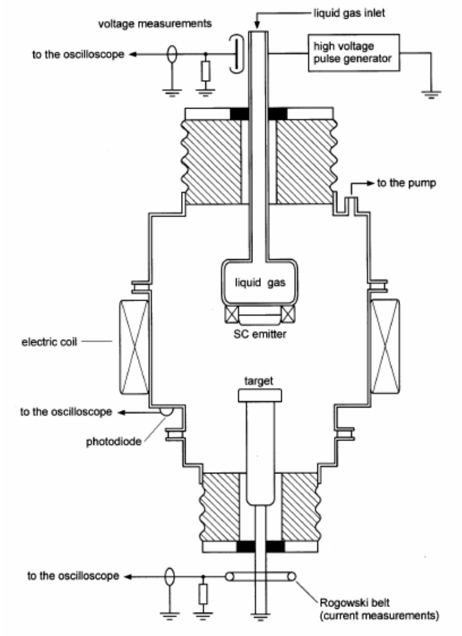
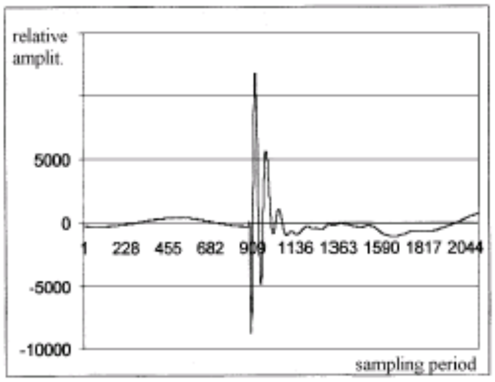
•Podkletnov developed a ***gravity beam experiment***. Here a large diameter superconductor, within a 0.9 Tesla magnetic field, is placed inside a vacuum chamber. The superconductor is charged from 0.5 to 1 million volts and discharged. Podkletnov claimed the resulting gravitational pulse is capable of moving a pendulum 0.8 km away from the device. He further claimed that the pendulum motion depended upon the shape of the superconductor and voltage level. He placed a cement wall between the device and the pendulum with similar results. Although not reported in the literature, he later claimed chunks of the cement wall were removed when the superconductor was charged up to 5 million volts. Podkletnov also claimed that when he used a thick metal plate, as a target- the material was not identified- the device's effects were similar to hitting the plate with a large sledgehammer. In fact he suggested that there existed at least a force of several hundred pounds within the gravitational impulse.





