

Yield Stress Fluids in Immiscible Two Phase Flow

ANDREAS A. HENNIG

VEILEDERE:

ALEX HANEN, NTNU

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FEDERICO LANZA, NTNU/UNIVERSITÉ PARIS SACLAY

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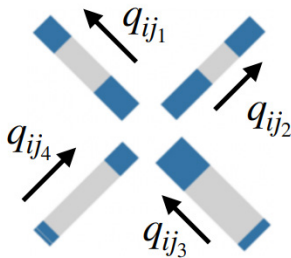
ALBERTO ROSSO, UNIVERSITÉ PARIS SACLAY



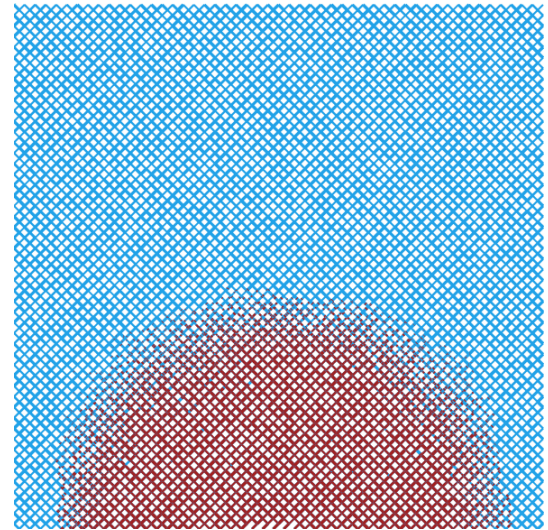
PoreLab
NTNU-UiO Porous Media Laboratory

Porøse medier

- Darcys lov – utfordringer med porøse medier
- Forventer 3 ulike fenomener for Newtonsk væske – kapillære og viskøse krefter dominerer
- Pore-Nettverksmodell



$$q = \frac{\kappa}{\mu} \frac{\Delta P}{L}$$



Ikkenevtonske væsker

- Bingham-væsker: Majones, oreokrem og... katter?
- System med koblede, ikkelineære ligninger – løses med ALM
- Kan utvides til indeks-fluider

On the rheology of cats

M.A. Fardin^{1,2,3,*}

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(Draft: July 9, 2014)

In this letter I highlight some of the recent developments around the rheology of *Felis catus*, with special applications for other species of the feline family. In the linear rheology regime many cats can enter the determination of the characteristic time of rate from surface effects to yield run. In the nonlinear rheology regime flow instabilities can emerge. Nonetheless, the flow rate, both in the small-dimensional control parameter, can be hard to compute because cats are active ecological materials.

Everything flows! This famous aphorism terence Hitchens¹ thought is also the motto: Everything flows and nothing stays fixed.² A recipe for is actually from Simplicius and Plato. Eu-? Well, it depends on the definition of a caty general, there is no doubt that there one to the rule! What is a flow? What is called out from the start for better, the of rheology is to recognize that states of matter of time). The first time, is a time T . What is true today may not be true in over time, one day 10, the next 10, the popular distinction between states of en made based on qualitative differences. Solid is the state in which matter ord volume and shape, liquid is the state or maintain a fixed volume but adapts to a container; and gas is the state in which

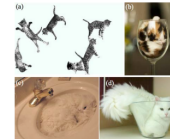


FIG. 1: (a) A cat appears as a solid material with a conical test shape rotating and bouncing. (b) Silly Putty on a

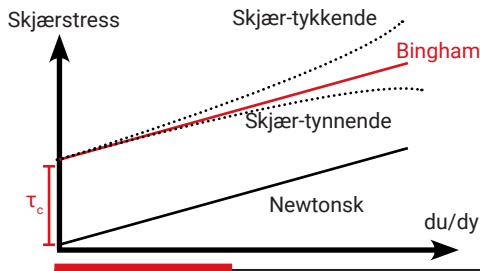
II. UNDERSTANDING SHEAR STRESS AND STRAIN IN SANDWICH COOKIE FLOW

In laboratory rheometry, a sample fluid is typically placed between two coaxial parallel disks. The lower disk is held fixed while the upper disk is rotated at a constant rotation rate Ω . This creates a wall-driven laminar (Cassie) flow with internal tangential velocity ranging linearly in height from $v = 0$ at the fixed lower disk to $v = r\Omega$ at the upper disk, where r is the radial position from the center of the disk [Figs. 2(a)-2(c)], and z is the height above the stationary lower disk. The velocity field in the fluid is, thus,²⁷

$$v_\theta(r, z) = \frac{\Omega r z}{H}. \quad (1)$$

For sandwich cookies, the analogy is apparent: the wafers are the parallel plates, and the creme is the fluid in between. When one wafer is fixed and the other is rotated, the central cylindrical disk of creme deforms until failure. Through analogy to this parallel plate setup, we calculate the material-level descriptors (shear stress, shear rate, and shear strain) for twisting Oreos, based on measured and applied quantities (torque and angular displacement). The shear rate $\dot{\gamma}$ arising from the rotation rate Ω with creme height H will be

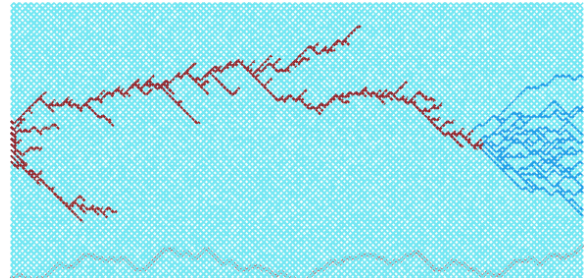
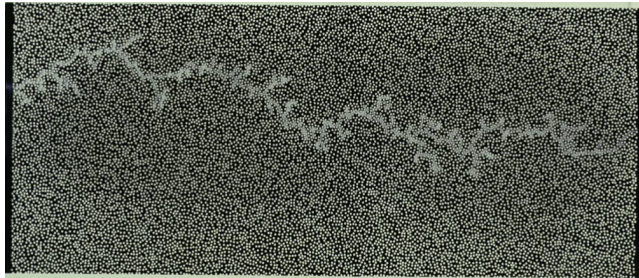
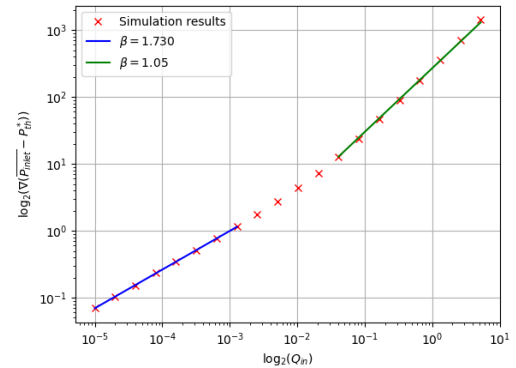
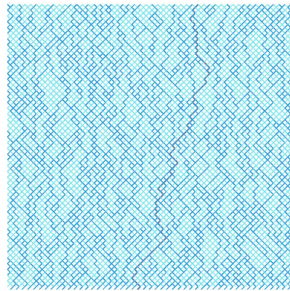
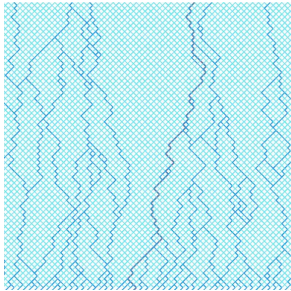
$$\dot{\gamma}_m = \frac{\partial v_\theta}{\partial r} = \frac{\Omega r}{H}, \quad (2)$$



