r/ThingsYouDidntKnow • 2 mo. ago
TheStocksGuy

Gauss's Law (Explained using a more basic approach Visualization)

Gauss's Law is a key concept in electromagnetism. It explains how electric flux through a surface relates to the charge inside it. The equation is:

$\Phi_E = \oint_S E * dA = Q_{enc} / \varepsilon_0$

Where:

- Φ_E is the electric flux.
- E is the electric field.
- dA is a tiny area on the surface with an outward direction.
- $\oint_S$ represents the integral over the closed surface S.
- Q_{enc} is the enclosed charge.
- ε_0 is the permittivity of space.

Visualization as Dots

- **Center Charge**: We have a charge in the center of a circle (Gaussian surface).
- **Field Lines as Dots**: Electric field lines are shown as dots radiating outward from the charge.
- **Gaussian Surface (Circle)**: A stationary circle captures the dots passing through it.

How It Works

1. **Dots Inside the Circle**: Dots start from the center and move outward, representing the electric field.
2. **Passing Through the Circle**: As dots cross the circle, they show the electric flux. The number of dots crossing equals the charge inside.
3. **Dot Growth**: Dots increase in size as they move outward, reflecting the field's properties.

Example Animation

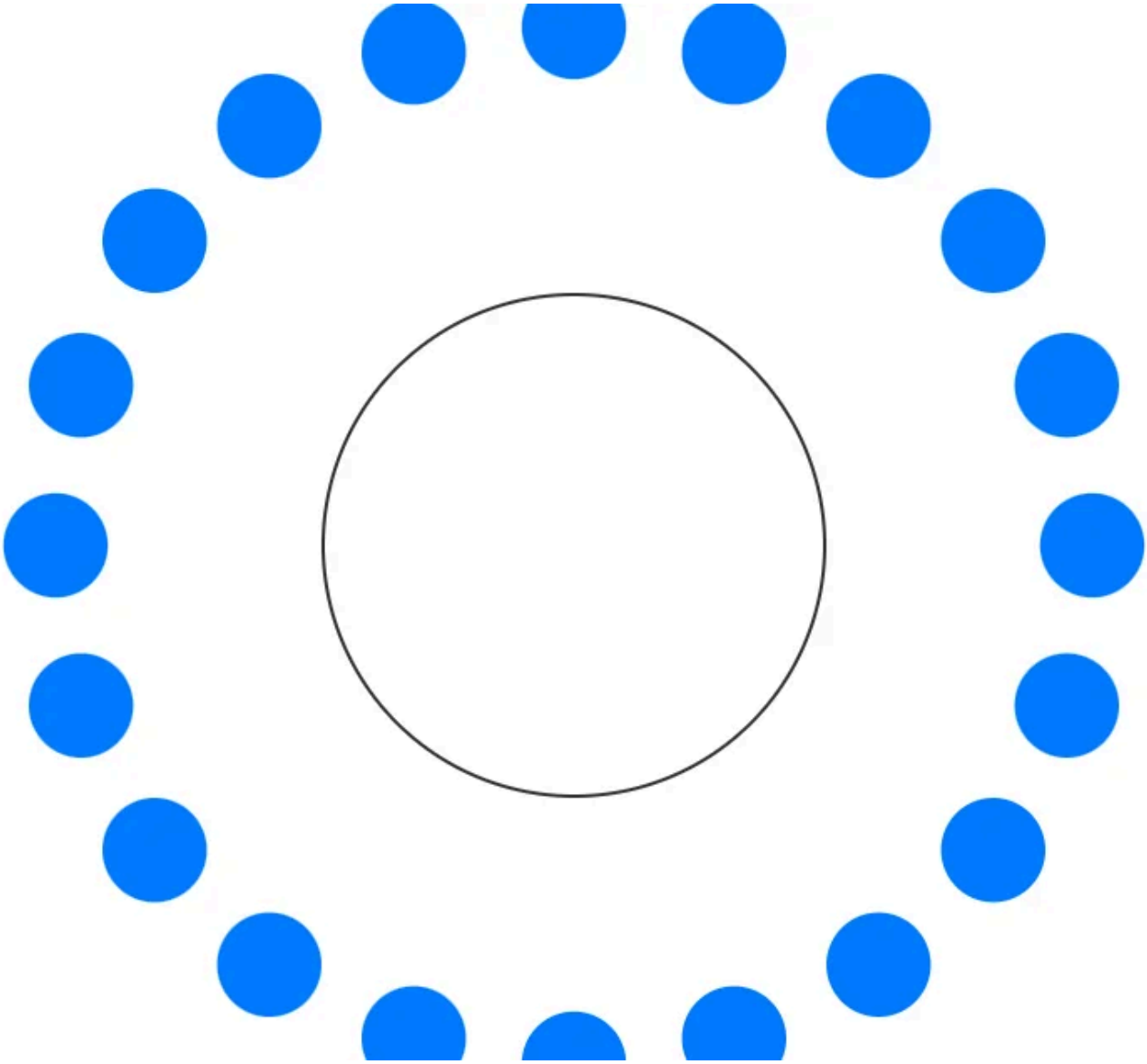
- The charge stays in the center.
- Dots (field lines) move outward from the charge.
- The circle (Gaussian surface) remains stationary, with dots passing through to show electric flux.

