Technische Universität München **Theoretische Physik T70**
Physik Department **B. Garbrecht, Wenyuan Ai**

Theoretische Physik 2 (Elektrodynamik)

Wintersemester 2016/17

Abgabe bis Freitag, 13.01.16, 12:00 neben PH 3218.

Übungsblatt Nr. 9 Dieses Blatt wird in den Übungen vom 16.01. - 20.01.16 besprochen.

Aufgabe 1:
Uniformly charged rotating sphere — 4 Punkte

(a)A homogenously charged sphere of radius R and total charge Q (the charge is distributed inside the whole the sphere not just on the surface) is rotating with a constant angular velocity $\boldsymbol{\omega}$ around the centre of the sphere (*i.e.* $\mathbf{v} = \boldsymbol{\omega} \times \mathbf{r}$). Derive the pertaining current density $\mathbf{j}(\mathbf{r})$ and verify that $\boldsymbol{\nabla} \cdot \mathbf{j} = 0$. Calculate the vector potential $\mathbf{A}(\mathbf{r})$ as well as the the magentic field $\mathbf{B}(\mathbf{r})$ inside and outside the sphere.
Hint: Make use of the spherical symmetry

$$\int_{|\mathbf{r}\,'|<R} d^3r' \, \frac{\mathbf{r}\,'}{|\mathbf{r} - \mathbf{r}\,'|} = C(r)\, \mathbf{r}\,,$$

and derive $C(r)$ by taking the scalar product of both sides with $\mathbf{r}/r^2$. (3 Punkte)

(b) Calculate the magnetic dipole moment $\mathbf{m}$ of the sphere. Compare the dipole field with the result from part (a). (1 Punkt)

Aufgabe 2:
Circular circuits — 6 Punkte

(a) Consider two wires along the curves $\mathbf{r}_{1,2}$ that carry the currents $I_{1,2}$. Express the total force between the wires through a double integral along the two curves. (1 Punkt)

(b) Two wires forming circular loops each of radius a are arranged parallelly with a distance $d \gg a$ with the common axis being z axis. Let the lower loop carry the current I_1, the upper loop the current I_2. Calculate the force $\mathbf{F}_{21} = -\mathbf{F}_{12} \sim \mathbf{e}_z$ between the two circuits. Express the result in terms of a power series in the small parameter $s = (a/d)^2$ up to order s^4. (5 Punkte)