Strømning i ett rør

$$q_{ij} = \begin{cases} \sigma_{ij} \left(\Delta p_{ij} + p_\gamma - \tau_{ij} \right) & \text{if } |\Delta p_{ij} + p_\gamma| > \tau_{ij} \\ 0 & \text{if } |\Delta p_{ij} + p_\gamma| \leq \tau_{ij} \end{cases}$$

Resultater og videre arbeid



Økt strømning

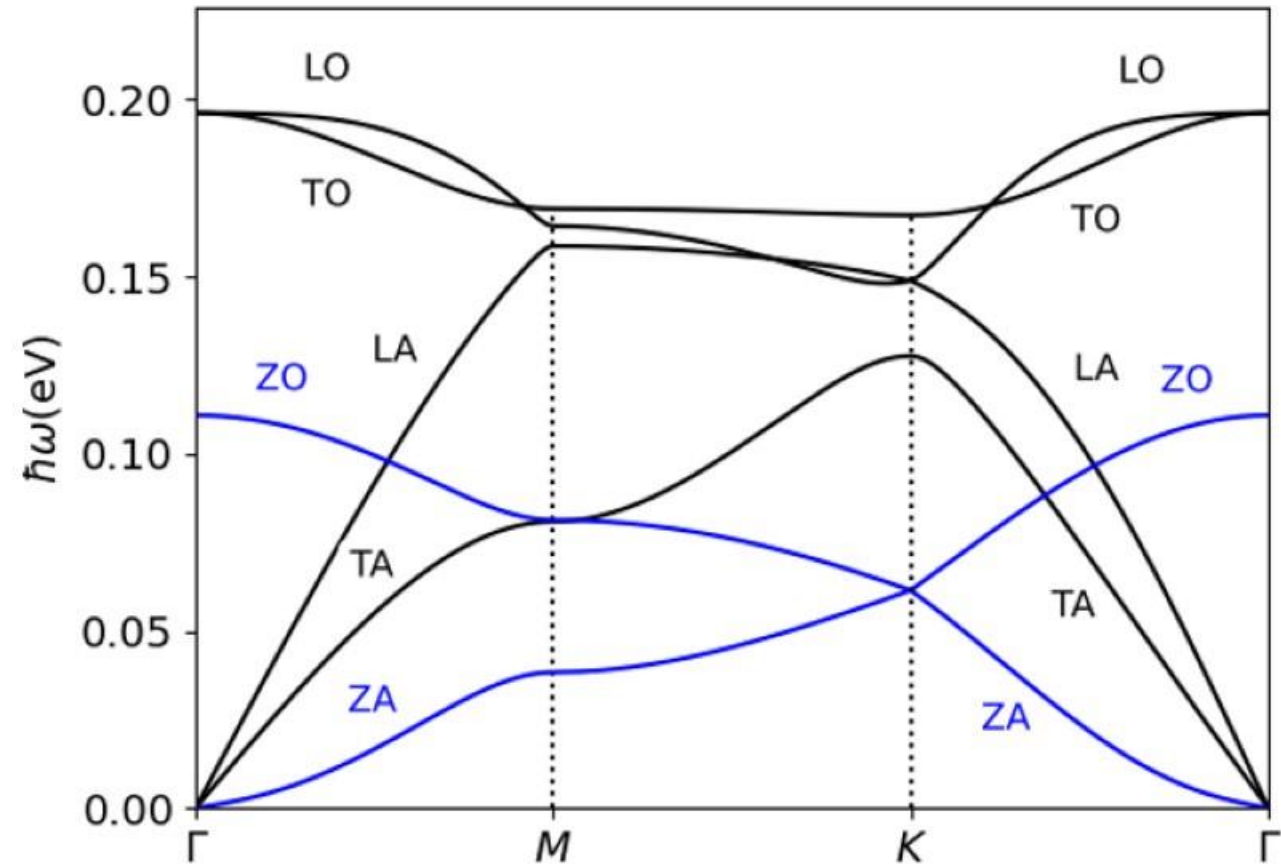
Magnon-fonon interaksjoner i ikke-likevekt

Jostein Kløgetvedt

Veileder; Alireza Qaiumzadeh

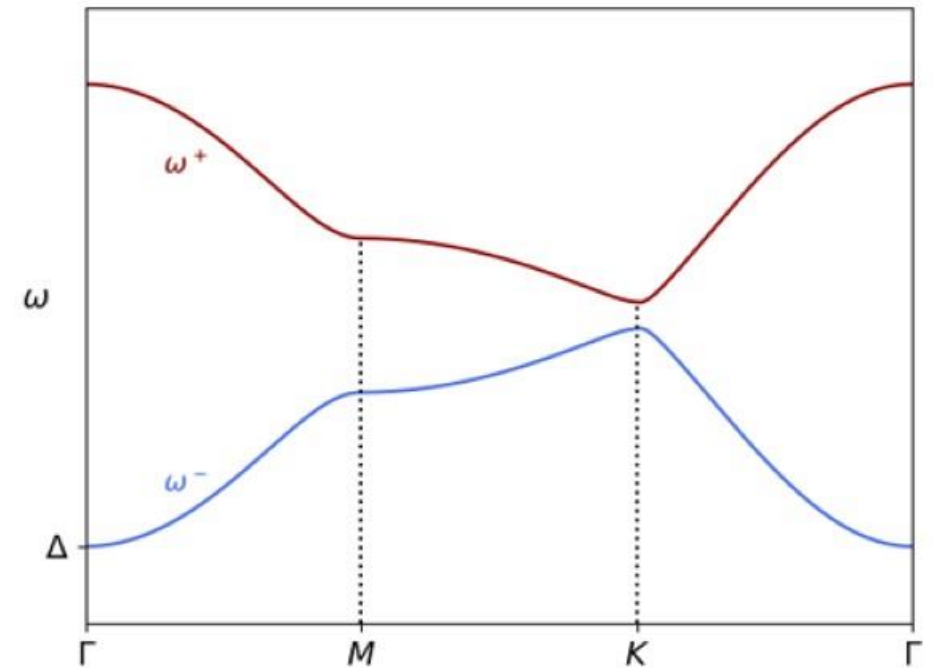
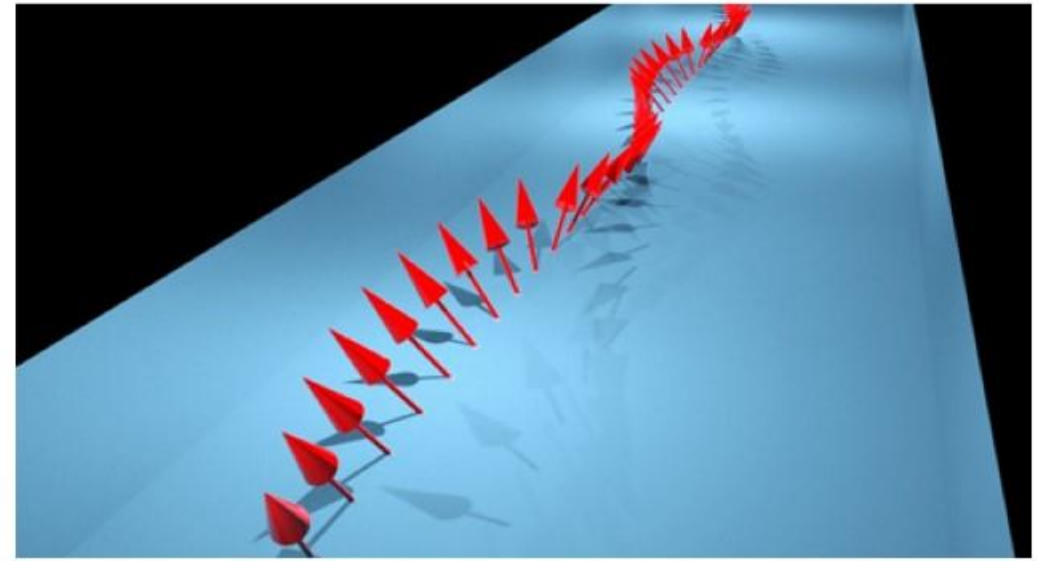
Fononer

