

Light and Color in Nature - Scattering Effects -

Seminar
WS 2003/04

Marcus Magnor

Overview

- **Last Lecture**
 - Interference
- **Today**
 - Light scattering
 - “Scientific Soft Skills”
- **Next Time**
 - On January 16: Presentations
 - Kunagy: Mirages
 - Benjamin & Martin: water rendering

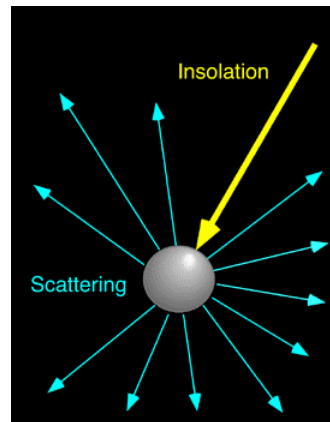
List of Topics

- Rainbow
 - **Stephan 6.2.**
- Water
 - **Jan-Christian 13.2., Dennis-Patrick 13.2, Benjamin-Martin 16.1.**
- Caustics
 - **Christian-Michael 13.2.**
- Mirages
 - **Kuangyu 16.1.**
- Jewelry
 - **Sabine 23.1.**
- Nebulae
 - **Andrei 6.2**

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Single Particle Scattering

- **Particle**
 - Spherical shape
 - Dielectric material
 - Little/no absorption
 - In air/vacuum
- **Light**
 - Parallel illumination
 - Monochromatic wave
 - Not polarized
- **How much radiance in what direction ?**
 - Far away from particle
 - Particle size
 - Refractive index
 - Illumination wavelength



<http://www.geog.ouc.bc.ca/physgeog/contents/7f.html>

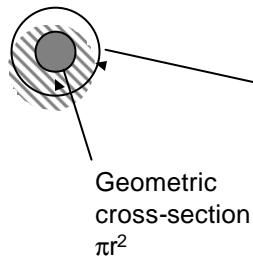
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Particle Size Matters

- **>> wavelength**
 - Ray optics
 - Shadow, reflection
 - No wavelength dependency
- **~ wavelength**
 - Mie scattering
 - Diffraction
 - Multiple dipole radiation
 - Weak wavelength dependency
- **<< wavelength**
 - Rayleigh scattering
 - Single dipole radiation
 - Strongly wavelength-dependent ($1/\lambda^4$)

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Scattering Theory: Extinction



Particle scattering is defined in terms of cross-sectional areas & efficiency factors

