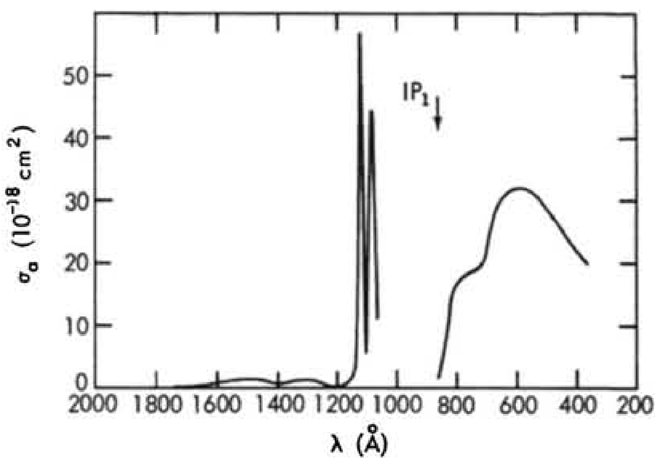

Fig. 1.8. Absorption cross-section of CO_2 from experimental data (after E. W. McDaniel [9]).

A number of analytical approximations to the Chapman function have been developed, including the extension to a constant scale height gradient β (cf. Sect. II.1). For an isothermal atmosphere a useful approximation of the Chapman function is given in terms of the tabulated error function

$$\mathrm{Ch}\left(x, \frac{\pi}{3} \le \chi \le \frac{\pi}{2}\right) \cong \left(\frac{\pi x}{2}\right)^{\frac{1}{2}} \left\{1 - \mathrm{erf}\left(\frac{x^{\frac{1}{2}}\cos\chi}{\sqrt{2}}\right)\right\} \exp\left(\frac{x\cos^2\chi}{2}\right)$$

$$\mathrm{Ch}\left(x, \chi \ge \frac{\pi}{2}\right) \cong \left(\frac{\pi x}{2}\sin\chi\right)^{\frac{1}{2}} \left\{1 + \mathrm{erf}\left(\frac{x^{\frac{1}{2}}\cos\chi}{\sqrt{2}}\right)\right\} \exp\left(\frac{x\cos^2\chi}{2}\right) \quad (1.9)$$

where $x = R/H = (R_0 + h)/H$ with H the scale height and R_0 the planetary radius. The *Chapman function* for different values of x and its comparison with $\sec\chi$ is shown in Fig. 1.9.

For $\chi = 90°$, $\mathrm{Ch}(x, \pi/2) = (x\pi/2)^{\frac{1}{2}}$, representing the ratio of the total content in the line of sight to the vertical content of an atmospheric constituent, a quantity of interest in occultation experiments. At high enough altitudes where the optical depth is small the exponential factor in (1.9) can be neglected and the ion production function in this "low attenuation region" assumes the simple form

$$q = J(\sigma_i, \lambda) n_j(z) \quad (1.10)$$

where $J = \langle \sigma_i \Phi_\infty \rangle$ is the photoionization rate coefficient (or frequency of ionization ν_{ion}, [sec^{-1}]). The ionization coefficient is based on the averaged ionization cross-sections and photon fluxes over all pertinent wavelengths. For the light atmospheric constituents H and He, which will make up the main constituents of planetary exospheres, the ionization coefficients are listed for Venus, Earth and Mars in Table 1.8. Since many wavelengths will contribute