- Kvantisert, kollektiv eksitasjon av vibrasjoner i et fast stoff
- Mikroskopisk modell
- Figur; Energispekteret i en heksagonal krystall



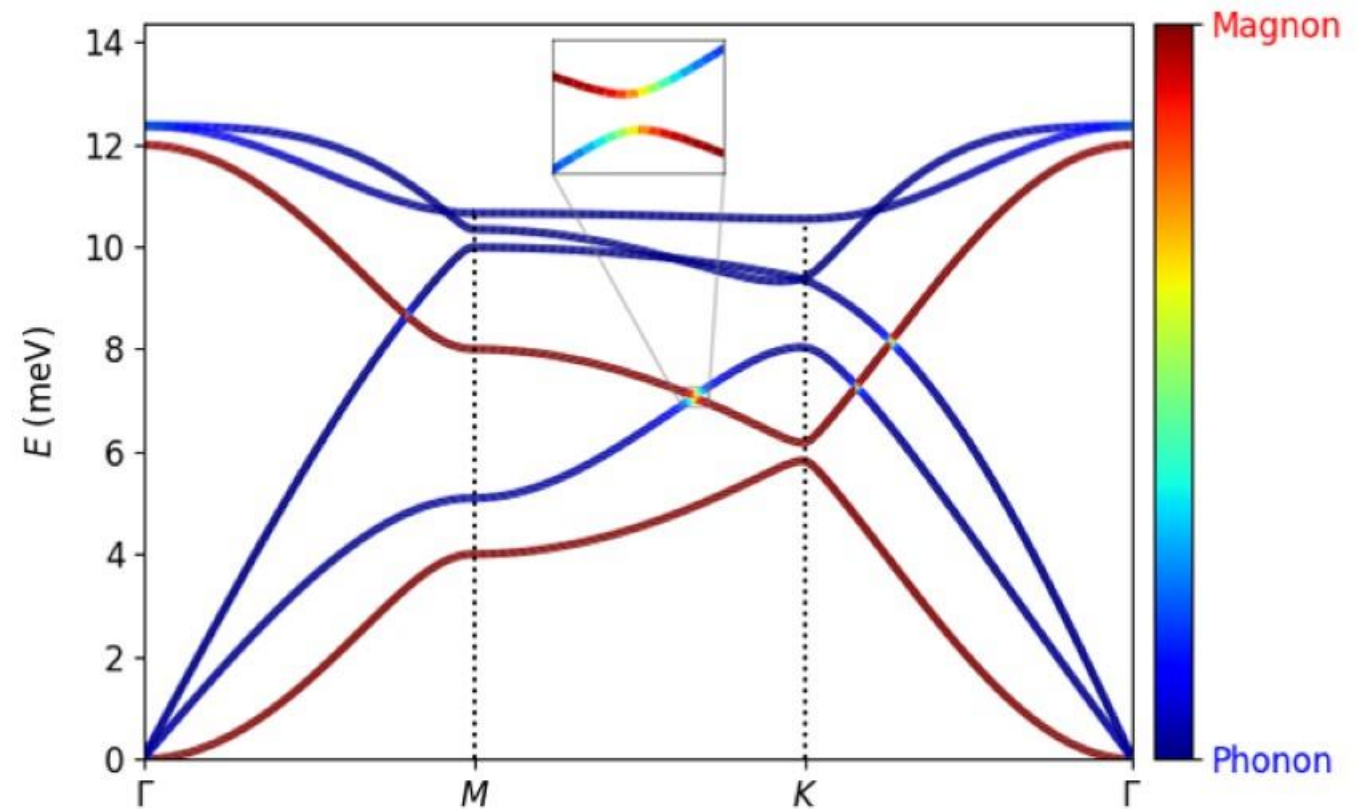
Spinnbølge

- Avvik i magnetiseringen i et materiale
- Magnon; kvantemekaniske beskrivelsen av en spinnbølge
- Figur; Energispekteret i en heksagonal krystall



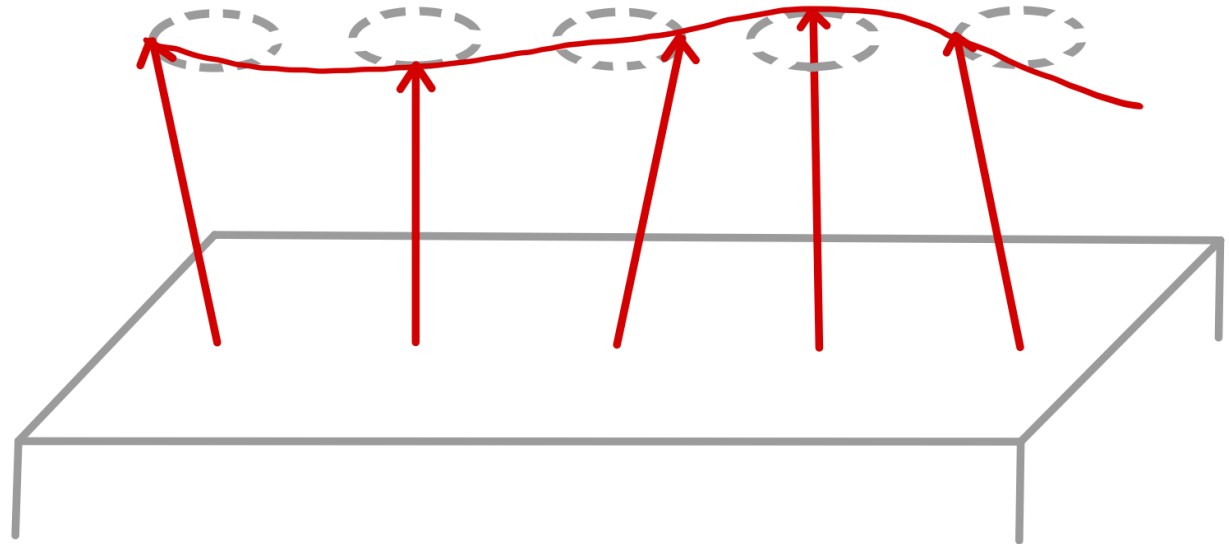
Interaksjoner

- Hybridisering og spredning (scattering)
- Hybridisering $\rightarrow$ ny kvasipartikkel



Bose-Einstein kondensasjon av magnoner

Anne Louise Kristoffersen



Partikkel BEK

- Kald gass
- Individuelle bølgefunksjoner $\rightarrow$ makroskopisk bølgefunksjon