C_{ext} = effective area projected by the particle that determines extinction

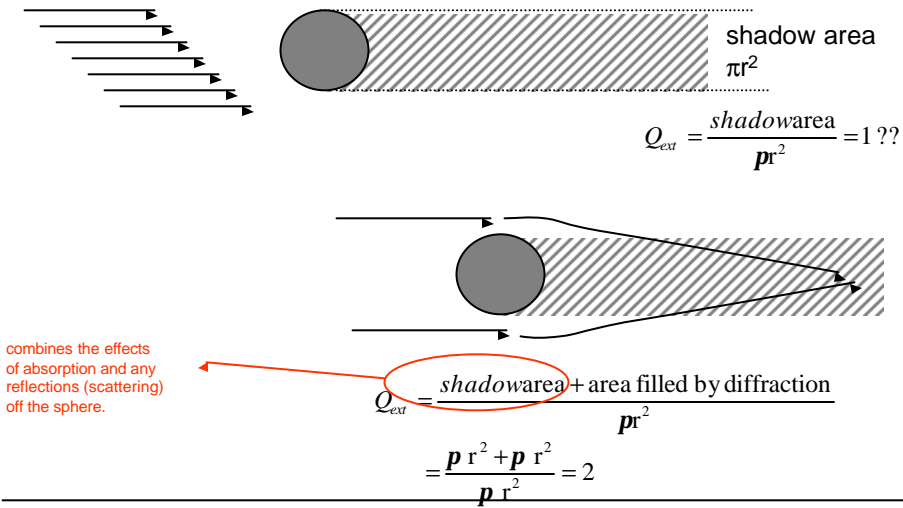
Similarly C_{sca} , C_{abs}

The efficiency factor then follows

$$Q_{ext,sca,abs} = \frac{C_{ext,sca,abs}}{\pi r^2}$$

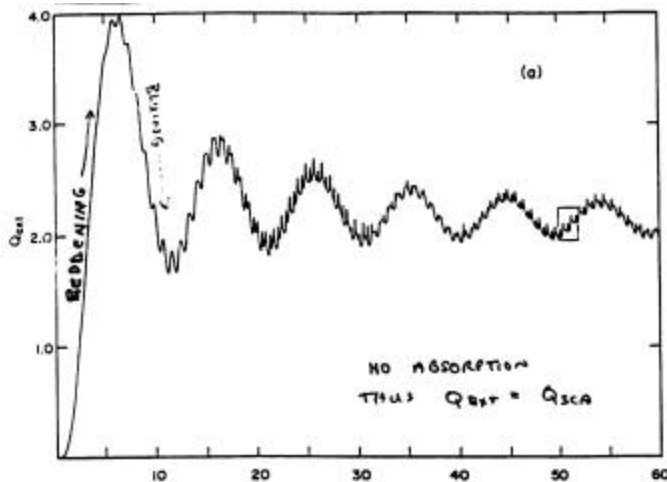
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Extinction Paradox



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Extinction, Poisson Spot

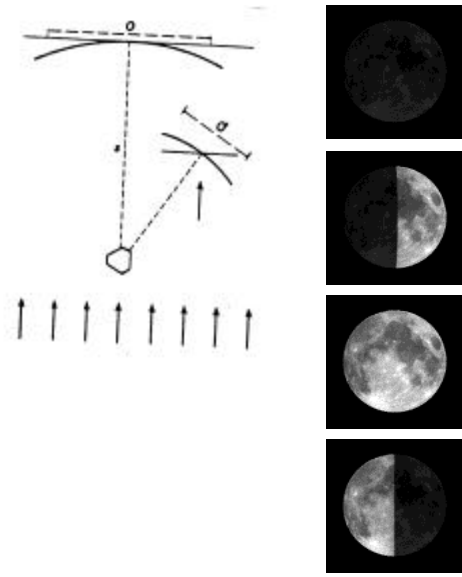


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The Phase Factor

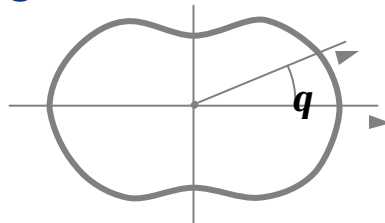
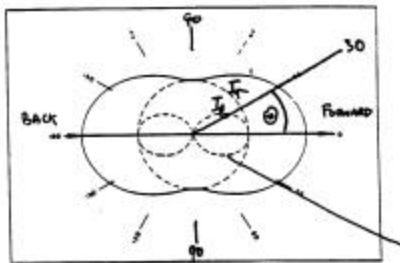
- Angle dependency of scattered intensity

$$I_{sca}(\Theta) = \frac{C_{sca} k^2}{4\pi} P(\Theta) I_0$$

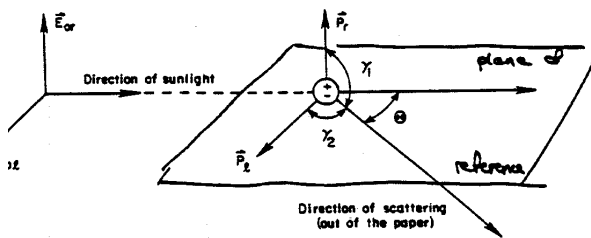
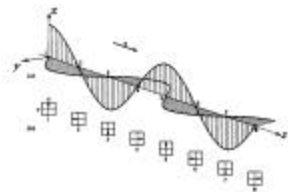


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Rayleigh Scattering



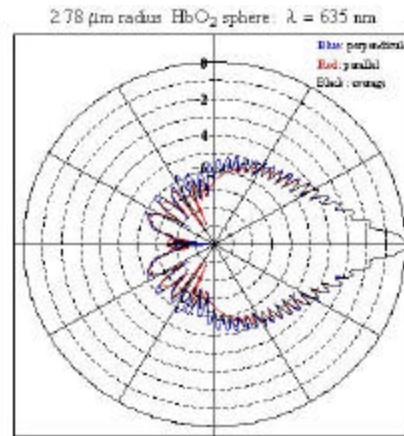
$$P_R(q) = \frac{3}{16\pi} (1 + \cos^2 q)$$



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Mie Scattering

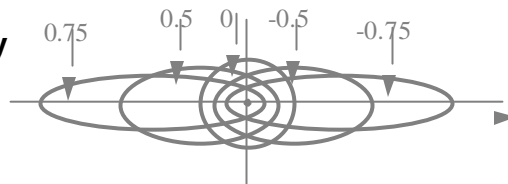
- **Anisotropic scattering**
 - Forward scattering
 - depends on relative particle size
- **Complex pattern**
 - Many lobes



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Henyey-Greenstein Approximation

