Detection of Light

Course Organization

Course Setup

'Detection of Light' consists of two parts:

A. (Feb-Apr, 3 EC): A basic introduction in 8 lectures, completed by a written exam.

B. (Apr – Jun, 3 EC): A continuation in the form of 7 guest lectures on specific topics/technologies, completed by a written report ("literature study").

For students of Astronomy (Research) following DTL, part A is mandatory, part B is optional; for Instrumentation students, both parts are mandatory.

Lectures – Part A

Check out course website at:

http://home.strw.leidenuniv.nl/~brandl/DOL/Detection_of_Light.html

#	Date	Lecturer	Title	Topics	Homework
1	7-Feb-20	BB	Organization & Refresher of Solid State Physics	General: grading, exercises, book, nature of light, EM spectrum, technology, photographic plate, overview of detectors principles and types; solid state physics: atomic energy levels, crystal: bands, conductors and semi-condd., k-vector, Fermi energy	Homework
	14-Feb-20			*no lecture*	
2	21-Feb-20	BB	Intrinsic Photoconductors & Noise	general principle, box diagram, conductivity, mobility, tau, gain, quantum efficiency and responsivity; intro noise: poisson & Gaussian & 1/f noise; detector noise: Johnson, kTC, 1/f, BLIP	Homework
3	28-Feb-20	BB	Extrinsic Photoconductors	energy bands, doping, wavelength ranges, limitations, drawbacks and comparisons; BIB detectors, photodiodes, avalanche diodes	Homework
4	6-Mar-20	BB	IR Arrays & CCDs	IR arrays: principle, construction, readout electronics; CCDs: principle, back/front illuminated, thinned, readout, CTE, CT architectures, variants	Homework
5	13-Mar-20	LB	Operations and Artifacts	Readout schemes: SUR, Fowler, linearity & dynamic range, data rates; cryogenics	Homework
6	20-Mar-20	LB	Operations / Bolometers	(Buffer slot -- will be filled)	Homework
7	27-Mar-20	BB	Bolometers	Basic operation, time constants, superconducting, edged; comparison: responsivity, noise, NEP	Homework
8	3-Apr-20	BB	Heterodyne Detectors	general principle, IF, mixing, sidebands, bandwidth, components (HEB, SIS); performance: throughput, S/N, noise and antenna temperature, comparison coherent-incoherent detectors	Homework
	17-Apr-20		**14:15 - 18:00hr**	**EXAM in room HL414**	

Exam – Part A

- Part A (**3EC**) concludes with a written exam on 17 April 2020, 14:15 - 18:00 hr.
- It is a written, "closed book" exam. Pocket calculators are required at the exam.
- Final Grade = 80% written exam + 20% mandatory homeworks

The exam consists of three parts:

*I. Calculations [**35pt**] – (60 min)*

*II. Qualitative explanations [**25pt**] – (40 min)*

*III. Multiple choice questions [**20pt**] – (20 min)*

The maximum number of points is 80.

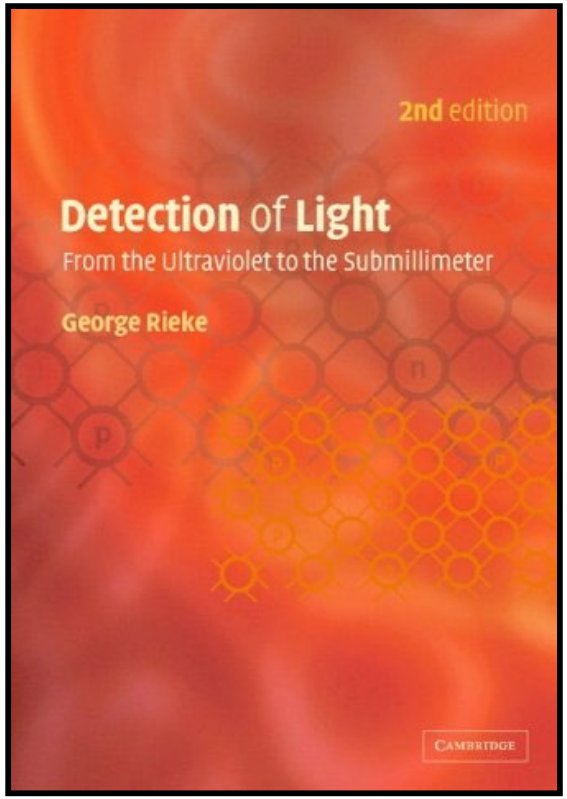
Homeworks – Part A

- 8 sets of homeworks
- Homework set will be distributed after each lecture on Friday via the course website
- Hand-in of the completed homework is on paper at the start of the subsequent lecture (usually one week later)
- Written feedback will be provided
- In case of questions → ask Patrick Dorval
- Homeworks are strongly recommended to practice for the exam
- Homeworks account for 20% of the final grade (Note: if handed in, they may improve your written exam grade, but not reduce it)

