Astrophysical light scattering problems
PAP316, spring 2023, period 4, 5 cr

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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 5-12, 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=JnNpdGU9ZWhvc3QtbGl2ZSZzY29wZT1zaXRl#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