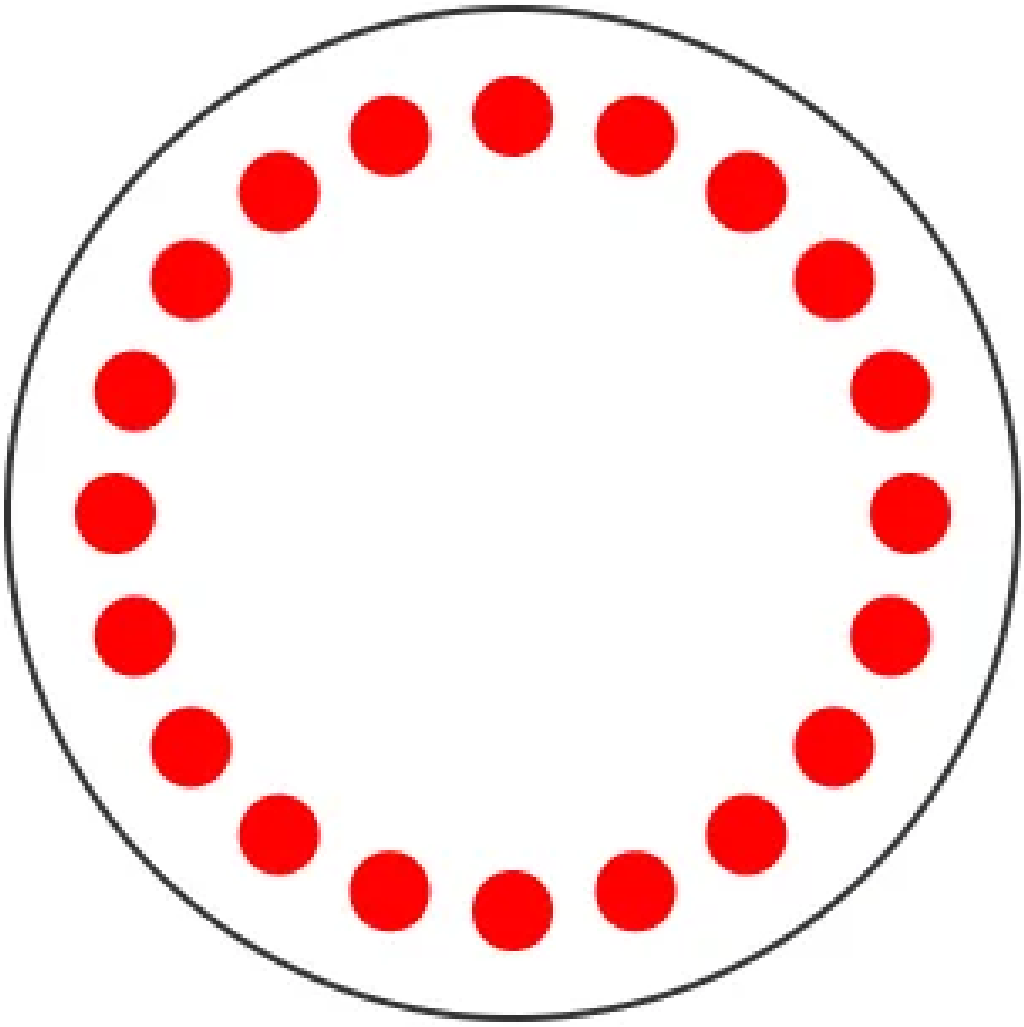
This visual approach demonstrates Gauss's Law by showing electric field lines as growing dots moving through a Gaussian surface. It highlights the relationship between enclosed charge and electric flux, making it easier to understand.

```
<head>
  <meta charset="UTF-8">
  <meta name="viewport" content="width=device-width, initial-scale=1.0">
  <title>Gauss's Law Visualization</title>
  <style>
    body {
      margin: 0;
      display: flex;
      justify-content: center;
      align-items: center;
      height: 100vh;
      background-color: #f0f0f0;
    }

    canvas {
      border: 2px solid #333;
      background-color: #fff;
    }
  </style>
</head>
<body>
  <canvas id="gaussCanvas"></canvas>
  <script>
    const canvas = document.getElementById('gaussCanvas');
    const ctx = canvas.getContext('2d');
    canvas.width = window.innerWidth;
    canvas.height = window.innerHeight;

    let isRunning = true;
    const maxLength = canvas.width / 2; // Maximum distance the field dots can move

    document.body.addEventListener('click', () => {
      isRunning = !isRunning;
      if (isRunning) animate();
    });

    const gaussianSurface = {
      x: canvas.width / 2,
      y: canvas.height / 2,
      radius: 150,
    };

    const charge = {
