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Modeling of the Ortho-Para Abundance Ratio of Cyclic C_3H_2 in Dark Clouds

I. H. Park[1], E. Herbst[2], Y. Morisawa[3], & T. Momose[3]

[1] Chemical Physics Program, The Ohio State University, Columbus, OH 43210, USA
email: ihpark@mps.ohio-state.edu
[2] Departments of Physics, Chemistry and Astronomy, The Ohio State University, Columbus, OH 43210, USA
[3] Kyoto University, Division of Chemistry, Kyoto, 606-8502, Japan

Abstract. We present the first attempt to model the ortho-to-para abundance ratio of *c*-C_3H_2 so as to reproduce its observed ratio in cold dense clouds. According to observations for TMC-1C (a prestellar core) and L1527 (a protostellar core), the *o*/*p*-C_3H_2 ratio is 2.4 - 2.5, a value which is only slightly lower than the statistical ratio of 3 pertaining to high temperature equilibrium.

In order to model the ortho-to-para abundance ratio, we used a large network of chemical reactions augmented by reactions that specifically consider the formation and depletion of ortho and para forms of the molecules c-C_3H_2 and c-$C_3H_3^+$. The reaction branching fractions were determined by a variety of considerations.

We then investigated the sensitivity of the calculated ortho-to-para ratio for c-C_3H_2 to a number of factors such as time, density, elemental C/O ratio, the depletion of metals from the gas, and the cosmic ray ionization rate. While these parameters can affect the calculated ratio, the major factor appears to be the choice of branching fractions for the neutral products of the $C_3H_3^+ + e^-$ dissociative recombination reaction. In particular, in order to reproduce the *o*/*p*-C_3H_2 ratio, it is necessary that the product channel C_3H_2 + H be the dominant one.

Keywords: ISM: abundances, molecular processes