MEASUREMENT OF THE VOLATILE COMPONENT IN PARTICLES EMITTED FROM AN ARTIFICIAL COMET; K. MAUERSBERGER*, H.-J. MICHEL, D. KRANKOWSKY, P. LÄMMERZAHL, AND P. HESSELBARTH, MAX-PLANCK-INSTITUT F. KERNPHYSIK, P.O.B. 103 980, D-6900 HEIDELBERG

A series of KOSI (= Kometensimulation) experiments has been performed in a large space simulator where mixtures of ices (H_2O, CO_2, CH_3OH) and minerals (olivine, montmorillonite, suspended carbon) are exposed to artificial solar radiation simulating the environment of a comet nucleus near 1 AU. Among other observations aiming at characterizing the evolution of icy samples, emission of gases and of solid particles are measured using various methods.

A novel instrument was developed to measure the volatile component (mostly H_2O) of solid particles collected at about 1 m distance from the surface of the sample comet. This ice particle detector is an ionization gauge contained in a 1 litre volume that has only a narrow tube orifice; its dimensions determine a time constant for gas loss of ~0.4 seconds. The volatile components of a particle entering the detector would evaporate at dropping on the hot (~100°C) bottom of a collector inside causing a momentary increase of gas pressure. The time integral of pressure is a direct measure of the amount of volatile material. Accumulated dust residuals are analysed after the experiment.

In a recent experiment about 600 gas pulse events were observed. They fall in two distinct categories: (1) short pressure pulses of high amplitude decaying within about 0.4 seconds, and (2) long pulses with rise time of a few seconds and decay times of several tens of seconds. Obviously, the first type are ice particles sublimating immediately upon impact, whereas in the other particles the volatile parts are heated with some delay. We attribute this behaviour to agglomerates based on a skeleton of silicate grains.

The observed size distribution ranges between 10^{-11} g and 10^{-5} g of volatile material (Fig. 1). The cutoff at small particles is probably due to their in-flight sublimation; for the largest particles statistics become poor with the small detector area, although this fraction contains the bulk of the mass. An overall ice/mineral ratio of the ejecta is, therefore, difficult to estimate.

Ice particles occur at their maximum rate immediately at turn-on of the sun and drop to much lower frequencies within less than an hour; in contrast, mineral type particles reach their maximum frequency only after ~30 minutes, then their abundance decreases over a longer period of time (Fig. 2). Since gas emission varies only little during the first few hours, the occurrence of icy particles must be controlled by their abundance on the surface of the sample comet rather than by the drag force. It appears that the mineral type particles with icy component do not exist at the beginning but are formed in the process of insolation when plain ice grains exposed are disappearing through sublimation. In the course of time, exposed mineral structures would also become depleted of volatiles and then could be ejected as "dry" particles, sampled in the detector but not observed as gas pulses.

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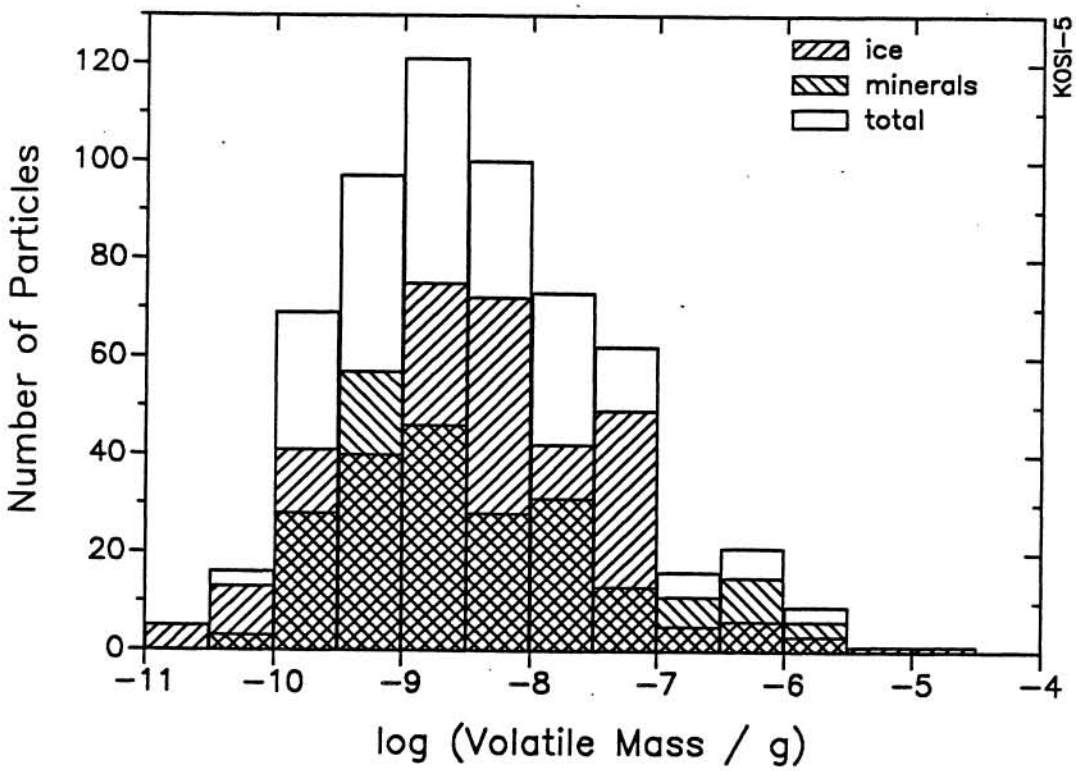

