Solution of the Particles Scattering Problem in Unitary Quantum Theory by Using the Oscillating Charge Equation

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Abstract

In this article the problems of scattering at Coulomb and short-range potentials are discussed. By using computational solution of the differential equation with the oscillating charge authors are showing that this approach corresponds to the existing experimental data.

Keywords: Unitary Quantum Theory, Schroedinger Equation, Sighting distance, Tunneling Effects, Cross-section

Introduction

The study of the process of the particles scattering is the main method of the elementary particles physics study. Rutherford was the first who applied such analysis and discovered the existence of heavy nucleus in the atoms. By using common Coulomb's law and Kepler equation he derived formula for the dependence of the scattering angle from the sighting distance and speed of a flying particle:

$$tg\left(\frac{\theta}{2}\right)=\frac{zZe^2}{mv^2b} \tag{1}$$

The same correlation was obtained in Quantum theory. Experiments made by Rutherford confirmed the validity of this scattering formula, and he was very proud of this because formula was derived on the basis of classical points without any quantum theory ideas.

It should be noted that Coulomb potential had been already known from the other independent experiments, and the scattering problem became leading in the process of interaction potential determining. But in spite of the numerous measuring of the hadrons scattering processes the potential of the strong interaction has not been rendered yet. This is not simply by coincidence, because the modern quantum theory couldn’t compute either electron charge or elementary particles masses while it is possible with UQT [1-15]. Moreover no low-energy nuclear reactions are possible in standard quantum theory even they have been confirmed by experiments long ago [16]. The phenomenon of chemical catalysis well explained in UQT [17] is also incomprehensible. The proper solution of the problem of a wave packet scattering at another wave packet is a too distant future due to nonlinear nature, today we cannot even imagine how we can come to grips with the strong settings of this problem. Below we are going to solve the classical problem of scattering of the particles at Coulomb and short-range potentials for the oscillating charge equation, that is by the authors opinion is more adequate.

Scattering at Coulomb Potential

First of all we should demonstrate that application of the equation with oscillating charge does not conflict with the formula (1). Equation with oscillating charge may be written in both autonomous and non-autonomous forms. The properties of such equations are discussed in details in [8-12]. Further we are going to discuss the solution for autonomous equations as far as solution of the problem of scattering for the non-autonomous equation has similar results but more intricate. Autonomous equation with oscillating charge for arbitrary potential has the following form:

$$m\frac{d^2\boldsymbol{r}}{dt^2} = 2Q\,gradU(\boldsymbol{r})cos^2(-m\frac{d\boldsymbol{r}}{dt}\mathrm{r}+\varphi) \quad (2)$$

$$\frac{d^2x}{dt^2} = 2Q\frac{x}{r^3}cos^2(-x\frac{dx}{dt} - y\frac{dy}{dt} + \varphi); \qquad \frac{d^2y}{dt^2} = 2Q\frac{y}{r^3}cos^2(-x\frac{dx}{dt} - y\frac{dy}{dt} + \varphi) \quad (3)$$

Where $r = \sqrt{x^2 + y^2}$.

The same equations can we written for the classical charge:

$$\frac{d^2x}{dt^2} = Q\frac{x}{r^3}; \qquad \frac{d^2y}{dt^2} = Q\frac{y}{r^3} \quad (4)$$

The systems 3 and 4 were numerically solved for similar initial terms:

$Vx_0 = 5, x_0 = -1000, b = 0 \div 1,\ \varphi = 0 \div \pi,\ Vy_0 = 0,\ \Delta T = 1000,$

number of particles N=10000. Each calculation was made for randomly chosen initial phase and sighting distance. The Fig.2 and Fig.4 show the dependence of the number of scattered particles on the scattering angle and they are practically coincident. The Fig.3 and Fig.5 demonstrate the dependence of $btg\frac{\theta}{2}$ for 500 randomly chosen particles; it should be constant for the solution of equations 3 and 4. As we can see from the diagrams this condition is fulfilled. But it's quite amazing as for the equation 4 the deviation angle θ depends on the sighting distance and the energy only, while for the solution of the equation 3 the angle θ depends on the initial phase also. The coincidence appears because the Coulomb potential varies very slowly. Thus the scattering at the Coulomb potential is correctly described by the equation with the oscillating charge.

