

**MEASUREMENT OF ELECTRIC CHARGES
ON FUSED SILICA TEST MASS**

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Dielectric test mass suspended by fused silica fiber is well isolated electrically and can trap and store electric charges.

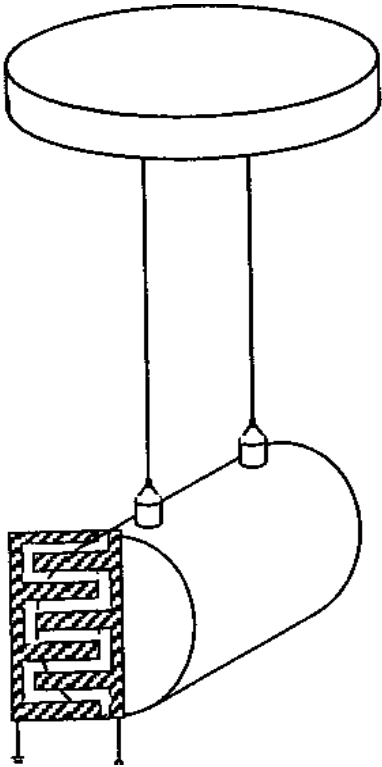
Accidental variations of the charge δq can produce the fluctuating force $\delta F \sim q \cdot \delta q$ if, for example, an electrode of the electrostatic actuator is placed in vicinity of the test mass.

The goal of the work is to study behavior of electric charges on fused silica test mass.

This work is the continuation of research of the test mass damping associated with electrostatic actuators. The same set up was used to measure the electric charge.

Experimental set-up

Electric charge sitting on the end face of 0.5 kg fused silica cylinder suspended by two fused silica fibers in the high vacuum chamber was monitored by means of the vibrating capacitor probe technique.



*to high impedance
amplifier*

The multistrip electrostatic actuator (two sets of gold strips were sputter-deposited on the polished surface of the fused silica plate mounted parallel to end face with a gap 3mm) was used:

- to excite torsion oscillation of the bifilar pendulum ($f = 1.14$ Hz).
- as a probe connected to the high impedance amplifier to measure electric charge (motion of the charge cylinder induced the

charge on the actuator electrodes that resulted in the change of the amplifier's input voltage).

High $Q \approx 8 \times 10^7$ of this mode (relaxation time $\tau^* \approx 2.2 \times 10^7$ sec) allowed monitoring the charge in the process of free decay of the torsion oscillation over a long period of time.

