Theoretische Physik 2 (Elektrodynamik) WS 2018/2019
Technische Universität München
December 7, 2018

Exercise Sheet 8*

Deadline: Sheet to be turned in by Friday 14th of December 2018 by 12 pm in the mailbox next to PH3218.

Exercise 1:
Dipole and Quadrupole moments of a point-charge distribution **2 Points**

Four point-charges with charge q are placed at the following Cartesian coordinates,

$$(0, d, 0), (0, -d, 0), (0, 0, d) \quad \text{and} \quad (0, 0, -d),$$

and another four with charge $-q$ are placed at:

$$(-d, 0, 0), \left(-\frac{d}{2}, 0, 0\right), (d, 0, 0) \qquad (2d, 0, 0).$$

Compute the dipole moment $\vec{p}$ and the quadrupole tensor Q of this charge configuration.

Exercise 2:
Magnetic field around a hollow cylinder traversed by a current **3 Points**

An infinitely long hollow cylinder with inner radius R_1 and outer radius R_2 is traversed by an homogeneous electrical current I. Compute the magnetic field $\vec{B}$ using the Ampere-Law at the interior and exterior of the cylinder's external surface. Sketch the magnitude of the magnetic field $|\vec{B}|$ as a function of the distance to the cylinders symmetry axis.

Exercise 3:
Lorentz force and work done by an EM field **2 Points**

Consider a particle of charge q and mass m at rest lying at the origin of a Cartesian coordinate system at $t = 0$. Let $\vec{E}$ by a constant electric field in the positive z-direction and $\vec{B}$ a constant magnetic field pointing in the positive x-direction. Find the trajectory, $\vec{r}(t)$, followed by this particle as a function of time. Does the average motion of the particle follow the electric field's direction? Does the magnetic field do some work on the particle (show it)? What is the average work done by the electric field on the particle after one period?

Exercise 4:
Generating an homogeneous magnetic field **3 Points**

Two parallel identical circular conducting rings of radius R, are parallel to the $x - y$ plane and have their centers located at $(0, 0, b)$ and $(0, 0, -b)$. Compute the the vector potential, $\vec{A}$ of this setup by superposing the potentials corresponding to a single ring. Expand $\vec{A}$ around the origin up to order $\mathcal{O}(\rho^3, \rho z^2)$. Find the relation between R and b, that will make the magnetic field at the origin as homogeneous as possible.

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