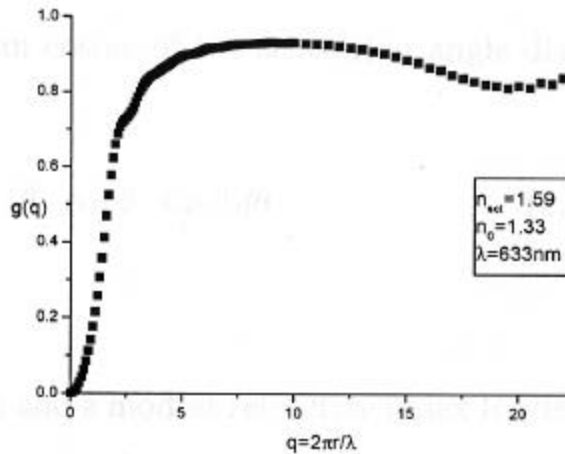
- **Approximation of true angle dependency**
- **Mean value for size ensemble**



$$P_{\text{HG}}(\mathbf{q}) = \frac{(1-g)^2}{4p(1+g^2-2g\cos(\mathbf{q}))^{3/2}}$$

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Phase Factor Example



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Multiple Scattering

- **3D radiative transfer, 3D rendering equation**
- **Astrophysics**
 - Radiation density inside stars
- **Nuclear physics**
 - Neutron density & velocity in reactor, nuclear bomb
- **Limit: Diffusion Theory**
 - Very many scattering events
 - Effective anisotropy
 - Analytic expression

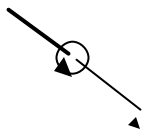
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Participating Media

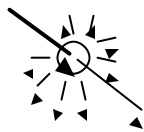


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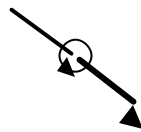
Atmospheric Scattering



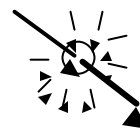
absorption



outscattering



emission



inscattering

$$dL = \left[-(\mathbf{s}_{abs} + \mathbf{s}_{sct}) \cdot L + L_{emit} + \frac{1}{4\mathbf{p}} \mathbf{s}_{sct} \int_0^{2\mathbf{p}} d\mathbf{j} \int_0^{\mathbf{p}} d\mathbf{J} \cdot L_{in}(\mathbf{J}, \mathbf{j}) \cdot P(\mathbf{J}) \cdot \sin \mathbf{J} \right] \cdot d\mathbf{l}$$

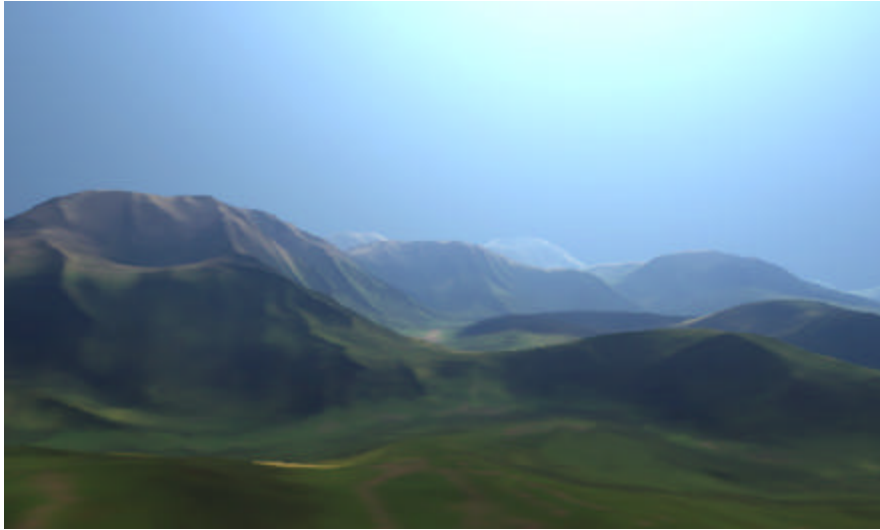
Absorption coefficient \mathbf{s}_{abs}

Scattering coefficient \mathbf{s}_{sct}

Phase function $P(\mathbf{J})$

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Rayleigh Scattering



Naty Hoffman, Arcot J Preetham

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Mie Scattering



Naty Hoffman, Arcot J Preetham

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From Dust to Dawn



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Soft Skills in Science

Preparations

- Reading a scientific paper
- Researching secondary literature

Talk Slides

- Structure

Presentation

- Keeping cool
- Self-presentation
- Timing
- Handling Questions

Scientific Paper

- LaTeX
- Structure
- Style (tense, narrator)

