LONGPATH FOURIER TRANSFORM SPECTRA OF AMMONIA

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ABSTRACT: The ammonia molecule is known to be useful as a probe for studying conditions inside interstellar clouds and planetary atmospheres. Correct interpretation of interstellar and planetary spectra need to be supported by adequate laboratory measurements. In the present studies we report the high resolution Fourier transform spectra of ammonia recorded with a pathlength of 192m at the Kitt Peak National Observatory. Transitions with intensities that are two orders of magnitude weaker than those that have been reported earlier, have been observed and assigned. These include high J transitions, hot bands and forbidden transitions. These transitions are not saturated under long paths such as those available in planetary atmospheres and are therefore useful in the estimation of temperatures. The forbidden transitions have been processed with other relevant data to provide complete information on the energy levels. Such information is required for the calculation of equilibrium population of energy levels and partition functions, which go into the estimation of spectral intensities and abundances in terrestrial, interstellar and planetary atmospheres.

INTRODUCTION

Ammonia ranks as the first polyatomic molecule to be discovered in interstellar space (1), and it is particularly useful as an interstellar thermometer. Ammonia lines observed in the 9-12 um region in the thermal emission spectra of Jupiter play an important role in determining the opacity of the Jovian atmosphere (2). Proper interpretation of spectral observations of planetary and interstellar atmospheres in terms of their composition and thermal structure need to be supported by adequate laboratory measurements. In the present studies longpath Fourier transform spectra of $^{14}NH_3$ are reported and their possible applications to astrophysical studies are discussed.

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EXPERIMENTAL DATA

High resolution FT spectra of ammonia were recorded with a pathlength of 192m at the Kitt Peak National Observatory, in Tuscon, Arizona. Absorption spectra were recorded with a White type multiple reflection cell having a base length of 6m.

ANALYSIS AND RESULTS

The availability of longpath FT spectra have made it possible to measure very weak features such as forbidden transitions, hot bands and high J transitions in the ν_2 band of ammonia. The theoretical model used for the description of the ($a2\nu_2 \leftarrow s\nu_2$) hot band energy levels takes into account the $\Delta k=3$ off-diagonal interactions. The data have been fitted within the limits of their experimental accuracy using the standard polynomial expression for the diagonal matrix elements(3).The analyses of the high J transitions and forbidden transitions have been reported elsewhere (3,4).

DISCUSSION

Ammonia is fairly widespread in the interstellar medium and it has been detected in several galactic objects from spectroscopic studies. Strong absorption in the ν_2 band of ammonia in the 9-12 um region is expected to be mainly responsible for the opacity of the Jovian atmosphere. Data on hot bands and high J transitions become important over long atmospheric paths, since such transitions are not saturated under these conditions and are sensitive to pressure, temperature and pathlength. Forbidden transitions observed in these studies have provided complete information on the spacing of energy levels not accessible from allowed transitions(3).Such information is useful in the calculation of population of energy levels and partition functions which are required in the estimation of abundances in terrestrial, interstellar and planetary atmospheres.

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