Scattering of Particles on Short-Range Potential

Usual scattering of particles on Coulomb potential at different angles corresponds to monotonic dependence on particle's velocity. However, if potential is short-range (for example like Yukawa one), then the scattering maximums appear in different angles and scattering now has resonance character. The first deeply studied phenomenon of such a type was Ramsauer-Townsend effect. At the first years of quantum theory development that phenomenon roused everybody interest. There was experimentally detected the abnormal large-scale penetration of gas molecules or atoms for low-velocity electrons. In more general sense there were discovered non-monotonic dependence of effective cross- section of low-velocity electrons scattering on their velocity. Such dependence was at deep contradiction with classical idea, because according to it scattering monotonically decrease with electron velocity growth. But it were appeared for *Ar*, *Kr*, *Xe* that with the energy growth the effective cross-section of scattering run up to it's maximum near 12 *eV* and then smoothly decreases. Deep minimum of full efficient section is in the area of energies of range 0.7 *eV*. Later the same effect had been proved within researches of electron mobility in gas.

The similar resonance phenomena are well known in optics – enlightenment of lenses for optical devices. For that the surface of the lens is covered with the special film of such a thickness and the index of refraction to obtain such a difference in phases of waves reflected from film and glass that the waves are able to suppress each other. In that case the reflected wave does not exists at all. That effect is similar to full transparency of one-dimensional barrier at definite energies.

In general, the mathematical modeling of considered processes with the help of the equations with oscillated charge has confirmed the existence of the phenomena said above. It remains valid for the equations with oscillating charge too. Since the use of potentials containing exponents (for example, of the Yukawa or Gauss potentials) have led to computational difficulties because of their rapid grow and possible overflowing with further stopping of calculations, we have used the following spherically symmetric polynomial potential:

$$U(r)=\frac{U_0}{\left(1+\left(\frac{r}{a}\right)^2\right)^2}, \quad (5)$$

Assume that the immovable source of scattering potential $U(\mathbf{r})$ is time-constant and is placed at the origin of fixed coordinate system OXY. Then the non-autonomous system of equations with oscillating charge describing the particles' motion on coordinate plane OXY has the form:

$$\frac{d^2x}{dt^2}=2Q\frac{a^4x}{(a^2+x^2+y^2)^3}cos^2\left(-x\frac{dx}{dt}-y\frac{dy}{dt}+\varphi\right) \quad (6)$$

$$\frac{d^2y}{dt^2}=2Q\frac{a^4y}{(a^2+x^2+y^2)^3}cos^2\left(-x\frac{dx}{dt}-y\frac{dy}{dt}+\varphi\right) \quad (7)$$

Generally at the short-range potential the number of the scattered particles abruptly decreases as the scattering angle grows. At the same time, diffraction maximums appear when the length of de Broglier wave is commensurable to the characteristic potential value [10-12]. These features are illustrated by our model. For example we use the typical angular picture of the scattering for initial terms:

$$Vx_0=1, x_0=-200, b=0\div 10, \varphi=0\div\pi, a=\frac{1}{4}, Vy_0=0, Q=1, \Delta T=400, N=10000$$

The diagram of the dependence of the number of scattered particles from the scattering angle is shown at the Fig. 6. Resonance peaks appear at another starting conditions (Fig.7):

$$Vx_0=0.18, x_0=-120, b=0\div 1, \varphi=0\div\pi, a=1, Vy_0=0, Q=1, \Delta T=1500, N=10000$$

In general there is nothing strange or new in such pictures of scattering.

