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Қ. И. Сәтпаев атындағы Қазақ ұлттық техникалық зерттеу университеті

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СЕРИЯ ГЕОЛОГИИ И ТЕХНИЧЕСКИХ НАУК



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NAS RK is pleased to announce that News of NAS RK. Series of geology and technical sciences scientific journal has been accepted for indexing in the Emerging Sources Citation Index, a new edition of Web of Science. Content in this index is under consideration by Clarivate Analytics to be accepted in the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts & Humanities Citation Index. The quality and depth of content Web of Science offers to researchers, authors, publishers, and institutions sets it apart from other research databases. The inclusion of News of NAS RK. Series of geology and technical sciences in the Emerging Sources Citation Index demonstrates our dedication to providing the most relevant and influential content of geology and engineering sciences to our community.

Қазақстан Республикасы Ұлттық ғылым академиясы "ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы" ғылыми журналының Web of Science-тің жаңаланған нұсқасы Emerging Sources Citation Index-те индекстелуге қабылданғанын хабарлайды. Бұл индекстелу барысында Clarivate Analytics компаниясы журналды одан әрі the Science Citation Index Expanded, the Social Sciences Citation Index және the Arts & Humanities Citation Index-ке қабылдау мәселесін қарастыруда. Web of Science зерттеушілер, авторлар, баспашылар мен мекемелерге контент тереңдігі мен сапасын ұсынады. ҚР ҰҒА Хабарлары. Геология және техникалық ғылымдар сериясы Emerging Sources Citation Index-ке енуі біздің қоғамдастық үшін ең өзекті және беделді геология және техникалық ғылымдар бойынша контентке адалдығымызды білдіреді.

НАН РК сообщает, что научный журнал «Известия НАН РК. Серия геологии и технических наук» был принят для индексирования в Emerging Sources Citation Index, обновленной версии Web of Science. Содержание в этом индексировании находится в стадии рассмотрения компанией Clarivate Analytics для дальнейшего принятия журнала в the Science Citation Index Expanded, the Social Sciences Citation Index и the Arts & Humanities Citation Index. Web of Science предлагает качество и глубину контента для исследователей, авторов, издателей и учреждений. Включение Известия НАН РК. Серия геологии и технических наук в Emerging Sources Citation Index демонстрирует нашу приверженность к наиболее актуальному и влиятельному контенту по геологии и техническим наукам для нашего сообщества.

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E-mail: kenkab@mail.ru, khadi_kab@mail.ru, gauhar_omashova@mail.ru**CALCULATION AND VISUALIZATION
OF THE ELECTRIC FIELD OF A SPACE-CHARGED SPHERE**

Abstract. The article presents the calculations and visualization of the electric field of a space-charged sphere (i.e., a sphere charged throughout its volume) done using the MATLAB program. There is the calculation of the electric fields and potentials inside and outside of a space-charged sphere as a function of the distance from the center of the sphere. The electric field inside the sphere is proportional to the distance of the field point from the center of the sphere and the potential inside the sphere is inversely proportional to the squared distance from the center of the sphere. The electric field outside the sphere decreases inversely proportionally to the square of the distance from the center of the sphere, and the potential decreases inversely proportionally to the distance from the center of the sphere. There is the calculation of the electric field and potential at the surface and at the center of the sphere. The equipotential lines of the electric field outside and inside the sphere are represented in three-dimensional space and in projection on the X-Y plane.

Key words: visualization, the space-charged sphere, potential, electric field, equipotential lines.

Introduction. Nowadays all educational institutions of Kazakhstan are provided with computer hardware and software, interactive boards and internet. Almost all teachers have completed language and computer courses for professional development. Hence the educational institutions have all conditions for using computer training programs and models for performing computer laboratory works. During several years we have been conducting the work on organization computer laboratory works on physics with use of resources of the Fizikon Company [1, 2] which are developed at Al-Farabi Kazakh National University by V.V.Kashkarov and his group. Some of worksheet templates for computer laboratory works are introduced in educational process of our university and schools of the Southern Kazakhstan [3-28]. Students of the physics specialties 5B060400 and 5B011000 successfully master the discipline “Computer modeling of physical phenomena” which is the logical continuation of the disciplines “Information technologies in teaching physics” and “Use of electronic textbooks in teaching physics”. The aim of this discipline is to study and learn the MATLAB program language [29] system, acquaintance with its huge opportunities for modeling and visualization of physical processes. This article is devoted to organization of performance of the laboratory work "Calculation and visualization of the electric field of a space-charged sphere" in the MATLAB language.