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Reading/Reviewing a Paper

- **Reading order**
 - Read the title: Is it comprehensible ?
 - Read the abstract: Does it make clear what is presented ?
 - If not: read the introduction
 - Read the conclusions: Does it explain what has been achieved ?
 - Read the results section
 - (Look over the bibliography: any important groups missing ?)
- **At this point, you should have a clear idea what this work is all about**
 - Go ahead and read about actual work

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Researching Secondary Literature

Source #1: The Internet

- **General scientific publications**
 - www.google.de
 - Extended search for pdf files only
 - citeseer.nj.nec.com/cs
 - From MPII computers: Web of Science
 - www.mpg.de/it/WoS/
- **Computer graphics**
 - Graphics.lcs.mit.edu/~fredo/book.html
 - www.cs.brown.edu/~tor

MPII, UoS Library

- www.mpi-sb.mpg.de/services/library/catalogues/catalogues.html
 - Journal articles
 - Older proceedings

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Talk Preparations

- **Make sure you understand what you are talking about**
- **No more than 1 slide per talk minute !**
 - For 20-minute talk, no more than 20 slides total !
- **Powerpoint presentation**
- **Structure**
 - Title slide: title, your name & affiliation, place, date
 - Motivation slides: teaser, show why this subject is interesting
 - Outline slide: structure of your talk (4-6 headings)
 - Scientific work slides
 - Results slides
 - Summary/conclusions slide
 - (Outlook slide)
- **“Tell people what you will tell them, then tell them, then you tell them what you have told them !”**
 - Repeat the most important phrases/ideas/results

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Talk Preparations

- **How to start**
 - Write key words on slides
 - Order key words as you want to present them
 - Create graphics/download images to make main ideas visually comprehensible
 - Position images above or right of text
 - Make figures/images large enough
 - Formulae: only the fundamental equations, if necessary
 - Give no lengthy derivation
 - Explain all symbols on same slide (figure)
 - Explain in words what can be directly read out of formula
 - Nothing ? Then leave out !
- **Font size: No smaller than 20 !**
- **Bullets per slide: No more than 4-5 big ones**
 - Include your key words in bullets, lets you hold your talk without additional material
 - Have somewhat more to say than just reading the bullets

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Giving your Talk

- **How to keep cool**
 - Know what you are talking about
 - Give the talk in front of the mirror once before
- **Some tricks/tips**
 - Have a glass of water available
 - Give yourself a break by taking a sip
 - Speak more slowly than you usually would
 - Hard, but you can try to remember
 - Intonation
 - Make an audible pause at the end of each sentence
 - Breathe deeply between sentences
 - Make short sentences
 - Don't use many uncommon words
 - Imagine you talk to a class of 10-year olds
 - Convey your excitement !
 - You want to advertise your work
 - Keep to the time limit !
 - Nothing is more annoying than a missed coffee break
 - Better be a couple of minutes short => restrict number of slides

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Giving your Talk

- **Clothes**
 - Wear comfortable clothes
 - No ties at computer graphics conferences ;-)
 - Dress as if you have to meet your future parents-in-law for the first time
- **Hands**
 - Have a pen in one hand
 - Put the other hand on the desk
 - Try not to have your hands in your pocket, especially not both hands
 - When pointing on your slides, use the mouse pointer
 - Laser pointer wobbles too much
- **Body**
 - Stand comfortably, lean on desk, move from one leg to the other
 - Look at your audience once in a while, don't have your eyes on your laptop all the time
 - Don't turn around to the screen to point to things (your backside facing your audience)

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Giving your Talk

- **Discussion and Questions**
 - If you don't understand the question, or you need to think about a good answer, ask the questioner kindly to repeat the question
 - If you think the question is stupid, answer to a (related) different question
 - People will assume you didn't understand the question but probably won't ask again
 - Answer at length: to questions to which you can (and want) to say something, take your time to elaborate
 - Killing time on nice questions leaves no time for unpleasant questions
 - Be well-tempered when answering
 - Even if you have the impression that the questioner wants to challenge you, keeping a friendly face will always give you the emotional advantage

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Writing a Scientific Publication

Goal: you want other scientists to cite your work

- **Conference Proceedings**
 - People will most likely read your paper only after your talk
 - Give an impressive talk
 - Without the presentation, no-one will notice your work
- **Journal Articles**
 - Not very common in computer graphics
 - People like travelling to conferences, have the money to do so
 - Progress too fast
 - Long delay between submission and publication
 - 1-2 years
 - Worth only in most prestigious journals
 - No researcher has the time to look over more than 1-2 journals every month

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Anatomy of a Scientific Paper

- **Title**
- **Abstract**
- **Introduction**
 - Motivation
 - Paper outline
- **Related Work**
 - Previous fundamental work, important groups in the field
 - Make clear:
 - How does your work fit in ? Relate to other work
 - how does your work improve previous state-of-the-art ?
- **(Scientific Main Part: Theory, System)**
- **Results**
 - Convincing
 - Advertise
- **Discussion/Conclusions/Future Work**
 - Repeat briefly what has been presented
 - Mention weaknesses of your work by describing what you will be working on next
- **Bibliography**
 - Be generous
 - Cite important people in the field (might be your reviewers !)

