# Theoretische Physik II
# Elektrodynamik

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# Kapitel 1

# Mathe

$f, g$ sind skalare Felder, $\boldsymbol{F}, \boldsymbol{G}$ sind vektor Felder:

**Produktformeln**

$$
\begin{aligned}
\boldsymbol{\nabla}(fg) &= f\boldsymbol{\nabla}(g) + g\boldsymbol{\nabla}(f) \\
\boldsymbol{\nabla} \cdot (f\boldsymbol{G}) &= f\boldsymbol{\nabla} \cdot (\boldsymbol{G}) + \boldsymbol{G} \cdot \boldsymbol{\nabla}(f) \\
\boldsymbol{\nabla}(\boldsymbol{F} \times \boldsymbol{G}) &= \boldsymbol{G} \cdot \boldsymbol{\nabla} \times (\boldsymbol{F}) - \boldsymbol{F} \cdot \boldsymbol{\nabla} \times (\boldsymbol{G}) \\
\boldsymbol{\nabla} \times (f\boldsymbol{G}) &= f\boldsymbol{\nabla} \times (\boldsymbol{G}) - \boldsymbol{G} \times \boldsymbol{\nabla}
\end{aligned}
$$

**Identitäten**

$$
\begin{aligned}
\boldsymbol{\nabla} \times (\boldsymbol{\nabla}\boldsymbol{F}) &= \boldsymbol{\nabla}(\boldsymbol{\nabla} \cdot \boldsymbol{F}) - \Delta\boldsymbol{F} \\
\boldsymbol{\nabla} \times (\boldsymbol{\nabla} f) &= \boldsymbol{0} \\
\boldsymbol{\nabla} \cdot (\boldsymbol{\nabla} \times \boldsymbol{F}) &= 0 \\
\boldsymbol{\nabla} \times (\boldsymbol{a} \times \boldsymbol{\nabla} f) &= \boldsymbol{a}\Delta f - \boldsymbol{\nabla}(\boldsymbol{a} \cdot \boldsymbol{\nabla} f)
\end{aligned}
$$

**Kugelkoordinaten**

$$
\begin{pmatrix} x \\ y \\ z \end{pmatrix} = \begin{pmatrix} \rho \sin\phi \cos\theta \\ \rho \sin\phi \sin\theta \\ \rho \cos\phi \end{pmatrix}, \qquad \int\limits_{-\infty}^{+\infty} f(\boldsymbol{r}) \, \mathrm{d}r = \int\limits_{0}^{2\pi} \int\limits_{0}^{\pi} \int\limits_{0}^{\infty} f(r, \phi, \theta) r^2 \sin\phi \, \mathrm{d}r\mathrm{d}\phi\mathrm{d}\theta
$$

**Gradienten eines skalaren Feldes**

$$
\boldsymbol{\nabla} g(\boldsymbol{r}) = \sum_i \boldsymbol{e}_i \frac{1}{\left|\frac{\partial \boldsymbol{r}}{\partial u_i}\right|} \frac{\partial}{\partial u_i} g(\boldsymbol{r})
$$

## 1.1 Integralsätze

**Gaußscher Satz**

$$
\int_V \boldsymbol{\nabla} \cdot \boldsymbol{E}(\boldsymbol{r}) \, \mathrm{d}^3 r = \oint_F \boldsymbol{E} \, \mathrm{d}\boldsymbol{f}
$$

**Stokes Satz**

$$
\int_F \boldsymbol{\nabla} \times \boldsymbol{a} \, \mathrm{d}\boldsymbol{f} = \int_{\partial F} \boldsymbol{a} \, \mathrm{d}\boldsymbol{r}
$$

**Greensche Identitäten**

$$\int_V \boldsymbol{\nabla} g(\boldsymbol{r}) \cdot \boldsymbol{\nabla} h(\boldsymbol{r}) + g(\boldsymbol{r}) \Delta h(\boldsymbol{r}) \ \mathrm{d}^3 r = \oint_{\partial V} g(\boldsymbol{r}) \boldsymbol{\nabla} h(\boldsymbol{r}) \ \mathrm{d}\boldsymbol{f}$$

$$\int_V g(\boldsymbol{r}) \Delta h(\boldsymbol{r}) g(\boldsymbol{r}) - h(\boldsymbol{r}) \Delta g(\boldsymbol{r}) \ \mathrm{d}^3 r = \oint_{\partial V} g(\boldsymbol{r}) \boldsymbol{\nabla} h(\boldsymbol{r}) - h(\boldsymbol{r}) \boldsymbol{\nabla} g(\boldsymbol{r}) \ \mathrm{d}\boldsymbol{f}$$