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A BLOW AGAINST A MAGNETIC FIELD,(U)
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FOREIGN TECHNOLOGY DIVISION

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A BLOW AGAINST A MAGNETIC FIELD

by

R. Leonidov

FOREIGN TECHNOLOGY DIVISION

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A BLOW AGAINST A MAGNETIC FIELD

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Block	Italic	Transliteration	Block	Italic	Transliteration
А а	*А а*	A, a	Р р	*Р р*	R, r
Б б	*Б б*	B, b	С с	*С с*	S, s
В в	*В в*	V, v	Т т	*Т т*	T, t
Г г	*Г г*	G, g	У у	*У у*	U, u
Д д	*Д д*	D, d	Ф ф	*Ф ф*	F, f
Е е	*Е е*	Ye, ye; E, e*	Х х	*Х х*	Kh, kh
Ж ж	*Ж ж*	Zh, zh	Ц ц	*Ц ц*	Ts, ts
З з	*З з*	Z, z	Ч ч	*Ч ч*	Ch, ch
И и	*И и*	I, i	Ш ш	*Ш ш*	Sh, sh
Й й	*Й й*	Y, y	Щ щ	*Щ щ*	Shch, shch
К к	*К к*	K, k	Ъ ъ	*Ъ ъ*	"
Л л	*Л л*	L, l	Ы ы	*Ы ы*	Y, y
М м	*М м*	M, m	Ь ь	*Ь ь*	'
Н н	*Н н*	N, n	Э э	*Э э*	E, e
О о	*О о*	O, o	Ю ю	*Ю ю*	Yu, yu
П п	*П п*	P, p	Я я	*Я я*	Ya, ya

*<u>ye</u> initially, after vowels, and after ъ, ь; <u>e</u> elsewhere. When written as ё in Russian, transliterate as yё or ё. The use of diacritical marks is preferred, but such marks may be omitted when expediency dictates.

GREEK ALPHABET

Alpha	Α	α	*α*		Nu	Ν	ν	
Beta	Β	β			Xi	Ξ	ξ	
Gamma	Γ	γ			Omicron	Ο	ο	
Delta	Δ	δ			Pi	Π	π	
Epsilon	Ε	ε	*ϵ*		Rho	Ρ	ρ	*ϱ*
Zeta	Ζ	ζ			Sigma	Σ	σ	*ς*
Eta	Η	η			Tau	Τ	τ	
Theta	Θ	θ	*ϑ*		Upsilon	Τ	υ	
Iota	Ι	ι			Phi	Φ	φ	ϕ
Kappa	Κ	ϰ	κ	*ϰ*	Chi	Χ	χ	
Lambda	Λ	λ			Psi	Ψ	ψ	
Mu	Μ	μ			Omega	Ω	ω	

RUSSIAN AND ENGLISH TRIGONOMETRIC FUNCTIONS

Russian	English
sin	sin
cos	cos
tg	tan
ctg	cot
sec	sec
cosec	csc
sh	sinh
ch	cosh
th	tanh
cth	coth
sch	sech
csch	csch
arc sin	$\sin^{-1}$
arc cos	$\cos^{-1}$
arc tg	$\tan^{-1}$
arc ctg	$\cot^{-1}$
arc sec	$\sec^{-1}$
arc cosec	$\csc^{-1}$
arc sh	$\sinh^{-1}$
arc ch	$\cosh^{-1}$
arc th	$\tanh^{-1}$
arc cth	$\coth^{-1}$
arc sch	sech^{-1}
arc csch	csch^{-1}

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rot	curl
lg	log

GRAPHICS DISCLAIMER

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A BLOW AGAINST A MAGNETIC FIELD

R. Leonidov

I often had the occassion to be in the rolling plants where the blooming mills crushed billets weighing many tons as if they were clumps of dough. I observed the operation of the biggest machine of modern times - a stamping press with the "height" of a ten-story building. But all these giants of heavy machine building seemed like toys in comparison with the instrument of the Dubna physicists - a synchrophasotron later, I learned that just one part of the synchrophasotron - the circular electromagnet - weighs 36 tons! I was told that 2000 meters and as many various control apparatuses follow the operation of the accelerator. It was calculated that during the operation of the giant, the power of its assemblies reaches 140,000 kilowatts. This is 1/4 the power of Dneproges [Dnepr hydroelectric power plant]!

