Effect of internal heat conduction on the surface temperature and outgassing rate for comet 67P/Churyumov-Gerasimenko. P. von Allmen, S. Lee, S. Keihm, L. Kamp, M. Hofstadter, and S. Gulkis, Jet Propulsion Laboratory, California Institute of Technology, 4800 Oak Grove Drive, Pasadena, CA 91109, U.S.A., pva@jpl.nasa.gove.

The ESA Rosetta spacecraft will be orbiting the comet 67P/Churyumov-Gerasimenko in 2014. One of the instruments on board is the Microwave Instrument for the Rosetta Orbiter (MIRO), which will collect data in the millimeter and submillimeter ranges with a spatial resolution of a few tens of meters when the spacecraft is closest to the comet. In preparation for interpreting these observations, we have calculated the temperature profile inside the volume and at the surface of the comet. Several researchers have performed similar calculations for 67P/C-G, but little information is available about the impact of internal heat conduction on the surface temperature and outgassing rate, which determine in part the gas density, temperature, and mean velocity profiles of the coma.

The geometry of the comet is represented by a shape model that was obtained by fitting observed light intensity time series [1]. An upper layer of the comet consisting of ice-free dust is assumed to cover an interior region that contains a large percentage of crystalline water ice. The physical properties of the two layers in the comet are described in terms of a thermal conductivity, a specific heat and a mass density. Sublimation at the interface between the dust and the interior is included as described in ref. [2]. The temperature profile is obtained by solving the heat equation within a multi-scale approach. The top layer, which includes the dust and a portion of the ice-rich interior, is described by a 1-Dimensional (1-D) model [2]. The 1-D problem is solved separately for each triangle at the surface of the shape model, assuming a given heat flux at the bottom of the simulation domain and no lateral heat transfer. The heat flux at the bottom is obtained by solving the 3-Dimensional (3-D) heat equation for the interior of the comet. The 1-D and 3-D models are solved iteratively until the temperature profile has converged.

Figure 1 shows a section of the temperature field inside the comet for a plane that contains two principal axes of the moment of inertia tensor and the sun, which is located at 1.3 AU from the comet. In this simple example, the comet is assumed to be at rest. Figure 2 shows the resulting surface temperature map. It is clearly seen that the regions in the shade have a finite temperature that can reach 40K in this example. The temperature in these regions would be zero if the internal heat conduction is neglected. Thermal properties were taken as in [2]: ρ_{dust} = 980 kg/m3, c_{dust} = 830 J/kg/K, κ_{dust} = 0.22 W/m/K, ρ_{ice} = 925 kg/m3, c_{ice} = 1570 J/kg/K, and κ_{ice} = 3.1 W/m/K

We will present further results for the 3-D thermal profile and surface temperature maps for 67P/C-G in full orbital motion. We will examine the impact of internal thermal conductivity on the surface temperature, in particular in regions that are close to the North and South poles. Seasonal effects will be compared with diurnal fluctuations. The outgassing rate and molecular velocity distribution for each surface tile will be calculated using the 1-D temperature profiles [2]. We carried out a radiative transfer calculation using the derived thermal profile along with electrical and physical properties of the nucleus to compute the expected thermal emission for comparison with MIRO.

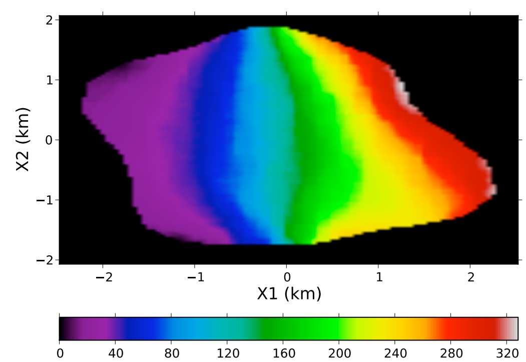

Figure 1: Section of the 3-D temperature profile.

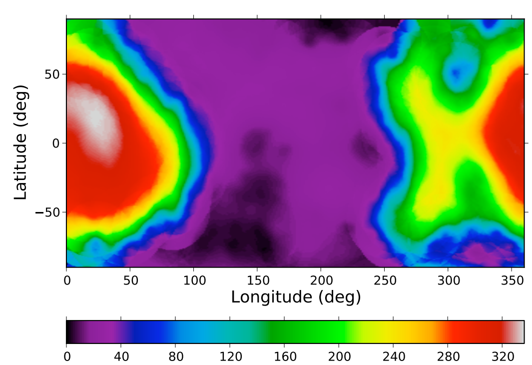

Figure 2: Map of the surface temperature.

References

[1] Lamy Ph.L. et al. (2007) *Space Sci. Rev.*, 128, 23-66. [2] Davidsson B.J.R. et al. (2010) *Icarus*, 210, 455-471.