Magnon-BEK i ferromagnetiske isolatorer

- Prosjektoppgave
- Heisenberg

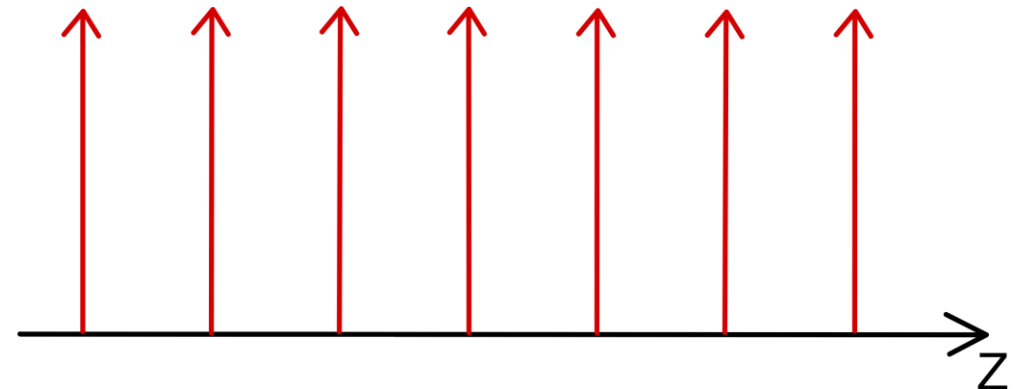
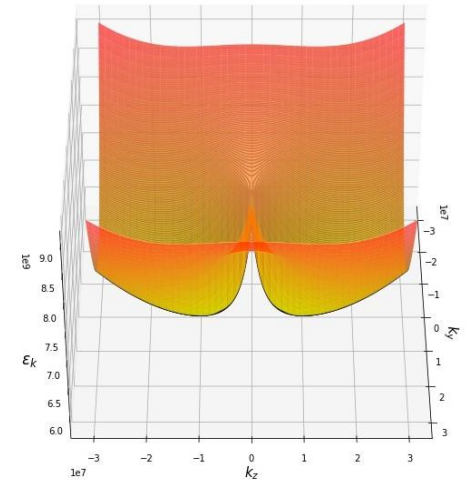
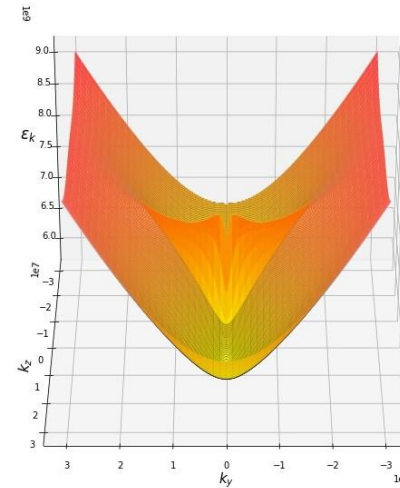
$$H_H = -J \sum_{ij} \vec{S}_i \cdot \vec{S}_j$$

- Zeeman

$$H_{Zee} = \sum_i h S_i^z$$

- Dipol

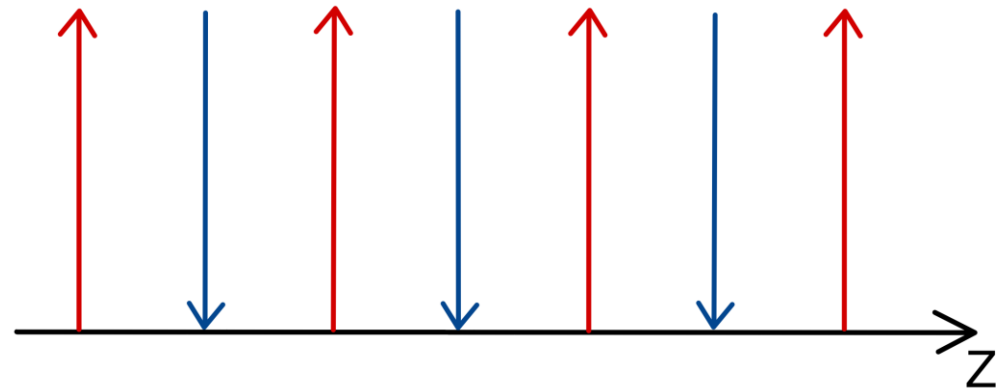
$$H_{dip} = \sum_{ij} \sum_{\alpha\beta} D_{ij}^{\alpha\beta} S_i^\alpha S_j^\beta$$



Magnon-BEK i antiferromagnetiske isolatorer

- Masteroppgave
- Dzyaloshinskii-Moriya

$$H_{DMI} = -\sum_{ij} \mathbf{D}_{ij} \cdot (\vec{S}_i \times \vec{S}_j)$$



Study of Strongly correlated Kane-Mele-Hubbard Model by Schwinger Boson Formalism

Supervisor: Dr. Alireza Quaiumzadeh

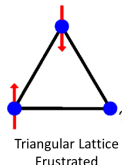
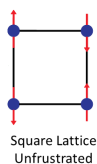
Jesper Lind-Olsen

Norges Teknisk-Naturvitenskapelige Universitet
Institutt for Fysikk
Center for Quantum Spintronics

Thursday 1st December, 2022

Background and Theory

- Model known to support the quantum spin liquid phase
- Interesting from a theoretical point of view and for applications
- Ground state exhibits gapped excitations and topological order
- Topological phases $\longrightarrow$ within quantum computing and quantum information
- Methods: Bosonization of a spin Hamiltonian and Schwinger boson mean field theory

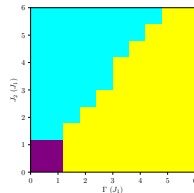
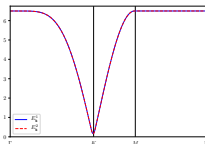
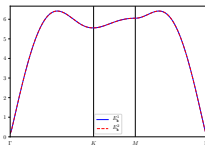
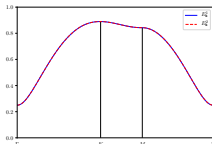


$$\hat{H} \sim \sum_{ij} \mathbf{s}_i \cdot \mathbf{s}_j$$

$$\rightarrow \sum_{ij} \sum_{\alpha\beta\gamma\kappa} \hat{b}_{i\alpha}^\dagger \hat{b}_{i\beta} (\sigma_{\alpha\beta} \cdot \sigma_{\gamma\kappa}) \hat{b}_{j\gamma}^\dagger \hat{b}_{j\kappa}$$

My project - preliminary results

- Extension of work done by Fosstveit
- Focus on learning mathematical methods $\rightarrow$ results will hopefully follow in the masters thesis



Summary and Outlook

- The model I considered proved it self too difficult for the time constraints
- For the master thesis - Try to solve this problem
- End goal: Predict measurable transport properties in the QSL phase
- Due to the topological nature, transport such as spin-Hall and thermal Hall are non-trivial in a QSL
- Use these to distinguish between QSL and magnetic phases

Magnon-medierte interaksjoner mellom elektroner i en multi-bånd modell

Prosjektoppgave Desember 2022,

Sara Abnar med veileder Asle Sudbø for QuSpin

NM/FMI heterostruktur

- Lave temperature

- Elektroner ved

Fermi nivå



- Magnoner



- Interaksjoner

- Cooper-par

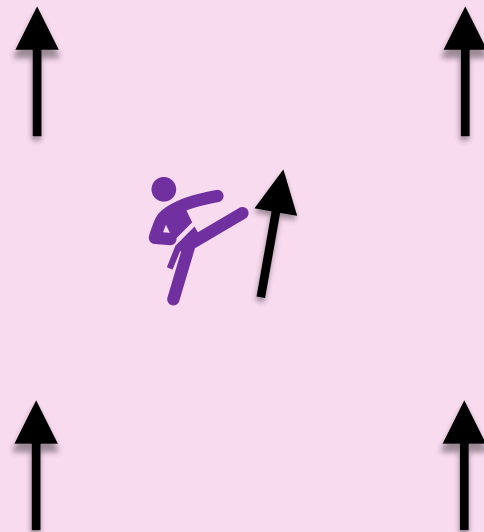


- Superleder

Vanlig metal (NM)



