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This Week's Citation Classic

Plass G N. Models for spectral band absorption. *J. Opt. Soc. Amer.* **48**:690-703, 1958.
[Aeronutronic Systems, Inc., Glendale, CA]

Various models are studied which represent the absorption of the infrared spectral bands. The centers of the spectral lines may be regularly spaced in frequency, spaced at random, or have a more complicated distribution. Results are derived for Lorentz, Doppler, and combined line shapes. [The *SCI*® indicates that this paper has been cited over 95 times since 1961.]

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"When I was on the faculty at Johns Hopkins University from 1946-1955, I became interested in the many experiments on infrared spectroscopy that were being done by John Strong. I collaborated with him on an article which showed the importance of the pressure broadening *of* spectral lines in explaining radiative transfer in the Earth's atmosphere.[1] This work was valid only for a single isolated spectral line, whereas the radiation in our atmosphere is controlled by polyatomic molecules such as H_2O, CO_2, and O_3. These all have complicated infrared spectra with many overlapping spectral lines. The need for mathematical methods applicable to these real molecules was obvious and I studied this problem for some years.

"In 1955 I joined an industrial research laboratory amid predictions from my university friends that it would be the end of my scientific career! Actually I found that, when I was freed from teaching and serving on time-consuming committees, I could devote much more time to research than before. I reconsidered the problem just described and saw how to combine the previous work of Elsasser, Mayer, and Goody to make general and useful models for spectral band absorption.[2-4] The absorption was calculated for various different band models and these results were compared. The models included a band with regularly spaced lines and one with randomly spaced lines. A new derivation for the latter case showed that the result could be written in terms of a single parameter —the absorption by a single line. Thus the band absorption can be immediately obtained for various line shapes: Lorentz, Doppler, and combinations of these. Several new band models were proposed including (1) the random model with a finite number of spectral lines in the interval under consideration, and (2) the random superposition of several different bands each with regularly spaced lines, but with the possibility of this spacing being different for each band. These models provided a better representation of actual spectral bands.

"The regions of validity of the linear, square root, and nonoverlapping approximations were considered in this article, while a more detailed investigation with applications to actual band spectra appeared several years later.[5]

"At the time this work was done there were relatively few scientists interested in this field. Their number has increased exponentially in recent years as measurements of the parameters of the Earth's atmosphere, ocean, and surface are made from satellites, and as the effects of varying amounts of CO_2, aerosols, and other atmospheric components on the climate are studied. These and many other studies require mathematical calculation of the radiative exchange by infrared bands. The summary of the various models and approximations for band absorption given in my article have apparently been useful in many of these new studies.

"As for myself, I returned to a university faculty in 1963 and have continued research on radiative transfer in planetary atmospheres. More recently, I have been especially interested in various methods for the calculation of the multiple scattering of light in realistic planetary atmospheres "

1. **Strong J & Plass G N.** The effect of pressure broadening of spectral lines on atmospheric temperature. *Astrophysical J.* **112**:365-79, 1950.
2. **Elsasser W M.** Mean absorption and equivalent absorption coefficient of a band spectrum. *Phys. Rev.* **54**:126-9, 1938.
3. **Mayer H.** *Methods of opacity calculations.* Los Alamos, NM: Los Alamos Scientific Laboratory, 31 October 1947. Los Alamos Report LA 647.
4. **Goody R M. A** statistical model for water-vapour absorption. *Quart. J. Roy. Meteorol. Soc.* **78**:165-9, 1952.
5. **Plass G N.** Useful representations for measurements of spectral band absorption. *J. Opt. Soc. Amer.* **50**:868-75. 1960.