

# Electrodynamics Exam

## 2 March 2015, 18.30-21.30 uur

Rules:

- Closed book part  $\leq 2$  hours, open book part all remaining time.
- Please formulate clearly and concisely. Read carefully.
- Grade =  $1 + \frac{score}{10}$ .

### 1. Radiation and Special Relativity [8+8+8+8+8=40 points]

- Explain how retardation plays a role in the production of radiation.
- Use the basic ideas underlying special relativity to explain the difference between the classical and relativistic Doppler effect.
- Can a relativistically moving observer and one in rest agree on the total emitted and absorbed power? State why (not).
- Construct Lorentz invariants using all the properties of the absorption coefficient  $\alpha_\nu$ , for photon frequency  $\nu$ . Always give units.
- Explain what Thomson scattering is and under what conditions relativistic effects are likely to modify its associated cross section.

### 2. Radiation Basics [5+5+5+5=20 points]

- Describe a fundamental similarity between Bremsstrahlung, synchrotron emission and inverse Compton scattering, use the gamma factor  $\gamma$ .
- Explain why one does not expect much polarization from synchrotron emission driven by a tangled magnetic field. Use the concept of beaming.
- Consider thermal Bremsstrahlung and discuss when it may suffer from a photon discreteness effect.
- Explain, using the equation of radiation transfer, how blackbody radiation may emerge from a medium with an embedded non-thermal source.

➤ end of closed book part, please hand in questions 1 and 2.

### 3. An Observable Spectrum [10+10+10=30 points]

- Provide a drawing of intensity versus frequency for saturated inverse Compton scattering produced by a thermal and non-relativistic medium. Use formulas to explain the relevance of the (frequency dependent) Compton  $y$  parameter.
- What two intrinsic physical causes can you think of that would induce a low-frequency cut-off in such a spectrum?
- What limitations does the Earth's atmosphere pose to actually observe the spectrum that you provide?

➤ end of exam, please hand in question 3.