In unitary quantum theory mass spectrum of numerous elementary particles were obtained [12-14]. It appeared that in terms of mass density any particle can be presented as a bubble parted by spherical harmonic. For simplicity the heaviest Dzhan particle can be presented as a potential [13,14]:

$$U(r)=r^2e^{-r^2}$$

Our system of equations would look like:

$$\frac{d^2x}{dt^2}=2Q\frac{(1-x^2-y^2)x}{e^{x^2+y^2}}cos^2\left(-x\frac{dx}{dt}-y\frac{dy}{dt}+\varphi\right) \quad (8)$$

$$\frac{d^2y}{dt^2}=2Q\frac{(1-x^2-y^2)y}{e^{x^2+y^2}}cos^2\left(-x\frac{dx}{dt}-y\frac{dy}{dt}+\varphi\right) \quad (9)$$

For initial values

$$Vx_0=1/3, x_0=-1000, b=0\div 100, \varphi=0\div\pi, Vy_0=0, Q=5, \Delta T=3000, N=10000$$

If we change slightly the velocity and take $Vx_0=0.3344$ then scattering change sharply (Fig.9). Obviously striking resonant phenomena appears inside the bubbles. It looks like hadronic streams, but this diagram does not concern that phenomenon anyhow. Probably it can be observed at high energies but it's a question of far future.

The method discussed here can be helpful in future for the construction of scattering potentials corresponding to different scattering pictures.

Conclusion

We should admit that we have not expected such results at all because of the current opinion that diffraction scattering can be seen only in the cases when strong inelastic interaction presents and scattering particles wave length is small in comparison with radius of interaction (neutrons scattering on nuclei and pions scattering on nucleons). We should note that in accordance with the strict Unitary Quantum Theory the division of scattering processes into elastic and inelastic ones is a kind of idealization [15-21]. That conclusion can be also extended at equations with oscillating charge. More over the most astonishing is the fact of discovery of wave character of the mention process described by non-linear equations.

In general, the results of mathematical modeling are coinciding with intuitively expected on the base of qualitative analysis. For example, Ramzauer-Townsend effect is totally understandable. Really, if the length of de Broglie wave is much bigger than atom dimensions, and if the incident electron has the phase corresponding to very small charge, then appears the effect of irregular atom transparency. These electrons pass through atom. Similar situation exists in the s-state of the atom [19-21].

As de Broglie wave length is very slowly decreases with the energy, such effects of high transparency should take place for any particles at head-on collision. It is evident from the analysis of experimental data that in modern physics the said effect is detected for any particles of counter-current bunches at head-on collision.

It was carried out also the modeling of particles' scattering on some others potentials of Yukawa or Gauss types and the general pattern of the processes were the same. The only difference was the more sharp appearance of resonance peaks at higher energies.

We have carried out the same calculations in the case of the autonomous equations. The results are practically congruent with the above-mentioned ones. We are not going to analyze large quantity of experimental data dealing with differential cross-sections of various scattering processes. It is a problem for future. That is why we even have not integrated the differential cross-sections to get the full picture.

The approach examined can be easily extended to the scattering caused by object consisting of few connected particles (Glauber approximation).

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References

Sapogin L.G. (1973). «United Field and Quantum Mechanics», *System Researches (Physical Researches)* Acad. Science USSR, Vladivostok, 2, pp. 54-84, (Russian).

Sapogin L.G. (1979). «On Unitary Quantum Mechanics». *Nuovo Cimento*, vol. 53A, No 2, p.251.

Sapogin L.G. (1980). A Unitary Quantum Field Theory . *Annales de la Fondation Louis de Broglie*, vol.5, No 4, p.285-300.

Sapogin L.G. (1982). A Statistical Theory of Measurements in Unitary Quantum Mechanics. *Nuovo Cimento*, vol.70B, No.1, p.80.

Sapogin L.G. (1982). A Statistical Theory of the Detector in Unitary Quantum Mechanics. *Nuovo Cimento*, vol.71B, No.3 , p.246.

Sapogin L.G., Boichenko V.A. (1988). On the Solution of One Non-linear Equation . *Nuovo Cimento*, vol.102B, No 4, p.433.

Sapogin L.G., Boichenko V.A. (1991). On the Charge and Mass of Particles in Unitary Quantum Theory . *Nuovo Cimento*, vol.104A, No 10, p.1483.

