

these differences are small. Towards the East, the conditions grow worse. In winter time, however, the eastern part has a good clear sky.

Prof. Stratton again thanked the speaker and his Russian colleagues, and closed the meeting.

COMMISSION 14. (WAVE-LENGTHS.)

PRESIDENT: Prof. A. FOWLER.

SECRETARY: Dr W. F. MEGGERS.

Prof. Fowler expressed regret at the absence of Messrs Babcock, Burns, Kayser and Nagaoka.

In opening the discussion on sources of the primary standard, Prof. Fowler presented the following extracts from a communication which had been forwarded by Mr Babcock:

"The preliminary specifications adopted by the I.A.U. in 1925 are a simplified description of the Michelson lamp, naming the conditions which were at that time considered necessary and sufficient by Prof. Fabry himself. Even by implication they do not suggest a substitute for the original lamp. It goes without saying that a vacuum tube provided with internal electrodes is not intended for use with high frequency, but rather with the customary well-known type of excitation. In any case, before amending our specifications so as to prohibit high frequency excitation, at least three laboratories should agree that this is necessary."

"Dr Meggers has stated that it has not yet been demonstrated that the simplified specification of 1925 will yield a wave-length identical with the primary standard, and has criticised the selection of 200,000 waves as the limit. But the experience both of Fabry and Pérard has shown that, regardless of theoretical considerations concerning the width of the red line, any Michelson lamp that yields well-measurable fringes at 200,000 waves retardation is in fact sufficient for reproducing the primary standard well within the limits of our knowledge of its value."

"Since the cadmium line is decidedly more difficult and troublesome to reproduce with extreme accuracy than are certain lines in the spectra of the rare gases, and since its absolute value is not known with such high precision as can be attained in comparative measures of suitable lines, and since we have such excellent secondary standards in neon and krypton, there is no justification *at present* for attempting to refine the specifications for the primary standard beyond such a limit as will insure its reproduction within about 1 part in 10 million. For such higher accuracy as may be reached in *relative* measurements the rare gases are practically always used anyway."

"Even under normal conditions of operation Pérard has found that Michelson lamps show a self reversal of the red line which is observable with retardations a little greater than 200,000 waves. This is a sufficient basis for the choice of that number as a criterion."

"As regards the specifications adopted in 1927 by the I.C.W.M., which Dr Meggers advocated as a description of Michelson's lamp, we find that continuous current excitation is permitted. This is a definite departure from Michelson's procedure. As a matter of policy, precise agreement by at least three laboratories would seem to be required before the I.A.U. should adopt such a change, particularly since the results obtained at the Reichsanstalt and by Pérard seem not to be in complete

accordance." (Mr Babcock's further remarks on the question of the volume of the Michelson lamp are included in the report of Commission 14.)

The specifications of the cadmium lamp for producing the primary standard were then discussed at considerable length by Pérard, Fabry, Meggers and Jackson. In the first place, notwithstanding Babcock's contention, it was considered that the limit of 200,000 waves named in the I.A.U. specification of 1925 was entirely unsatisfactory, and that the maximum possible order of interference should be insisted upon; it was accordingly suggested that the adoption of this recommendation be rescinded.

Although the weight of evidence submitted in the report revealed a preference for the specification adopted by the I.C.W.M. in 1927 (subject to the correction of the statement of volume, as mentioned in the report), the consensus of opinion at the meeting was that the I.C.W.M. specification itself required considerable revision in the light of subsequent experience. Thus, several observers have reported that the presence of a trace of air or rare gas in the cadmium lamp increases the brightness and sharpness of the primary standard without affecting the adopted value of the wave-length, and Pérard has reported a further advantage in thus permitting the lowering of the difference of potential between the terminals of the lamp by some hundreds of volts. It accordingly seems to be no longer necessary to prohibit the use of tubes which, when connected to the usual high tension circuit, become luminous at room temperature. Dr Pérard's experience has further indicated that a temperature of 300° C. is preferable to that of 320° C. mentioned in the specification of the I.C.W.M. Finally, it was the general opinion that the volume of the cadmium lamp is of no great importance.