Fig. 1: Distribution of the masses (volatile component only) of the two different types of particles.

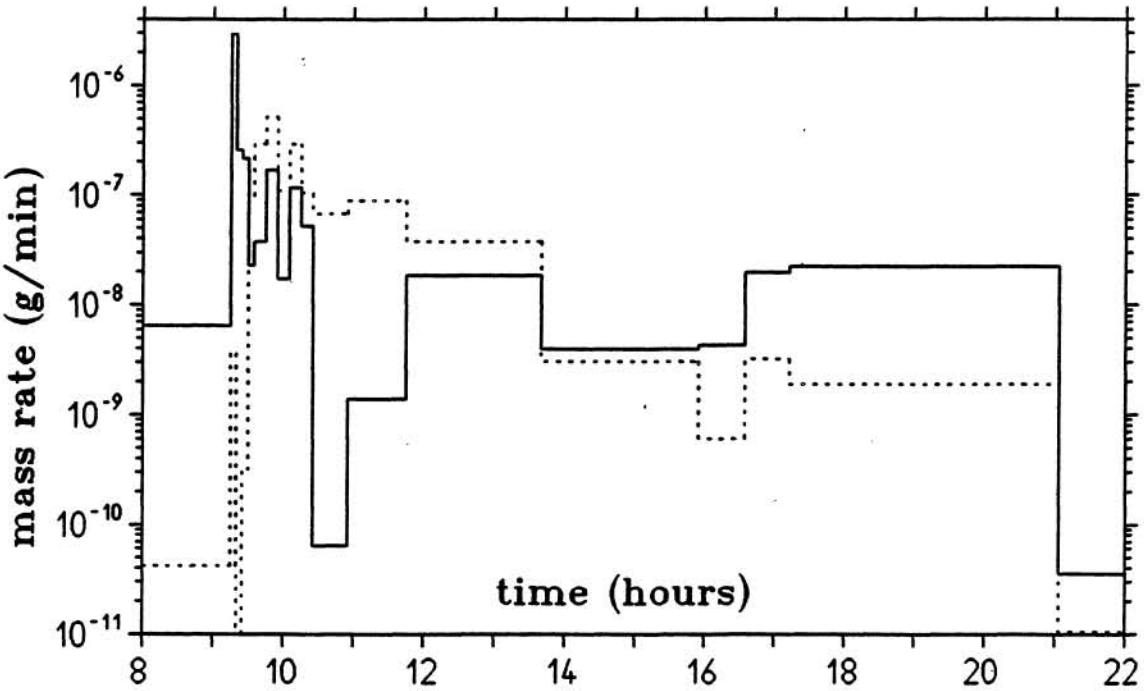

Fig. 2: Sampling rates of volatile material during the insolation period (from 09:15 to 22:06 hours LT). The full line represents icy particles, the dotted line mineral type particles.