WAVE-LENGTHS OF SILICON LINES.—Supplementing his recent work on the wave-length of the magnesium line at λ 4481, Prof. Hartmann has now redetermined the wave-lengths of the two silicon lines at λ 4128 and λ 4131, and has published his results in No. 1, vol. xviii. of the *Astro-physical Journal*.

These two lines, which are of great importance in the discussion of stellar spectra, generally appear broad and hazy in laboratory spectra, but, by photographing the spectrum of Geissler tubes containing silicon tetra-fluoride at low pressure, Prof. Hartmann has obtained them as sharply defined lines, from measurements of which he has obtained 4128.204 and 4131.040 as their respective wave-lengths, these values being based on Kayser's wave-lengths for three iron lines, viz. λ 4118.709, λ 4132.217 and λ 4144.933.

By similar means he has redetermined the wave-length of the carbon line at λ 4267, and gives 4267.301 as its exact value.

THE ECLIPSE OF THE MOON, APRIL 11-12.—In the July number of the *Bulletin de la Société Astronomique de France* a large number of photographs of this eclipse, obtained by various correspondents of the society, are reproduced. The photographs were obtained with many various instruments, and they, together with the remarks accompanying them, emphasise the exceptional density of the earth's shadow during this eclipse.

A METHOD OF APPLYING THE RAYS FROM RADIUM AND THORIUM TO THE TREATMENT OF CONSUMPTION.¹

THE successful results reported in the treatment of rodent cancer by the rays from radium, and the general germicidal action of the rays, make the discoveries and investigations by Prof. Rutherford of the radio-active emanations of radium and thorium of great possible importance to medical men. The present article deals with the manner in which these emanations can be inhaled into the lungs and be made the means of applying the rays from radium and thorium to the treatment of consumption, in the hope that medical men will be induced to undertake research in this field. The rays from radium and thorium are very similar in kind, but differ greatly in relative degree. Five minutes' application of radium would be about equivalent to ten years' application of the same weight of thorium. Both elements continually and spontaneously produce radio-active emanations, or gases in infinitesimal quantity, beyond the present means of chemical or spectroscopic detection, but endowed with very considerable powers of giving out rays on their own account of exactly similar kind to the rays from radium and thorium themselves. The best condition for the free escape of these emanations, so that they can mingle with the air the patient breathes, occurs with both radium and thorium compounds when they are dissolved in water. In the solid state the emanations are often stored up by the salt and do not escape. Three-quarters of the normal activity of a dry solid radium compound is due to the stored up emanation. This escapes into the air instantly when it is dissolved in water.

If the air containing the emanation is removed and stored in a gas-holder away from the radium, the quantity slowly diminishes, and the radium solution grows a fresh crop as fast as the old disappears. In four days one-half of the emanation removed has disappeared, and one-half has reappeared in the vessel containing the radium solution, provided, of course, that it has been closed air-tight in the interval. After about three weeks the amount of the old emanation remaining is negligibly small; the amount reformed is a practical maximum, the same as was originally obtained on dissolving the solid salt. In the case of thorium one-half of the emanation disappears or is reproduced, as the case may be, in one minute. In five minutes the old emanation has practically all disappeared, and the thorium solution, if kept in a closed bottle, again contains as much as it ever did or can contain. In three weeks for radium, and in five minutes for thorium, an equilibrium in the amount of emanation present is reached, as much dis-

appearing as is reproduced, in the same way as the population of a country remains constant when the number of births in any given time equals the number of deaths.

These considerations regulate the "dosage." The longer a patient breathes through a thorium solution the greater the dose of emanation. With radium, however, once the emanation has all been inhaled, no further effect is produced, and the solution must be left tightly closed to recover its emanation before it can again be advantageously used. Further, in dealing with the thorium emanation, it is essential that the air should reach the patient's lungs within the shortest possible time, say half a minute, after leaving the thorium solution.

The property of the emanations of leaving behind a film of radio-active matter wherever they come into contact, which causes the phenomenon of "excited" or "induced" radio-activity, is important in the present connection, because this excited activity will remain in the air-cells of the lungs after the emanations themselves have been exhaled. This excited activity gradually disappears in the course of time, becoming negligible with thorium after two days, and with radium after three or four hours. The practical effect of this in both cases will be to cause a feeble continued action of the rays on the lungs after the more powerfully radio-active emanations have all been exhaled.

Which emanation will prove the more suited for the present purpose is, of course, a matter for trial, but thorium possesses many compensating advantages which make up for its very feeble radio-activity. It is cheap, and can be procured in any quantity. Unlike radium, the effect of its emanation is proportional to the time of inhalation. Moreover, in dealing with the emanation there is practically no limit to the quantity effectively employable. The radiation from a solid salt, owing to absorption of the rays by the salt itself, is practically confined to a thin surface layer, but with the emanation no such absorption occurs. The emanation from a kilogram or more of thorium salt could be effectively employed on the lungs of a single patient. Thorium nitrate, a very soluble salt, is the most suitable compound to employ, but the free nitric acid present should be neutralised after the salt has been dissolved in water by cautious addition of ammonia with stirring, until precipitation is about to take place. A gas washing bottle, with outlet and inlet tubes ground in, could be used as the inhaler, and this should be filled as full as possible with the moderately concentrated solution. There is not much fear that an hour's daily inhalation of the emanation from 100 grams of dissolved thorium nitrate would produce any ill effect, and both the quantity employed and the time of inhalation could, after due trial, be increased indefinitely. For use with the radium emanation the inlet and outlet tubes should be provided with taps. A few milligrams of the salt, radium bromide, for example, should be placed in the dry bottle, and water drawn in to dissolve it, the taps being then closed. For the first trials, a few bubbles only of the total gas contained in a fairly large bottle should be drawn into the lungs with a deep breath of air, and retained as long as possible before being exhaled. The dose should be only very gradually increased, and the effect on the system very carefully watched, for the radium emanation is an exceedingly powerful agent. Mixed with air it glows brightly in a dark room, and exerts a very rapid oxidising action on carbonaceous matter, and even on mercury. The maximum possible dose for any one quantity of radium solution would be obtained by inhaling the whole gaseous contents of the bottle, a few bubbles at every breath, once every twenty-four hours.

The immunity of these processes from external interference, the simple nature of the treatment proposed, the infinitesimal quantity of the active agents employed, the manner in which the emanations may be inhaled to do their work at the very seat of the disease, leaving behind in their place the excited activity to continue the work in a gentle manner after they have been exhaled, make out a strong case why the attention of medical men should be directed to these new weapons which physics and chemistry have placed at their disposal. Indeed, if nature had designed these phenomena for the purpose proposed, it is difficult to see in what way they could be improved upon.

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¹ Abridged from the *British Medical Journal*, July 25.