Dr Pérard informed the meeting that this subject would be considered by the International Committee on Weights and Measures at the approaching meeting of that body in October, and on the motion of Dr Meggers, seconded by Prof. Fabry, it was decided to defer further action on this matter until the I.C.W.M. had made its recommendation. It was agreed, however, that the opinions of Commission 14 on the points above mentioned should be communicated to the President of the I.A.U., with a request that they should be forwarded to the President of the I.C.W.M.*

[In a communication received after the meeting of the Commission, Dr Jackson expresses the opinion that it would be preferable to specify that the volume of the lamp should be not less than 20 or 25 c.c., but agrees that this restriction is not absolutely necessary. He also states that after a consultation with Dr Pérard, his confidence in the Osram ("Osira") lamp as a reliable source of the primary standard has been very much shaken. There are slight differences between the results obtained by Pérard and himself, which he is convinced must be due to actual differences in the radiations of the lamps and not to errors of measurement. With lamps carrying a current of 1 ampere, the discordance was small; using a lamp "avec aplatissement," Pérard found a wave-length for Cd_r 0.0002 Å greater than that given by the Michelson lamp, whilst with an English Osram lamp of ordinary type Jackson could detect no measurable difference. With lamps excited by a current of 2 amperes, however, Jackson found the wave-length given by the Osram lamp to be only 0.0001 or 0.0002 Å greater than that given by the Michelson lamp, whilst Pérard, with the same type of lamp, found a difference in the same direction but three or four times greater. Dr Jackson finds it difficult to believe that the experimental error of either observer can have exceeded 0.0001 Å and is now of opinion that the

* See p. 302 below.

new type of cadmium lamp cannot at present be considered a suitable source of the primary standard.]

Referring next to iron arc standards, Prof. Fowler explained that no new values could at present be put forward for adoption, but it was thought that the provisional list of infra-red wave-lengths given in Table I of the report would be useful to many observers. He expressed the hope that other observers would soon test these values, as obtained from the integrated arc light, so that secondary standards in the iron arc may be extended beyond the present limit at 6750 Å.

The neon secondary standards were discussed by Fowler, Pérard and Jackson. Dr Jackson pointed out that his observations (*Proc. Roy. Soc. A*, **143**, 124, 1933) had shown that the apparent wave-lengths of these lines vary considerably according to the resolving power with which they are observed, on account of the presence, on the more refrangible side of each line, of a satellite due to the rarer isotope of neon. Similar and accordant results had since been obtained by Pérard and himself, using still larger étalon separations. With gaps of 5 to 7 cm. the apparent wave-lengths are 0.002 Å longer and with short gaps and low resolutions about 0.002 Å shorter than the adopted values, which are only reliable for gaps not greater than 4 cm. and resolving powers not less than about 250,000. It is unfortunately difficult to apply the necessary corrections to observations made with étalons of 0.5 to 1 cm. separations, such as are very frequently used in interferometric measurements of wave-lengths. Dr Jackson thought it probable that the systematic differences between the wave-lengths of the ultra-violet iron lines determined by Burns and himself were due to the use of neon standards by one of them. Similarly, Babcock's measurements of iron secondary standards against the primary standard are systematically lower than those of Monk, who used the neon lines for comparison. Again, the titanium vacuum arc wave-lengths of Brown (primary standard) are systematically lower than those of Kiess (neon standards).

In view of these serious limitations to the use of neon standards, and of the fact that the krypton lines are twice as sharp as the neon lines, Dr Jackson was of opinion that the krypton lines are much superior to those of neon as secondary standards; they have the additional advantage that they cover a much larger spectral range and have lately been shown by him to yield identical wave-lengths whether observed transversely or end-on. Dr Pérard and Prof. Fabry were also of opinion that the krypton standards should be used in preference to those of neon whenever possible. On the motion of Dr Meggers, it was agreed that in view of the demonstrated variability of neon wave-lengths with conditions of observation, the recommended neon values in Table II of the report be adopted with the reservation that they apply only to the conditions under which they were determined, viz., with interferometers of high resolving power but étalons not exceeding about 4 cm.

No fault was found with the krypton secondary standards listed in Table III of the report, and the recommended values were adopted. The restriction imposed on the neon values was considered sufficient evidence of the recognition by the Commission of the superiority of the krypton standards over those of neon, which had been emphasised by Dr Jackson.

Prof. Fowler stressed the importance of further measurements of wave-lengths in the spectrum of argon, since these lines are easily produced and are free from all objections on account of hyperfine and isotopic structure.

In a written communication, Mr Babcock questioned the advisability of making the I.A.U. responsible for the establishment of a system of standards of wave-

length extending throughout the ultra-violet region. He was inclined to regard this as a task belonging primarily to the physicists rather than to the astronomers, and suggested that the I.A.U. may not be justified in going beyond the point of full co-operation for the assurance of homogeneity of the system established by astronomers with any other system that may eventually be adopted for the vast range of shorter wave-lengths. After some discussion it was concluded that accuracy of wave-lengths in the extreme ultra-violet was of sufficient importance to astronomers to justify the Commission in recommending a direct attack on the problem of convenient secondary standards in that region, so that values consistent with the adopted secondaries in the less refrangible parts of the spectrum, and of equal relative precision, may be obtained.