Here is the brief theory of the electric field of a space- charged sphere. If $\rho = \frac{q}{V} = \frac{q}{\frac{4}{3}\pi R^3}$ is the

volume charge density of the sphere, then the electric field inside the space-charged sphere according the Gauss's theorem will be:

$$4\pi(r)^2 E = \frac{4\pi(r)^3 \rho}{3 \varepsilon_0} \Rightarrow E(r \leq R) = \frac{1}{4\pi\varepsilon_0} \frac{qr}{R^3} \text{ or } E(r \leq R) = \frac{\rho r}{3\varepsilon_0} \quad (1)$$

and the electric field outside the space-charged sphere will be

$$E(r > R) = \frac{q}{4\pi\epsilon_0 r^2} \quad \text{or} \quad E(r > R) = \frac{\rho R^3}{3\epsilon_0 r^2} \quad (2)$$

The potential difference inside the space-charged sphere is given by the expression:

$$-\int_{\varphi_1}^{\varphi_2} d\varphi = \int_r^R E dr \Rightarrow \varphi_1 - \varphi_2 = \frac{q}{8\pi\epsilon_0 R^3} (R^2 - r^2) \quad \text{or} \quad \varphi_1 - \varphi_2 = \frac{\rho R^2}{6\epsilon_0} - \frac{\rho r^2}{6\epsilon_0} \quad (r < R) \quad (3)$$

and the potential difference outside the space-charged sphere is

$$\varphi(r > R) = \frac{q}{4\pi\epsilon_0 r} \quad \text{or} \quad \varphi(r > R) = \frac{\rho R^3}{3\epsilon_0 r} \quad (4)$$

In the given formulae ρ is the volume charge density of the sphere, q is the charge of the sphere, R is the radius of the sphere, r is the distance from the center of the sphere, ϵ_0 is the electric constant.

The formulae (2) and (4) show that outside the space-charged sphere the electric field and the potential are the same as if all of the charge were concentrated at the center of the sphere.

Methods. The program for calculation and visualization of the electric field of a space-charged sphere is written in the MATLAB language. This program calculates the electric fields and potentials of the field inside and outside of a space-charged sphere and visualizes its equipotential lines.

% The electric field inside a space-charged sphere

>> q=9e-9; % input the charge of the sphere

>> e0=8.85e-12; % input the electric constant

>> R=0.10; % input the radius of the sphere

>> r=0:0.01*R:0.1*R; % input the radius vector

>> ro=q./(4*pi*R.^3/3); % calculation of the volume charge density of the sphere

>> E1=q.*r./(4*pi*e0*R.^3); % calculation of the electric field inside the sphere

>> E11=q./(4*pi*e0*R.^2) % calculation of the electric field at the sphere surface

E11 = 8.0926e+003 % result

>> fi1=ro*R.^2./(2*e0)-ro.*r.^2./(6*e0); % calculation of the field potential inside the sphere

>> plot(r,E1,'k-') % visualization of the electric field inside the sphere

>> plot(r,fi1,'k-') % visualization of the field potential inside the sphere

>> grid on % drawing the coordinate grid

>> xlabel('r,m') % input the name of the axis

>> ylabel('E1,V/m') % input the name of the axis

>> title('E1=F(r)') % input the name of the graph

The result is presented in the figure 1.

>> fi1=ro*R.^2./(2*e0)-ro.*r.^2./(6*e0); % calculation of the field potential inside the sphere

>> plot(r,fi1,'k-') % visualization of the field potential inside the sphere

>> grid on % drawing the coordinate grid

>> xlabel('r,m') % input the name of the axis

>> ylabel('fi1,V') % input the name of the axis

>> title('fi1=F(r)') % input the name of the graph

The result is presented in the figure 2.

Figure 1 shows that the electric field inside the sphere increases linearly from zero at the center up to its maximum at the surface of the sphere. But the field potential inside the space-charged sphere falls from 1214 V at its center to 809 at its surface (figure 2).