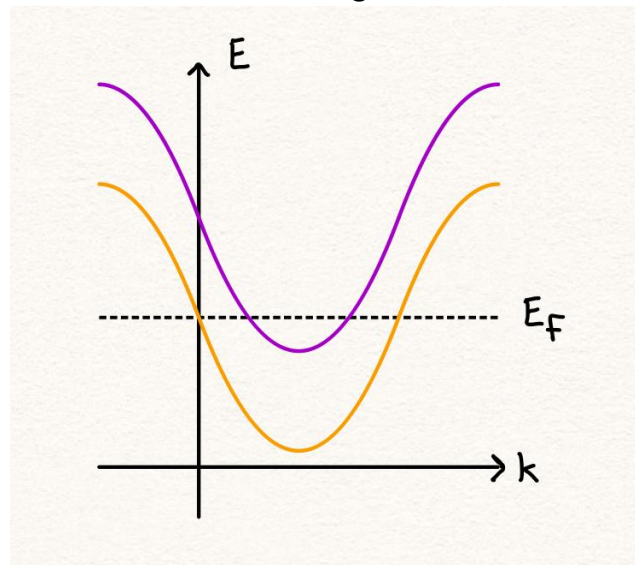
Ferromagnetisk insulator (FMI)



Multi-bånd tilfellet

- Flere Fermi nivå
- Bedre superledning?
 - Større strøm?
 - Høyere temperaturer?

Enkelt to-bands diagram



Ladningstetthetsbølger

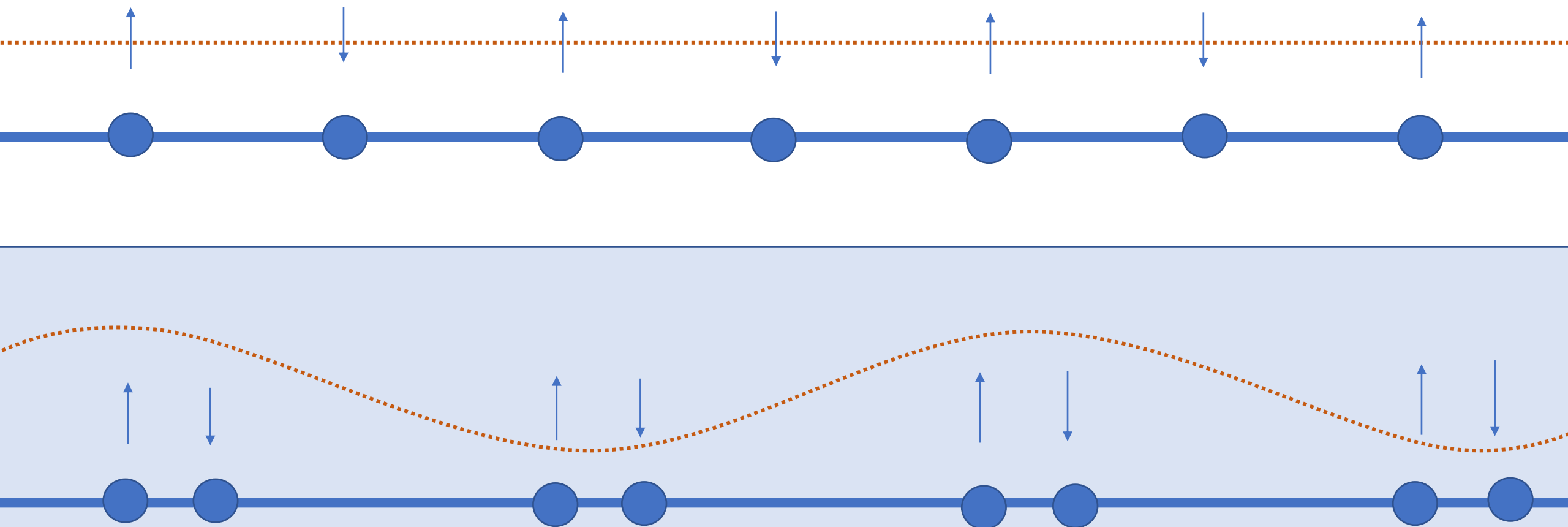
Marthe og Stine

Ladningstetthetsbølge

vs

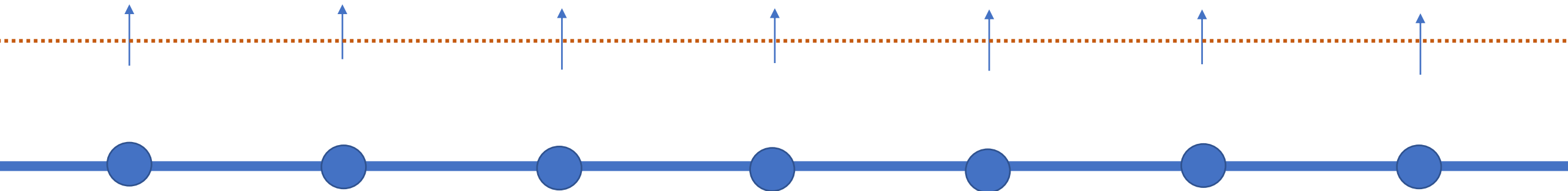
Superledning

Fonon-elektron interaksjoner

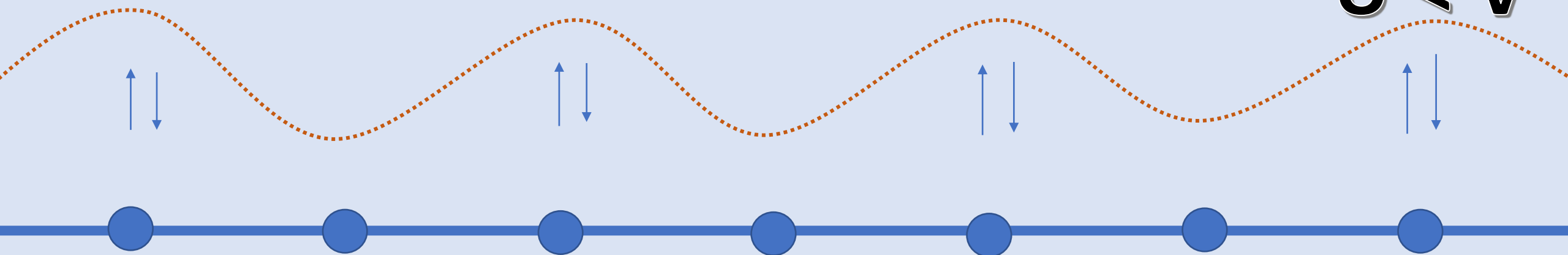


Elektron-elektron interaksjoner

$$U > V$$



$$U < V$$



A Functional Integral Approach to Magnetism and Superconductivity

Sondre Duna Lundemo

Supervisor: Asle Sudbø

December 1, 2022



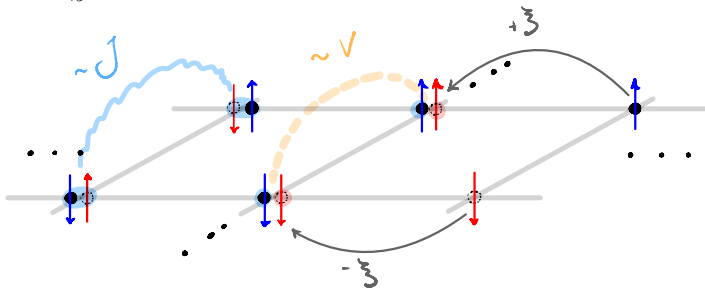
Ginzburg-Landau Theory for itinerant ferromagnetism and superconductivity