But all these figures added nothing and took away nothing from the first startling impression which I experienced when standing in front of the accelerator's tremendous arena. In this arena, almost 5 times larger than the arena of the Moscow Circus, gladiator protons died heroically to the glory of relativistic mechanics. Accelerated by a giant sling of the accelerator to almost the speeds of light, these elementary particles which were gripped by an invisible wall of powerful magnetic fields were carried along to meet their death. The last act in the tragedy - the collison - was carefully recorded by photographic plates.

The production of the contemporary accelerator is a flux of accelerated hydrogen nuclei - protons. The gigantic engineering structure in Dubna provides several "batches" of products per minute. Each of them contains thousands of millions of "parts." However, during an entire year of round-the-clock operation the weight of all the products is a millionth of a gram.

The tenth aniversary of the Dubna accelerator will take place soon. During this time, an accelerator almost three times more powerful has been constructed in Switzerland using the resources of several countries. However, the palm of first place will soon return to us: near Serpukhovo, an accelerator "producing particles" with an energy twice as great as that in Switzerland will operate. Each such structure is not cheap and the scientist are seeking ways to somehow solve the very same problem differently. The original idea of a fundamentally different accelerator belongs to a professor of Moscow University, Yakov Petrovich Terletskiy.

The energy of the particles which are accelerated in the accelerator depends on only two factors. It is directly proportional to the radius of the circle over which the particles are carried in the accelerator and the intensity of the magnetic field. And there are no other opportunities to "nudge" it. Contemporary technology for strong magnetic fields permits the reliable obtaining of an intensity of tens of thousands of Oersteds. It is just such an intensity that is created by the electromagnets of the synchrophasotron. Now, if you need to obtain a proton with an energy of ten billion electron-volts, the radius of the accelerator is determined without any integrals and with the aid of simple division. It comprises 30 meters for the indicated energy. This is also the parameters of the Dubna instrument.

Do you want to have a more "armor-piercing shell" for striking atomic nuclei? Increase the radius of the circular electromagnets. But how much more? For you see, even in the arena of the Moscow Luzhnik's it will be tight for today's synchrophastron! So here, it is necessary to follow a different path which is left to us by nature - to increase the intensity.

Of what can contemporary electrical technology boast? Special coils with cooling provide a field with an intensity of several thousand Oersteds. The limit of today's technology is located somewhere here. Such fields have been capable of creation for a long time. But the "salvo" of the accelerator occurs practically instantaneously. What if instead of a stationary, constantly operating field we create it at short time intervals but, in return, we raise the intensity even higher?

At one time, Acadamician Petr Leonidovich Kapitsa obtained a field of 270,000 Oersteds. True, the coil did not withstand it and was destroyed with a terrible roar. Discharging powerful capacitors, Petr Leonidovich raised the intensity to half a million Oersteds. There is information that the Americans have succeeded in reaching 800,000 Oersteds. In any case, the optimists believe that by such a method it is possible to attain a field with an intensity of a million Oersteds. Well, on such a "field" it is possible to collect an abundant harvest. It is not difficult to calculate that the radius of an accelerator with the same power as the one in Dubna will comprise only 30 centimeters.

The method proposed by Professor Terletskiy can lead to the creation of magnetic fields an order of magnitude even more powerful. If he succeeds in doing this, an accelerator of ten billion electron-volts will become a pocket accelerator in the full meaning of the word. The radius of its working zone will be three centimeters.

Just what is the essence of Professor Terletskiy's idea? If we pass an electric current through a closed circuit with a self-inductive coil, a magnetic field arises inside the circuit. One need only disconnect the coil and the field will disappear. True, the field does not disappear immediately but sometime after the cutoff of the coil circuit. The induced currents are the reason for the slow "dying away" of the field. The physicists call this delay the relaxation time. It may be rather considerable. Thus, for example, for a copper sphere with a diameter of 10 centimeters the relaxation time, according to the calculations of Professor Terletskiy, exceeds 1 second. And, in contemporary physics, much can be done in 1 second.