>> fi10=ro*R.^2./(2*e0) % calculation of the field potential at the center of the sphere

fi10 = 1.2139e+003 % result

>> r=R:0.1*R:5*R; % input the vector of the distance

>> fi2=ro*R.^3./(3*e0.*r); % calculation of the field potential outside the sphere

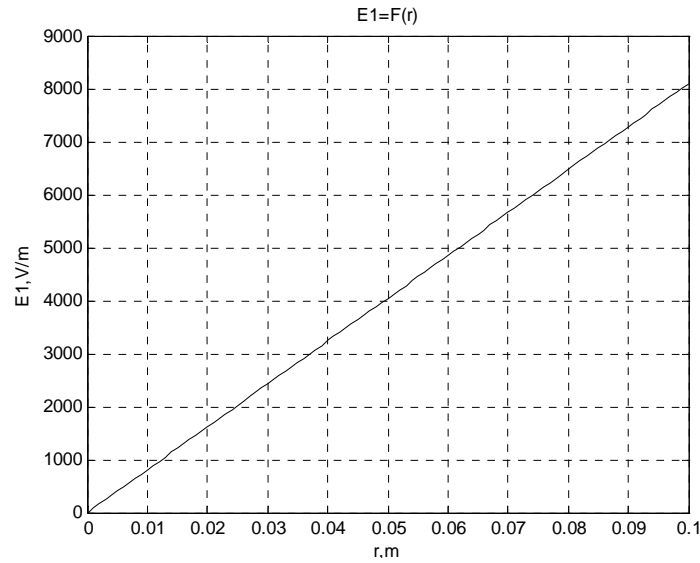


Figure 1 – The electric field inside the sphere as a function of the distance from the center of the sphere

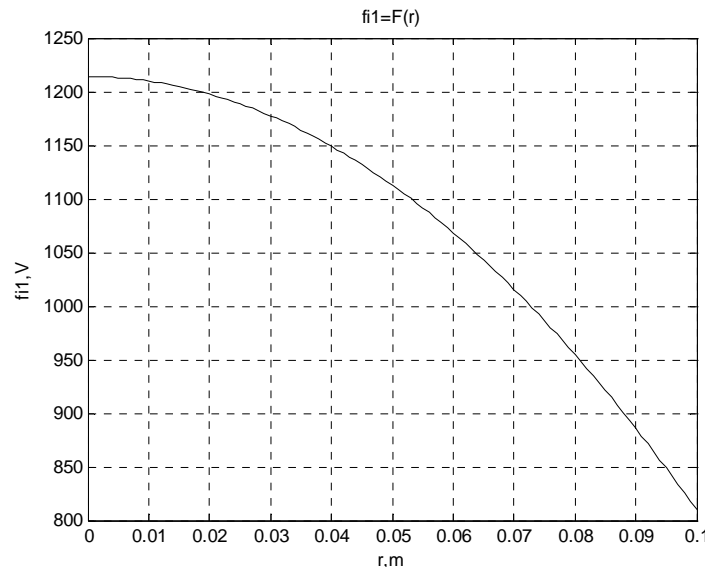


Figure 2 – The field potential inside the sphere as a function of the distance from the center of the sphere

```
>> fi22= ro*R.^2./(3*e0) % calculation of the field potential at the surface of the sphere
```

```
fi22 = 809.2624% result
```

```
>> plot(r,fi2,'k-') % visualization of the field potential outside the sphere
```

```
>> grid on % drawing the coordinate grid
```

```
>> xlabel('r,m') % input the name of the axis
```

```
>> ylabel('fi2, V') % input the name of the axis
```

```
>> title('fi2=F(r)') % input the name of the graph
```

Results. The result is presented in the figure 3.

```
>> E2=q./(4*pi*e0*r.^2); % calculation of the electric field outside the space-charged sphere
```

```
>> plot(r,E2,'k-') % visualization of the electric field outside the space-charged sphere
```

```
>> grid on% drawing the coordinate grid
```

```
>> xlabel('r,m') % input the name of the axis
```

```
>> ylabel('E2, V/m') % input the name of the axis
```

```
>> title('E2=F(r)') % input the name of the graph
```

The result is presented in the figure 4.

