Groenewald did not introduce any mechanical rest mass, m_0, but set $e^2/2a$ equal to the observed mass of the electron.

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Identification of CO in the Solar Atmosphere*

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RECENTLY, a short section of the solar limb spectrum, extending approximately from λ23,100 to λ23,300, was traced with the high dispersion infrared spectrometer[1] attached to the Snow telescope at the Mount Wilson Observatory. It was noted that over 15 weak lines were conspicuously enhanced in intensity by about a factor of two as compared with their appearance in the spectrum of the center of the disk. Furthermore, the majority of the lines were regularly spaced in a fashion that left no doubt as to their molecular origin. It should be pointed out that enhancement toward the limb is common among solar molecular lines observed in the photographic region of the Fraunhofer spectrum,[2] but that no solar lines of molecular origin have hitherto been noted in the lead-sulfide region of the spectrum.

Investigation of the positions and spacing of the enhanced lines makes it certain that they are members of the positive branch of the $3-1$ vibration-rotation band of CO centered at 4207.03 cm^{-1}. The strengthening of the lines toward the limb indicates that they are formed relatively high in the atmosphere where the temperature is about 5000°K. At this temperature the intensity maximum of the CO bands, although relatively flat, occurs at about $J=30$. The observed positions of the solar lines agree to within a few hundredths of a wave number with those calculated for the lines $J=25$ to $J=35$ from the molecular constants recently derived for CO by Rao.[3]

Additional confirmation of the presence of CO in the solar atmosphere has come from an examination of neighboring regions of the spectrum in the infrared atlas,[4] which reveals not only many additional lines of the $3-1$ band, but also numerous lines arising from the $2-0$ band at 4260.13 cm^{-1} and the $4-2$ band at 4154.28 cm^{-1}. In every case, there is precise agreement between the observed and calculated line positions, and for all three bands the only lines observed are those with rotational quantum numbers in the neighborhood of $J=30$. All of the lines in the spectrum of the disk center are very weak; their central absorptions usually do not exceed 5 percent. Also, the line intensities do not appear to differ significantly from one band to the other, which is not surprising inasmuch as the Boltzmann factor is relatively small at solar temperatures.

It should be noted that CO is expected to be one of the most abundant molecules in the solar atmosphere, according to calculations by Russell.[5] Its failure to be observed previously is due only to the location of its electronic bands in the inaccessible ultraviolet.

In view of the presence of the overtone transitions $2-0$, $3-1$, and $4-2$ at 2.3μ, it is to be expected that the corresponding fundamentals $1-0$, $2-1$, and $3-2$ will be very strong. Migeotte has observed indeed the $1-0$ band at 4.7μ in the solar spectrum both at Columbus, Ohio,[6] and from the Jungfraujoch.[7] He states, however, that the band originates in the earth's atmosphere and believes that the solar contribution to the band is negligible. He observes further that the band undergoes large and apparently random fluctuations in intensity, the line R_3 varying from 15–50 percent central absorption. Later, the 4.7μ band was observed by Shaw, Chapman, Howard, and Oxholm,[8] also at Columbus, but they found that the central absorption of R_3 was never less than 45 percent over a period of three or four months.

On the basis of observations made at the McMath-Hulbert and Mount Wilson Observatories, it can be stated that the telluric contribution to the $2-0$ band, if present, is no greater than the contribution from the center of the solar disk. This result would imply that at least half of the contribution to the $1-0$ band is also solar. If so, the $2-1$ and $3-2$ bands should appear with strength comparable to $1-0$, at 2116.75 cm^{-1} and 2090.28 cm^{-1}, respectively. Inspection of the table of wavelengths and of the tracing of the 4.7μ region published by Shaw, *et al.*[8] suggests that some lines of the two difference bands may be present, but they are very much weaker than those of the $1-0$ band at 2143.38 cm^{-1}. It would obviously be extremely important to compare tracings of the 4.7μ band made at various points on the solar disk, to determine the existence both of intensity variations and of Doppler shifts resulting from solar rotation.

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Far Infrared Transmission of Silicon and Germanium

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THE infrared transmission spectra of elementary silicon and germanium are of interest because of the remarkable electrical properties of these materials. The temperature-dependence of electrical resistance of germanium, for example, has been interpreted[1,2] as indicating a conduction-band gap resulting from impurity acceptors of approximately 0.01 ev. Study of the absorption of electromagnetic radiation of energies of this magnitude could thus furnish useful evidence for the solid-state theory of the properties of germanium,[3] and perhaps yield more accurate values of the band-gap energies than can be obtained from thermal and electrical measurements.

The infrared transmissions of optically polished samples of silicon and germanium of 2-mm thickness are given in Table I for

TABLE I. Infrared transmission for 2-mm samples of germanium and silicon (uncorrected for reflection losses).

cm^{-1}	T_{Ge}	T_{Si}	cm^{-1}	T_{Ge}	T_{Si}
260	0.12	0.36	540	0.31[a]	0.20
270	0.07	0.37	560	0.33	0.17
280	0.05	0.39	580	0.40	0.18
290	0.05	0.39	600	0.44	0.05
300	0.03	0.38	610	—	0.03[a]
320	0.03	0.37	620	0.47	0.05
340	0.01	0.37	640	0.45	0.27
360	0.01	0.37	660	0.47	0.30
380	0.11	0.37	680	0.47	0.32
400	0.24	0.36	700	0.48	0.36
420	0.15[a]	0.36	720	0.48	0.25
440	0.23	0.36	736	—	0.18[a]
460	0.27	0.37	740	0.47	0.18
480	0.37	0.28	760	0.47	0.19
500	0.34	0.25	780	0.47	0.22
516	—	0.14[a]	800	0.46	0.25
520	0.32	0.20			

[a] Indicates band minimum.