Sapogin, L.G., I.V.Kulikov (1995) Cold Nuclear Fusion in the Unitary Quantum Theory», *Chinese Journal of Nuclear Physics*, vol.17, No 4, p.360-370,.

Sapogin, L.G. (1996) Cold Nuclear Fusion and Energy Generation Processes in Terms of the Schroedinger Equation . *Chinese Journal of Nuclear Physics* vol.19,#2, p.115-120, 1996

Sapogin L.G., Ryabov Yu.A., Utchastkin V.I. (2003). *Unitary Quantum Theory and a New Energy Sources.* Ed. MADI, Moscow, (Russian).

Sapogin L.G., Ryabov Yu.A, Boichenko V.A. (2005). *Unitary Quantum Theory and a New Sources of Energy*, Archer Enterprises, Geneva, NY, USA.

Sapogin L.G., Ryabov Yu. A., Boichenko V. A. (2008). *Unitary Quantum Theory and a New Sources of Energy*, Ed. Science-Press, Moscow, (Russian, transl. from English).

Sapogin L.G., Ryabov Yu. A. (2008). «On the mass spectrum of elementary particles in Unitary Quantum Theory», *The Old and New Concepts of Physics*, Vol. 5, No 3 www.uni.lodz.pl/concepts

Sapogin L.G., Ryabov Yu. A. (2010). «New Theoretical Results about the Mass Spectrum of Elementary Particles». *Applied Physics Research*, vol. 2, No 1, p.86-98, May. www.ccsenet.org/apr

Sapogin L.G.(2010), About Unitary Quantum Field Theory *Applied Physics Research*, vol. 2, No 2, p.114-140, November. www.ccsenet.org/apr

Sapogin L.G., Ryabov Yu. A. (2011). "Approximation Equations with oscillating charge in Unitary Quantum Theory and its applications to the analysis of some quantum problems." *International Journal of Applied Science and Technology*,Vol.1, No 5, September.www.ijastnet.com

Sapogin L.G., Ryabov Yu. A. (2011). Unitary Quantum Theory and Catalytic Process Theory. *International Journal of Pure and Applied Sciences and Technolodgy* 3(2),pp.93-120 www.ijopaasat.in

Sapogin L.G.(2011), An Unitary Unified Quantum Field Theory *Global Journal of Science Frontier Research*,vol.11, Issue 4,Version 1.0, July.

Sapogin L.G., Dzhanibekov V.A. , Ryabov Yu. A., (2012),"Problems in the Unitary Quantum View of the World" *International Journal of Applied Science and Technology*,Vol.2, No .5, May. www.ijastnet.com

Sapogin L.G.,Dzhanibekov V.A. (2012),"Object Lessons of the Unitary Quantum Theory " *Journal of Modern Physics and Applied* ,Vol., No .1 page 1-22, http://scik.org

Sapogin L.G., Dzhanibekov V.A., Ryabov Yu.A. (2014) **"***The Unitary Quantum Theory and Modern Quantum Picture of the World***"** Current Trends in Technology and Science vol.3 issue 4.

