitation would be equivalent to 10,000 volts and Li^7, in the presence of hydrogen, would be disintegrated with sufficient rapidity to have completely disappeared from the sun unless it is being continually replaced by some other process. The presumably more stable isotope, Li^6, on the other hand, should not be disintegrated and one might expect to find the relative abundance of this isotope greater than it is on the earth (6 percent).

An opportunity for deciding this question is offered by the large isotope shift of 0.15A in the resonance lines of neutral lithium at λ6707.8, which has been investigated by Hughes.[1] These lines, which form a very narrow doublet, are the only lithium lines found in the sun and occur there only in the spot spectrum. They are split by the magnetic field of the spot into a pattern which is between a Zeeman and a Paschen-Back effect and is therefore unsymmetrical; this splitting has been carefully investigated by Kent.[2] The wave-lengths of the zero-field Li^7 doublet have been accurately measured by King[3].

The microphotometer curve shown in Fig. 1 was made from a plate taken in the first order of the 75-foot grating on Mount Wilson and very kindly lent to the author by Dr. King. The plate has two exposures of the spot spectrum. both of which were microphotometered to make sure that none of the details of the line shape were caused by a chance defect in the emulsion. The spot was very near the center of the sun's disk; therefore the line of sight was nearly parallel to the magnetic field and only the perpendicular components of the Zeeman pattern had to be considered.

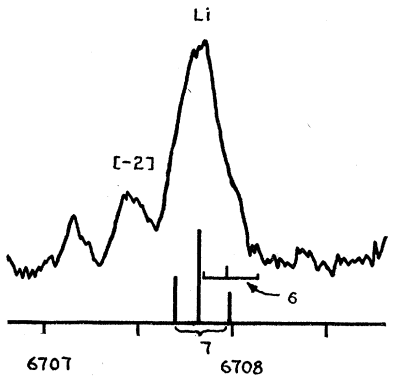

FIG. 1. Microphotometer curve of the lithium line λ6707.8 in the sun spot spectrum. Positions of Li^7 and Li^6 lines are shown below. No line is found in the disk spectrum at the position of the Li line.

The vertical lines drawn upward from the lower border of the figure are the components of the Li^7 line in a field of 3555 gauss, as observed by Kent. (The pattern is theoretically more complicated but it appeared as three lines with his resolving power, which is sufficient for our purpose. The fields of sun spots range from 3000 to 4000 gauss.) The components of the Li^6 line are shown above and to the right, their lengths relative to those of Li^7 being in the ratio of the terrestrial abundances.

It is immediately obvious that the whole observed line can be accounted for by the presence of Li^7 alone. The only evidence for the existence of Li^6 is a tiny hump in the position of the component farthest to the red, but this is no larger than the irregularity of the background, and may not be real. While we cannot definitely confirm the presence of Li^6, we can by assuming that this hump is due to Li^6, set an upper limit to its abundance. By a consideration of the Rowland intensities of the lines and from the calibration of the Rowland scale by Russell, Adams, and Moore,[4] we conclude that the abundance of Li^6 is less than 12 percent.

This result, that the relative abundance of Li^6 on the sun is certainly not much greater than on the earth, seems to indicate that the temperature of the sun's interior is lower than 100,000,000°C, that the low-velocity disintegration results are wrong, or that there is some other process producing Li^7 in the sun.

EDWIN MCMILLAN*

Department of Physics,
University of California,
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[1] Hughes, Phys. Rev. **38**, 857 (1914).
[2] Kent, Astrophys. J. **40**, 337 (1914).
[3] King, Astrophys. J. **44**, 169 (1916).
[4] Russell, Adams and Moore, Astrophys. J. **68**, 1 (1928).
* National Research Fellow.

Inability of X-Rays to Decompose Water

Measurements by Risse[1] did not show any decomposition of air-free water by x-rays. We have re-examined this problem with more accurate methods of analysis. Carbon dioxide, oxygen and hydrogen were determined by means of a Van Slyke apparatus, and hydrogen peroxide by electrometric titration, both methods being sensitive to about 1 micromol per liter. Air-free water was irradiated in glass sealed 20 cc Pyrex flasks with dosages up to 150 kiloroentgen. Hydrogen peroxide and oxygen were not found. A few micromols/liter of carbon dioxide and hydrogen were usually produced, but this amount did not depend on the dosage above a few kiloroentgen, and is ascribed to organic impurities. This view has been confirmed by a study of the action of x-rays on solutions of organic substances. It is concluded that pure air-free water is not decomposed by x-rays. This result, by its contrast to observations with radioactive rays, raises an interesting problem which we expect to investigate using α- and β-rays from radon under our experimental conditions.

HUGO FRICKE
E. R. BROWNSCOMBE

The Walter B. James Laboratory for Biophysics,
The Biological Laboratory,
Cold Springs Harbor, L. I., N. Y.,
July 22, 1933.

[1] O. Risse, Zeits. f. physik. Chemie **A140**, 133 (1929).