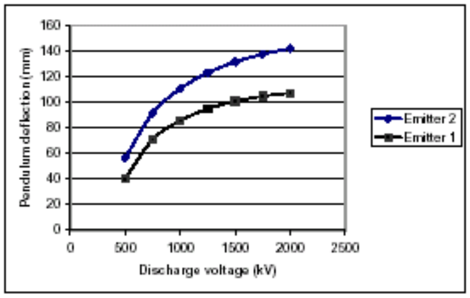
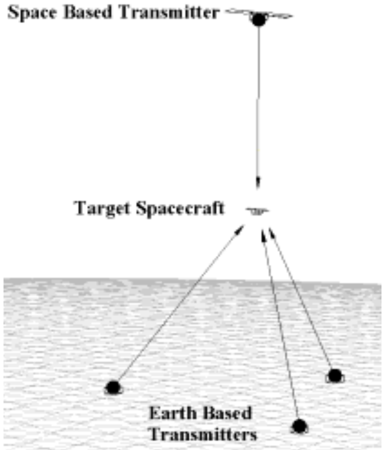
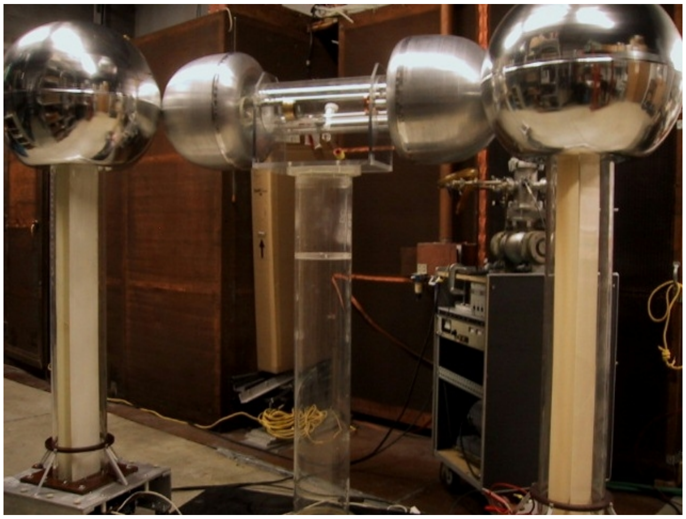
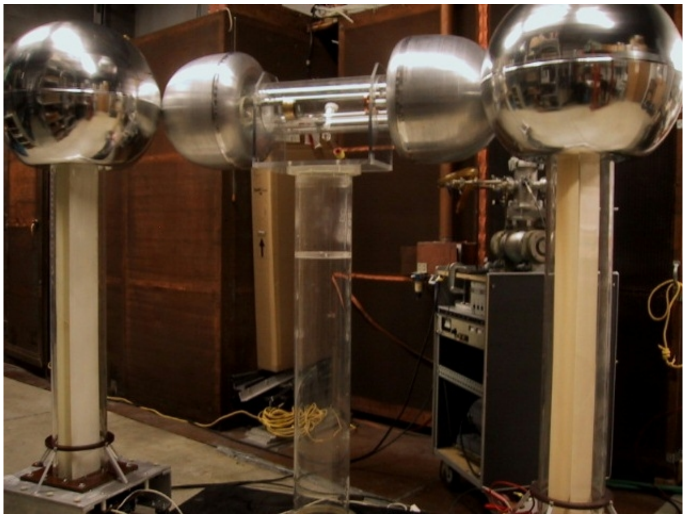