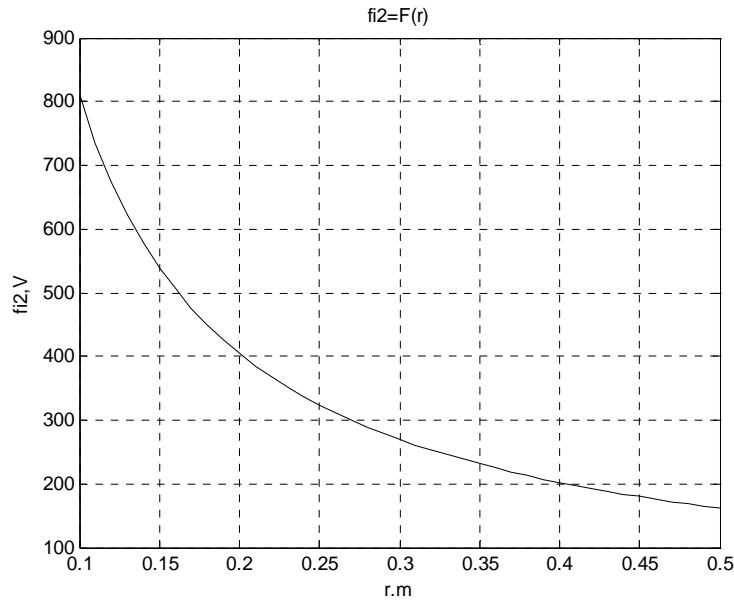


Figure 3 – The field potential outside the sphere as a function of the distance from the center of the sphere

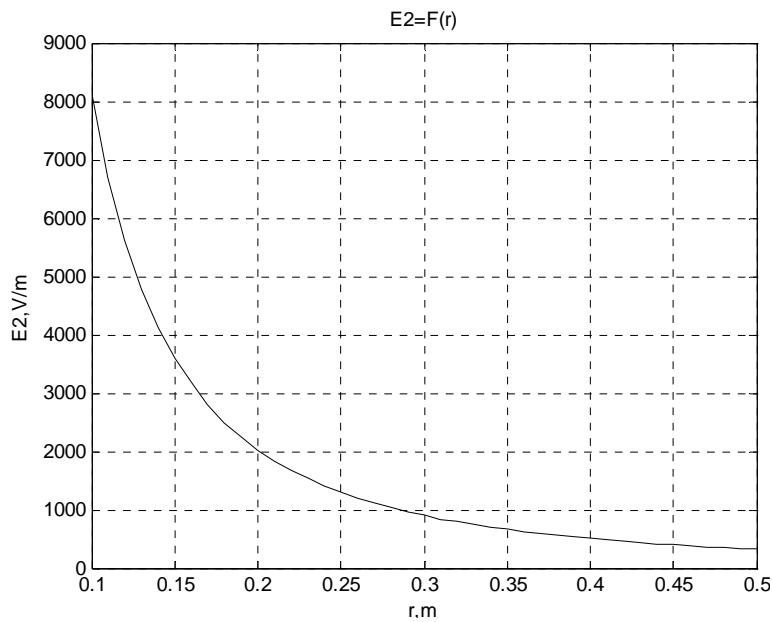


Figure 4 – The electric field outside the space-charged sphere as a function of the distance from the center of the sphere

Comparison of the curves given in the figures 3 and 4 demonstrates that the electric field outside the space-charged sphere decreases with distance quicker than the field potential.

```
% Visualization of equipotential lines (inside the sphere)
>> q=9e-9; % input the charge of the sphere
>> e0=8.85e-12; % input the electric constant
>> R=0.10; % input the sphere radius
>> x=-R:0.01*R:R; % input the vector of the coordinate x
>> y=-R:0.01*R:R; % input the vector of the coordinate y
>> [X,Y]=meshgrid(x,y); % drawing of a grid at knots of which x and y coordinates are recorded;
    % (arrays X and Y).
>> r1 = ((X -0.01* R).^ 2 + (Y+0.01*R).^ 2).^0.5; % calculation of the distance
>> r2 = ((X +0.01* R).^ 2 + (Y-0.01*R).^ 2).^0.5; % calculation of the distance
```

```

>> r=sqrt(r1.^2+r2.^2); % calculation of the distance
>> ro=q./(4*pi*R.^3./3); % calculation of the volume charge density
>> fi1=ro*R.^2./(2*e0)-ro.*r.^2./(6*e0); % calculation of the potential
>> Z=fi1; redesignation
>> contour3(X,Y,Z,100); % visualization of equipotential lines
>> xlabel('X,m') % input the name of x axis
>> ylabel('Y,m') % input the name of y axis
>> zlabel('fi2=V') % input the name of z axis
>> title('fi2=F(x,y)') % input the name of the figure

```

The result is presented in the figure 5.