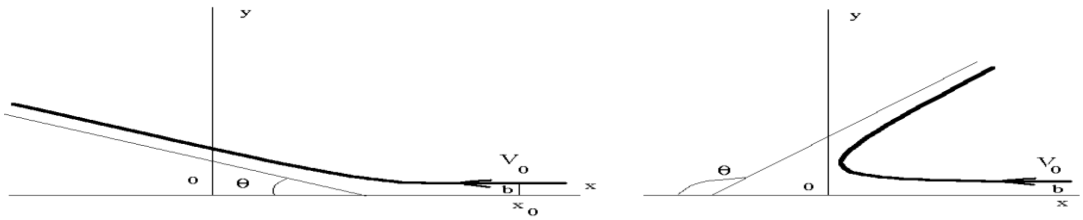

Fig.1: Particle Path after Scattering

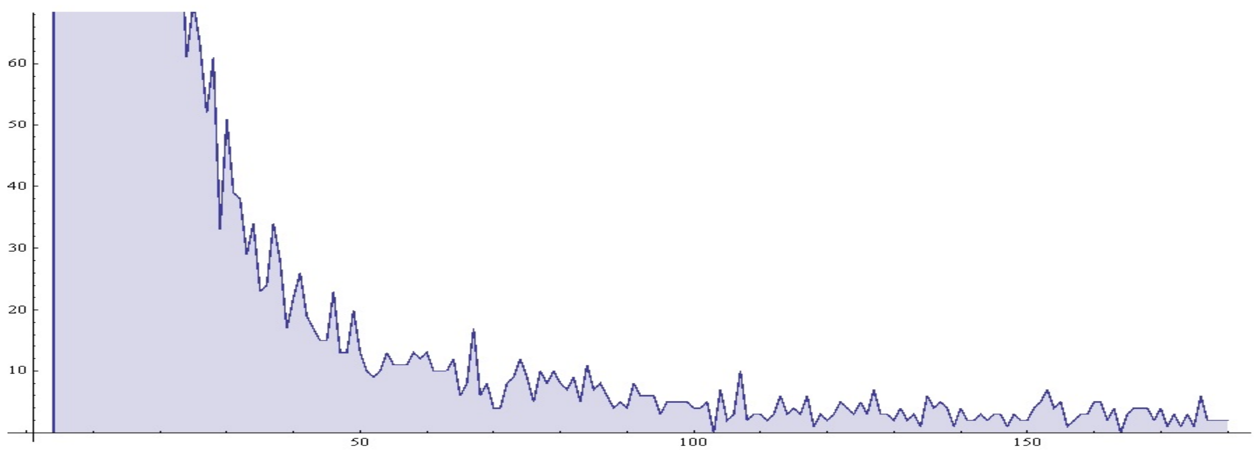

Fig.2: Dependence of Scattered Particles Number from the Angle for the Equations (3)

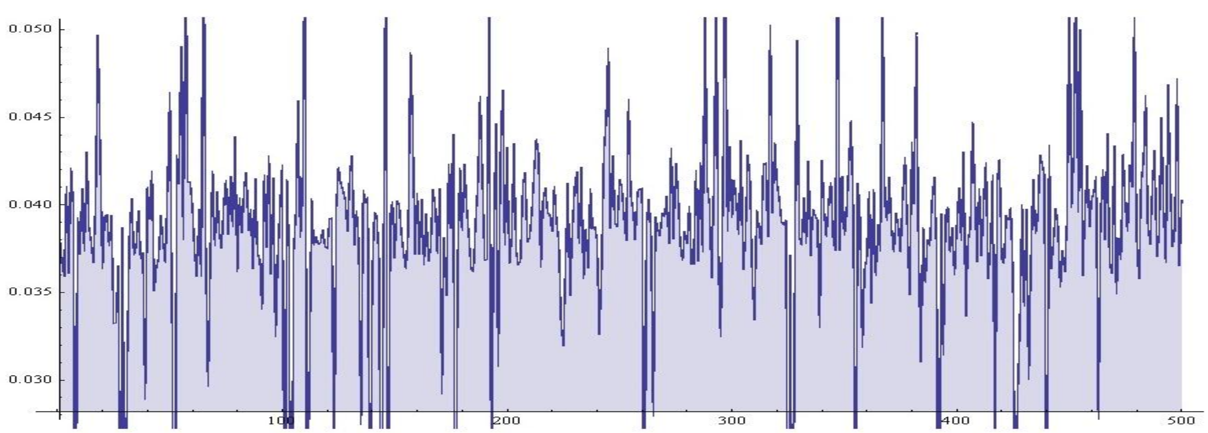

Fig.3: Value $btg(\theta/2) \sim 1/v^2$ for the Equation (3) for 500 Random Particles