Dr Meggers transmitted a suggestion from Prof. Kayser that this Commission should attempt to standardize some appropriate symbols for the description of the appearance of certain spectral lines. Dr Meggers also suggested that this Committee should put its stamp of approval on the notation now widely used for the representation of spectral terms. A recommendation that this Committee consider the standardization of notation for the character and for the quantum description of spectral lines was adopted.

Dr Meggers reported informally that, on account of a small discrepancy between the recent determinations of the index of refraction of normal air and our adopted value, the dispersion of normal air is being redetermined at the National Bureau of Standards. This redetermination is further justified by improvements in light sources, interferometer design and spectral sensitivity of photographic plates, which permit increased precision and greater range now as compared with nearly two decades ago.

Recommendations

1. In view of the prospect that the International Committee on Weights and Measures will soon propose a new and improved specification for the production of the primary standard it is recommended that the I.A.U. defer further action on this matter until the I.C.W.M. has made its recommendation.

2. It is recommended that the 8-figure values of 20 neon wave-lengths in Table II of the report be adopted as secondary standards, with the reservation that they apply only to the conditions under which they were determined, viz., with interferometers of high resolving power but étalons not exceeding 40 mm.

3. It is recommended that the new values for 20 krypton lines presented in Table III of the report be adopted as secondary standards of wave-length.

4. It is recommended that Commission 14 consider the standardization of notations for the character and for the quantum description of spectral lines.

The following letter and resolution have been received from Prof. Volterra, President of the International Committee of Weights and Measures.

Bureau International
des
Poids & Mesures

Pavillon de Breteuil,
Sèvres (S.-&O.),
Le 15 octobre 1935

Monsieur le Président,

Par votre lettre du 18 juillet 1935, vous avez bien voulu me communiquer la Note établie par la Commission No. 14 de l'U.A.I., chargée de l'étude des étalons de

longueurs d'onde, et des tables de spectres solaires, en exprimant le désir qu'aurait cette Union, de voir le Comité international des Poids et Mesures établir un texte renouvelé, relatif aux spécifications de la lampe à cadmium Michelson, susceptible d'émettre la raie rouge étalon des longueurs d'onde lumineuses.

Pour répondre à cette demande, j'ai l'honneur de vous remettre le texte ci-inclus, qui, s'inspirant de cette Note, a été élaboré par notre Commission spéciale des longueurs d'onde lumineuses (MM. Zeeman, Cabrera, Kösters, MacLennan, Nagaoka, Sears, Pérard), et approuvé par le Comité international en séance plénière. En adoptant ce texte, qui donne les spécifications qui ont paru les meilleures pour l'émission de la raie de référence 6 438·4696 UA, dans la lampe du type Michelson, le Comité a néanmoins exprimé l'avis que devait être réservée à l'expérimentateur la liberté d'employer éventuellement d'autres sources dans des conditions convenablement choisies.

En remerciant vivement votre Union d'avoir bien voulu consulter notre Comité à cette occasion, je vous prie d'agréer, Monsieur le Président, les assurances de ma bien haute considération et de mes sentiments sincèrement dévoués.

Le Président du Comité international
des Poids et Mesures,

V. A. VOLTERRA

Monsieur le Président
de l'Union Astronomique Internationale

Spécifications pour la lampe à cadmium du type Michelson

Pour émettre dans des conditions favorables la raie primaire des longueurs d'onde lumineuses $\lambda=6\ 438\cdot4696$ UA, la lampe à cadmium du type Michelson, comportant des électrodes intérieures et excitée par courant électrique, continu ou alternatif de fréquence industrielle, doit être maintenue à une température voisine de 300° C. (en tout cas ne dépassant pas 320° C.), et contenir de l'air sous une pression comprise entre 0·7 mm. et 1 mm. de mercure à cette température. Si elle présente un tube capillaire ou plus généralement un étranglement destiné à augmenter sa brillance, aucune dimension latérale de cet étranglement ne devra être inférieure à 2 mm. L'intensité du courant d'excitation ne dépassera pas une valeur telle que sa densité risque d'atteindre 7 mA. par millimètre carré de la section la plus étroite de la région observée.

COMMISSION 16. (PLANETS, COMETS AND SATELLITES.)

PRESIDENT: Rev. T. E. R. PHILLIPS.

SECRETARY: Mr C. LUPLAU-JANSSEN.

The President referred to two matters left over from the meeting at Cambridge, Mass. in 1932, viz. (a) the formation of a small sub-committee on Martian Nomenclature, and (b) the appointment of a Secretary to deal with the work on the physical study of comets. He had requested Messrs Antoniadi, Lampland, and Maggini to form the Committee on Martian Nomenclature, but the question was difficult and complicated, and it had not yet been found possible to come to a conclusion apart from the acceptance of the nomenclature of Schiaparelli as an agreed basis.