      x: gaussianSurface.x,
      y: gaussianSurface.y,
    };
```

```
const fieldSpeed = 2;
const dotSizeIncrement = 0.20;

for (let i = 0; i < numFieldDots; i++) {
  const angle = (i / numFieldDots) * (2 * Math.PI);
  fieldDots.push({
    x: charge.x,
    y: charge.y,
    angle: angle,
    length: 0,
    size: dotSizeIncrement,
  });
}

function drawGaussianSurface() {
  ctx.beginPath();
  ctx.arc(gaussianSurface.x, gaussianSurface.y, gaussianSurface.radius, 0, Math.PI * 2);
  ctx.strokeStyle = '#333';
  ctx.lineWidth = 2;
  ctx.stroke();
}

function drawFieldDots() {
  fieldDots.forEach(dot => {
    const xPos = charge.x + Math.cos(dot.angle) * dot.length;
    const yPos = charge.y + Math.sin(dot.angle) * dot.length;

    ctx.beginPath();
    ctx.arc(xPos, yPos, dot.size, 0, Math.PI * 2);
    ctx.fillStyle = dot.length <= gaussianSurface.radius ? '#ff0000' : '#007bff';
    ctx.fill();

    if (isRunning) {
      dot.length += fieldSpeed;
      dot.size += dotSizeIncrement;
      if (dot.length > maxLength) {
        dot.length = 0;
        dot.size = dotSizeIncrement;
      }
    }
  });
}

function animate() {
  if (!isRunning) return;
  ctx.clearRect(0, 0, canvas.width, canvas.height);
```

```
    }

    animate();
  </script>
</body>
</html>
```





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