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Explosion and high-temperature plasma-as a consequence of the exponential equation of motion of gas molecules

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In this paper, an exponential equation of motion for gas molecules is derived for the first time. The paper shows that the Kadic-Edelen forces, written in 1983 by analogy with electrodynamics, are forces that act on the momentum of particles as on a charge. The paper considers the application of the centrally symmetric force of the tensor compensating field in gas in the active state. It is shown that the intensity tensor in the gas is diagonal, so it leads to an increase in the momentum of the gas molecules exponentially in the direction of their movement. Thus, there is an exponential change in the kinetic energy of the gas molecules in the volume where the centrally symmetric intensity tensor acts. The action of a large positive intensity tensor in the gas leads to an explosion and high-temperature plasma.

Introduction

As you know, an explosion can be represented as an exponential increase in the average kinetic energy of gas molecules in a certain volume. However, the equations of motion for gas molecules describing the explosion have not yet been obtained. This paper solves this problem by using the Kadich-Edelen forces obtained from the minimum of the action.

In the pioneering work of Kadic-Edelen in 1983 [1], by analogy with electrodynamics [2], the forces that act on the momentum of a particle as on a charge were written.

$$f_j = p_i \left(-\frac{\partial v_i}{\partial x_j} + \frac{\partial A_{ij}}{\partial t} \right), \quad (1)$$

$$f_j = -e_{jpk} p_i v_p e_{qmn} \frac{\partial A_{in}}{\partial x_m}, \quad (2)$$

here e_{jpk} - antisymmetric Levi-Civita tensor, v_p - particle velocity.

The forces (1,2) are derived from the minimum of action in the methodological paper [3] for a particle with momentum p_i in the compensating field of the distortion 4-tensor v_i , A_{ij} , as well

as Coulomb $f_j = q \left(-\frac{\partial \varphi}{\partial x_j} - \frac{\partial A_j}{\partial t} \right)$ and Lorentz $f_j = e_{jpk} q v_p e_{qmn} \frac{\partial A_n}{\partial x_m}$ forces for a charged

particle q in the field of the electromagnetic 4-potential φ , A_j [2].

Thus, the forces (1, 2) recorded by Kadic-Edelen from the analogy with electrodynamics [1] actually exist and act on the momentum p_i of the particles.

In the process of deducing forces from the minimum of action in [3], it was proved that in (1,2) we are talking about the quantum momentum of particles as the charge of interaction. The transition from the quantum momentum $p_i = \hbar k$, where k is the wave vector, to the momentum of a continuous medium $p_i = \rho v_i$ with density ρ , is a phase transition that is accompanied by a violation of the gradient symmetry of the compensating interaction field - the distortion tensor [4].

It is shown in [4] that the continuous medium is a passive or low-symmetric state of the distortion tensor. The passive state here means that the components of the distortion 4-tensor v_i , A_{ij} in a continuous medium are rigidly connected to the charge p_i in a low-symmetric state: the momentum is equal $p_i = \rho v_i$, and the distortion tensor is proportional to the stress tensor $\sigma_{ij} = \rho c^2 A_{ij}$. This is a generalization of Hooke's law, here-the speed of sound.

When the elastic state of a continuous medium is destroyed, the relation $p_i = \rho v_i$ is not fulfilled and the elasticity $\sigma_{ij} = \rho c^2 A_{ij}$ disappears. Dislocations and cracks appear in the solid state and plastic deformations occur, which are described by the distortion tensor A_{ij} , and in the gas a high-temperature plasma is formed and an explosion occurs. The phase transition of the destruction of a continuous elastic medium is described in detail in the paper [5].

The purpose of this paper is to show that the equation of motion for gas molecules in the active field of the distortion tensor, or in the highly symmetric state of the distortion tensor, leads to an exponential increase in the momentum of the gas molecules, and, as a result, to the appearance of high-temperature plasma and explosion.

1. The exponential equation of motion for gas molecules

Firstly, let's find out what is known about the Kadic-Edelen forces (1, 2). In [1], it was shown that the force (2) is the Peach-Keller force in a solid [6]. No associations were made with force (1) in the Kadic-Edelen theory [1]. In addition, it is known that the first term of the force (1) is the potential Bernoulli force or the potential term of the Euler hydrodynamics equations [3, 7]. This is all the known information about the use of forces (1, 2) in modern physics.