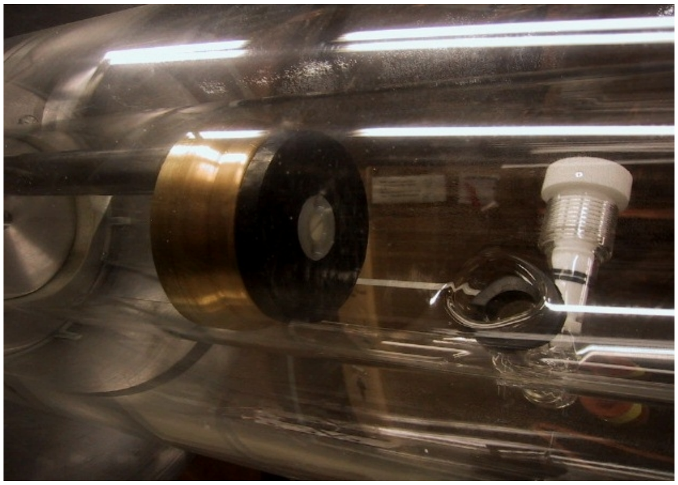
Fig. 3



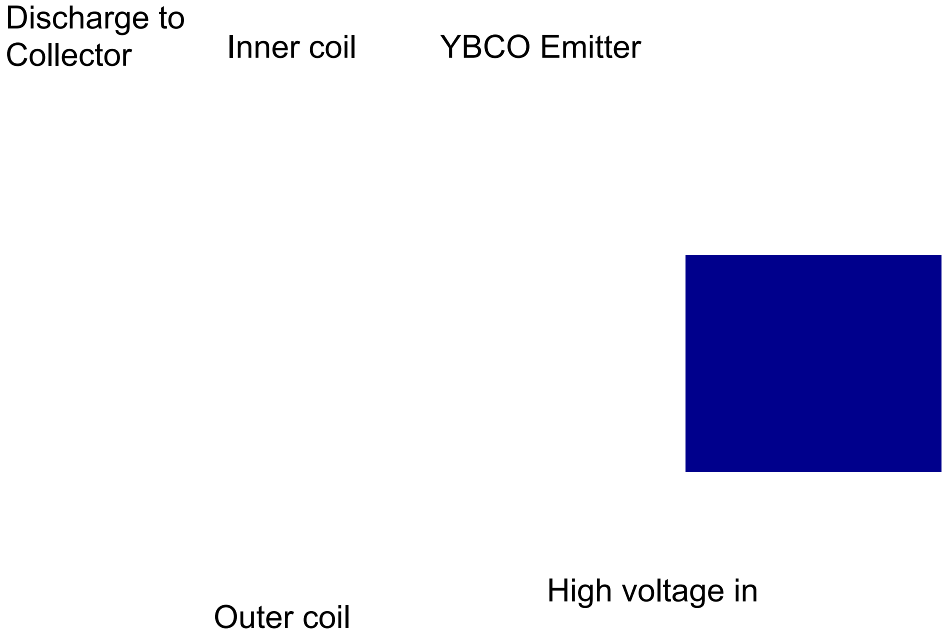
Note the following. For two emitters, there is no appearance of a singularity at 511 KVs. The first graph is a pendulum response. The last graph is using this device to place a satellite into orbit using three of these devices as ground-based beam powered systems with a forth one in orbit for station keeping. Last figure is a simplification of the device…Paul…







The last one is the picture I asked for others… No one else seems to have this picture so hold it close….



Podkletnov gravity beam experiment

Weak gravitational shielding properties of composite bulk $YBa_2Cu_3O_{(7-x)}$ superconductor below 70 K under e.m. field

Report MSU-chem 95. Los Alamos database nr. cond-mat/9701074 (LaTeX). This is an informal ASCII version. E.E. Podkletnov Moscow Chemical Scientific Research Centre

ABSTRACT

A high-temperature $YBa_2Cu_3O_{(7-x)}$ bulk ceramic superconductor with composite structure has revealed weak shielding properties against gravitational force while in a levitating state at temperatures below 70 K. A toroidal disk was prepared using conventional ceramic technology in combination with melt-texture growth. Two solenoids were placed around the disk in order to initiate the current inside it and to rotate the disk about its central axis. Samples placed over the rotating disk initially demonstrated a weight loss of 0.3-0.5%. When the rotation speed was slowly reduced by changing the current in the solenoids, the shielding effect became considerably higher and reached 1.9-2.1% at maximum. P.A.C.S. 74.72.-h High-T_c cuprates.

1. INTRODUCTION

The behavior of high-temperature ceramic superconductors under high-frequency magnetic fields is of great interest for practical applications. Crystal structure seems to be the key factor determining all physical properties of bulk superconductors, and the interaction of this structure with external and internal e.m. fields might result in quite unusual effects. Despite a large number of studies [1,2,3] the nature of these interactions still remains unresolved.

Our recent experimental work [4] clearly indicated that under certain conditions single-phase bulk, dense
$YBa_2Cu_3O_{(7-x)}$revealed a moderate shielding effect against gravitational force. In order to obtain more information about this unusual phenomenon, a new installation was built, enabling operation with magnetic fields of up to 2 T and frequencies up to 10^8 Hz at temperatures from 40 to 70 K. A new experimental technique was employed to modify the structure of the ceramic superconductor. All these efforts yielded a larger value of the shielding effect (up to 2.1%), providing good hopes for technological applications. A gravitational shielding effect of this strength has never been previously observed, and its implications present serious theoretical difficulties (see [11] for references and an analysis of some hypotheses). Thus, great attention was devoted to the elimination of any possible source of systematic errors or of spurious non-gravitational effects. The small disturbances due to air flows pointed out by some authors [9,10] were eliminated by weighing the samples in a closed glass tube (see Section 2.1). The entire cryostat and the solenoids were enclosed in a stainless steel box. But probably the best evidence for the true gravitational nature of the effect is that the observed weight reductions (in %) were independent of the mass or chemical composition of the tested samples (Section 3).

According to public information, a NASA group in Huntsville, Alabama, is now "cloning" our experiment. This is a difficult task, especially in view of the sophisticated technology involved in the construction of the large ceramic disk and in the control of its rotation. We are also aware, through unofficial channels, that other groups are working on similar experiments with smaller disks.