Model:

$$\mathcal{S}[\bar{\psi}, \psi] = \int_x \sum_{\sigma} \bar{\psi}_{\sigma}(x) [\partial_{\tau} + \xi(-i\nabla)] \psi_{\sigma}(x) \quad (\text{Free electrons})$$

$$- \int_{x,y} \bar{\psi}_{\uparrow}(x) \bar{\psi}_{\downarrow}(y) V(x-y) \psi_{\downarrow}(y) \psi_{\uparrow}(x) \quad (\text{Spin singlet SC})$$

$$- \int_{x,y} J(x-y) \mathbf{S}(x) \cdot \mathbf{S}(y). \quad (\text{Ferromagnetic exchange})$$



Ginzburg-Landau Theory for itinerant ferromagnetism and superconductivity

Free energy functional

$$\beta F = \text{---}\bullet\text{---} + \text{---}\bigcirc\text{---} + \frac{1}{2} \text{---}\square\text{---} + \dots \quad (\text{Superconductivity})$$

$$+ \text{~}\bullet\text{~} + \text{~}\bigcirc\text{~} + \frac{1}{2} \text{~}\square\text{~} + \dots \quad (\text{Magnetism})$$

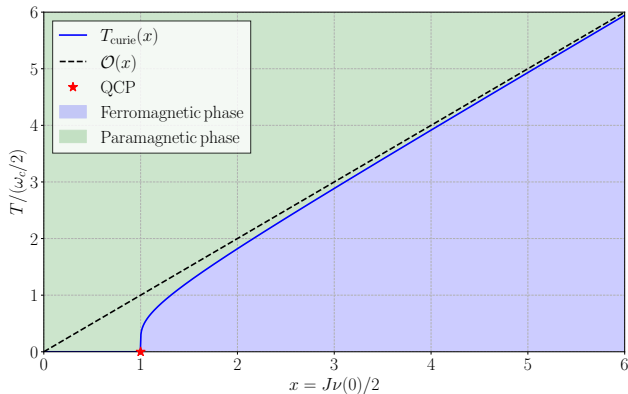
$$+ \text{~}\triangle\text{~} + \frac{1}{2} \text{~}\square\text{~} + \text{~}\square\text{~} + \dots \quad (\text{Coexistence})$$

Assorted results

Studying the particle-hole bubble  yields the critical temperature

$$T_{\text{curie}} = \frac{\omega_c}{2} \left(\text{artanh} \left(\frac{2}{J\nu(0)} \right) \right)^{-1},$$

and the phase-diagram:



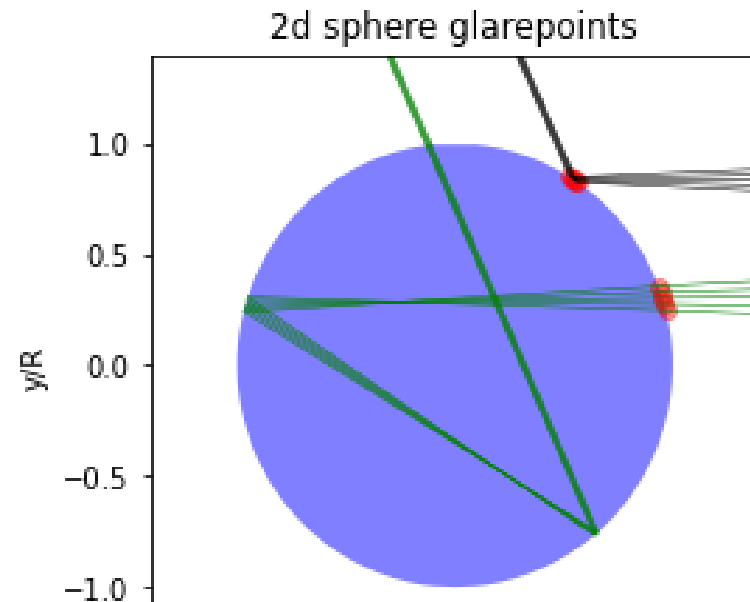
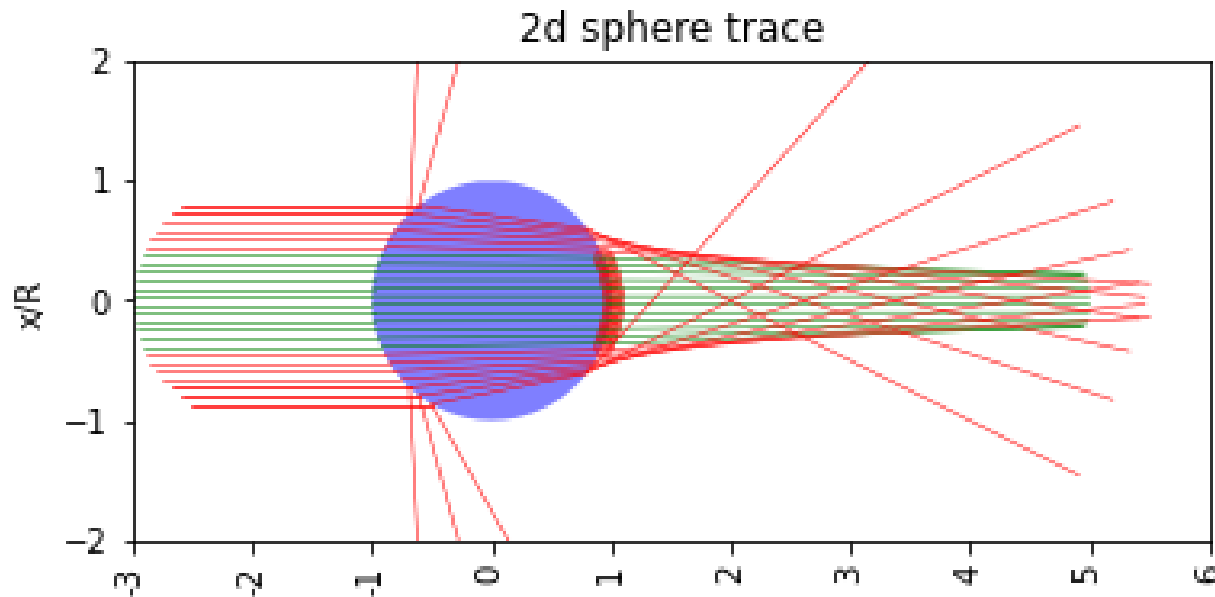
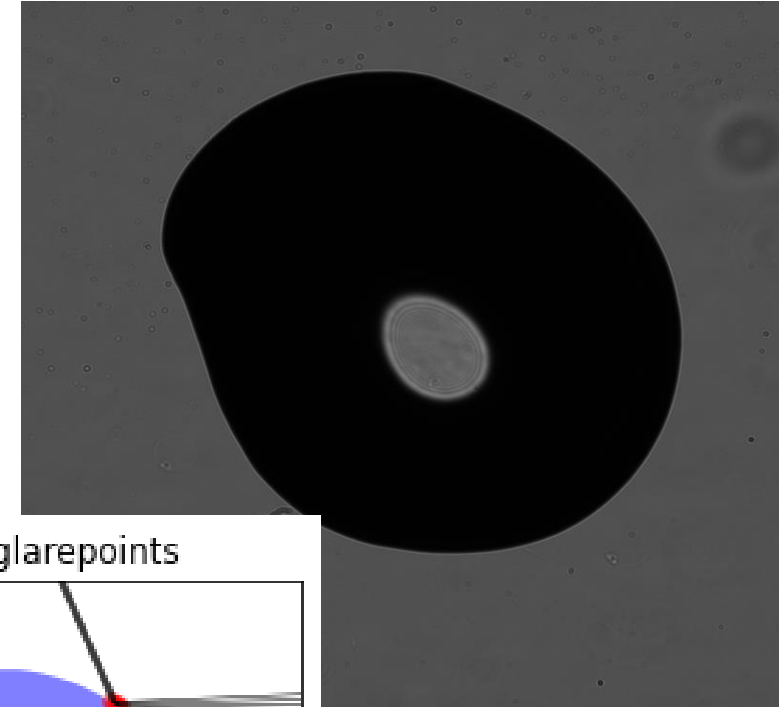
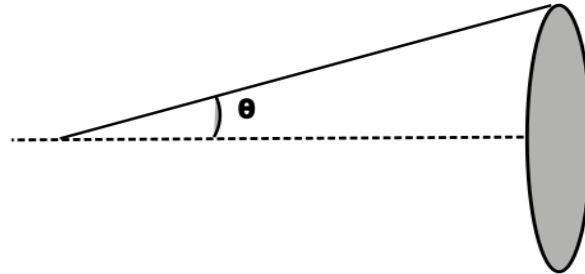
Calculation of droplet glare points