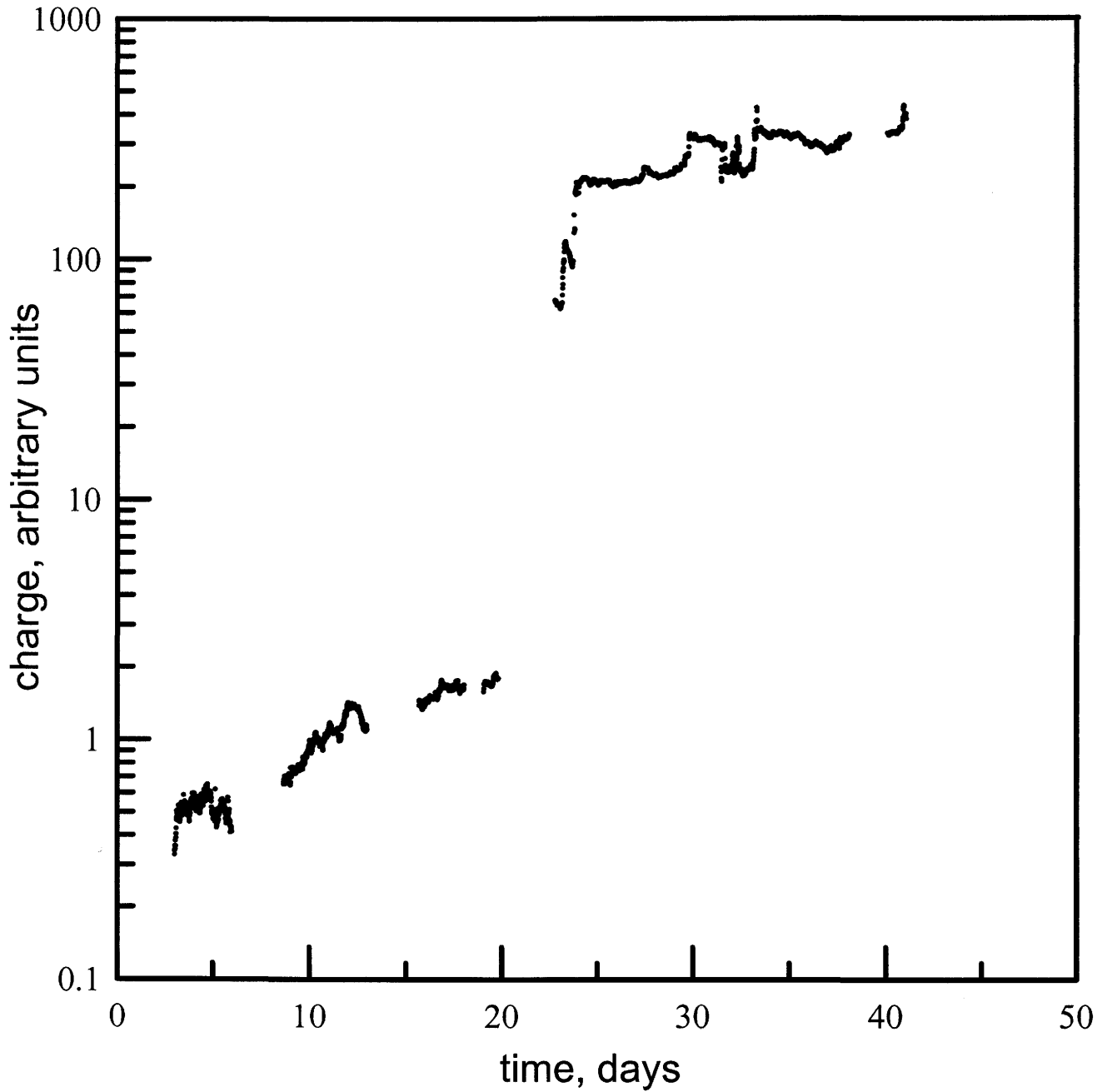
Result of measurements

The test mass was discharged before the measurements. It was possible to change the electrostatic charge by switching on the ion pump for some chosen time interval (we used only turbomolecular pump to evacuate the chamber).