2. EXPERIMENTAL

2.1 CONSTRUCTION OF THE DISK

The shielding superconducting element was made of dense, bulk, almost single-phase YBa_2Cu_3O_{7-x} and had the shape of a toroidal disk with an outer diameter of 275 mm, an inner diameter of 80 mm, and a thickness of 10 mm. The preparation of the

123-compound and fabrication of the disk involved mixing the initial oxides, then calcining the powder at 930 C in air, grinding, pressing the disk at 120 MPa, and sintering it in oxygen at 930 C for 12 hours with slow cooling to room temperature. After that, the disk was put back in the furnace at 600 C, and the upper surface was quickly heated to 1200 C using a planar high-frequency inductor as shown in Figure 1. During this last heating, the gap between the disk and the inductor was chosen precisely so that heating would occur only in the top 2 mm-thick layer of the disk, although the material's high heat conductivity caused some heating below this region. Finally, the disk was slowly cooled down to room temperature in a flow of oxygen and treated mechanically in order to obtain good balance during rotation. A thin (1 mm) foil of magnetic material was attached to the upper surface of the disk, using hot-melt adhesive, to facilitate rotating the disk as described below. Table 1 summarizes the steps in the disk's construction. The phase and crystal structure of the superconductor were studied using X-ray diffraction analysis (XRD) and a scanning electron microscope (SEM) equipped with an energy dispersive spectral (EDS) analyzer. The samples were cut layer by layer from the bulk ceramic disk.

The transition temperature T_c was determined from the resistive transition in a variable temperature cryostat, under zero magnetic field, using an AC current and sputtered golden contacts. The critical current density was measured for samples cut from the top and from the bottom of the superconducting disk. Measurements of J_c were carried out at 75 K using an AC current, four-probe method, and direct transport measurements.

The analysis of the cross-section of the ceramic $YBa_2Cu_3O_{(7-x)}$ disk revealed the existence of two zones with different crystal structures. The upper part of the disk (6-7 mm thick) had an orthorhombic structure typical of the quench and melt growth process [5,6] and consisted mainly of single-phase orthorhombic 123-compound. This material was dense, with uniformly fine grain boundaries, i.e. no impurities or secondary phases were found between the grains. Inter-grain boundaries were barely visible, indicating that there were good electrical contacts between the particles of the superconducting body and that the sintering of the material had produced a nearly perfect crystal lattice with no apparent defects.

The grains were less than 2 microns wide and were oriented (75%) with c-axis parallel to the surface of the disk. The transition temperature for this region of the disk was determined by direct measurements to be 94.2 K. The lower part of the disk, which was in contact with a water-cooled base during the high-frequency heat treatment, had a markedly different structure: randomly oriented grains, with typical grain sizes between 5 and 15 microns. The porosity of this zone varied from 5 to 9%. The transition temperature T_c was equal to 60.5 K, and the material contained about 40% of the tetragonal phase.

Crystal lattice parameters for these two layers, as calculated from XRD, are listed below. These are dimensions in nm: Upper layer: a=0.381; b=0.387; c=1.165; Lower layer: a=0.384; b=0.388; c=1.170 (orthorhombic phase); a=0.387; c=1.183 (tetragonal phase). The first (upper) layer was quite homogenous, with even volumetric distributions of elements in all the samples. EDS analysis showed the presence of small inclusions of Y_2BaCuO_5 in the lower layer.

2.2 OPERATION OF THE APPARATUS

Two identical solenoids were placed around the superconductor using fibreglass supports, as shown in Figures 2, 4, 5. The gaps between these solenoids and the disk were large enough for it to move about 20 mm in any lateral direction. The toroidal disk was placed inside a cryostat equipped with a set of three coils (Fig. 3) that could keep it levitating when it reached the superconducting state. The angle beta was between 5 and 15 degrees. This helped to keep the rotating disk in a stable position, otherwise it tended to slip aside.