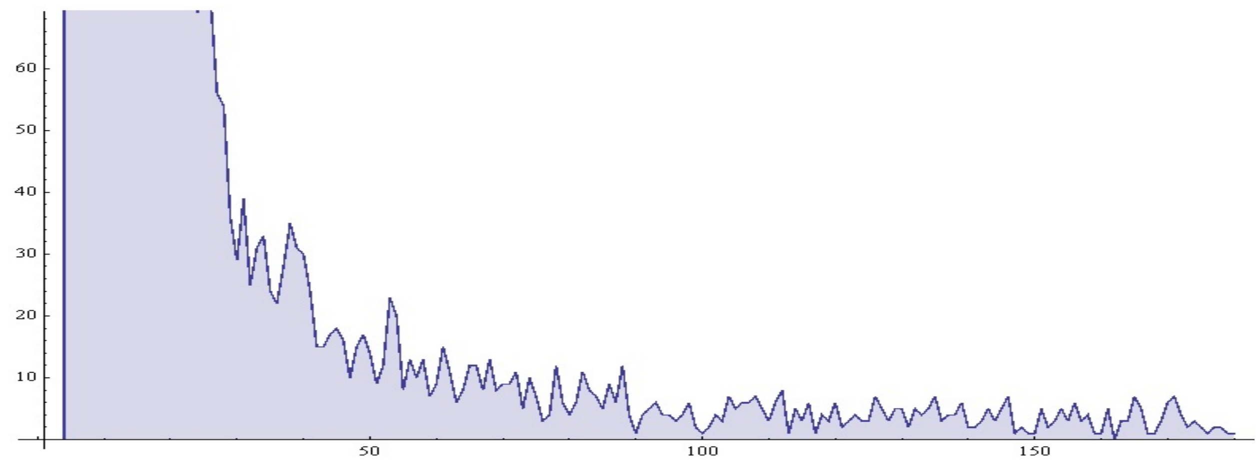

Fig.4: Dependence of the Scattered Particles Number from the Angle for the Equations (4)

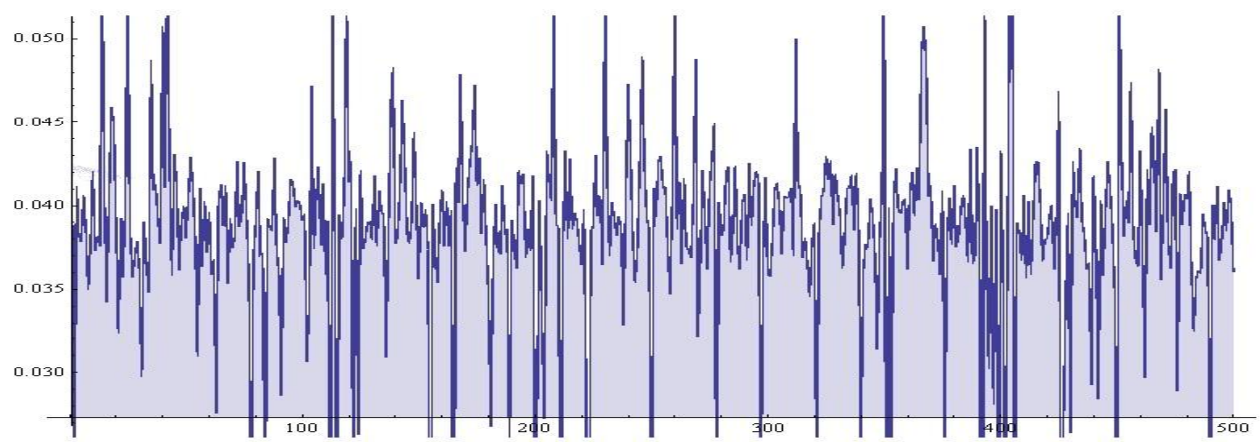

Fig.5: Value $btg(\theta/2) \sim 1/v^2$ for the Equation (4) for 500 Random Particles