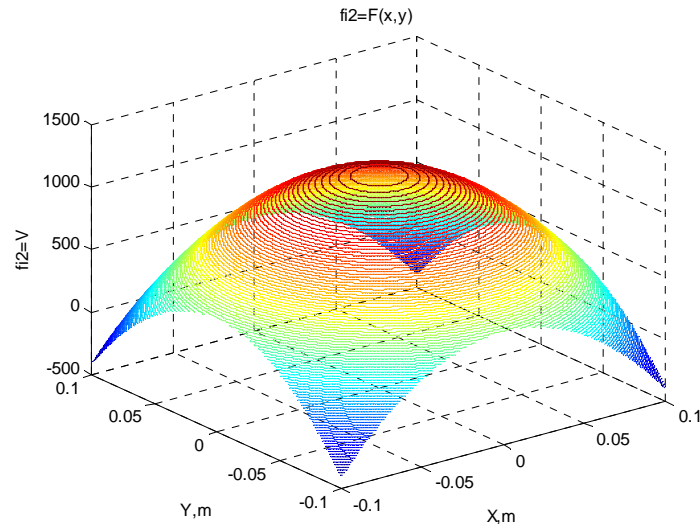


Figure 5 – Equipotential lines inside the sphere in three-dimensional space

```

>> view([0 0 100]) % command for drawing the projection on the X-Y plane.

```

The result is presented in the figure 6.

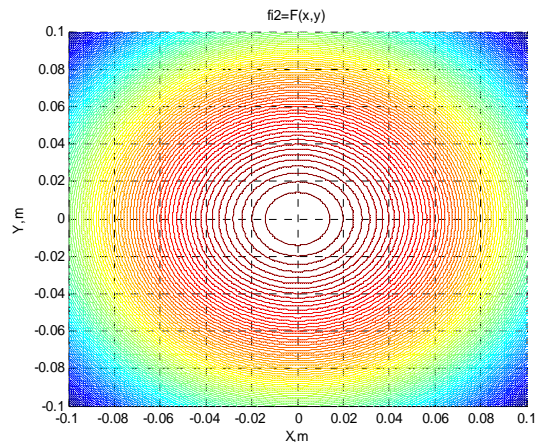


Figure 6 – Equipotential lines inside the sphere in projection on the X-Y plane

```

% The electric field outside a sphere
% Program of visualization of equipotential lines
>> q=9e-9; % input the charge of the sphere
>> e0=8.85e-12; % input the electric constant
>> R=0.10; % input the sphere radius
>> x= R :0.01*R:5*R; % input the vector of the coordinate x

```

```

>> y=R:0.01*R:5*R; % input the vector of the coordinate y
>> fi2=ro*R.^3./(3*e0.*r); % calculation of the potential outside the sphere
>> Z=fi2; % redesignation
>> [X,Y]=meshgrid(x,y); % drawing of a grid at knots of which x and y coordinates are recorded;
    % (arrays X and Y).
>> r2 = ((X +0.01* R).^ 2 + (Y-0.01*R).^ 2).^0.5; % calculation of the distance
>> r1 = ((X -0.01* R).^ 2 + (Y+0.01*R).^ 2).^0.5; % calculation of the distance
>> r=sqrt(r1.^2+r2.^2); % calculation of the distance
>> ro=q./(4*pi*R.^3./3); % calculation of the volume charge density
>> fi2=ro*R.^3./(3*e0.*r); % calculation of the potential outside the sphere
>> Z=fi2; % redesignation
>> contour3(X,Y,Z,100); % visualization of equipotential lines
>> xlabel('X,m') % input the name of x axis
>> ylabel('Y,m') % input the name of y axis
>> zlabel('fi2=V') % input the name of z axis
>> title('fi2=F(x,y)') % input the name of the figure

```

The result is presented in the figure 7.

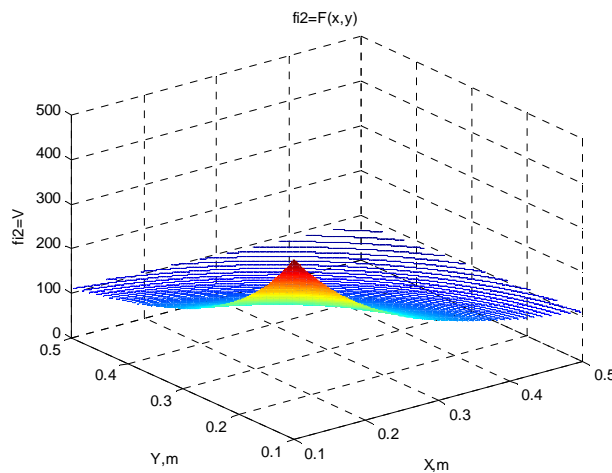


Figure 7 – Equipotential lines outside the sphere in three-dimensional space

```

>> view([0 0 100]) % command for drawing the projection on the X-Y plane.

