of a heavenly body by variations in the refrangibility of the rays which it emits—motions often impossible even to detect by any other means. I therefore deem it proper that I should proceed to state the delicate conditions on which depend the perfection of experiments which so satisfactorily elucidate the nature of those grand and refined problems offered to spectral observation.

It is, first of all, essential that forks 1 and 2 should really be in unison. Two forks, sounded together, may give no perceptible beats, for they may constrain each other into a common forced oscillation, and thus both will give the same number of vibrations, yet may be removed from equality when separately vibrated. The process I have adopted is as follows: Three forks are taken which are supposed to give the same number of vibrations in a given time. They are supported on india-rubber tubing, and are thus insulated. One of the forks is now loaded so that it gives two or three beats in a second, with one of the other two that are to be brought into exact unison. The interval of time occupied by twenty or thirty of these beats is accurately determined by means of a chronograph (one of Casella's registering stop-watches does very well). The interval occupied by the same number of beats given with the second fork is now ascertained, and if it differs from that given by the first, the quicker vibrating fork is made to give the same number of beats as the slower by loading it with wax. When the forks have thus been carefully adjusted, I have had no difficulty in projecting the ball, in Exp. 1, at a distance of sixty feet, and I believe that it could have been accomplished at a distance of 100 feet. The ball of cork should be *spherical*, so that it will always just touch the fork, no matter how much it may rotate around its suspending thread, which latter should consist of only one or two fibres of unspun silk. The cork is rendered as smooth as possible and is then *varnished*; this is important, for the varnish gives a firm coating to the ball, without sensibly increasing its weight, and is especially useful in covering the minute asperities or elastic projections on its surface, which otherwise would act as "buffers" to the impacts of the fork and deaden its projectile effects.

The above-stated conditions having been obtained, no physicist will have any difficulty in repeating these experiments.

A machine has been devised by which a uniform motion of translation can be given to the forks, and with this I propose making a quantitative investigation of the phenomena, using an apparatus essentially the same in its action as the one here described.

We may substitute for the suspended cork-ball a light plane mirror, held between two stretched vertical fibres, while one of its edges touches the fork. The motions of a beam of light reflected from the mirror to a screen, indicate most beautifully the vibrations of the fork. This ingenious and most delicate device for detecting vibrations is due to Prof. O. N. Rood, of Columbia College, N.Y., who first used it in a public lecture, delivered in New York on the 28th of last December. We have, however, in our special work, found the image of the projected ball more convenient, and sufficiently delicate, for our experiments.

Quantitative relations in the experiments and analogical facts in the phenomena of light.

The UT_3, No. 1 fork, makes 256 complete vibrations in one second, while fork No. 3 makes 254, giving for the respective wave-lengths of these vibrations 4·367 and 4·401 feet, which we will designate in order as λ and λ'. We will take 1,118 feet per second as the velocity of sound at 60° F.

Now 256 vibrations in 1,118 ft. make $\lambda = 4{\cdot}367$ ft.
and 254 „ „ $1{,}118 - 2\lambda\,(=1{,}109{\cdot}266)$ give $\lambda = 4{,}367$ ft.

As the velocity of propagation of the vibrations and λ are the same in both cases, it follows that $\left(n = \frac{V}{\lambda}\right)$, the number of vibrations in a second, reaching a distant point, is the same, and, therefore, 256 vibrations from a body at rest will produce the same effect on a distant surface, as 254 vibrations emanating from a body which moves toward that surface, with a velocity of 2λ, or of 8·734 feet per second; and this is the velocity we gave the fork in Exps. 6 to 9.

We will now examine the analogical phenomena in the case of light. Let fork No. 1, giving 256 vibrations a second, stand for 595 millions of millions vibrations a second, which we will take as the number of vibrations made by the ray D_1 of the spectrum. Then fork No. 3 will represent 590 millions of millions vibrations per second, which gave a wave-length ·0000042 millimetre longer than that of D_1, and nearly corresponds with an iron line situate ·42 div. below D_1 on Angström's chart. We saw that fork No. 3, giving 254 vibrations a second, had to move toward the ear with a velocity of 8·734ft., to give the note produced by 256 vibrations per second, emanating from a fixed point; so a star sending forth the ray which vibrates 590 millions of millions times a second, will have to move toward the eye with a velocity of 28,470 miles per second to give the colour produced when ray D_1 emanates from a stationary flame.

SCIENTIFIC SERIALS

Annalen der Chemie und Pharmacie, October 1871. Naumann has made a long series of experiments on the dissociation-tensions of ammonic carbonate, he finds that when it is volatilised it is entirely decomposed into ammonia and carbonic anhydride, and that for lower temperatures the dissociation-tensions of this body increase by increase of temperature precisely as the tensions of other substances. Leist has obtained three compounds of bismuth oxide with sulphuric acid, all of which are basic salts, he has not been able to form the normal salt except in combination with potassium. Faust has made a series of experiments on the derivatives of phthalic acid, he has obtained nitrophthalic, bromophthalic, and dechlorophthalic acids. Faust and Saame have made a careful examination of the chloro-compounds, both addition and substitution of naphthaline: this work has already been performed many years ago by Laurent; the authors have thought fit to commence a revision of the subject, but it is as yet far from complete. A very long paper by Schutzenberger follows "on the acetyl derivations of carbo-hydrates, mannite and its isomerides, and on certain vegetable products," this contains some interesting though complicated results. A translation of Dr. Mills' paper on the nitration of chloroform, and two other papers of less interest complete this number.

Annales de Chimie et de Physique, March 1872.—The greater portion of this number is occupied by the second part of MM. Pierre and Puchot's researches on some of the bodies produced in fermentation. They give the results of a very detailed study of propylic alcohol, its haloid ethers, the formiate, acetate, propionate, butyrate, and valerate, and propylic aldehyde; butylic alcohol and the same series of ethers as above, and amylic alcohol with its butyrate and valerate. Besides these we have the detailed description of several other ethers, methyl valerate, and ethyl propionate and valerate, forming altogether a very complete and exhaustive monograph on these subjects. The author has also made some interesting observations on the "simultaneous distillation of water with certain alcohols insoluble therein." Thus a mixture of water and amylic alcohol, when submitted to distillation, boils at 96°, and a definite proportion of the two bodies is found in the distillate, at this temperature 2 parts of water and 3 of amylic alcohol invariably condense; should the water be in excess the whole of the amylic alcohol will pass over, the thermometer remaining at 96°. Butylic alcohol and water distil over at 90·5° when a constant mixture of 5 parts of alcohol and 1 part of water condenses.—M. Bourgoin has electrolysed a solution of potassic phthalate, and finds that it splits up into water, carbonic oxide, and carbonic anhydride, an aqueous solution of phthalic acid does not appear to be decomposed by the electric current.

THE *Scottish Naturalist* for April contains a number of short articles on various branches of Scottish Natural History. Among the more interesting may be mentioned especially a note by Dr. Buchanan White on the discovery in Braemar of a colony of *Zygæna exulans*, a common moth in the Alpine districts of Southern Europe and in Scandinavia, but hitherto unknown in Britain. Dr. White considers it, like some of the characteristic plants of the district, a relic of the glacial epoch which once overspread Scotland; its characters are intermediate between the northern and southern forms.—Mr. George Sim contributes an important paper, comprising a list of the stalk-eyed Crustacea of the north-east coast of Scotland, with descriptions of new genera and species, and a plate.—The instalment of the catalogues of Insecta Scotica includes a continuation of the Lepidoptera by Dr. Buchanan White, and the commencement of the Coleoptera by Dr. D. Sharp.