A diffusion approach to vibrational kinetics of molecules in plasma

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Modelling of vibrational kinetics of molecules in a plasma environment is a very important and interdisciplinary topic linking plasma physics to chemical physics and has applications to clean energy issues, materials science and space exploration. In particular, CO_2 is presently under widespread investigation in the perspective of carbon neutral fuels and oxygen production on Mars. Most of present literature on the subject is based on the State-to-State approach (STS) which is convenient but time consuming and hinders somewhat the insight. The authors have developed a new approach which is based on reconsidering the powerful and mathematically appealing diffusion approaches developed mostly in the 70s. In these lasts, a function F is introduced, F being a doubly derivable extension of the vibrational distribution to a continuum of internal energy. This function F is assumed to be the solution of a Fokker-Planck equation. The new method proposed is based on numerical and semi-analytical approaches and allows us to remove some approximations limiting the original approach and reproduces closely present STS calculations. Furthermore, the possibility to apply the language and techniques of transport and diffusion processes to vibrational kinetics provides a complementary view, somewhat faster codes and new insight into molecular physics and process optimization.