Note on Atmospheric Absorption Caused by the Rotational Water Band

In a recent article[1] the writer computed the infra-red absorption of the atmosphere which is caused by the rotational water band. The work was based upon the analysis of the rotational spectrum given by Randall, Dennison, Ginsburg and Weber.[2] The average absorption for an interval containing many individual lines is proportional to the square root of the optical mass, a known result for the absorption of a line spectrum when the distance between the lines is large compared with the line width.

The black-body curve for $T=300°$ extends from about 4μ towards longer waves and has its maximum around 10μ. Thermal radiation of the atmosphere is mainly due to the vibrational water band at 6μ and to the rotational band. It appears from the above-mentioned calculations that the highest rotational lines are too weak to cause appreciable absorption and with an average water content of the atmosphere there should be practically complete transparency between about 8μ and 22μ. This result is not in agreement with the measurements of the heat radiation of the sky which give much higher values of the total radiation than one would expect on this basis. The discrepancy can be removed by taking into account the effect which is produced by the very intense rotational lines at a large distance from the line center. Although these lines are situated at the far infra-red side of the band (50μ), they produce absorption between 10 and 20μ. The absorption coefficient due to the line wings is readily seen to be

$$k=\sum_{\nu_0} i_0\alpha/\pi(\nu-\nu_0)^2,$$

where the summation extends over all lines of the band. The i_0 are the line intensities and α is the half-width for which, as previously,[1] a value of 0.25 cm^{-1} was assumed. Under atmospheric conditions line broadening is due to collisions and therefore α is proportional to the air pressure. The above value refers to standard pressure. Numerical calculations have been carried out for $T=220°$ (temperature of the stratosphere) and $T=300°$. They yield the results given in Table I, if the optical thickness of water vapor is expressed in grams of water per cm^2. For $\nu>500$ cm^{-1} the following formula gives a good approximation

TABLE I. *Values of k at 200 and 300° Kelvin.*

$\nu(cm^{-1})$	400	450	500	600	700	800	900	1000
k_{220}	2.61	1.43	0.96	0.54	0.35	0.23	0.18	0.14
k_{300}	3.50	1.36	0.90	0.46	0.30	0.21	0.15	0.12

$$k=(78{,}000-240t)/(\nu-200)^2$$

where t is the temperature on the centigrade scale. It must be emphasized that this absorption is exponential, $J=J_0e^{-kx}$; it is therefore far more sensitive towards changes in the water content of the atmosphere than the absorption within the band itself which varies only with the square root of the water mass. This is in agreement with the observations of the thermal radiation of the sky which shows a very considerable dependence upon humidity. Under laboratory conditions the continuous absorption is too weak to be observed in moist air; it does however show up in the absorption of steam.[3] The absorption is proportional to the half-width of the lines and since the latter is not precisely known, the relative variation of the above figures is more significant than their absolute values.

A more detailed account of this work will be given later.

W. M. ELSASSER

California Institute of Technology,
Pasadena, California,
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[1] W. M. Elsasser, Astrophys. J. April, 1938.
[2] H. M. Randall, D. M. Dennison, N. Ginsburg and R. L. Weber, Phys. Rev. 52, 160 (1937).
[3] G. Hettner, Ann. d. Physik 55, 476 (1918).

Recalescence in Uranium

During the summer of 1937 the thermionic work function and the emissivity of well-outgassed uranium were investigated. The results will be published at a later date.

In the course of these experiments a striking double recalescence was observed, resembling the well-known phenomenon in iron at the β–γ transition just above 900°C. It is thought that there may be corresponding changes in the crystal structure of uranium at temperatures in the vicinity of 600 and 800°C. An attempt is being made to investigate the matter further by means of x-rays.

W. L. HOLE
R. WRIGHT
H. B. WAHLIN

Department of Physics,
University of Wisconsin,
Madison, Wisconsin,
April 12, 1938.

Cosmic Rays; Barometric Effect, Variations of Second Kind and Disturbances Produced by the Earth's Magnetic Field

Simultaneous records of the zenithal intensity of cosmic rays have been made during a period of nearly a year with large Geiger-Müller counters in two separated double coincidence arrangements. The new method of mutual control proved very reliable and rendered even semi-hourly values trustworthy as may be seen from the Figs. 1–3. In these the cosmic-ray intensity I reduced to 750 mm Hg together with the variations of the atmospheric pressure, the horizontal X (N–S) and vertical Z components of the earth's magnetic field are plotted separately for each arrangement for the month of January, 1938. I am very indebted to Professor Bartels and his staff for these magnetic data from the Adolf-Schmidt Observatorium Niemegk.

In the first half of January, 1938 the records run nearly undisturbed both for I, X and Z contrary to the second half of the month, during which three great magnetic storms, each of different behavior, occur. At once the cosmic-ray intensity diminishes simultaneously and almost in the same manner as X, and inversely as Z, but distinctly different each time as the magnetic storms themselves