```

The result is presented in the figure 8.

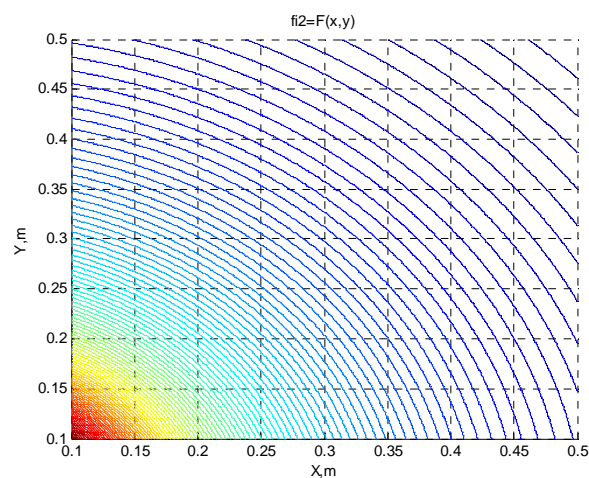


Figure 8 – Equipotential lines outside the sphere in projection on the X-Y plane

Conclusion. The MATLAB program for calculation and visualization of the electric field of a space-charged sphere allowed to

1) calculate the electric field and electric potential inside a space-charged sphere as a function of the distance from the center of the sphere. The electric field inside the sphere is proportional to the distance of the field point from the center of the sphere and the potential inside the sphere is inversely proportional to the squared distance from the center of the sphere. (The electric field inside a space-charged sphere increases proportionally to the distance from zero to $E_1=8092,6$ V/m at its surface (figure 1). The field potential decreases as the reciprocal of the squared distance from $\varphi_1=1213,9$ V at the center up to $\varphi_2 = 809.2624$ V at its surface (figure 2));

2) calculate the electric field and potential outside a space-charged sphere as a function of the distance from the center of the sphere. The electric field outside the sphere decreases inversely proportionally to the square of the distance from the center of the sphere (figure 3, and the potential decreases inversely proportionally to the distance from the center of the sphere (figure 4).

3) draw equipotential lines of the electric field outside and inside the sphere in three-dimensional space and in projection on the X-Y plane.

The students can be suggested to work out the similar program for calculation and visualization of the electric fields and electric potentials inside and outside the analogous charged sphere of a certain radius and charge evenly distributed throughout the volume of the sphere.