A schematic of the electrical connections is shown in Fig. 6. High-frequency electric current (10^5 Hz) was first sent to the two main solenoids around the disk to initiate an internal current in the ceramics while the disk was still at room temperature. Then the system was slowly cooled down to 100 K by liquid nitrogen, and then quickly cooled by liquid helium vapors to 65-70 K, at which point the disk became superconducting (Fig. 7). The main solenoids were switched off. After this, the high-frequency current was sent to the coils below the disk, and the superconductor raised up (about 15 mm) because of the Meissner effect. Then a small current (10^5 Hz) was sent to the main solenoids, causing the disk to begin rotating counter-clockwise with increasing speed. The rotation speed was increased up to 5000 rpm. At this point, the first measurements of weight for various objects were taken (Fig. 8).

Next, the disk's rotational speed was slowly reduced by changing the current in the main solenoids (Fig. 9). The speed of rotation was regulated by means of laser beam reflections off a small piece of plastic light-reflecting foil attached to the disk. Measurements of the sample's weight were taken repeatedly during this period. The frequency of the e.m. field was varied from 10^3 to 10^8 Hz. Samples made of various materials were tested, including metals, glass, plastic, wood and so on. All the samples were hung over the cryostat on a cotton thread connected to a sensitive balance. The distance between the samples and the cryostat varied from 25 to 1500 mm in the first run, and was increased up 3 meters in the second run. The weight of the samples typically ranged from 10 to 50 grams. Every precaution was taken to avoid disturbances and extraneous factors, including induced magnetic fields. The influence of air flows was eliminated by encasing the samples in a vertical glass tube.

In the original experiments, samples were weighed with a modified balance that previously was employed for precision differential thermogravimetric analyses. In the latest runs, since the samples weighed from 100 g to 250 g, a standard analytical balance was used. Given these masses and the balance's accuracy (0.01 g), weight losses of 0.01% should be easy to detect. In addition, the latest work used two other types of balances, shown in Fig. 8. One has a blue laser that projects a light beam onto a scale attached to a nearby wall, making very small changes clearly visible to the eye. The other system responds to the movement of a small conductor inside a solenoid and transmits this information to an amplifier for continuous logging.

3. RESULTS

The levitating disk revealed a clearly measurable shielding effect against the gravitational force even without rotation. In this situation, the weight-loss values for various samples ranged from 0.05-0.07%. As soon as the main solenoids were switched on and the disk began to rotate in the vapors of liquid helium, the shielding effect increased, and at 5000 rpm, the air over the cryostat began to rise slowly toward the ceiling. Particles of dust and smoke in the air made the effect clearly visible. The boundaries of the flow could be seen clearly and corresponded exactly to the shape of the toroid.

The weight of various samples decreased no matter what they were made from. Samples made from the same material and of comparable size, but with different masses, lost the same fraction of their weight. However, the shape and position of the sample did affect the weight loss, causing slight variations (about 10%) in the shielding effect. The maximum loss of weight was achieved when a sample was positioned with its largest surface parallel to the surface of the disk, so that the effect being projected by the disk impinged on the maximum area. The best measurement gave a weight loss of 0.5% while the disk was spinning at 5000 rpm, with typical values ranging from 0.3 to 0.5%. Samples placed above the inner edge of the toroid (5-7 mm from the edge) were least affected, losing only 0.1 to 0.25% of their weight.

During the time when the rotation speed was being decreased from 5000 to 3500 rpm, using the solenoids as braking tools, the shielding effect reached maximum values: the weight loss of the samples was from 1.9 to 2.1%, depending on the position of the sample with respect to the outer edge of the disk. These peak values were measured during a 25-30 seconds interval, when the rotational speed was decreasing to 3300 rpm. Because of considerable disk vibration at 3000-3300 rpm, the disk had to be rapidly braked in order to avoid unbalanced rotation, and further weight measurements could not be carried out.

The maximum shielding properties were coincident with maximum current inside the superconducting disk. According to preliminary measurements, the upper layer of the disk was able to carry over 15000 A/cm^2. The samples' maximum weight loss was observed only when the magnetic field was operating at high frequencies, on the order of 3.2 to 3.8 MHz.