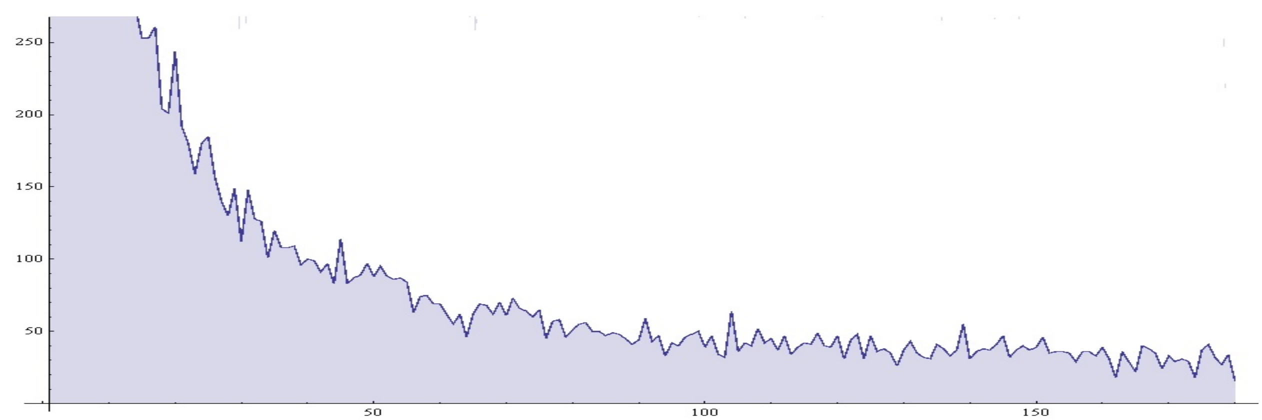

Fig.6: Dependence of the Scattered Particles Number from the Angle for the Equations (6) and (7)

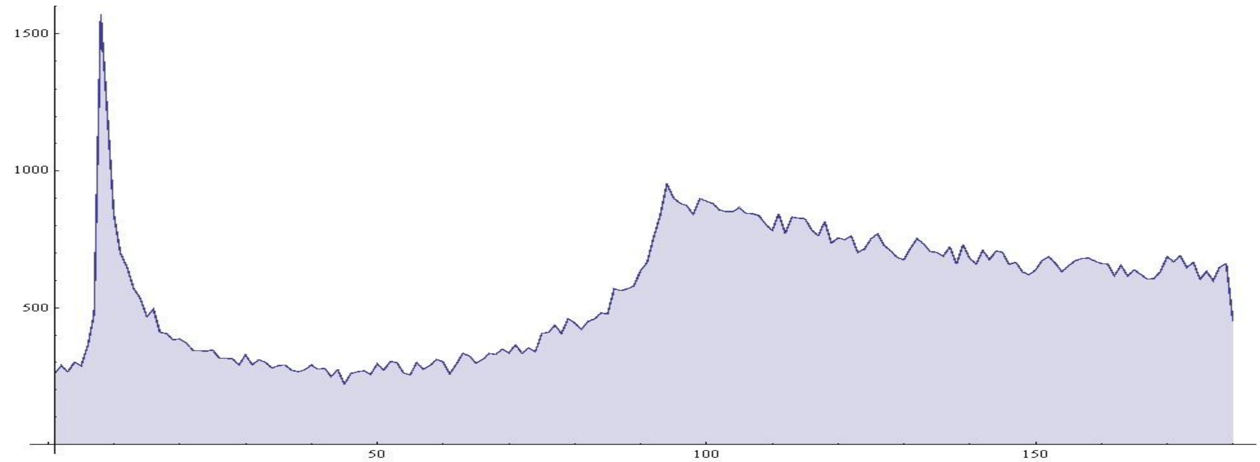

Fig.7: Dependence of the Scattered Particles Number from the Angle for the Equations (6) and (7)

