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Gaussian Action Field Teaching Research Based on CIDO Virtual Simulation Philosophy

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Abstract: In the teaching of General Physics, for the physics content's highly abstract and unified, put forward the teaching research of Gaussian action field based on CIDO virtual simulation philosophy, let Students explore and master the laws of motion of objects and fields to achieve the goal of general physics. This paper discusses the necessity and feasibility of CIDO virtual simulation philosophy based on Gauss's theorem and Stokes' theorem of vector field, which are the two basic laws of action in physics course, using Gauss's Theorem and Stokes' theorem of vector field, we first carry on the actual simulation experiment design, and introduce the mutually orthogonal force line and energy surface, to establish and draw the line of Action and equipotential energy surface of electric field or magnetic field, to help students understand and master the abstract field substance and its basic action property from personal participation and experience; On the CIDO virtual simulation philosophy, establish a gravitational field model and vortex gravitational field specifications within the Earth, and study the longitudinal and lateral perturbation effects of the gravitational field within the Earth. Teaching from the concrete to the abstract gradually, let students gradually form a knowledge system, from understanding, understanding to mastering knowledge, to carry out basic cognition and model thinking training for students, developing students 'problem-solving ability by using knowledge model. IntroductionIn the period of new engineering education reform, colleges and universities vigorously explore and promote education reform with the theory and practice of new engineering courses as the carrier. General physics is the first compulsory basic course for science and engineering majors in Colleges and universities. It allows students to master the professional basic knowledge of natural science, have certain ability to analyze and solve problems, strong professional application ability and thinking innovation ability. For the general physics is highly abstract and unified, this paper puts forward the teaching research of Gaussian field action model based on CIDO virtual simulation philosophy, and establishes an intuitive Gaussian action field model, so that students can learn and explore the motion law of object and field matter, so as to achieve the training goal of general physics course.

1. Unified Gaussian Field Model Teaching

1.1. The Basis of CIDO Virtual Simulation Philosophy

The new CDIO education [1] model is widely used in the cultivation mode, construction of curriculum system, curriculum teaching, and other aspects of engineering professional education. It represents concept, design, implementation, and operation, allowing students to actively think, participate, learn, and practice from conception to operation, comprehensively improving their knowledge level, practical ability, and personal comprehensive quality, achieving the goal of cultivating high-quality, practice-oriented Comprehensive and creative senior talent objectives.

In general physics teaching, from micro、macro to cosmology, the research objects are divided into tangible material entities and intangible objective field substances. Objects are concrete and intuitive, and field substances are abstract and potential. In the interactive process between teachers' teaching and students' learning, it is difficult for students to understand the transition from tangible to intangible, which puts forward new problems and higher requirements for teaching. On CIDO virtual simulation [2] philosophy, using Gauss theorem to establish the field material action model, present the abstract model with the visual model, and compare and analyze with the object, which is easy for students to understand and master the action field. Its theoretical basis is that nature is basically unified. First, there are five unified material models, such as mass charge, charge, magnetic charge, heat charge and light charge; The second is the unified motion vector field theory, such as the objective forms of translation, rotation and vibration; The third is the unified action vector field theory, such as the basic interaction between four pairs of unity-opposite gravity and repulsion.

Using the gauge invariance of the unified field, the intrinsic model and characteristics of typical gravitational field sources are explored [3]. Following the unified field law and analogical reasoning with electrostatic field and steady magnetic field, two basic laws of gravitational field can be obtained.

1.2. Two Basic Vector Field Principles

Gauss theorem of vector field: "the integral of the normal component of any vector C to any closed surface s can also be written as the integral of the divergence $\nabla \cdot C$ of the vector to the volume surrounded by the surface".

Gauss theorem shows that the vector field is active or passive, and its spatial field intensity is directly proportional to the field source density in this spatial region. For example, the electrostatic field of point charge field source is active, and the steady magnetic field of slender direct current field source is passive.

Stokes theorem of vector field: "the circulation of any vector C around any loop L is equal to the curl of the vector $\nabla \times C$ The integral of the normal component of C to any closed surface s".