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Writing

- **Style**
 - Don't use first person (I did ...), rather use plural (we did ...), or
 - Keep to passive (it was found ...)
 - Keep to present tense
 - Keep consistently either to American or British spelling
 - To find similar words, use a thesaurus
- **How to overcome writer's block**
 - Don't be stressed when writing, writing is a creative task
 - Relax
 - Think about what you want to write when you do something else
 - Drink a glass of wine while writing the first draft
 - ...

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LaTeX

- **LaTeX Cookbook**
 - English
 - www.starlink.rl.ac.uk/cgi-bin/htxserver/sc9.htx/sc9.html
 - German
 - www.uni-giessen.de/hrz/tex/cookbook/cookbook.html
- **Style file**
 - www.cs.kuleuven.ac.de/~graphics/EGSR2003/data/egsr2003_latex.zip
 - Eurographics Symposium on Rendering (EGSR) style file
 - www.cs.kuleuven.ac.de/~graphics/EGSR2003/data/egsrSample.pdf
 - Example pdf document
- **German/English – English/German**
 - <http://dict.leo.org>

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Book Tips

- **14 Ways to Say Nothing with Scientific Visualization**
 - www.seismo.unr.edu/ftp/vis/14ways.pdf
- **Effective Scientific Electronic Publishing**
 - www.cl.cam.ac.uk/~mgk25/publ-tips.html
- **Scientific Career**
 - “A Ph.D. is not enough”, Feibelman 1994, 15.24 Euro
- **Rhetoric**
 - “Classical Rhetoric for the Modern Student”, Corbett, Connors 1998 49.49 Euro
 - “Die Macht der Rhetorik”, Braun 2002, 15.90 Euro
- **Thesaurus**
 - “The Oxford Paperback Thesaurus”, Waite 2001, 12.90 Euro
 - “Sag es treffender”, Textor, Morell 2002, 20.40 Euro

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Wrap-Up

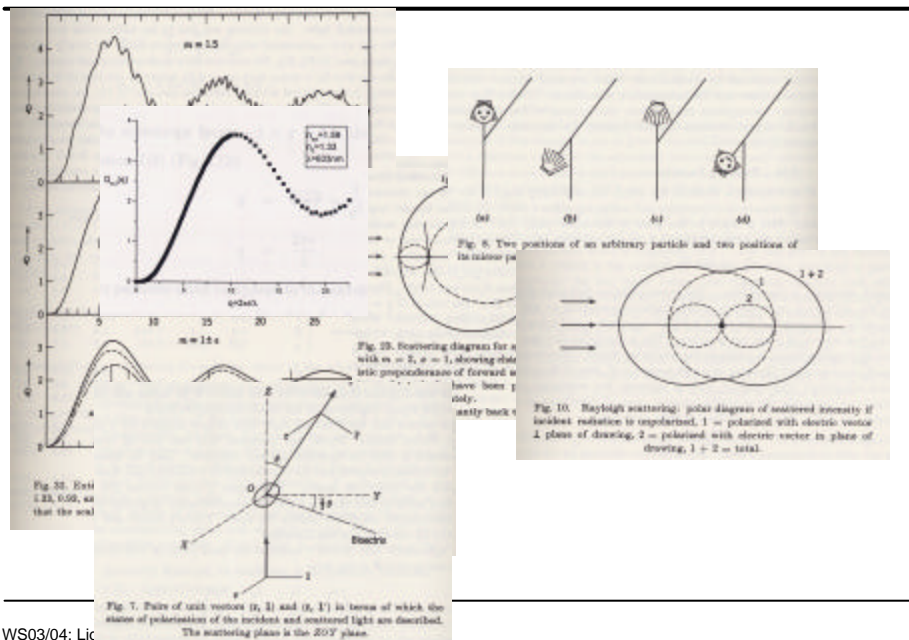
Scattering

- depends on relative size of particle size to wavelength
 - size \sim / $<$ wavelength: strongly wavelength-dependent
- Multiple scattering: radiative transfer theory
 - in general, no analytic solution

Next time

- January 16
- Presentations

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