The article [8] investigated the application of forces (1, 2) in a continuous medium. As a result of this application, it was possible to solve several problems of classical continuum mechanics. It was possible to describe the cylindrical vortex movements in the atmosphere in the form of cyclones and anticyclones depending on the pressure change, to explain the lifting force in a tornado, to explain the homogeneous velocity changes depending on the pressure. Without taking into account the forces (1, 2), it was impossible to solve these problems, most of which are related to the Millennium problem of the Navier-Stokes equations.

However, a continuous medium is a passive or low-symmetric state of the distortion tensor. The study of the continuous environment is very important, since it is connected with the life activity of a person. But from the point of view of physics, the most interesting is the highly symmetric

or active state of the distortion tensor. In this paper, we study the equation of motion of gas molecules as a result of the action of the centrally symmetric force of the distortion tensor in the active state (1).

As in electrodynamics, we introduce the concept of distortion tensor intensities which are the forces acting on the unit charge of the pulse and the unit flow of the momentum. This was done in [3, 9]:

$$\varepsilon_{ij} = -\frac{\partial v_i}{\partial x_j} + \frac{\partial A_{ij}}{\partial t}, \quad (3)$$

$$\rho_{ij} = -e_{jmn} \frac{\partial A_{in}}{\partial x_m}. \quad (4)$$

We call them the centrally symmetric intensity (3) and the vortex intensity (4) by analogy with electric and magnetic intensities in electrodynamics [2].

As you know, the study of electrodynamics begins with the study of the motion of a charge q in a homogeneous constant electric field E_j . This motion is described by an equation of motion $\partial p_j / \partial t = qE_j$, it has a linear solution $p_j = p_{0j} + qE_j t$. In this case, the direction of the momentum of the particle, in the general case, changes.

Let us do the same and study the motion of a gas particle with momentum p_i in a homogeneous constant field ε_{ij} (3). Since we are talking about a gas, consider the isotropic situation where the intensity ε_{ij} is the diagonal tensor $\varepsilon_{ij} = \varepsilon \delta_{ij}$, here δ_{ij} is the Kronecker symbol. This follows from the fact that the stress tensor in the gas has a diagonal form $\sigma_{ij} = -P \delta_{ij}$ and from the equations of state for the distortion tensor [9], here P is pressure.

Then the force $f_j = p_i \varepsilon_{ij}$ (1, 3) acting on the gas molecule will have the form $f_j = p_j \varepsilon$.

Substituting this force into the equation of motion of the gas molecule $\partial p_j / \partial t = f_j$, we get:

$$\partial p_j / \partial t = p_j \varepsilon. \quad (5)$$

This equation has a solution in the form of an exponent for the constant intensity ε .

$$p_j = p_{0j} \exp(\varepsilon t). \quad (6)$$

If the intensity ε is positive, then the momentum of the gas molecules will increase exponentially in the volume of the gas where the intensity $\varepsilon_{ij} = \varepsilon \delta_{ij}$ acts. In this case, the direction of motion of the gas molecules will not change as a result of the force $f_j = p_j \varepsilon$ (1, 3, 5, 6).

Since in equation (5) the magnitude of the momentum changes, and not its direction, the expression (6) will lead to an increase in the kinetic energy of the gas molecules in the volume where the positive intensity \mathcal{E} acts.

As you know, the average kinetic energy of gas molecules determines the temperature. The kinetic energy of the gas molecules will increase exponentially in accordance with (6) during elastic collisions of the gas molecules.

When the kinetic energy of the gas molecules reaches the ionization energy, the collisions will cease to be elastic and a high-temperature plasma will arise.

The appearance of an active positive field $\mathcal{E}_{ij} = \mathcal{E}\delta_{ij}$ in gas essentially describes a gas explosion (5, 6). It is shown in [5] that an active positive field $\mathcal{E}_{ij} = \mathcal{E}\delta_{ij}$ appears when gas as a continuous medium is destroyed as a result of the occurrence of a critical pressure P^C in the gas. In this case, the critical vortex field ρ_{ij}^C penetrates into the gas and into the field \mathcal{E}_{ij} (3), which is proportional to the rate of penetration of the vortex intensity ρ_{ij} (4) into the continuous medium or the speed of destruction of the continuous medium.