Intensity maxima when a liquid droplet is illuminated and viewed from a certain direction.

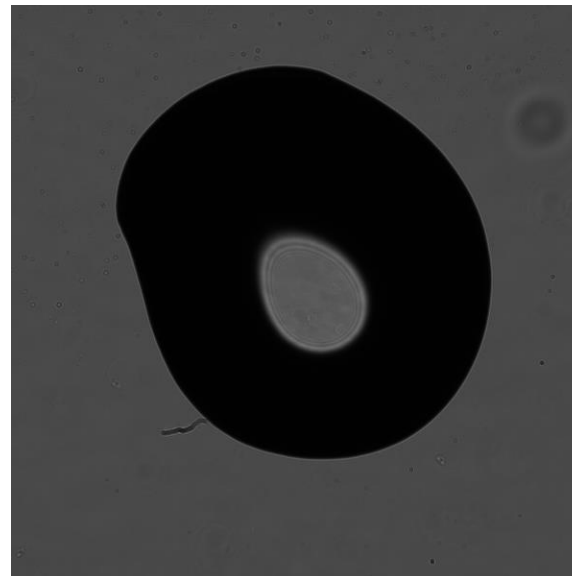
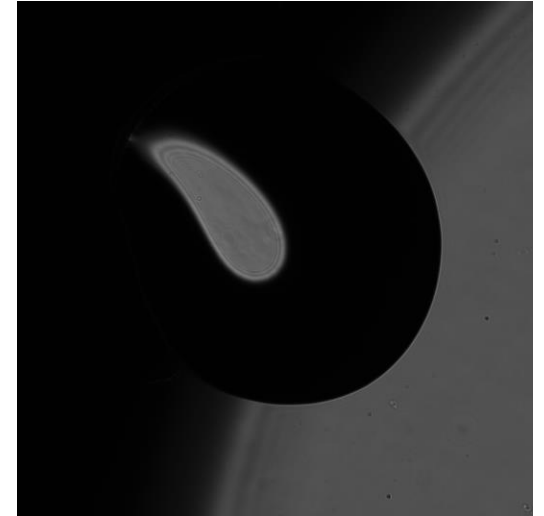
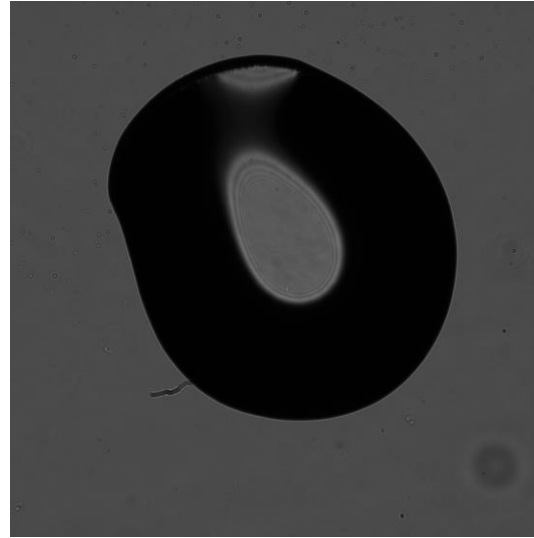
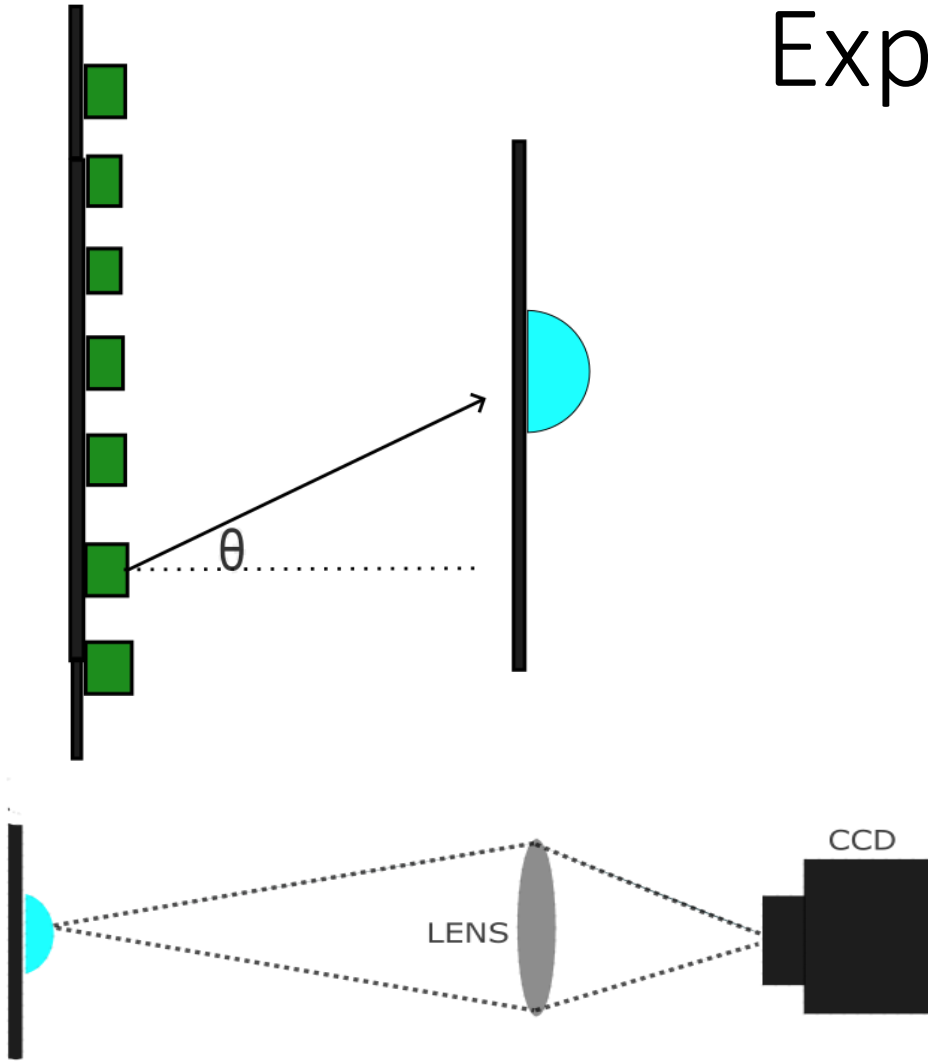
Glare points are then the exit points of the rays.

