

OXYGEN AS WELL AS WATER PROVED TO EXIST IN
THE ATMOSPHERE OF MARS

IN SCIENCE for January 29, 1909, I announced that I had determined the amount of water vapor in the atmosphere of Mars by quantitative measurements of the relative intensification of little *a* in its spectrum, as exhibited in the Mars-moon spectrograms taken by Dr. Slipher at the Lowell Observatory. Through the kindness of Dr. Lowell, I have been enabled to continue the examination of these plates, and with improved facilities, I am now able to add the definite establishment of a relative intensification of the oxygen bands in the spectrum of Mars.

In my previous communication, an earlier paper in the *Philosophical Magazine* was referred to, but not quoted, in which I ascribed Dr. Slipher's success to his having made use "not of the comparatively feeble 'rain-band' near *D* which has been the subject of much contention in the past, but of the much more powerful water-vapor band '*a*' in the extreme red." This might be interpreted as meaning that though little *a* is intensified in the spectrum of Mars, the rain-band near *D* is unaffected, although I had no intention of making such an assertion. Dr. Slipher did, indeed, say that "the spectrum of Mars shows no selective absorption not found in that of the moon photographed under the same conditions";¹ but his obvious meaning is that other Martian absorption bands, though doubtless present on these plates, are too feeble to be certainly distinguished in the presence of telluric bands of the same wavelength. I should say the same myself of any *immediately* apparent intensification of the rain-band or of the oxygen bands in the spectrum of Mars; but it is well known that by sufficiently delicate methods, and by taking the average of a large number of observations, almost vanishingly small quantities can be evaluated. The reliability of the measurement must be tested by its probable error, and by a thorough investigation of the possible sources of error. I have now made such an investiga-

tion of the relative intensity of great *B* in the spectra of Mars and the moon at equal altitudes, and find that *B* in Mars is more intense by an amount eight times as great as the probable error, thus confirming the existence of oxygen in the atmosphere of the planet. Lowell Observatory Bulletin No. 41 may be consulted for the details of the observation.

In SCIENCE for March 26, 1909 (p. 500), Professor Campbell reproves me for not knowing that "*the effects of oxygen and water vapor on Mars were no more visible in the region λ 5400- λ 6900 of the spectrum than were the effects of oxygen and water vapor existing on the moon!*" (Italics and exclamation point are Professor Campbell's.) The reason why I did not mention facts which Professor Campbell considers so obvious as to require only his statement to prove them, is that I already had evidence at that time that great *B* (λ 6867) is more intense in Mars; but because the probable error of the measurement with the apparatus then used was large, I waited until improved apparatus and more reliable results could be obtained before making the announcement.

Eight entirely independent series of measures were made on four plates, each containing three spectrograms. No computations were made until after the last measurement had been completed, and I had no knowledge whatever of the significance of the result until the computations were finished. Since every one of the eight series gave a positive result, and since the method was so guarded as to eliminate every source of possible error which is known to me, I have no hesitation in announcing the intensification of great *B* in the spectrum of Mars as a fact. Nevertheless, I must warn any one who seeks to repeat the observation that its verification will demand exceptional facilities, a long apprenticeship in the art of delicate photometric comparisons, and a good deal of patience and persistence. The measurement is much more difficult than the by no means easy one of the intensification of the little *a* band of water vapor in Mars. In illustration of the difficulty of the

¹ *Astrophysical Journal*, 28, p. 403, December, 1908.

latter observation, I may say that in trying to demonstrate it to visitors, the first objection is apt to be, "but I don't see any band." When, after some coaching, the faint hazy band is seen, the next assertion is usually that there is no difference in its intensity in different spectra; and it is hopeless to expect a verification of the delicate quantitative measurement, unless the would-be observer can acquire the requisite skill. It is important that the spectrograms of the water-vapor band shall be secured when the water vapor in the *total* terrestrial air column is in smallest quantity. A low dew-point at the earth's surface does not guarantee this condition, which, in general, is almost never present in summer. For this reason the spectroscopic data should be obtained in winter.

FRANK W. VERY

WESTWOOD, MASS.,
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QUOTATIONS

THE HARVARD MEDICAL SCHOOL AND HARVARD COLLEGE

THE modern tendency to align medicine with the other professions as a graduate topic is a sound as well as an irresistible tendency. But we think that some authorities have fallen into a logical error in attempting to buckle end-to-end, in the required training of a physician, the present college curriculum, and the medical curriculum as it grew up in pre-university days. The courses provided by medical schools comprise many which afford a high type of culture looked at from any standard. He would be exceedingly narrow who should deny that many of the courses which are indispensable ingredients of a medical education are also essentially academic, and worthy components of anybody's education. We go so far as to regard practically all the studies of the first year and a half of the Harvard Medical School as in posse, if not in esse, studies of an academic rank, as cultural studies. In brief, we desire to see them, while maintaining their indispensable rôle in medical education, open to all persons who

have any hygienic aims or any anthropological interests.

We would not "let down the bars" to all who might care to wander about in medicine unguided. We should throw proper restrictions about these courses, such as are thrown about all other advanced courses by the faculty of arts and sciences. But we should offer, to be taken and counted toward the bachelor's degree under proper precautions, all these courses. Let us admit to them any persons who wish to study the fundamental facts of health and disease amongst all the other economic, sociological or anthropological facts which to-day make up the proper study of mankind.

By this device we should destroy forthwith the familiar bugbear of "counting twice" certain studies, under the "combined A.B. system," toward both A.B. and M.D. For we regard the diagnostic and therapeutic courses of the medical school as the essentially medical courses, and the other so-called fundamental courses as not merely medical, but in a broad sense biological. We consequently see no objection to including such courses in work for a bachelor's degree, though we foresee hesitation on the part of some of those who grew up when the medical school was virtually independent of the university, to acknowledge the sources of some of their own culture.

We deny categorically the danger of undue specialization in this field and have above called attention to some random examples of greater specialization by persons who later won their doctorates in other fields.

We insist that our plans, if carried out, would encourage academic freedom and would be in line with all that is good in the elective system. In fact, so harmonious are these ideas with the university system as it otherwise stands that we can lay claim to no originality whatever in the advocacy of our plans. In short, we ask for nothing more than a logical application to medical studies of principles which have long successfully governed the graduate school of arts and sciences.

In this event, some men would receive the