The following tables show how the maximum shielding effect varied in response to changes in the disk's rotation speed or the current frequency. Frequency held constant at 2 MHz:

Rotation speed (rpm)	Weight loss (%)
4000	

	0.17
4200	0.19
4400	0.20
4600	0.21
4800	0.22
5000	0.23

Rotation speed held constant at 4300 rpm:

Frequency (MHz)	Weight loss (%)
3.1	0.22
3.2	0.23
3.3	0.24
3.4	0.26
3.5	0.29
3.6	0.32

Remarkably, the effective weight loss was the same even when the samples, together with the balance, were moved upward to a distance of 3 m, but still within the vertical projection of the toroidal disk. No weight loss at all was observed below the cryostat.

The shielding effect decreases slightly the gravitational force within a vertical projection above the disk. The projection creates a kind of vertical tunnel in the air, within which the air pressure is slightly reduced. (The observed effect also works in other gases and even in liquid media.)

The difference between the atmospheric pressure over the cryostat and the pressure below it was measured with high precision using a mercury barometer. It was equal to 8 mm for the maximum shielding effect. Such a pressure differential produces a lifting force on the cryostat (of the order of 10^2 Kg/m^2). However, in the present case, this is of no practical interest.

4. DISCUSSION

The interaction of a superconducting ceramic body with the gravitational field is a complicated process and cannot be characterized by one single law or physical phenomenon. Also, a comprehensive explanation of the mechanism responsible for high-temperature superconductivity has not yet been found. Still, these facts do not make the observed phenomenon less interesting.

In our previous work [4] the loss of weight of samples over the levitating superconductor was smaller, varying from 0.05 to 0.3%. At that time it was difficult to exclude entirely any influence from a radio-frequency field because the sample was separated from the disk and the magnets by a thin plastic film. Now, the superconductor is situated in a stainless steel cryostat, so the influence of non- gravitational factors should be negligible.

The modification of the superconductor's crystalline structure produced a composite body with a dense and highly oriented upper layer and a porous lower layer with random gain orientation. The upper layer is able to carry high J_c current under considerable magnetic field, while the lower layer cannot conduct high currents and is not resistant to the external magnetic field. The wide intergrain boundaries in the lower part of the disk are also a source of a great number of Josephson junctions that are responsible for the direct and reverse, primary and secondary, Josephson effects. The presence of this tetragonal non-superconducting phase allows interaction with the external magnetic field.

The combination of two different crystal structures, with different behaviors in magnetic fields, creates a composite ceramic body with unique properties. According to Faraday's law, placing a normal conductor in a magnetic field induces electric current inside it.

During levitation, the magnetic field usually does not penetrate into a superconductor for more than a penetration depth; thus, the interaction with the field is extremely small. But in the described experiment, the superconductor also carries high frequency electric current modified by Josephson effect. It is reasonable to speculate that some interaction between between the composite ceramic body and the external magnetic field takes place. This interaction depends on the coherence length, the flux pinning, the field frequency and the field force, the penetration depth, and the parameters of the crystal lattice. These characteristics are interrelated in a complex way. According to the experimental data (compare also [10], where only a static field was applied), a levitating superconductor does not reveal any unusual shielding if it has no contact with the AC magnetic field.

As analyzed in [7], pinning centers with different origins may exist inside the superconducting disk, and fluxes will be trapped at some of them. Fluxes trapped at weak centers will begin to move first, while those trapped at strong centers will not move until the Lorentz force exceeds the pinning force. The overall current will be composed of the superposition of flux motions with different speeds. Generally speaking, the quantized fluxes move as a bundle after being formed in a local flux lattice by the magnetic interaction between them.

The temperature is also of great importance, as it determines the thermodynamic functions - in particular, the order parameter and the free energy inside a superconductor. The shielding effect was observed only below 70 K, although the ceramic disk had already become superconducting at 94 K.

