

Astrophysical light scattering problems

PAP316, spring 2023, period 4, 5 cr

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May 5, 2023

Overlook

- Course home page:
 - <https://wiki.helsinki.fi/display/PAP316/>
- Lectures, March 15 – May 4 (28 h)
 - on Wednesdays, 10.15-12.00 (excluding April 12)
 - on Thursdays, 10.15-12.00 (excluding April 6)
- Exercise sessions, March 18 – May 4 (14 h)
 - on Thursdays, 12.15-14.00 (excluding April 6)
- Student project presentations and reports by **May 29, 2023 (inclusive)**

Overlook

- Exams
 - Project tasks, including (1) an introductory presentation during the lectures (**polarimetric fit with PolTrig**), (2) a presentation in a final interactive session, and (3) a written report (see below), maximum **15 points**
 - reports by May 29, 2023
 - presentations by May 29, 2023
 - final exam, maximum **15 points**
 - **home exam on May 5-29, 2023**
 - **30 points** in total from exams
- Exercises, 15 questions
 - 20% of points required
 - maximum **3 bonus points** on a linear scale
- Course points, maximum **33/30 points**

Overlook

- Project tasks are **case studies**
 - Photometric and polarimetric phase curves
 - Moon, Mercury, Mars
 - Asteroids, Comets
 - Saturn's Rings
 - Icy Moons of Outer Planets
 - Transneptunian Objects and Centaurs
 - Exoplanets (Mars can be a proxy)
 - Single object assigned to each student
- **Course theme** selected depending on the number of students
- Successful project tasks result in student coauthorship in a submission of **a scientific article**

Literature

Course book:

- L. Kolokolova, James Hough, Anny-Chantal Levasseur-Regourd, *Polarimetry of Stars and Planetary Systems*, Cambridge University Press, 2015
- Course book electronically available at the University of Helsinki as pdf-files:
https://helsinki.primo.exlibrisgroup.com/permalink/358UOH_INST/qn0n39/cdi_askewsholts_vlebooks_9781316322437

Supplementary reading:

- C. F. Bohren & D. R. Huffman, *Absorption and Scattering of Light by Small Particles*, Wiley & Sons, 2010
 - Electronically available (single-user license) at the University of Helsinki:
<http://web.b.ebscohost.com.libproxy.helsinki.fi/ehost/detail/detail?vid=0&sid=0a5fb219-4f48-44c6-b012-7dc88d4b3ee5%40pdc-v-sessmgr02&bdata=JnNpdGU9ZWhvc3QtbGl2ZSdzY29wZT1zaXRI#AN=246658&db=nlebk>
- H. C. van de Hulst, *Light Scattering by Small Particles*, Wiley & Sons, 1957 (Dover, 1981)
- M. Minnaert, *The Nature of Light and Colour in the Open Air*, Dover, 1954 (Dover 2003)

Supplementary theory reading:

- M. I. Mishchenko, *Electromagnetic Scattering by Particles and Particle Groups, An Introduction*, Cambridge University Press, 2014
- M. I. Mishchenko, L. D. Travis, A. A. Lacis, *Multiple Scattering of Light by Particles: Radiative Transfer and Coherent Backscattering*, Cambridge University Press, 2006
- M. I. Mishchenko, L. D. Travis & A. A. Lacis, *Scattering, Absorption, and Emission of Light by Small Particles*, Cambridge University Press, 2002
- M. I. Mishchenko, J. W. Hovenier, & L. D. Travis, *Light Scattering by Nonspherical Particles*, Academic Press, 2000
- A. Doicu, Y. Eremin & T. Wriedt, *Acoustic & Electromagnetic Scattering Analysis Using Discrete Sources*, Academic Press, 2000
- J. D. Jackson, *Classical Electrodynamics*, Wiley & Sons, 1998

Lectures

The lectures ([Physicum, D116](#)) will offer an introduction to light scattering as well as to computational software. Guidance for exercises and projects available during lectures and exercise sessions.

- March 15, Introduction to photometry and polarimetry, 10-12, AV
- March 16, Introduction to spectrometry; Mercury, Venus, and Mars, 10-12, AV
- [March 22, The Moon, 10-12, KM](#)
- [March 23, Asteroids, 10-12, KM](#)
- March 29, Comets, 10-12, KM
- March 30, Interplanetary dust, 10-12, KM
- [April 5, Experiments and instrumentation, 10-12, AP](#)
- [April 13, Experiments and instrumentation, 10-12, AP](#)
- April 19, Icy moons of outer planets, Saturn's Rings, 10-12, KM
- April 20, Transneptunian objects and Centaurs, 12-14, KM
- [April 26, Interstellar polarization, 10-12, KM](#)
- [April 27, Exoplanets, 10-12, KM](#)
- May 3, Experiments and instrumentation, 10-12, AP
- May 4, Experiments and instrumentation, 10-12, AP

Exercises

The exercises are organized in [Physicum, D116](#)

- March 16, 12-14
 - Guidance for Exercise 1, answers due April 6
 - Guidance for projects
- March 23, 12-14
 - Guidance for Exercise 2, answers due April 13
 - Guidance for projects and Exercise 1
- March 30, 12-14
 - Guidance for Exercise 3, answers due April 20
 - Guidance for projects and Exercises 1 & 2
- [April 13, 12-14, Exercise 1](#)
 - Guidance for projects and Exercise 3
- [April 20, 12-14, Exercise 2](#)
 - Guidance for projects
- [April 27, 10-12, Exercise 3](#)
 - Guidance for projects
- May 4, 12-14
 - Guidance for projects

Projects

- Karri Muinonen, Antti Penttilä, Anne Virkki, Mikko Vuori:
Supervision
- (1) Ceres (taxonomic class C): Anne Keski-Vakkuri
- (419) Aurelia (F):
- (20) Massalia (S): Ari Leppälä
- (24) Themis (C): Iida Kostamo
- (55) Pandora (M):
- (44) Nysa (E):
- (64) Angelina (E):
- Mercury:
- Moon: Karri Muinonen