IP2: IMAGE PROCESSING IN REMOTE SENSING
EXERCISE 2

Due Date: Mo. 16.06.2014, 8 am

Scope: Electromagnetic Radiation

Please send your solutions via e-mail to: germer@informatik.uni-hamburg.de

Use the subject "IP2-Ex2 GROUPNAME" and write your solutions

- Either as plain text or
- Convert them to PDF and attach the PDF to the mail.

1 POLARIZATION OF ELECTROMAGNETIC WAVES 6 P.

Two linear polarized traversal waves of same wavelength and amplitude but with a different phase are moving along the z-axis. The first wave has an assigned electric field in parallel to the x-axis, the second wave's electric field is parallel to the y-axis. The phase shift of wave 1 with respect to wave 2 is of 90°.
Which polarization do you expect for a superposition of both waves? Explain the result and give a graphical interpretation.

2 DOPPLER EFFECT 6 P.

A driver has ben fined by the police for ignoring a red traffic light. When interviewed at the court he makes the following testimony: "I was not able to the see the red light signal, since – due to the Doppler effect – the red light was shifted into the ultra violet (UV) area of the spectrum. Thus the sign of the traffic light was invisible to me!"

Assume the following wavelengths:

λ_{red} = 700 nm
λ_{uv} = 350 nm

How fast would the driver be, if the traffic light were invisible to him?

3 BASIC RADIOMETRIC PROPERTIES: RADIANT FLUX 18 P.

Assume that the following values are given:

Radiant intensity of the Sun: $I_S = 1.24 \cdot 10^{25}$ W sr^{-1}

Distance between Earth and Sun:

At perihelion (ca. January, 3rd):	$147.1 \cdot 10^6$ km
At aphelion (ca. July, 5th):	$152.1 \cdot 10^6$ km

Geographic Location of Hamburg: N 53°33.000', E 010°00.000'

Declination of the Sun[1]:

January, 3rd: -22°50.800'
July, 5th: 22°48.300'

Reflection factors:

Water:	0.05
Coniferous forest:	0.04

Derive the following values:

a) **Dihedral angle $d\Omega_S$ and distance r_S:**

At which dihedral angle $d\Omega_S$ appears a horizontally aligned terrain area element dF_G in Hamburg, observed from the Sun? (The dihedral angle of the projection dF_S from dF_G, irradiated perpendicular by the Sun):

I. At perihelion (January, 3rd)

II. At aphelion (ca. July, 5th)

b) **Dihedral angle $d\Omega_S$ and zenith angle Θ:**

Determine the altitude of the Sun at noon (when the Sun stays south with maximal altitude) in Hamburg w.r.t to the southern horizon. How large is the zenith angle Θ at this time?

I. At the perihelion transit of the Earth

II. At the aphelion transit of the Earth

c) Radial intensity E_G:

I. Compute the radial intensity E_G of the sun w.r.t a horizontally aligned terrain area element dF_G in Hamburg at noon for January, 3rd and July, 5th. Neglect all atmospheric effects.

II. When is the radial intensity higher? Closer to the Sun or far distant?

d) **Radiant exitance M_G and radiance L_G:**

Assume, that we are looking perpendicular (from above) to a group of conifers at the bank of the Alster lake.

I. Compute the Radiant exitance M_G for the conifers and the water surface of the lake for January, 3rd and July, 5th.

II. If E_G is given, how does the radiance of the water surface $L_{G,W}$ differ from the radiance of the conifers $L_{G,N}$?

Total points: 30

[1] The declination denotes the angle between the equatorial plane and the direction to the star, measured at the Earth center.