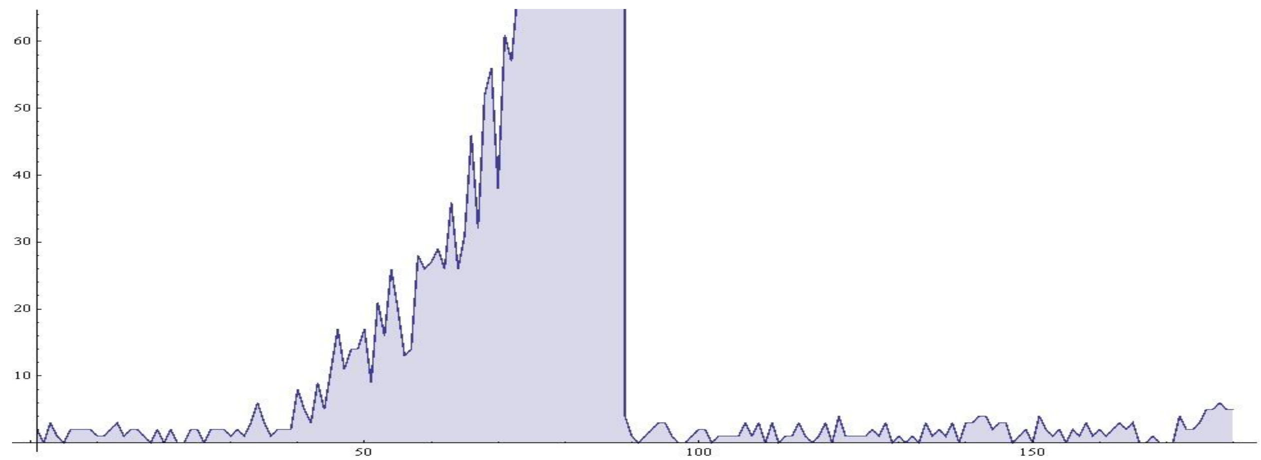

Fig.8: Dependence of the Scattered Particles Number from the Angle for the Equations (8) and (9)

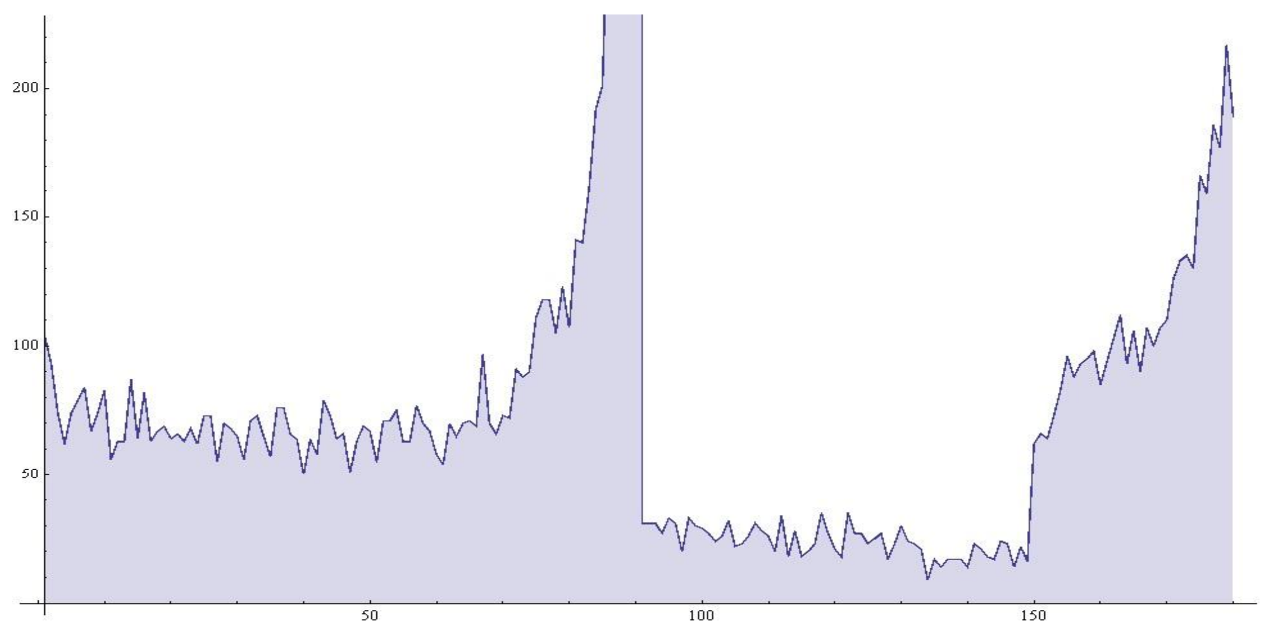

Fig.9: Dependence of the Scattered Particles Number from the Angle for the Equations (8) and (9)