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Bibliographic review and new measurements of the integrated cross sections of 8 molecules (H_2O, CO, CO_2, CH_3OH, NH_3, CH_4, HCOOH and H_2CO) in the solid form at 25K

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Abstract

Infrared spectra from ISO and Spitzer telescopes revealed the presence of several molecules in the solid phase such as H_2O, CO, CO_2, CH_3OH, NH_3, CH_4, HCOOH and H_2CO in the environment of some Young Stellar Objects (YSOs) ([1], [2], [3], [4]. To quantify the column density of those molecules, the knowledge of some spectroscopic parameters, especially the integrated cross section A (cm.molecule^{-1}) is required. For some molecules, inconsistencies on the values of spectroscopic parameters can be found in the literature. The purpose of this study is to compare all the values found in the literature with the ones that we have measured recently in order to propose more convincing values.

1. Introduction

The integrated cross section, generally noted A and also called band strengths is defined as the quotient between the area of an absorption band (cm^{-1}) and the column density of the considered molecule (molecules.cm^{-2}). This spectroscopic parameter is essential to retrieve quantitative information from infrared spectra of astrophysical objects or laboratory analogues. Nevertheless, there is sometimes a lack of information for the solid phase. For some molecules (H_2CO or HCOOH) very few measurements exist, for some others (CH_3OH for example) some inconsistencies can be found in the literature. The aim of this work is to measure in a coherent way the integrated cross sections at low temperature (25K) of several molecules known to be present in solid phase in the interstellar medium. Then, the values found in this work will be compared to values presented in the literature.

2. Experimental measurements.

In the laboratory, experimental measurements of the integrated cross section require the knowledge of others intrinsic parameters such as the density (g.cm^{-3}) and the index of refraction to determine the column density of icy films (molecules.cm^{-2}). Indeed, interferometric techniques allow the measurement of the thickness of the studied ice film when the index of refraction in the visible range is known. Then, the thickness can be converted in a column density if the density of the ices is known. All the ice films that we have prepared have been characterized simultaneously by interferometric technique and transmission infrared spectroscopy. These simultaneous measurements allow the quantitative determination of the spectroscopic parameters.

In this work, we first present a literature review of indexes of refraction, densities for the 8 studied molecules (H_2O, CO, CO_2, CH_3OH, NH_3, CH_4, HCOOH and H_2CO) . This bibliographic review allows us to

measure accurately the column density of ice films from interferometric techniques. Then experimental measurements of integrated cross sections of those molecules are given and compared to those found in the literature. This comparison enables us to propose accurate values of the integrated cross sections.

3. Summary and Conclusions

Our measurements are based on relevant values of density and refractive index. Thus our study allows to point some inconsistencies present in the literature and to propose more convincing values for the integrated cross sections. We can note that in most case, our values present less than 20% with the ones already used to calculate the column densities of ices in the interstellar medium.

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