Stokes theorem shows that the vector field is rotating or non-rotating, and the curl of any spatial field region indicates that the intensity of the spatial field is directly proportional to the density of the field source in this spatial region. For example, the electrostatic field of point charge field source is irrotational; The steady magnetic field of slender direct current source is rotating.

2. Object Field Motion Problem Based on CIDO Virtual Simulation Philosophy

For basic material elements, such as mass charge, electric charge, magnetic charge, thermal charge and light charge, establish qualitative object motion model for 3D dynamic virtual simulation, and then conduct comparative analysis to obtain quantitative object motion law model.

Gradually carry out teaching from concrete to abstract, so that students can gradually form a knowledge system, from understanding to mastering knowledge, and train students in basic cognition and model building thinking, Cultivate students' ability to use knowledge model to solve problems.

2.1. Establishment of Plane Simple Harmonic Model

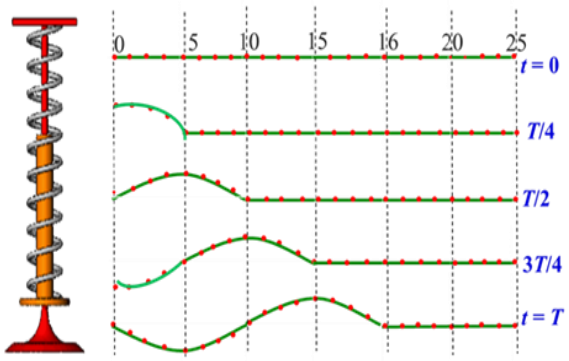

Figure 1: The dynamic model of line damping by 3D simulation

Using Laplace transform or Fourier transform, a complex periodic motion model can be equivalent to the superposition of several simple harmonic motions following the law of sine and cosine. A simple harmonic vibration model, first establish a qualitative 3D dynamic virtual simulation simple harmonic vibration model, and then obtain a quantitative object motion law model through the comparative analysis of rotation vector.

As shown in Figure 1, the line damping dynamic model is established by 3D simulation as the power source for generating simple harmonic wave, and the simple harmonic wave propagation model is established by image description and quantitative analysis. Inspire students to combine theory with practice, introduce the simple harmonic power of plane, cylinder and sphere, discuss the laws of independent propagation and superposition propagation in groups, and let students illustrate their expanded applications, such as sound wave and music, standing wave and musical instrument, color Doppler ultrasound and Doppler Effect.

2.2. Establish Electromagnetic Field Action Model

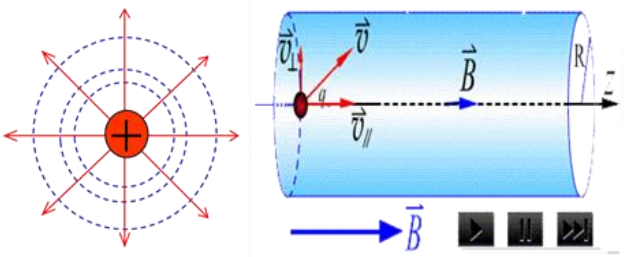

Figure2: The dynamic model of Electromagnetic field by 3D simulation

Using the Gauss theorem [4] and Stokes theorem of vector field, first carry out the actual simulation experimental design, introduce mutually orthogonal force lines and energy surfaces, establish and draw the action lines and equipotential energy surfaces of electric or magnetic field, and help students understand and master the abstract field matter and its basic action properties from personal participation and experience.

As shown in Figure 2, first let the students design a scientific simulation model [5], carry out reasonable simulation experiment operation, let the students draw the electric field line and equal potential energy surface, establish a quantitative electric field distribution action model, correctly process and analyze the experimental data processing, and understand and master the abstract field through experimental verification. Using 3D virtual simulation and introducing [6] Hall effect, let students understand the frontier of scientific application development and cultivate students' scientific thinking and innovative thinking ability.

3. Disturbance Effect of Gravitational Field Based on CIDO Virtual Simulation Philosophy

3.1. Gravitational Field Model in the Earth

Based on the data in Table 1, combined with the characteristics of the gravitational field in the earth, taking the earth center as the measurement zero starting point, the inner and outer radii of each J earth sphere are respectively expressed as the data model of the gravitational field in the reformed earth.