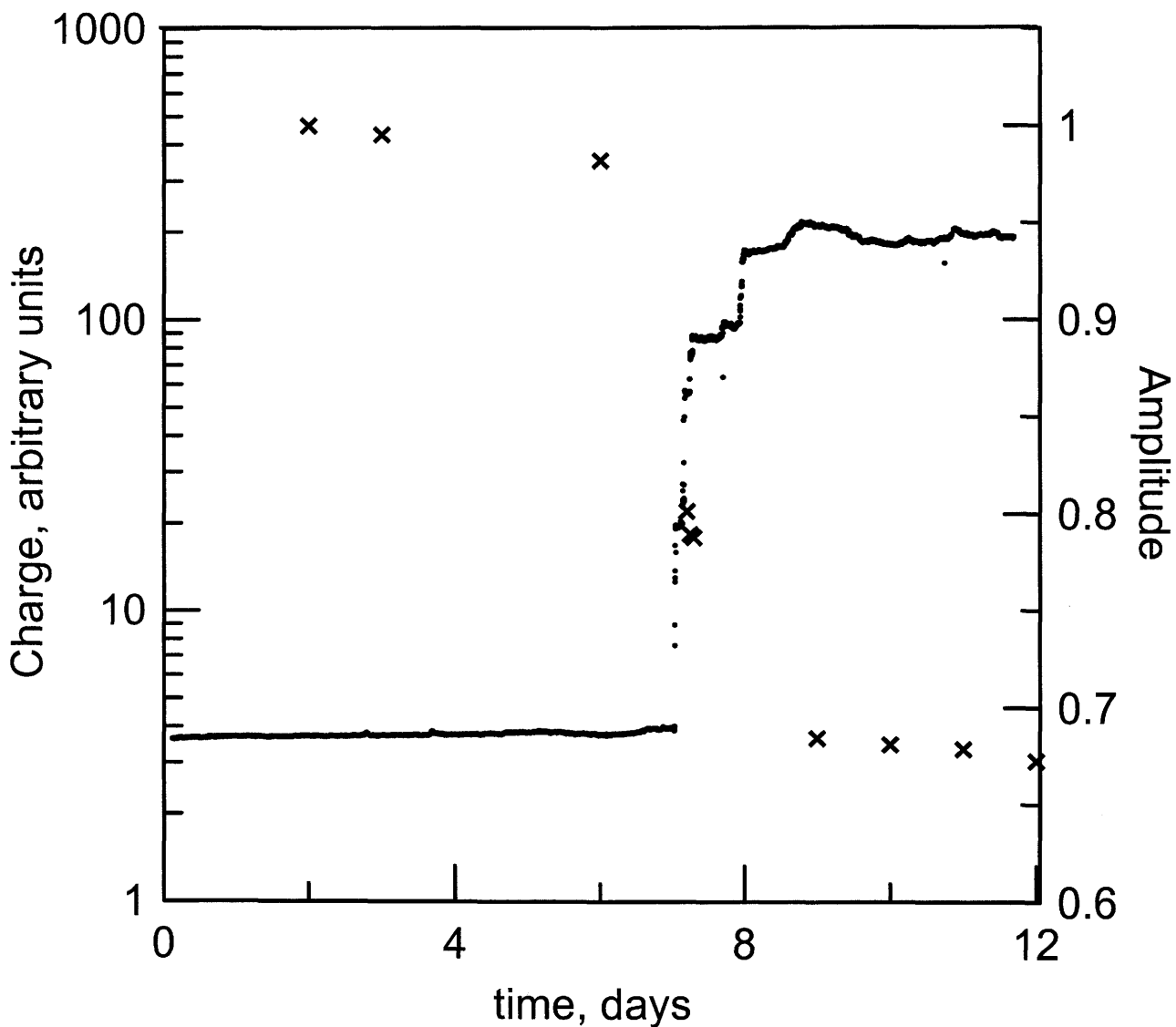
The minimum remain charge density of approximately $10^{-14} - 10^{-13} \text{ C/cm}^2$ ($6 \times 10^4 - 6 \times 10^5 \text{ electrons/cm}^2$) was achieved when the suspended test mass was keep long time (several months) under the atmospheric pressure.

- The rise of electric charge (in order of 10^{-15} C/cm^2 per day) was observed after evacuation of the vacuum chamber ($p < 10^{-7} \text{ Torr}$).
- A rate of the rise tends to decrease with increase of the charge.
- Two “jumps” of the electric charge with a total rise up to $10^{-12} - 10^{-11} \text{ C/cm}^2$ (these values correspond to a potential of about 10 V) were observed in two runs with the total duration of 4 months.
- “Jumps” of the charge had a specific structure.
- “Jumps” of the charge were correlated with sharp changes of the test mass oscillation amplitude.

