than m, depending on the constant G. This observation is of certain methodological interest. The point is that other possible physical fields can also lead, like the scalar and gravitational fields, to a negative contribution to the self-mass. For example, weak four-fermion interactions also make a negative contribution to the self-mass. The existence of other similar interactions with relatively small specific charges is likewise not excluded.

[1] R. Arnowitt, S. Deser, and C. Misner, Phys. Rev. 120, 313 (1960).
[2] L. D. Landau and E. M. Lifshitz, Teoriya polya (Field Theory), Fizmatgiz, 1962.
[3] I. Z. Fisher, JETP 18, 636 (1948).
[4] O. Bergman and R. Leipnik, Phys. Rev. 107, 1157 (1957).
[5] M. A. Markov, Suppl. Progr. Theoret. Phys. Extra Number, 85, 1965.
[6] E. Stueckelberg, Helv. Phys. Acta 14, 51 (1941).
[7] R. A. Asanov, JINR Preprint E2-3108, Dubna, 1967.

FEASIBILITY OF NEGATIVE DIFFERENTIAL CONDUCTIVITY (NDC) CONNECTED WITH AMPLIFICATION OF SOUND IN A SEMICONDUCTOR IN THE PRESENCE OF TRAPS

Yu. V. Gulyaev
Institute of Radio Engineering and Electronics, USSR Academy of Sciences
Submitted 25 March 1967
ZhETF Pis'ma 5, No. 11, 419-420 (1 June 1967)

We shall show in this note that an increase of the threshold field in the sound amplification coefficient, connected with adhesion of electrons, may result in a dropping section of the voltage-current characteristic of a semiconductor in the acoustic-instability mode.

The expression for the amplification coefficient of ultrasound in a semiconductor containing traps can be represented in the case when $q\ell \ll 1$ (q - wave number of sound wave, ℓ - electron mean free path) in the form [1]:

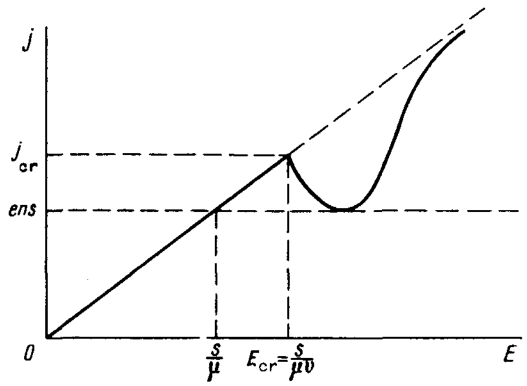
$$\alpha = \alpha_0 \left(1 - \frac{\mu E}{s} r\right), \qquad (1)$$

where $\alpha_0 > 0$ is some constant, μ the electron mobility, s the speed of sound, E the external electric field, and $0 \le r \le 1$ is the adhesion factor, which depends on the sound frequency and on the average electron lifetime.

Thus, the value of the threshold field in the sound amplification coefficient, $E_{cr} = s/\mu r$, turns out to be larger* by a factor $1/r$ than the field in the absence of adhesion. Physically this is connected with the fact that when $q\ell \ll 1$ the sound amplification is due to the formation and supersonic motion of bunches of space charge. It is well known, however (see [2]), that the velocity of these bunches in an electric field is determined by the drift mobility μ_α, which in the presence of adhesion can be appreciably smaller than the mobility μ which determines the drift velocity in a homogeneous electron current (in our case $\mu_\alpha = \mu r$).

Since we are considering the amplification of sound of small amplitude, only a small fraction of all the electrons is gathered into bunches when $E = E_{cr}$, so that the average drift mobility of the majority of the free electrons is μ. It follows therefore that the current at the critical point, $j_{cr} = en\mu E_{cr} = ens/r$, is larger by a factor $1/r$ than the current that would flow in the sample if all the electrons were to drift with the speed of sound.

When $E > E_{cr}$ the sound wave (which may comprise the intrinsic sound fluctuations in the sample) will be amplified until a stationary amplitude is established, determined by the nonlinear effects and by the value of the field E [3,4] (we assume that the sample is sufficiently long). With this (see [4]), if the supercriticality is sufficiently large, the amplitude of the stationary wave becomes so large that almost all the electrons are captured by the wave and consequently drift with a velocity close to that of sound. Thus, when $E > E_{cr}$ the current drops below ints critical value and approaches the value ens, i.e., a region with NDC appears on the voltage-current characteristic. Contributing further to this drop is also the fact that an ever increasing fraction of the conduction electrons is gathered into bunches and their average mobility decreases, tending to μ_α. With further increase of the field E, the amplitude of the stationary wave decreases [4], and the voltage-current characteristic should again return to its ohmic section. We thus obtain a voltage-current characteristic of the type shown in the figure.



It seems to us that the indicated NDC mechanism may be responsible for the occurrence of domain instability in CdS crystals in the sound-amplification mode (see [5,6]), since these crystals always contain a large number of traps.

The author thanks V. L. Bonch-Bruevich, S. G. Kalashnikov, and V. V. Proklov for a discussion of the work.

[1] T. Ishiguro, I. Uchida, and T. Suzuki, IEEE Int. Conv. Record 12, 93 (1964).
[2] R. Smith, Semiconductors (Russ. Transl.) IL, 1962.
[3] V. L. Gurevich and B. D. Laikhman, JETP 46, 598 (1964), Soviet Phys. JETP 19, 407 (1964).
[4] P. E. Zil'berman, FTT 9, 309 (1967), Soviet Phys. Solid State 9, 231 (1967).
[5] S. G. Kalashnikov, A. I. Morozov, and V. P. Kirillov, FTT 6, 3161 (1964), Soviet Phys. Solid State 6, 2522 (1965).
[6] W. H. Haydl and C. F. Quate, Phys. Lett. 20, 463 (1966).

*We have neglected here the lattice absorption of sound, which also leads to an increase of the threshold field E_{cr}.

PINCH EFFECT IN SEMICONDUCTORS WITH INTRINSIC CONDUCTIVITY

I. I. Boiko
Institute of Semiconductors, Ukrainian Academy of Sciences
Submitted 26 March 1967
ZhETF Pis'ma 5, No. 11, 421-423 (1 June 1967)

Semiconductors with inctrinsic conductivity (number of band electrons equal to number of band holes) having high carrier density and carrier mobility are convenient objects for the observation of the pinch effect - the spatial redistribution of the carriers in a crystal under the influence of the magnetic field of the current flowing through the crystal.

A phenomenological study of the pinch effect was made for a homogeneous crystal with isotropic conductivity, in the form of a plate ($-\infty < x < \infty$; $-d \le y \le d$; $-\ell \le z \le \ell$), with $d \sim L$, where L is the bipolar diffusion length of the carriers, $\ell >> d$, and the current is