# THE STRUCTURAL RELATION OF THE RARE EARTHS TO THE PERIODIC TABLE

A. F. Reiter

The modified copy of Lothar Meier's Periodic table just placed in the hands of the audience is a part of this paper. It differs from the original table in four important particulars.

1. The series are extended to show more emphatically the difference between the more metallic elements of the (a) division terminating in the most non-metallic elements in the (b) division of each series.

2. Both the atomic weight and the atomic number is recorded for each element.

3. The number of electrons for the successive external electronic shells is given for each element. Where different shells have a variable number of electrons, that number is given which best shows the systematic variation from element to element.

4. All the above information is given for the rare earths elements and they are assigned to their respective relations to each other and other elements in a second transition group between groups 2a and 3a.

To the discussion of the fourth point of differences above mentioned this paper is limited.

First, attention is called to the varying number of electrons in the successive shells from inside to outside according to J. J. Thompson, which constitutes the number of electrons in the outer shell or outer shell but one, of group O, or of the inert elements; this number is $2 \times 1^2$ in He; $2 \times 2^2$ in Ne and A; $2 \times 3^2$ in Kr and Xc; $2 \times 4^2$ in Rn. Next, attention is called to the systematic change of the number of electrons in the outer and next to the outer shells in passing from group 7a through 8 to group 1b, or through the transition groups of series LV and V. These electronic shells are: for Mn, 2-8-8-7; Fe, 2-8-14-2; Co, 2-8-15-2; Ni, 2-8-16-2; Cu, 2-8-18-1; which changes only in the external shell to Kr, 2-8-18-8. In series V the corresponding elements are Ma, 2-8-18-8-7; Ru, 2-8-18-14-2; Rh, 2-8-18-15-2; Pd, 2-8-18-16-2; Ag, 2-8-18-18-1, which changes only in the external shell through the rest of series V, terminating in Xe, 2-8-18-18-8. The change in the two outer shells in passing through group VIII in these two series is abundant justification of calling group VIII a transition group and the elements of the group, transition elements.

Next let us observe the rare earth elements. Their atomic numbers from 57 to 70 inclusive assigns them a position between Ba No. 56 and Lu No. 71, in series VI. Series I terminates in He with an external orbit of 2; Series II and III terminate respectively in Ne with 8 ad A with 8; then follow series IV and V terminating respectively in Kr with 18 and Xe with 18 in the outer orbit but one. Thus far after passing the first short series there are two series of a kind in the general structure of the orbits.

Series VI therefore to preserve the symmetry of the periodic table should terminate in the outer shell but one having $2 \times 4^2$ electrons. Since the rare earths have a uniform low valence of two they fit by their valence properties in a new transition group between IIa and IIIa, with shell structures as follows:

| | | |
|---|---|---|
| La, 2-8-18-18- 9-2; | Ce, 2-8-18-18-10-2; | Pr, 2-8-18-18-11-2; |
| Nd. 2-8-18-18-12-2; | Il, 2-8-18-18-13-2; | Sm, 2-8-18-18-14-2; |
| Eu. 2-8-18-18-15-2; | Gd, 2-8-18-18-16-2; | Tb, 2-8-18-18-17-2; |
| Dy, 2-8-18-18-18-2; | Ho, 2-8-18-18-19-2; | Er, 2-8-18-18-20-2; |
| Tm, 2-8-18-18-21-2; | Yb, 2-8-18-18-22-2; | |

From this element on through the VIII group transition elements increasing by one from element to element if we continue the outer orbit at two which corresponds with the low valence of these elements until Pt, 2-8-18-18-30-2, the group 1b has Au, 2-8-18-18-32-1. From here to the end of the series the 32 shell persists and the outer shell increases by one from group to group terminating the series with Rn, 2-8-18-18-32-8.

In series VI all elements following Ba and terminating in Pt constitute in reality a single transition group between Ba and Au. However, there is probably sufficient likeness between Lu to group IIIa and of the following elements to the groups following to which they have been assigned to warrant their continuance in these groups for the present at least.