A detailed description of the gas explosion as a phase transition is given in the paper [5]. In this paper, we want to show that the high-temperature plasma in gas is a consequence of the action of the positive intensity \mathcal{E} on the momentum of the gas particles, according to the equation of motion (5).

Let's discuss from the opposite. An explosion is an exponential increase of gas temperature. The gas temperature is the average kinetic energy of the gas molecules. The kinetic energy of a gas molecule is proportional to the square of the momentum of the gas molecule. Consequently, the momentum of the gas molecules during the explosion must change exponentially (6).

Thus, we formally come to the equation of motion (5). It follows that in order to describe a gas explosion, it is necessary to write the equation of motion for gas molecules in the form (5), where the momentum p_i is a charge. There is no other way to describe the explosion and the high-temperature plasma.

Note that when constructing this theory the equation of motion (5) was firstly obtained from (1), and only then the solution (6), which describes the explosion and high-temperature plasma in gas. In fact, the equation of motion (5) proves the validity of the constructed theory, where the momentum is a charge [9], since it is impossible to describe an explosion in gas in any other way.

Conclusion

To describe a high-temperature plasma in gas (5, 6) it is sufficiently to know that the quantum momentum is the charge of the minimal interaction induced by the translation subgroup, which was shown and proved in [3, 9]. The minimal interaction is understood as the interaction that is induced by the local symmetry group, or the local representation of the global symmetry group, and it is written using the extended derivative with a compensating field.

Note that in the Kadic-Edelen theory [1] there is no extended derivative, and, consequently, no compensating fields. The Kadic-Edelen theory is linear in construction and does not contain a minimal interaction, so it has not received proper development.

It should be understood that positive centrally symmetric intensity ε_{ij} does not always exist. For example, it is zero in a continuous medium in a sound wave [4]. Note that it is included in the equation of motion of a continuous medium with a minus sign [8]. When a continuous medium is destroyed, it is not equal to zero and has a positive value in the gas [5].

In gas, the molecules are not bound and have an initial momentum p_{0j} . Therefore, as a result of the action of intensity tensor $\varepsilon_{ij} = \varepsilon\delta_{ij}$ a high-temperature plasma arises (5, 6).

In a solid, the molecules are bound, so heating is present at the fracture sites, but it is not very large and is not accompanied by an explosion. For example, a wire is heated by plastic deformations when it is broken from side to side.

In fact, equation (5) is a non – trivial equation from the standpoint of classical field theory. The fact is that, unlike the equation of motion for a particle in an electric field $p_j = p_{0j} + qE_j t$, where the electric charge q is fixed, the motion of a particle with a charge p_j in a centrally symmetric field $\varepsilon_{ij} = \varepsilon\delta_{ij}$ leads to a change in the momentum of the particle p_j (6).

Consequently, the interaction charge of the particle p_j also changes. Such interactions have not been studied before in field theory.

Moreover, the compensating fields U_i , A_{ij} and intensities ε_{ij} , ρ_{ij} (3,4) in this model are tensor, and not vector, as in all known classical models of interactions in the field theory – gravity, electromagnetism, and Yang-Mills fields [10]. The model with tensor compensating fields has never been considered in field theory [3, 4].

It is the tensor intensity in an isotropic medium $\varepsilon_{ij} = \varepsilon\delta_{ij}$ that leads to the explosion of the gas (6), since it does not change the direction of the impulses of the gas molecules in the equation of motion (5). Note that this result cannot be obtained using the vector intensities of classical fields.

Therefore, it is possible that the intensity tensor in the form $\varepsilon_{ij} = \varepsilon\delta_{ij}$ and equation (5) can explain the expansion of the Universe, assuming that there is a very small positive field ε in space, which is left from the Big Bang.

The main question here, of course, is related to the minimal interaction that is induced by the local representation of the translation subgroup [9]. In [9], it is proved that the charge of such an interaction is a quantum momentum. Further calculations are a technical question, because the interaction charge sets the forces (1, 2) that act on it.

Thus, the equation of motion of gas molecules (5) in an active positive field describes and explains the high-temperature plasma and the explosion in the gas by the exponential solution (6). This is the simplest application of the forces (1, 2) of this interaction [9].

Since the forces (1,2) have never been explicitly taken into account, except for the Peach-Keller force [6], it can be expected that these forces will be used to describe and explain many phenomena that have previously been described only by phenomenological theories.

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