Time dependence of electric charge on the test mass



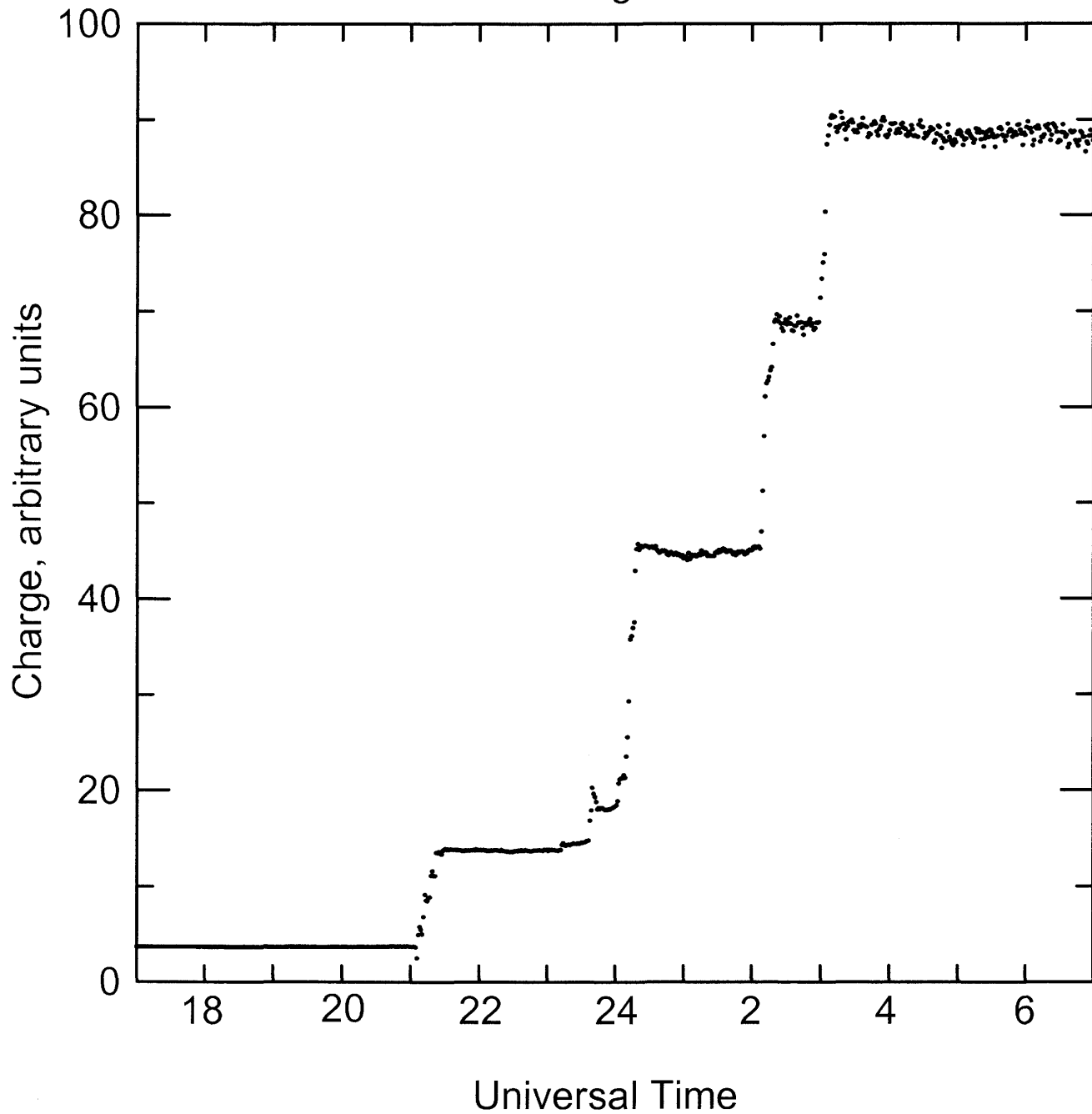
Time dependence of electric charge on the test mass and its amplitude



x - amplitude ● - charge

Fragment of record of electric charge on the test mass

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Conclusion.

A possible cause for the observed charging of the fused silica test mass may be cosmic and background radiation. They can produce photoemission of electrons from both the test mass and the walls of the vacuum chamber. Charging of the test masses can be a source of additional noise. We plan to continue this search.