EPSC Abstracts
Vol. 11, EPSC2017-746, 2017
European Planetary Science Congress 2017

Two-dimensional molecular line transfer for a cometary coma

S. Szutowicz
Space Research Centre Polish Academy of Sciences, Warszawa, Poland (slawka@cbk.waw.pl)

Abstract

In the proposed axisymmetric model of the cometary coma the gas density profile is described by an angular density function. Three methods for treating two-dimensional radiative transfer are compared: the Large Velocity Gradient (LVG) (the Sobolev method), Accelerated Lambda Iteration (ALI) and accelerated Monte Carlo (MC).

1. Model and Summary

Comets exhibit anisotropic gas emission from their nuclei that can be interpreted with non-uniform density distribution models. The main volatile constituent of cometary nucleus ices is water. In the proposed outgassing model, enhanced water emission is related to the discrete active area accompanied by a lower emission of more – uniformly - distributed material. The gas density profile is described by an angular density function.

For radiative transfer calculations the cometary coma is discretized into cells according to spherical coordinate system (r, β) where β is the latitude. A model of excitation of the cometary water molecule includes collisional excitation and infrared pumping by solar radiation. The fractional populations of water rotational levels are derived as simultaneously solution of equations of statistical equilibrium and the equation of radiative transfer in the iterative process. Three methods for treating radiative transfer in the cometary coma are adopted: the Large Velocity Gradient (LVG) (the Sobolev method), Accelerated Lambda Iteration (ALI) and accelerated Monte Carlo (MC). In the LVG method, the radiative transfer is solved locally, and in the ALI and MC methods the radiative energy is transported from one region to the next. In contrast with MC method, in ALI the sampling of the radiation field is not random and is based on a fixed set of long characteristics (LC). ALI and MC agree very well but computational cost of the ALI code is much more lower than MC.

Effects of the physical parameters of the cometary material like density, temperature, and expansion velocity on the line intensity are discussed. The results of simulations for two-dimensional (axisymmetric) density structures are compared; e.g. the population distribution of water rotational levels as a function of distance to nucleus, synthetic line profiles.