Landslide is a mass movement of material down a slope. Examples are snow or mud avalanches. The occurrence of landslides in weak gravity characteristic for comets, asteroids and other small celestial bodies was assumed to be unlikely, or even impossible. However, deposits probably created by landslides were in recent years discovered on the nuclei of comets 9P/Tempel 1 and 67P/Churyumov-Gerasimenko [5,7]. Both comets belong to the Jupiter family, and have effective diameters typical for this family, i.e. a few kilometers. Traces of landslides are identified also on asteroids Ceres and Vesta [3,4].
On small celestial bodies, where any liquid cannot be present on the surface, the mechanisms for the occurrence of landslides are different than on the Earth. The material may start flowing when some mechanism reduces internal friction (for example between dust grains). This can happen when pores become filled with water, so called liquefaction, but one can expect also fluidization, when gas and solid particles form a mixture. This is a dry flow instead of a traditional wet flow but also a flow. Another problem is the initiation (triggering) of motion. This can happen due to tectonic earthquakes, but also due to impacts of meteoroids. The latter are rare on the Earth, but common on celestial bodies without atmospheres, like Moon, or with very diluted atmospheres, like Mars. Therefore some of mechanisms of terrestrial landslides have analogy on small celestial bodies, but dramatic differences in physical situations have to be taken into account. All microscopic and macroscopic processes responsible for origin of instability, triggering, motion and deposition should be reconsidered taking into account these dramatic differences.

Preliminary investigations of dry flow on small celestial bodies were already performed, but the problem is still poorly understood. Only 4 years after the discovery of the large flow-like deposit on comet 9P/Tempel 1 it was shown by theoretical considerations, that it may be indeed the result of a landslide under microgravity [1]. The considered process was probably a result of large scale release of gas carbon monoxide tens of meters beneath the surface. The role of outflow of water vapor and the generation of small scale flows of dust require laboratory and theoretical investigation.

We plan to investigate conditions necessary for the flow of dry granular material on locally inclined surface of comets and asteroids. An important problem is the source of energy needed for the build up of the gas pressure beneath material covering the surface. On comets the surface is covered by a mixture of dust, sand, and pebbles. It is traditionally called dust mantle. A mixture of water ice and other volatile chemical species with grains of non-volatile material is below. This mixture can be warmed due to illumination of the surface, and due to generation of heat inside a celestial body. The latter can be the tidal or radioactive heating and can be expected on large asteroids, moons and giant comets. On the typical comets only the release of heat of phase exchange (crystallization of amorphous ice) is possible. The available heat could cause sublimation of ice, strongly dependent on the presence of admixtures in ice [2]. This means the release of gas beneath dust, which may cause fluidization of the dust mantle and its flow, when the surface is inclined.

We intend to perform both laboratory experiments and computer simulations.
(1) Laboratory experiments performed in vacuum chamber can show: how the presence of chemical species in water ice affect release of vapor due to sublimation, how the granulation of material covering ice and the inclination of the surface affect sliding of material and exposition of the initially hidden ice.
(2) Computer simulations are intended to find locations where the sublimation of ice may cause motion of loose material present on the surface and how far it may move. The possible consequences of uncovering initially buried ice for the geological processes will be investigated as well. The exposed ice may sublime faster than buried, that causes non-uniformity of the erosion.

The experiments should be performed using sand/dust with different granulation on porous ice with various admixtures detected in comets. Ice would contain also non-volatile grains and refractory material. We intend to consider two situations:
(1) non-volatile material (dust, sand, or gravel) mixed with ice on a non-volatile substrate, and
(2) non-volatile material without ice on ice-rich substrate.
In both cases the material underlying the porous cover can be either compact, or porous.
The planned experiments will be performed using our experimental setup previously used for measurements dealing with the sublimation of ice with volatile admixtures. The numerical simulations will be performed using extended versions of programs developed during recent study.

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