REFERENCES

- [1] CD of the open JSC "Phizicon". «The open physics 1.1».2001.
- [2] <http://elektronika.newmail.ru>
- [3] Kabyzbekov K.A., Saidakhmetov P.A., Arysbaeva A.S. Worksheet template for organization the independent performance of computer laboratory works // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics. 2013. N 6. P. 82-89.
- [4] Kabyzbekov K.A., Saidakhmetov P.A., Baidullaeva L.E., Abduraimov R. A technique of use of computer models for photo-effect and Compton effect studying, worksheet template for organization the performance of computer laboratory works // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2013. N 6. P. 114-121.
- [5] Kabyzbekov K.A., Saidakhmetov P.A., Turganova T.K., Nurullaev M.A., Baidullaeva L.E. Model of a lesson on converging and diverging lenses // Proceedings of NAN RK. Series physical-mat. 2014. N 2. P. 286-294.
- [6] Kabyzbekov K.A., Ashirbaev H.A., Saidakhmetov P.A., Rustemova K.Zh., Baidullaeva L.E. Worksheet template for organization the performance of computer laboratory work on study the diffraction of light // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2015. N 1(299). P. 71-77.
- [7] Kabyzbekov K.A., Ashirbaev H.A., Takibaeva G.A., Saparbaeva E.M., Baidullaeva L.E., Adineeva Sh.I. Worksheet template for organization the performance of computer laboratory work on study the motion of charged particles in a magnetic field // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2015. N 1(299). P. 80-87.
- [8] Kabyzbekov K.A., Ashirbaev H.A., Saidakhmetov P.A., Baigulova Z.A., Baidullaeva L.E. Worksheet template for organization the performance of computer laboratory work on study the Newton's rings // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2015. N 1(299). P. 14-20.
- [9] Kabyzbekov K.A., Ashirbaev H.A., Sabalakhova A.P., Dzhumagalieva A.I. Worksheet template for organization the performance of computer laboratory work on study the phenomenon of light interference // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2015. N 3(301). P. 131-136.
- [10] Kabyzbekov K.A., Ashirbaev H.A., Sabalakhova A.P., Dzhumagalieva A.I. Worksheet template for organization the performance of computer laboratory work on study the Doppler-effect // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2015. N 3(301). P. 155-160.
- [11] Kabyzbekov K.A., Ashirbaev H.A., Arysbaeva A.S., Dzhumagalieva A.I. Worksheet template for organization the performance of computer laboratory work on study physical phenomena // Modern high technologies. M., 2015. N 4. P. 40-43.
- [12] Kabyzbekov K.A., Saidakhmetov P.A., Ashirbaev Kh.A., Omashova G.Sh., Berdalieva J. Worksheet template for organization the performance of computer laboratory work on study electromagnetic oscillations // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2016. N 1(305). P. 111-116.
- [13] Kabyzbekov K.A., Saidakhmetov P.A., Omashova G.Sh., Berdalieva J., Dzhumagalieva A.I. Worksheet template for organization the performance of computer laboratory work on study the interaction between two infinitely long parallel current-carrying conductors // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2016. N 1(305). P. 135-140.
- [14] Kabyzbekov K.A., Saidakhmetov P.A., Omashova G.Sh., Suttibaeva D.I., Kozybakova G.N. Worksheet template for organization the performance of computer laboratory work on study isobaric process // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2016. N 2. P. 92-97.

- [15] Kabylybekov K.A., Omashova G.Sh., Saidakhmetov P.A., Nurullaev M.A., Artygalin N.A. Worksheet template for organization the performance of computer laboratory work on study the Carnot cycle // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2016. N 2. P. 98-103.
- [16] Kabylybekov K.A., Saidakhmetov P.A., Ashirbaev H.A., Abdubaeva Ph.I., Doskanova A.E. Study of the work done by gas on computer model // The Herald of NAN PK. 2016. N 2. P. 83-88.
- [17] Kabylybekov K.A., Saidakhmetov P.A., Omashova G.Sh., Serikbaeva G.S., Suyerkulova Zh.N. Worksheet template for organization the performance of computer laboratory work on study simple harmonic motions // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2016. N 2. P. 84-91.
- [18] Kabylybekov K.A., Madjarov N.T., Saidakhmetov P.A. An Independent design of research assignments for computer laboratory work on thermodynamics // Proceedings of the IX International scientific-methodical conference "Teaching natural. Sciences (biology, physics, chemistry), mathematics and computer science". Tomsk, 2016. P. 93-99.
- [19] Kabylybekov K.A., Saidakhmetov P.A., Omashova G.Sh. Organization of computer laboratory work on study the inductor reactance in an ac circuit // Proceedings of NAS RK. 2017. N 1. P. 77-82.
- [20] Kabylybekov K.A., Saidakhmetov P.A., Omashova G.Sh., Ashirbaev H.A., Abekova J.A. Organization of computer laboratory works on study of the isotherms of a real gas // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics. 2017. N 1. P. 77-83.
- [21] Kabylybekov K.A., Saidakhmetov P.A., Omashova G.Sh. Organization of computer laboratory works on study of the phenomenon of beats // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. N 2. P. 104-110.
- [22] Kabylybekov K.A., Omashova G.Sh., Spabekova R.S., Saidakhmetov P.A., Serikbaeva G. Arysbaeva A.S. Worksheet template for organization the performance of computer laboratory work on study the isothermal process // Herald of the National Academy of Sciences of Kazakhstan. 2017. N 3. P. 119-207.
- [23] Kabylybekov K.A., Omashova G.Sh., Spabekova R.S., Saidakhmetov P.A., Abdrakhmanova Kh.K., Arysbaeva A.S. Independent design of assignment for performance of a computer lab on study isochoric process // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. N 3. P. 127-134.
- [24] Kabylybekov K.A., Omashova G.Sh., Spabekova R.S., Saidakhmetov P.A., Serikbaeva G.S., Aktureeva G. Organization of computer laboratory works on study the turn-on and turn-off current of the power supply by using MATLAB software package // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. N 3. P. 139-146.
- [25] Kabylybekov K.A., Ashirbayev H.A., Abdrakhmanova Kh.K., Dzhumagalieva A.I., Kydyrbekova J.B. Organization of laboratory work on study the electric and magnetic fields by using MATLAB software package // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan. Series of Physics and Mathematics. 2017. N 3(313). P. 206-212.
- [26] Kabylybekov K.A., Ashirbaev H.A., Abdrakhmanova Kh.K., Dzhumagalieva A.I., Kadyrbekova J.B. Organization of the performance of the laboratory work "Modeling the electric field of a system consisting of a dielectric square and a long charged conductor" by using MATLAB software package // Proceedings of the National Academy of Sciences of the Republic of Kazakhstan, Series of Physics and Mathematics. 2017. N 4. P. 252-259.
- [27] Kabylybekov K., Saidullaeva N., Spabekova R., Omashova G., Tagaev N., Bitemirova A., Berdieva M. Model of a blank form for computer laboratory work on research of the speed selector // Journal of Theoretical and Applied Information Technology 15th July 2017. Vol. 95, N 13. P. 2999-3009. JATIT & LLS. Indexada en Scopus.
- [28] Kabylybekov K.A., Abdrakhmanova Kh.K., Abekova Zh.A., Abdraimov R.T., Ualikhanova B.S. Calculation and visualization of a system- an electron in a deep square potential well, with use of the software package of MATLAB // Proceeding of the III International Scientific and Practical Conference «Topical researches of the World Science» (June 28, 2017, Dubai, UAE). July 2017. Vol. 1, N 23. P. 7-13.
- [29] Porshnev S.V. Computer simulation of physical processes in the MATLAB package. M.: Hot Line-Telecom, 2003. 592 p.

