3D EQUIPOTENTIAL PROPERTIES

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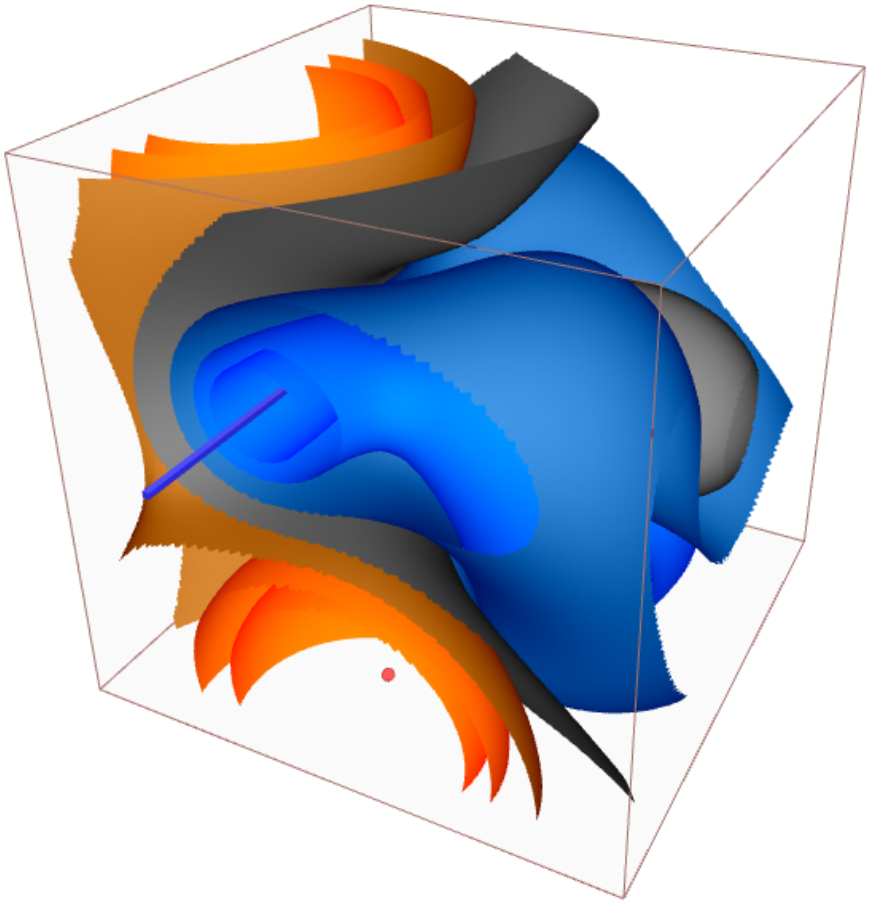

FIGURE 1. Equipotential Surfaces in Visualis Electromagnetism

DEFINITION

An equipotential surface is a three-dimensional geometric surface that represents a locus of points with the same electric potential in a static electric field. The electric potential (often denoted as V) at a point in space is given by the work done per unit charge against an electric field to move a positive test charge from a reference point (typically infinity) to that point.

PROPERTIES

A key property of an equipotential surface is that the electric field is always perpendicular to the equipotential surface at every point. This means for example that the work done in moving a charge along an

equipotential surface is zero, since work is defined as the integral of the force (in this case, the electric force) over the displacement, and the cosine of the angle between the force and displacement vectors. As the electric field and the displacement are perpendicular on an equipotential surface, the angle is 90 degrees, hence the work done is zero.

Another straightforward property is that equipotential surfaces will never cross, which can be seen very clearly on the 3D figures.

Computation

Mathematically, if $\vec{E}$ is the electric field and $d\vec{s}$ is an infinitesimal displacement along the equipotential surface, the work dW done is given by $dW = \vec{E} \cdot d\vec{s}$. As $\vec{E}$ and $d\vec{s}$ are perpendicular, their dot product is zero, hence $dW = 0$.

The difference in potential between two points, A and B, is given by $V_B - V_A = -\int_A^B \vec{E} \cdot d\vec{s}$. This integral is the work done in moving a unit positive charge from A to B. On an equipotential surface, this difference is zero by definition.

Visualis Physics

Visualis Electromagnetism offers clean views of equipotential surfaces around charges and plates, and the surfaces can be moved manually - and rebuilt in real-time - so that one can easily form an intuition about their shape even in complex configurations.