As to those ends, they are to be found in the charter of 1662; here are the words of our founder, Charles II.:

"... we look with favour upon all forms of learning, but with particular grace we encourage philosophical studies, especially those which by actual experiments attempt to shape out a new philosophy or to perfect the old."

So the King founded the Royal Society, enjoining on the fellows and their successors that their "studies are to be applied to further promoting by the authority of experiments the sciences of natural things and of useful arts".

These are the ends for which the Society was founded, and its long record shows how brilliantly it has set itself, and still continues, to achieve them, working as a band of fellows.

It happens that on the morning of Friday, March 4, before I had seen Dr. Campbell's letter in NATURE, I wrote a brief note to one of those whose names appeared in that morning's *Times*, congratulating him that I could now claim his help, not as that of a kind friend, but as a brother fellow; and that, I believe, represents the feelings of the fellows towards their colleagues.

Of course, fellows do recognise it as their duty and privilege to serve their humbler colleagues. *Noblesse oblige* is their motto, and as a senior member of the Society, I claim that it is still animated by the spirit of its founders, and does care far more for the welfare of science than for the dignity of its fellows.

R. T. GLAZEBROOK.

Ballards Oak,
Limpsfield, Surrey.

Complex X-Ray Characteristic Spectra

IT is well known that for the excitation of the characteristic X-ray spectra of elements, an electron has first to be removed from some internal level; when this is done, an electron from an outer level jumps to this vacant place, and characteristic radiation is emitted. The spectrum is called K, L, M ...... according to the level of the atom from which the electron was first removed.

This explanation suffices for the origin of the diagram lines, which show the same structure as lines due to alkalis, but there are, besides, other lines, the origin of which is still a matter of debate. Some of these have been traced to forbidden transitions;[1] but in addition, there are the so-called spark lines, which appear as faint satellites to the diagram lines. Hypotheses[2] have been advanced which ascribe these to double ionisation and single transition.

In this note we wish to direct attention to the existence of a third class of characteristic lines, which are due to *double ionisation and double transition.* Suppose in one single act of bombardment of the anticathode by electrons, two electrons are removed simultaneously from an internal level, say one from L_1, the other from L_2, and these places are filled up by simultaneous passage of electrons from higher levels, say one from M_1, the other from M_3. It can be shown from quantum principles and from analogy with optical spectra that one of the transitions will be allowed, the other forbidden, so that in the above example the transition may be written as $(L_1L_2 \longleftarrow M_1M_3)$; it is a composite transition and is the sum of the two transitions (1) $L_2 \longleftarrow M_3$, which is allowed, and (2) $L_1 \longleftarrow M_1$, which is forbidden. Lines due to such transitions are quite common in optical spectra: for example, in the case of Ba $6s^2\,{}^1S_0 - 5d\,.\,6p\,.\,{}^1P_1$ $\lambda 3501{\cdot}1$ cited by Russell and Saunders[3] in their classical paper on the spectra of alkaline earths.

There is no reason why double transitions should not occur in the X-ray region. But *their frequency will be approximately* double the frequency of the usual L-lines, and since the electron configuration in this case is $2s\,.\,2p^5 \longleftarrow 3s\,.\,3d^9$, the lines will form a multiplet $({}^1P,\ {}^3P) \longleftarrow ({}^1D,\ {}^3D)$, provided Russell-Saunders coupling continues to hold in such cases. *The fact that their frequency will be double the usual L-spectrum frequency marks them out as a distinct class.*

Attempts have been made in this laboratory to obtain such lines from a tungsten anticathode, and two lines have been obtained with the wave-lengths $\lambda = 723$ and 682 X.U. They are diffuse lines impressed on a continuous background, and may be found to be attended with satellites when higher resolution is used. These wave-lengths are approximately half the wave-length of tungsten L-lines. After searching the literature to determine whether such lines have been noticed by any previous worker, we find that Rogers[4] noted in 1923 the following lines from tungsten: $\lambda = 1450$, 1373, 1321, 1248·7, 1230, 1114, 1086 X.U. These have not been traced to the tungsten levels, or identified as satellites or non-diagram lines, and cannot be ascribed to any other element. But it will be seen that the wave-lengths of the first two of Rogers' lines are very nearly double the wave-length of the lines obtained by us. Hence it may be safely concluded that the lines obtained by Rogers are the same double transition lines obtained in the second order.

The full multiplet will be dispersed over a large wave-length range, and, with our present apparatus, such long exposures (amounting to a hundred hours) are needed that considerable time must elapse before the whole set of lines can be photographed. But the fact that double L-frequency lines have been obtained at all indicates that the ideas presented here are essentially sound.

We think that we have established the possibility of getting double transition lines constituting complex spectra in the X-ray region. To get double transition or multiple transition lines due to all elements will be a vast programme, but when this is done, it will probably afford us very useful material for working out coupling problems inside the atom. The idea probably explains the numerous critical levels obtained by Richardson and his students: for the most part, these levels have no apparent connexion[5] with the recognised X-ray levels which give rise to the diagram lines. This fact is at present inexplicable; but supposing the quantum theory can be adopted to explain the fact, then combining this with the ideas presented here, we find that we get an unforced explanation of the numerous levels obtained by Richardson, and need not give up the Bohr-Stoner levels (cf. Richardson[6]). The J-phenomenon also does not appear to be so inconceivable, as according to our views we may have characteristic lines approximately double the frequency of ordinary K-lines.*

M. N. SAHA.
SALIGRAM BHARGAVA.
J. B. MUKERJI.

Department of Physics,
University of Allahabad, Feb. 5.

[1] S. Idei, *Sci. Reports Tôhoku Imp. Univ.*, **19,** 560.
[2] B. B. Ray, *Phil. Mag.*, **8,** 772; 1929. Langer, *Phys. Rev.*, **37,** 457; 1931.
[3] Russell and Saunders, *Astro. J.*, **61,** 38.
[4] Lindh, "Handbuch d. Experimentalphysik", xxiv/2, p. 172.
[5] Chalklin, *Sci. Prog.*, Jan. 1932, p. 437.
[6] Richardson, *Proc. Roy. Soc.*, A, **128,** 63; 1930.

* The following cablegram dated Feb. 29 has been received from Prof. Saha:

Double transition K-line approximately double frequency K-alpha three obtained copper.—SAHA.