Literature

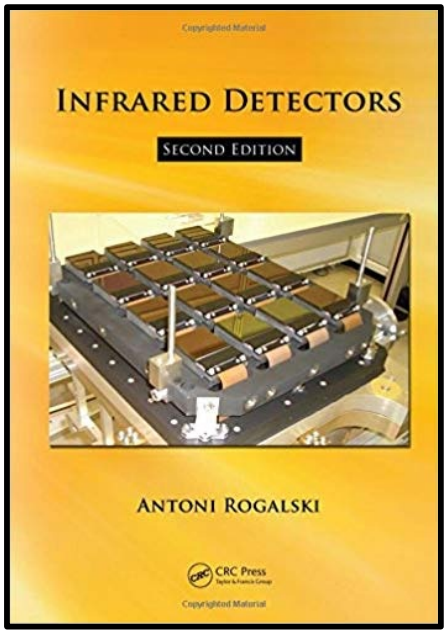
Main resource:

Detection of Light - from the Ultraviolet to the Submillimeter, by George Rieke, 2nd Edition, 2003, Cambridge University Press, ISBN 0-521-01710-6, paperback ~90 €



Further reading:

- *Infrared Detectors* (2nd Edition) by Antoni Rogalski, CRC Press, hardcover ~190 €, ebook ~35 €
- *Electronic Imaging in Astronomy:* Detectors and Instrumentation (2nd Edition) by Ian S. McLean;
- *Introduction to Solid State Physics* by Charles Kittel;



Guest Lectures – Part B

Part B consists of talks on specific topics, given by renowned guest lecturers. Preliminary program [TBC]:

Date	Speaker	Affiliation	Topic
24-Apr-20	Akira Endo	TU Delft	On-chip spectrometers
01-May-20	Pourya Khosropanah	SRON/TU Delft	TES and applications
08-May-20	TBD	ESO	Development, characterization and operation of detectors for astronomy
15-May-20	Alessandra Menicucci	TU Delft	Space radiation environment and its effect on detectors
22-May-20	*no lecture*		*university closed*
29-May-20	Jochem Baselmans	SRON/TU Delft	Kinetic Inductance detectors for imaging and spectroscopy from optical to Terahertz astronomy
05-Jun-20	TBD	TBD	TBD
12-Jun-20	Eric Costard	IRnova	QWIP detectors

“Exam” – Part B

- For students following also Part B there are two requirements for the additional **3 EC**:
  - Attendance of (most of) the lectures (absence to be excused)
  - A report (literature study) on a specific topic related to one of the guest lectures
- Report within 6 weeks (after registration) on a topic related to a specific lecture:
- Grading: O/V/G

Last year’s topics →

Lecturer	Project title
Akira Endo	Astronomical Instruments and the Uncertainty Principle
Akira Endo	Are Photons invisible?
Michel Antolovic	Photon counting Imaging Systems for Space Applications
Michel Antolovic	Electron multiplication in CCDs
Marco Beijersbergen	Detecting X-ray Photons with a DEPFET
Marco Beijersbergen	Detecting Gamma-ray Photons
Alessandra Menicucci	SPENVIS radiation environment and its effect on detectors: L2 Orbit
Alessandra Menicucci	SPENVIS radiation environment and its effect on detectors: Highly Elliptical Orbit
Jochem Baselmans	MKIDs and LEKIDs
Jochem Baselmans	Designing an on-chip spectrometer
J.R. Gao	Should LiteBird use TES or KID detectors?
J.R. Gao	Can you use KIDs for X-ray astronomy?

More important Points …

- You need to register in uSis
- Lecture room: Huygens #414 from 14:15 - 16:00 hr
- Lecturers: Prof. Dr. Bernhard Brandl (HL 1106) & Dr. Leo Burtscher (HL 1109c)
- TA (homeworks): Patrick Dorval, office: #1103; office hours: Mondays & Thursdays 13:00 – 14:00 hr; email: dorval@strw
- Course website: http://home.strw.leidenuniv.nl/~brandl/DOL/Detection_of_Light.html