What will happen if we condense the copper sphere so rapidly that it takes place within a time considerably less than the relaxation time? If there was a magnetic field within our sphere, it will not manage to disappear. The magnetic lines of force cannot intersect the conducting walls of the sphere and will also be compressed. And once the lines of force pass into space more densely, this means that the intensity of the field is increased. By how much? Once a magnetic field which fell into a trap or, as the physicist say, a "frozen" magnetic field is preserved, this means that the product of the intensity of the field times the area of the cross section of that Solomon's bottle in which our magnetic Genie is located remains constant. If its diameter is decreased ten-fold, this means that the area of the transverse cross section decreases 100 times and the intensity, in order to save the constancy of the flux, can do nothing but increase 100 times. This is the idea of the intensity multiplier which Professor Terletskiy has proposed.

Just how can we conform to the short time which the relaxation time allots us? Only an explosion can help here. The scheme proposed by the professor is extremely simple. The magnetic field is created in a cylinder rather than inside a sphere. From the theoretical point of view, both these bodies provide the same result but it is technically simpler to work with a cylinder. Located within it is a solenoid to which the powerful charge of capacitors is directed. The initial flux arises in this way. Since the cylinder has a cut along the generatrix, the magnetic flux passes through the walls freely. When the flux approaches the maximum, explosives which are laid around the outside of the cylinder are detonated. The cummulative explosion compresses the cylinder with a violent force, the slot is slammed, and the magnetic flux lands in the trap.

In 1959, in the famous city of the atomic bomb, Los Alamos, the Americans achieved an intensity of 14 million Oersteds by this method. And later, using a cumulative device a group of the Soviet Acadamician Sakharov obtained a magnetic field with an intensity of 25 million Oersteds. There is every reason to think that this figure is not the limit. The opinion exists that an underground burst of our atomic bomb will permit creating a magnetic field of 100 million Oersteds. True, the author of the method himself considered that this is already "fantasy in this regard."

A natural question may arise: why create such a device which an explosion will disfigure like a paper cup? For the same reason that we make paper cups. For cheapness. Before the device perishes, it will create a field of enormous intensity and we will be able to learn the results of its action in phenomena of interest to us. For you see, the speed with which information is transmitted along the channels of electronic measuring equipment considerably outstrips the speed of the explosion shock wave.

It is not difficult to calculate that an accelerator of 10 billion electron volts which is used one time costs approximately a billion times less than the synchrophasotron in Dubna. If a plant is constructed which will begin to stamp out magneto-cumulative accelerators then, despite the fact that the synchrophasotron of the Combined Institute Nuclear Studies provides about 1000 pulses per day the new accelerators which operate only once will nevertheless be more advantageous. Acadamician Sakharov's group believes that, on the basis of cumulative accelerators, it is possible to obtain particles with an energy of a hundred and even a thousand billion electron-volts.

What other possibilities besides the acceleration of elementary particles open fields of tremendous intensities in front of the physicist? First of all, large intensities will lead to tremendous pressures and temperatures. And these are just those conditions which the researchers of thermonuclear reactions so need. Charged plasma particles twist around magnetic fields like butterflies around a flower stalk and they are compressed by the explosive wave together with them. A high-temperature plasma with a temperature of hundreds of millions degrees is formed. A steady thermonuclear reaction may already begin under these "climatic" conditions. True, such a reaction is weak and was obtained by the Americans on the "Scilla" unit.

There is no doubt that this type of experiment may be of interest to astrophysicists and atomic scientists. Pressures of 4 million atmospheres which are formed in fields with an intensity of 10 million Oersteds are of interest to geologists and astronomers. Just such pressures exist in the depths of stars and our planet. Particles of matter fly out from regions with such pressures at speeds of hundreds and thousands of kilometers per second. Such velocities are found among meteorites which are flying in outer space. Most probably, the designers of space ships will be interested in learning how they act on metal. An electron which is flying in a magnetic field with an intensity of 100 million Oersteds becomes visible. The frequency of its radiation approaches that of light. Here, we can obtain a sort of light of tremendous brightness which is probably close to the brightness of contemporary lasers.

It would be possible to list again and again the fields in which a cumulative accelerator would be suitable but what has been said is fully sufficient. Each new experiment which goes beyond the limits of today's experiments has exceptional value for physics. In all probability, today there is no field of knowledge where as many ideas are expressed as in the physics of elementary particles. Dozens of them are proposed at each important conference on the theory of high energy particles. Some of them have been awaiting a check for decades. A light, cheap, and powerful cumulative accelerator could probably accelerate the matter considerably.

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