LINE MIXING AND COLLISIONAL BROADENING IN THE THERMAL RADIATION OF THE LOWER VENUS ATMOSPHERE:.

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Introduction: In the previous paper [1] we investigated the effect of the collisional line broadening on the spectrum and fluxes of the thermal radiation in the lower Venus atmosphere. It was shown that the Lorentzian form-factor at high pressure of the Venus atmosphere is no longer valid so that the absorption in the far wings of spectral lines is several orders of magnitude lower. We employed a theory of far-wing spectral line profile [2] which resulted in estimates of the thermal radiation fluxes in the lower atmosphere. However due to strong broadening exceeding typical rotational energy shift, spectral lines cannot be considered as isolated and the interference of states has to be accounted for [3,4]. In the current work we combine the two approaches and compare results with ground-based observations.

Line shape in the strong collision approximation: A simple and elegant way to take into account the effect of state interference on the rotation-vibration band is proposed in [3] by assuming a relaxation time parameter τ_0, common for all states forming the band. In this approximation the spectral absorption $\Phi(\nu)$ is expressed as

$$\Phi(\nu) = \frac{1}{\pi}\,\mathrm{Re}\left\{\frac{U(\nu)}{1-\tau_0^{-1}U(\nu)}\right\},$$

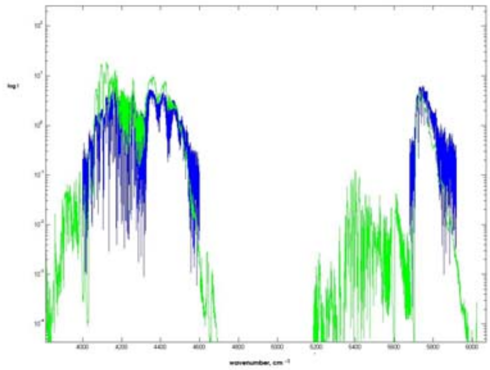
where

$$U(\nu) = \sum \frac{A_m}{\tau_0^{-1} + 2\pi i(\nu - \nu_m)}$$

and A_m are strengths of individual lines in a band.

The estimate of the relaxation time τ_0 is based on the empirical data of line broadening under normal pressures, averaged over the band. It is important that the calculations be done over *P*, *Q*, *R*-branches of each vibration band separately. In spite of technical simplicity of the above model, its implementation for Venus atmospheric absorption is complicated by *a priory* unknown validity field. In particular, the asymptotic behavior of band shape consisting of multiple dense rotational lines is proportional to $\sim\nu^{-4}$, whereas the far-wing approximation generally predicts the exponential asymptotic [3].

Line shape in the far wing: We have described in [1,2] the algorithm implemented for far-wing approximation neglecting the line mixing (state interference) effect. To account for both effects in practically useful calculations, the following approach may be employed. General shape of a spectral line is composed of two parts, central Lorentzian core and far wing suppressed by an exponential factor of power-scaled argument [2]. However in the central part of each line of the band, a Lorentzian is replaced by a line mixing profile presented above. Since most of strong vibration bands of interest for the Venus atmosphere have relatively dens distribution of rotational lines, within such bands the profile is identical to the model [3]. Far apart from the band, where the absorption is determined by a superposition of far wings of lines, it reveals exponential behavior. However this profile would not be identical to pure far-wing approximation since the parameters of the theory need to be updated.



Comparison with observations and implications for Venus Express: NIR transparency windows in the Venus atmosphere give us a chance to test theoretical radiative transfer models versus observations. A comparison of our calculations with data [5] kindly provided by B. Bezard, is presented in Fig. 1. Radiative transfer calculations were done according to [1] with the correction of error in partition sum evaluation. In some particular bands the discrepancy from observations is significant, while in other regions the model fits data with high accuracy. Tuning the model to available observations will allow us to derive physical parameters of the atmosphere from IR spectrometers of Venus Express project, as well as to remove the contribution of the atmosphere in observations targeting Venusian surface. This model presents a first attempt to construct fully *ab initio* radiative transfer model applicable for wide range of pressures and temperatures. Interpretations of Venus Express remote sensing data related to different atmospheric levels is only possible based on such or similar model.

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