The electric interactions inside the superconducting body below T_c change under the conditions of the experiment and this might alter the behavior of the whole atomic structure in such a way that the interaction with the gravitational field becomes different. Then, in order to maintain a stable energy level and a stable atomic and crystal lattice structure, the superconductor might exchange some energy with the gravitational field and slightly decrease it. There are no grounds to claim that the rotation momentum of the disk interacts with gravitation force, but it seems that fast rotation is favorable for stabilization of the shielding effect.

According to BCS theory of weak-bond conditions, electrons of conductivity and phonons in the crystal lattice interact from time to time: particles collide but still preserve their individual positions and properties. Under strong-bond conditions, however, interactions occur all the time, and free electrons and phonons no longer exist; the strong-bond condition thus gives birth to a strange mixture called the electron-phonon liquid. This liquid has specific properties, but the behavior of the electron-phonon mixture under various conditions is not yet well studied. It seems reasonable to suggest that this liquid has some properties similar to those typical of magnetic liquids, especially if we consider that magnetic hysteresis is characteristic for high T_c compounds. Also, it is worth noting that the experimental equipment described above has much in common with magneto-hydro-dynamic (MHD) generators.

The first attempt at a theoretical explanation of the effect has been offered by G. Modanese [11,12]. Further investigations now in progress may help to prove, change, or complete the present understanding of the observed phenomenon.

5. CONCLUSIONS

A levitating superconducting ceramic disk of $YBa_2Cu_3O_{(7-x)}$ with composite structure demonstrated a stable and clearly measurable weak shielding effect against gravitational force, but only below 70 K and under high-frequency e.m. field. The combination of a high-frequency current inside the rotating toroidal disk and an external high-frequency magnetic field, together with electronic pairing state and superconducting crystal lattice structure, apparently changed the interaction of the solid body with the gravitational field. This resulted in the ability of the superconductor to attenuate the energy of the gravitational force and yielded a weight loss in various samples of as much as 2.1%.

Samples made of metals, plastic, ceramic, wood, etc. were situated over the disk, and their weight was measured with high precision. All the samples showed the same partial loss of weight, no matter what material they were made of. Obtaining the maximum weight loss required that the samples be oriented with their flat surface parallel to the surface of the disk. The overall maximum shielding effect (2.1%) was obtained when the disk's rotational speed and the corresponding centrifugal force were slightly decreased by the magnetic field.

It was found that the shielding effect depended on the temperature, the rotation speed, the frequency and the intensity of the magnetic field. At present it seems early to discuss the mechanisms or to offer a detailed analysis of the observed phenomenon, as further investigation is necessary. The experimentally obtained shielding values may eventually prove to have fundamental importance for technological applications as well as scientific study.

ACKNOWLEDGMENT

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REFERENCES

[1] Riise A.B., Johansen T.H., Bratsberg H. and Yang Z.J., Appl. Phys. Lett. 60 (1992) 2294.
[2] Brand E.H., Am. J. Phys. 58 (1990) 43.
[3] Lofland S., Huang M.X. and Bhagat S.M., Physica C 203 (1992) 271.
[4] Podkletnov E. and Nieminen R., Physica C 203 (1992) 441.
[5] Murakami M., Morita M., Doi K., Miyamoto K. and Hamada H., Jpn. J. Appl. Phys. 28 (1989) 399.
[6] Murakami M., Morita M. and Koyama N., Jpn. J. Appl. Phys. 28 (1989) 1125.
[7] Takizawa T., Kanbara K., Morita M. and Hashimoto M., Jpn. J. Appl. Phys. 32 (1993) 774.
[8] Xu J.H., Miller J.H. Jr. and C.S. Ting, Phys. Rev. B 51 (1995) 424.
[9] Bull M., De Podesta M., Physica C 253 (1995) 199.
[10] Unnikrishnan, C.S., Physica C 266 (1996) 133.
[11] Modanese G., Europhys. Lett. 35 (1996) 413.
[12] Modanese G., Phys. Rev. D 54 (1996) 5002; Modanese G. and Schnurer J., "Possible quantum gravity effects in a charged Bose condensate under variable e.m. field", report UTF-391/96, November 1996, Los Alamos database nr.
gr-qc/9612022; ASCII version available from authors.