Ukrainian scientist develops maglev plan

by Lothar Komp

The immediate initiation of two major tasks is a life-and-death question for Ukraine. First is the reconnection to western Europe by high-speed transport technologies and the buildup of a modern energy and transport infrastructure. Second, and closely related, is the mobilization of still-existing research capacities in the military sector, aerospace, and research institutes in order to drive the Ukrainian economy out of an otherwise desperate situation.

Visiting a nuclear research center in Kiev these days shows how far the destruction of Ukraine's technological potential has already gone. Most of the scientists have left, while those who remain are employing themselves with only a slight hope of getting new machinery or their promised $30 salary. A similar situation can be found in universities. If you don't get your personal deal with international financier George Soros, there are not many chances left for you.

The case of the Ukrainian scientist V. Kozoriz and his unique maglev concept demonstrates what potential could be mobilized as soon as present criminal policies against the future of Ukraine are reversed.

When William Gilbert in the late 16th century studied the Earth's magnetic field, he was also interested in ancient experiments in magnetism. He reports on the idea of engineers more than 2,000 years ago, to use magnetism for improving the worship of holy statues. It was planned to let an iron statue float in the air under a hidden magnetic vault inside a temple. But unfortunately, this design of magnetic levitation, as Gilbert fully understood, is highly unstable. Either the statue falls to the ground or it sticks to the ceiling: not very impressive! In modern times, it was "proved" in theory by Lawrence Earnshaw that stable magnetic levitation is impossible in general. However, as today's maglev trains show, there are some exceptions.

In the 1930s, Hermann Kemper in Germany developed the concept of magnetic levitation by electromagnetic attraction (EMA), which later led to the construction of the German Transrapid. Here the instability problem of magnetic levitation is solved by sophisticated automatic control systems that detect and regulate the magnetic fields thousands of times a second in order to stabilize the train 8 millimeters above the track. After Kemper, the German physicist W. Braunbeck found another exception to the "Earnshaw prohibition" by using diamagnetic material, and especially the diamagnetic properties of superconductors. This approach is embedded in the electrodynamic repulsion (EDR) principle of today's Japanese superconducting train RTRI. But here the magnetic levitation depends on the speed of the train, and the train first has to accelerate on wheels.

A third approach to achieve stable magnetic levitation was invented in the 1970s by the Ukrainian scientist V. Kozoriz, after he discovered a far-reaching aspect of the behavior of superconductors in magnetic fields, called the magnetic potential well (MPW). When two parallel superconducting coils with electrical currents of the same orientation come together, they attract one another. But, contrary to the iron idol and magnetic ceiling in Gilbert's story, when the superconducting coils come closer and closer, there is a certain distance at which the attracting magnetic force vanishes, and the magnetic energy exhibits a minimum, or "well." A similar effect takes place in the case of only one superconducting coil, which moves through the magnetic field of a permanent magnet. Even more interesting, whenever the superconducting coil is pushed away from the point of zero magnetic force in any direction, it acts like a spring and starts to oscillate around that point. After a short time span, the oscillations have gradually vanished and the superconducting coil is back at its point of rest—exactly what Gilbert's ancient engineers had looked for in vain.

This MPW effect is a result of the very special behavior of superconducting coils in magnetic fields, which is completely different from iron or permanent magnets. Whenever a superconducting coil moves through a changing external magnetic field, its electrical current is adjusted in such a way, that the resulting magnetic flux through the area circumscribed by the coil remains constant. In conclusion, the existence of the magnetic potential well allows for an "inherently stable" magnetic levitation that does not need additional control systems or power sources.

The existence of the MPW effect was proven by experiments that were conducted by G. Karavaev and M. Kryukov in 1975, based on patterns put forward by Kozoriz. The first application of the MPW effect for magnetic levitation was by O. Cheborin and was published in 1979 in Ukraine. Cheborin placed two concentric niobium rings, 10 mm and 15 mm in diameter, on a support structure beneath a permanent magnet. After plunging the whole system into liquid helium, the support structure was slowly lowered. Due to the MPW effect, the now superconducting niobium rings reached a free equilibrium state, floating in the air. When the system was disturbed by external vibrations, the niobium rings started complex oscillations. However, the system remained stable, and with elimination of the external vibrations, the oscillations gradually vanished. Later, Kozoriz was able to show stable magnetic levitation of a 750 kg load by the MPW effect in an experiment with superconducting coils of 600 mm diameter.

In the Soviet Union there had been state programs for "Ecologically Pure Transport" that included "Transportation with Magnetic Car Suspension," headed by the State Committee of the U.S.S.R. for Science and Technology. But very little funding was given to this program, and it was decided to concentrate all efforts on the electromagnetic attraction (EMA) principle, where the German Transrapid was already 20 years ahead in research. In 1991, Kozoriz presented the Ukrainian maglev concept to the Future Transportation Technology Conference in Portland, Oregon, and again in August 1992 in Costa Mesa, California. His design was acknowledged as a new concept for maglev technology. It was intended by Kozoriz's group to construct a test site for the Ukrainian maglev connecting the Borispol Airport to the nearest metro station in Kiev, 30 km away. The cost of the project, including guideway, superconductive magnets, and computerized traffic control, was estimated to be $500 million. But no foreign investors could be found and the Ukrainian government did not show much interest.

Beyond maglev systems

Of course, there are many more applications for "inherently stable" magnetic levitation than just the construction of magnetic trains. The discovery of the MPW effect could transform transport technologies and industrial processes that involve high rates of rotation. One example is a new design of a linear motor, which is supposed to drive the Ukrainian maglev. Based on the MPW effect, this linear motor allows for a conversion of magnetic energy into kinetic energy during acceleration, and the reverse conversion during braking, with an efficiency potentially of 95%. Another example is the storage of energy by a quickly rotating magnetic stick. If a stick of about half a meter length is stabilized, not by ball bearings but instead by the MPW effect, it can easily achieve half a million rotations per minute without any losses to friction. This could lead to the development of long-range, gasoline-free automobile systems, using highly efficient magnetic-kinetic energy conversion. It's high time to utilize the hidden richness of Ukraine.

TABLE 1
Three concepts of magnetic levitation

	EMA	EDR	MPW
Kw/metric ton levitated	1	0.1	0.01
Clearance (mm)	10	100	100
Stabilization required	Yes	No	No
Wheels needed	No	Yes	No
Pressure (kg/cm^2)	5	10	100

EMA = electromagnetic attraction
EDR = electromagnetic repulsion
MPW = magnetic potential well