Table 1: Data model of gravitational field in the earth

Inner radiu (S/ km)	Outer radiu (S /km)	Depth (km)	Density (g/cm^{-3})
0	1271	1271	12.5
1271	1671	400	12.3
1671	3471	1800	10.7
3471	5391	1920	5.35
5391	6338	947	3.40
6338	6371	33	2.75

3.2. Specification of Gravitational Field in the Earth

Using the gauge equation and invariance of the unified field, according to Newton's law of universal gravitation and the law of motion, the gravitational field is an active, scattered and non-rotating conservative field, and the divergence is determined by the mass density, which reflects the strength of its tail. Unlike electrostatic field, the flux of gravitational field can only be negative real number. Some studies believe that this is due to the virtual mass of the field source, which is only an equivalent treatment method of theoretical calculation [7]. When the earth rotates from west to east around its own axis, a ring current will be formed in the interior of the earth. This ring current is the magnetic field source forming the earth's magnetic field, and the external magnetic field direction of the geomagnetic field is from the geographical south pole to the geographical North Pole; Following Biot Savart law, the current source that generates the earth's magnetic field is formed by the directional movement of negatively charged carriers, so the earth is negatively charged. From this point of view, the gravitational field is essentially an electromagnetic field, which is of great research value for the establishment of supersymmetric unified theory.

In a certain earth's sphere, the strength of the gravitational field [8] in the outer space of the earth's core is continuous and isotropic, which is determined by the mass density and volume of each layer. The strength of the gravitational field in each earth's sphere is calculated. The gravitational field in the solid earth has spherically symmetrical distribution and is continuous at the interface of two adjacent layers.

3.3. Specification of Vortex Gravitational Field in the Earth

Compared with the steady magnetic field, the mass flow is formed by the directional motion of the mass source [9], the gravitational field is a passive vortex field, and its curl is determined by the surface density of mass flow, which reflects the strength of its tail.

The vortex gravitational field in the earth is mainly formed by the earth's rotation, and the earth's rotation cycle. From the Stokes theorem of vortex gravitational field, there is the strength of vortex gravitational field, as shown in formula (1),

$$g = \frac{2\pi G}{hC^2}\sum_{i=k}^{n} I_k = \frac{2\pi G\rho_k}{TC^2} \tag{1}$$

When the density of the earth's core layer is the maximum, the intensity of the vortex gravitational field is the maximum. The intensity of the vortex gravitational field is very weak, and its disturbance effect can be ignored.

4. Longitudinal and Transverse Disturbance Effects in the Earth

4.1. Longitudinal Disturbance Effect in the Earth

Since the mass in each earth sphere is evenly distributed and has spherically symmetrical distribution [10], the gravitational force on the mass element in a certain earth sphere has a linear relationship with the vector diameter r. After establishing a model for analysis, it can be concluded formula (2)

$$F = -kr = g = \frac{d^2r}{dt^2} \tag{2}$$

The equation of motion is:

$$\frac{d^2r}{dt^2} + \varpi^2 r = 0 \tag{3}$$

Its vibration period is:

$$T = \frac{2\pi}{\varpi} = \frac{2\pi}{\sqrt{k}} = \frac{2\pi}{\sqrt{g/r}} = 2\pi\sqrt{\frac{r}{g}} \tag{4}$$

It can be seen that under the action of the cavity gravitational field[11], the mass element makes simple harmonic vibration and forms the longitudinal wave disturbance effect in the surrounding medium. As shown in the figure2, the distribution diagram of longitudinal gravitational field disturbance in the earth's interior is drawn according to the data in Table 1.