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КӨЛЕМДІ ЗАРЯДТАЛҒАН ШАР ӨРІСІН ЕСЕПТЕУ ЖӘНЕ БЕЙНЕЛЕУ

Аннотация. Көлемді зарядталған шар (яғни, шар, көлем бойынша біркелкі зарядталған) өрісін есептеу мен бейнелеу MatLab бағдарламасының көмегімен орындалды. Көлемді зарядталған шардың ішіндегі және сыртындағы электр өрісінің кернеулігі мен потенциалы берілген нүктенің шар центрінен өлшенген ара қашықтыққа тәуелділігі анықталған. Шар ішіндегі кернеулік шардың центріне дейін ара қашықтыққа пропорционал өседі, ал потенциалы сол ара қашықтықтың квадратына кері пропорционалды кемиді. Шар сыртындағы электр өрісінің кернеулігі шардың центрінен саналған ара қашықтықтың квадратына кері пропорционал кемиді, ал потенциалы сол ара қашықтықтыққа кері пропорционал кемиді. Шар центріндегі және бетіндегі потенциал мен кернеулік есептелген. Шар ішіндегі және сыртындағы эквипотенциалдар сызықтары үш өлшемді кеңістікте және X-Y жазықтығындағы проекциясы бейнеленген.

Түйін сөздер: бейнелеу, көлемді зарядталған шар, потенциал, кернеулік, эквипотенциалды сызықтар.

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ВЫЧИСЛЕНИЕ И ВИЗУАЛИЗАЦИЯ ЭЛЕКТРИЧЕСКОГО ПОЛЯ ОБЪЕМНО-ЗАРЯЖЕННОГО ШАРА

Аннотация. Вычисления и визуализация электрического поля объемно-заряженного шара (т.е., шар, равномерно заряженный по объему), выполнены с помощью программы MATLAB. Проведено вычисление напряженности и потенциала поля как внутри, так и снаружи объемно-заряженного шара как функций расстояния от центра сферы. Напряженность поля внутри шара пропорциональна расстоянию точки поля, где определяется напряженность, до центра сферы. Потенциал поля внутри шара обратно пропорционален квадрату расстояния точки поля, где определяется потенциал, до центра сферы. Напряженность вне шара уменьшается обратно пропорционально квадрату расстояния от центра шара, а потенциал уменьшается обратно пропорционально расстоянию от центра шара. Также вычислены напряженность и потенциал поля на поверхности и в центре сферы. Эквипотенциальные линии электрического поля внутри и снаружи шара представлены в трехмерном пространстве в проекции на плоскость X-Y.

Ключевые слова: визуализация, объемно-заряженный шар, потенциал, электрическое поле, эквипотенциальные линии.

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