MATHEMATICAL SIMULATION OF THE 3D+T DUSTY-GAS COMETARY ATMOSPHERE OF COMET 103P/ HARTLEY 2. V. V. Zakharov[1,2], J. F. Crifo[3] and A. V. Rodionov[4], [1]LESIA, Observatoire de Paris, 5 place Jules Janssen, F-92195 Meudon, France, Vladimir.Zakharov@obspm.fr, [2]Gordien Strato S.A.R.L., 3 Allee de la Graineterie, 91370 Verrieres le Buisson, France, [3]LATMOS, 11 Boulevard D'Alembert, 78280 Guyancourt, France, crifo@aerov.jussieu.fr, [4]FSUE RFNC - VNIIEF, 37 Mira Ave, Sarov, 607188 Nizhny Novgorod region, Russia, avrodionov@rambler.ru.

Introduction. The Deep Impact flyby spacecraft encountered comet 103P/Hartley 2 in the frame of an Extrasolar Planet Observation and Deep Impact Extended Investigation (EPOXI) mission. Observations of the comet were carried out for 2 months on approach (5 September to 4 November) and for 3 weeks on departure (4 to 26 November), during which more than 105 images and spectra were obtained [1].

We report the results of application of our 3D+t dust-gas coma model to a model nucleus which shape and dimensions close to those of 103P/Hartley 2 nucleus and conditions at the moment of closest approach i.e. at 13:59:47.31 UTC on 4 November 2010 (1.064 AU from the Sun).

Modeling methods. A multi-species 3D+t gas model is based on: (1) gas-dynamic approach – the numerical integration of the Navier–Stokes equations combined with a locally plane-parallel solution of the collisional Boltzmann equation for the nonequilibrium near-surface Knudsen layer (BE-NSE) [2]; and (2) kinetic approach - the direct simulation Monte–Carlo (DSMC) method. In the region close to the nucleus we use quasi-steady approximation. For the dust coma two approaches are used as well. (1) Fluid approach - the Dust Multi Fluid method (DMF); and (2) stochastic approach - the Dust Monte-Carlo (DMC) [3]. The DMC method allows not only to obtain the spatial distributions of dust but also to trace the individual trajectories of grains. We assume that dust grains are spherical moving under influence of three forces: the nucleus gravitational force, gas coma aerodynamic force, and solar radiation pressure force, and consider the full mass range of ejectable grains. The present 3D+t model was already applied for simulations of the dusty-gas coma of the comet 67P/Churyumov-Gerasimenko [4].

Nucleus model. We approximate the nucleus of 103P/Hartley 2 by an axisymmetric analytical shape shown in Fig.1. The surface of the nucleus is ice-dust mixture characterized by the icy area fraction f (f=const - "homogeneous" nucleus, $f\neq$const - "inhomogeneous" nucleus). The surface flux of volatile components consists of a fraction a_0 distributed uniformly over the surface, and a fraction $(1-a_0)$ distributed over the sunlit surface in proportion to its illumination. The upward flux of H_2O at each point is computed from sublimation energy budget equation. A nightside (and shadow) an internal heat transfer free parameter is introduced to simulate a heat flux from the nucleus interior at points in shadow. At each point and each size, the dust mass flux is proportional to the gas mass flux.

Results. The largest part of our simulations are made in a range of probable conditions at the moment of closest approach to 103P/Hartley 2. The results illustrate the complex structure of gas and dust coma (see example on Fig.2). We discuss similarities and distinctions of the simulation results and observational data.

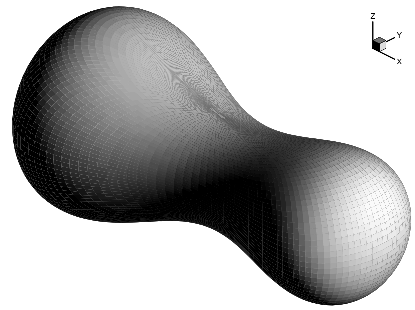

Figure 1: The shape of the model nucleus.

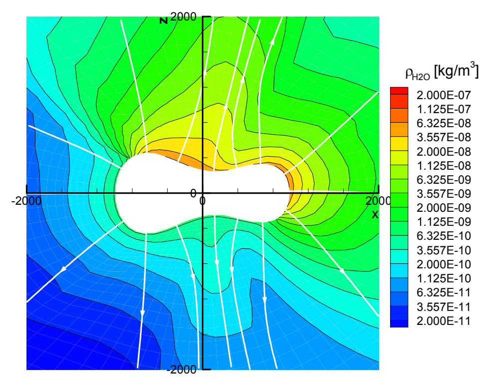

Figure 2: Isocontours of water density and flowlines.

References: [1] A'Hearn M. F. et al. (2011) *Science 332*, 1396. [2] Rodionov A.V. et al. (2002) *PSS, Vol. 50, Issue 10-11*, pp. 983-1024. [3] Crifo J.-F. et al. (2005) *Icarus, Vol. 176, Issue 1*, pp. 192-219. [4] Zakharov V.V. et al. (2011) *EPSC-DPS Joint Meeting*, Abstracts EPSC-DPS2011-126-1.