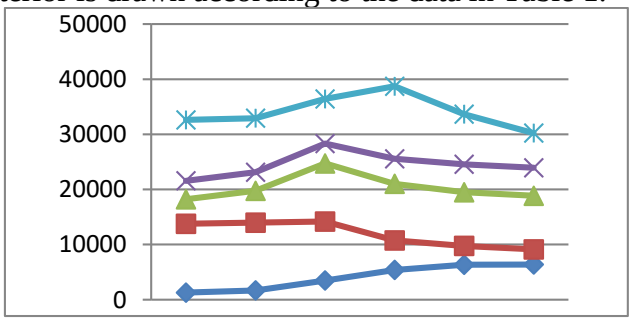

Figure 3: Distribution of longitudinal gravitational field disturbance inside the earth

According to figure 3, at the junction of the outer nuclear liquid layer and the lower mantle layer, there is an inflection point in the longitudinal distribution, the layer density and the layer radius change inversely symmetrically, and the layer gravitational field intensity, layer vibration period and seismic longitudinal wave velocity have similar change trends.

Near the earth's surface, the influence of the atmosphere, hydrosphere and biosphere in the outer circle of the earth must be taken into account. The standard value of the gravitational field intensity is 9.801N/kg, which increases compared with the calculated value of the gravitational field intensity of the outer transition layer of the upper mantle, which is 9.726 N/kg; The standard value of the earth's rotation period is 86.16 ks, which increases by 81.10 ks compared with the value of 5.06 ks in the outer transition layer of the upper mantle. It is inferred from the gauge equation calculated above that the change is caused by the synthesis of multiple factors; The reason why its gravitational field intensity changes little is that its gravitational field intensity is inversely proportional to the vector diameter, but directly proportional to the mass of the earth in the vector diameter r; The motion period under the action of the earth's gravitational field [12] is directly proportional to the vector diameter. In addition to the atmosphere, hydrosphere and biosphere, the vector diameter increases by a large proportion, while the intensity of the gravitational field changes very little.

4.2. Lateral Disturbance Effect in the Earth

It can be inferred from the previous calculation that the strength of the transverse gravitational field in a certain earth's sphere is:

$$g_{xj} \cong -\frac{2G\rho_j}{r\cos\theta} \tag{5}$$

In order to improve the calculation accuracy, take the latitude angle range from 850 to 890, and replace it with the parameters of a certain earth sphere to calculate the strength of its transverse gravitational field [13]. The calculated data results are shown in Table 2.

Table 2: Distribution of gravitational field intensity in the earth's sphere

Longitudinal gravitational field		Transverse gravitational field in different dimensions angles (10^{-13}N/kg)				
g(N/kg)	T/ks	85°	86°	87°	88°	89°
4.43	3.36	149	186	247	368	719
5.78	3.38	112	139	185	275	538
10.55	3.60	46.8	58.3	77.4	115	225
10.28	4.55	15.1	18.8	24.9	37.1	72.6
9.75	5.06	8.14	10.1	13.5	20.1	39.2
9.73	5.08	6.55	8.17	10.8	16.1	31.6

According to the data analysis in Table 2, the strength of the earth's transverse gravitational field [14] is very small, with an order of magnitude of about. With the increase of latitude angle, the strength of its transverse gravitational field increases. As the radius of the earth's sphere increases, the layer density decreases, the strength of the transverse gravitational field decreases, and the disturbance effect decreases.

The vibration period is calculated by the previous method. When the latitude angle is, at the outer radius of the earth's core, its transverse gravitational field [15] is the strongest and its vibration period is the largest; When the latitude angle is, the transverse gravitational field is the weakest and the vibration period is the shortest at the outer radius of the crustal layer. Through calculation,

reasoning and demonstration, the very weak vortex gravitational field can be ignored. The gravitational field in the solid earth is isotropic, and its disturbance effect is mainly affected by the circle radius, mass density and latitude angle of the gravitational field.

5. Conclusions

Establish 3D virtual dynamic physical model or application model with diversified CDIO virtual simulation teaching means[16], design simulation experiment and experimental operation based on theory, draw image material action field model from point to line to surface, conduct scientific measurement and obtain effective experimental data, so that students can fully understand the material motion model, master the law of abstract material action field, and guide students to integrate theory with practical application, It has greatly improved students' ability to analyze and solve problems, and cultivated students' scientific thinking and innovative thinking ability.

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