in the atom, but remain bound to it. The frequencies of the radiations scattered by the atom would be

$$\nu' = \nu - \frac{E_l - E_k}{h},$$

where ν is the incident frequency, E_k is the energy of the initial level and E_l of the final level of the electron. When E_l is positive, it may have an arbitrary value, and, as has been shown by Wentzel and others, the scattered radiation is of the Compton type, in which the change of wave-length depends on the direction of observation. On the other hand, when E_l is negative, the electron remains bound to the atom, and we have a type of X-ray scattering completely analogous to that observed in the optical case. The frequency of the Raman type of X-ray scattering is independent of direction and is as sharply defined as that of the unmodified radiation.

Experiments to observe the new type of X-ray scattering here indicated have been in progress at Calcutta for some time. Meanwhile, results have been reported by Bergen Davis and Dana Mitchell (*Phys. Rev.*, vol. 32, p. 331 ; 1928) which may be regarded as a demonstration of its existence. Studying the scattered radiation from graphite excited by molybdenum $K\alpha_1$, they found three new lines the frequencies of which differed from that of the incident radiation by amounts corresponding to changes of energy level of the scattering electron by 279, 57, and 34 volts respectively. The first and the last may be identified with the transition of an electron from the K and L_1 levels respectively, to a level of very loose binding to the carbon atom. The radiation corresponding to a change of energy of 57 volts may be identified with the case in which both the L_1 electrons are shifted outwards. The latter supposition is not unreasonable in view of the well-known existence of double excitation in connexion with spark lines in the X-ray region of the spectrum.

K. S. KRISHNAN.

210 Bowbazar Street,
Calcutta, Oct. 25.

X-ray Studies on the Nitrides of Iron.

SINCE the two communications to NATURE of May 26 and Sept. 1, 1928, with the above title were written, I have done some more work on the nitrides with the highest nitrogen content attainable.

In the first communication it was mentioned that some of the lines in the photogram of a preparation with 11·3 per cent nitrogen (mean of three new analyses 11·23 per cent) were split, and the conclusion was drawn that this probably was due to the fact that the preparation consisted of two parts with different nitrogen content.

It has now been found that all preparations with maximum nitrogen content give exactly the same photograms, and it can be shown that these photograms are caused by a new phase ζ. In this phase the iron atoms form an orthorhombic lattice with the elementary dimensions $a = 2{\cdot}758$ A., $b = 4{\cdot}819$ A., and $c = 4{\cdot}419$ A. The co-ordinates 0 0 0, 1/2 1/2 0, 1/2 1/6 1/2, and 0 2/3 1/2 reproduce the observed intensities very well. These positions are quite analogous to those in an orthohexagonal cell of close-packed atoms, and the dimensions of this orthorhombic cell are also very similar to the dimensions of the orthohexagonal cell of the ϵ-phase at its highest limit of homogeneity, at about 11 per cent nitrogen. There exist consequently very close relations between the ϵ- and the ζ-phases, the nature of which still remains to be determined.

Owing to the evidently very limited homogeneity range of the ζ-phase, and the fact that its composition practically coincides with the formula Fe_2N, it is most probable that the ζ-phase is the nitride Fe_2N. The nitrogen atoms, therefore, probably occupy definite places in the lattice, though nothing in the photograms indicates this. This can, however, be explained by the small atomic number of the nitrogen.

Three Fe – N phases therefore evidently exist in the concentration range now investigated. The first, Fe_4N, has the cubic structure described before (also independently found by R. Brill; see *Z. f. Krist.*, **68**, 379; 1928). The second is the ϵ-phase with a homogeneity range of about 8 to 11 per cent nitrogen and a hexagonal close-packed arrangement of the iron atoms. The third, ζ, is probably Fe_2N. Its iron atoms are arranged in an orthorhombic lattice, very similar to a hexagonal close-packing. It has not been possible to determine the positions of the nitrogen atoms in the two last phases.

GUNNAR HÄGG.

Institute of Metallography,
Institute of General and Inorganic
Chemistry of the University,
Stockholm, Nov. 21.

Action and Reaction in Rotary Motion.

A BICYCLE wheel, loaded at the rim, is placed upon an axle about four feet in length. This axle passes vertically through a hole in the centre of a rotating stool and is fixed rigidly to the stationary pedestal of the stool. A man standing upon the rotating stool can now set himself in rotation in one direction by turning the bicycle wheel in the opposite direction. A more striking demonstration can be given when the axle of the bicycle wheel is not fixed to the pedestal but rests upon the rotary part of the stool. In this case the man stands upon the stool grasping the axle of the bicycle wheel and holding it vertically in his left hand. With his right hand he sets the wheel in rotation (clockwise), and he necessarily rotates with the stool in the opposite sense (anti-clockwise). By applying the palm of his hand to the rim of the bicycle wheel, the man can stop his own rotation and that of the wheel at the same time. If a second man standing upon the floor stops the rotation of the man on the stool, the latter can again start himself in rotation by taking energy from the bicycle wheel. In a complete analysis of these rotations, friction in the bearings of the rotating parts must be taken into account.

R. C. COLWELL.

West Virginia University,
Morgantown, W. Va.

Plant Growth in a Cheddar Cave.

GOUGH'S Cave at Cheddar, Somerset, is illuminated by electric light in those parts which are shown to the public. Within a radius of about six feet from almost every electric bulb (of the ordinary gas-filled type) the rock or clay is covered with a growth of green plants. At some points there is only a film of *Protococcales* ; at others the growth is more luxuriant and consists of mosses, liverworts, fern prothalli, and ferns. At a point about a quarter of a mile from the entrance of the cave there is growing a plant of the Hart's Tongue Fern (*Scolopendrium vulgare*) about eighteen inches in height.

We are informed that this growth of plants has only been noticed in the cave since the former 60 candle-power lamps were replaced by 120 candle-power lamps about two years ago.

L. HARRISON MATTHEWS.
J. E. HAMILTON.

37 Cornwallis Crescent,
Clifton, Bristol,
Dec. 8.