The NA of the objective defines accept angle of the exiting rays.

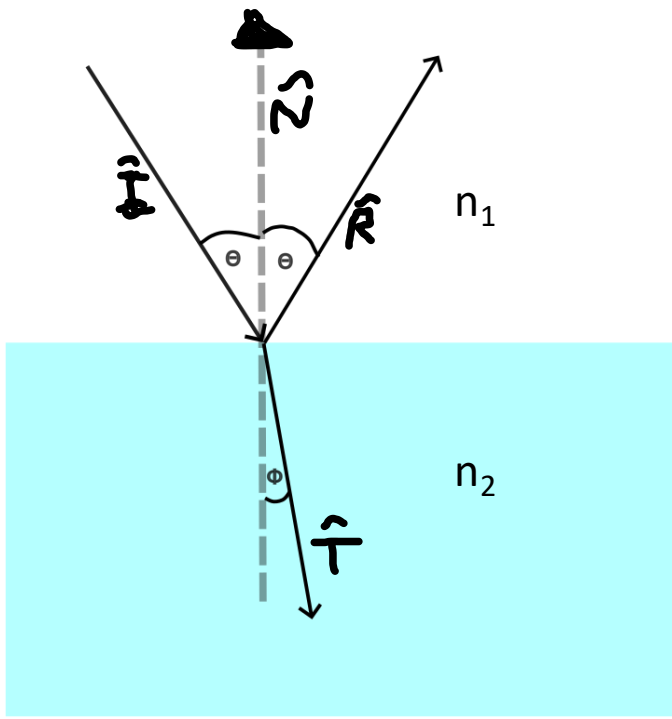
$$NA = n \sin \theta_{\max}$$



Experimental images



Ray tracing



$$\theta_i = \theta_r$$

$$n_1 \sin \theta = n_2 \sin \Phi$$

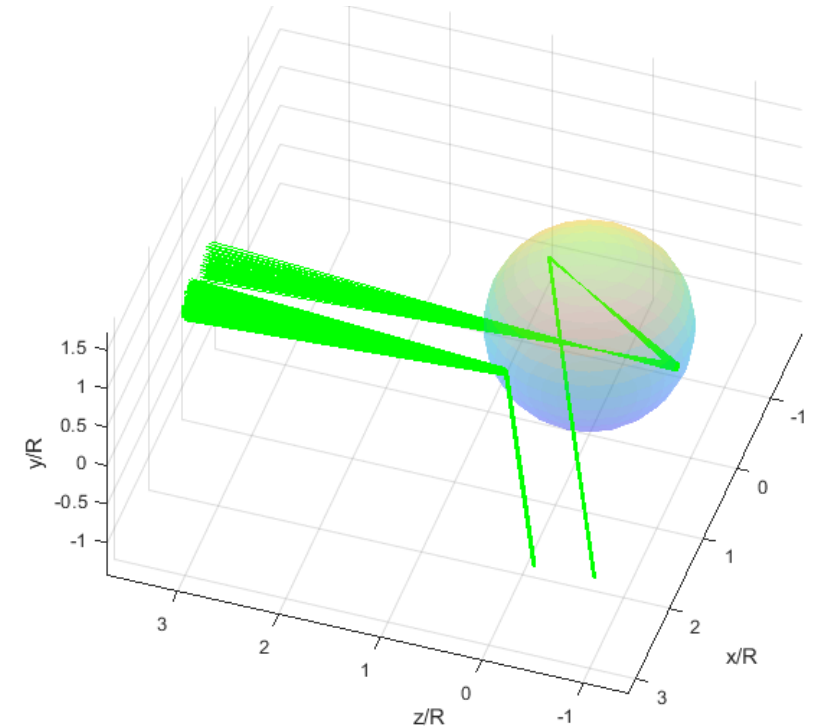
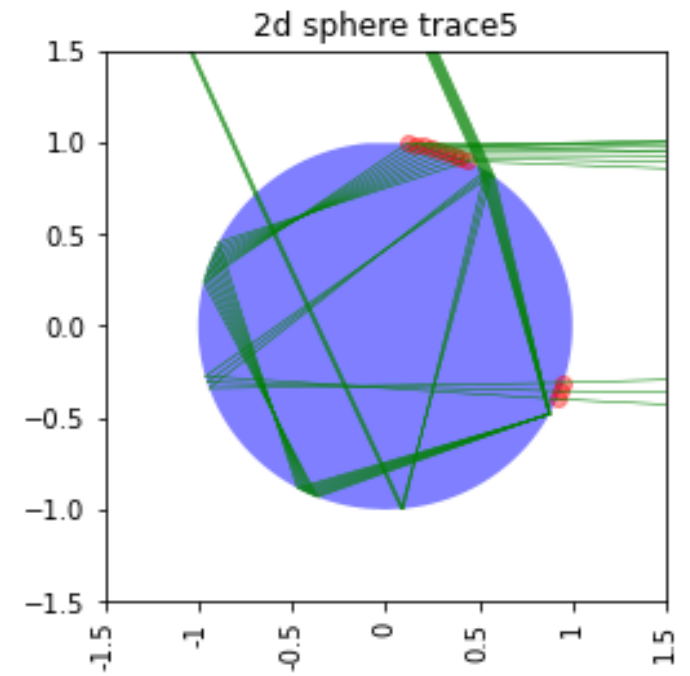
$$\hat{\mathbf{T}} = \alpha \hat{\mathbf{I}} + \beta \hat{\mathbf{N}}.$$

and one finds that $\alpha = (n_1/n_2)$, $\beta = (n_1/n_2) \cos(\theta_i) - \sqrt{1 - (n_1/n_2)^2 \sin^2(\theta_i)}$.

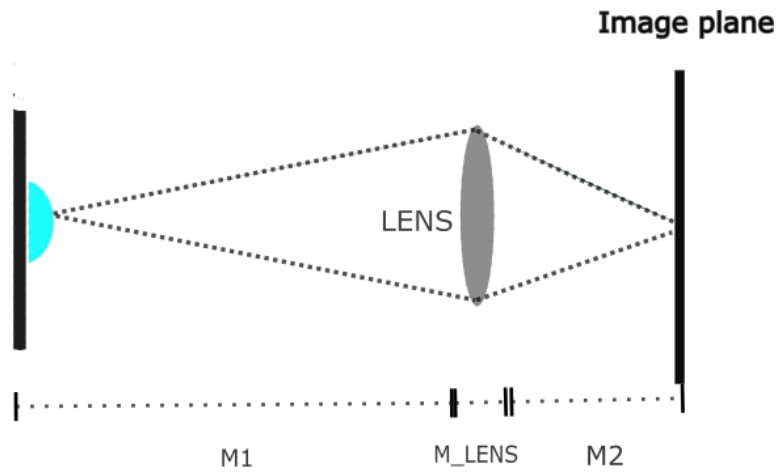
Similarly we write

$$\hat{\mathbf{R}} = \gamma \hat{\mathbf{I}} + \sigma \hat{\mathbf{N}}$$

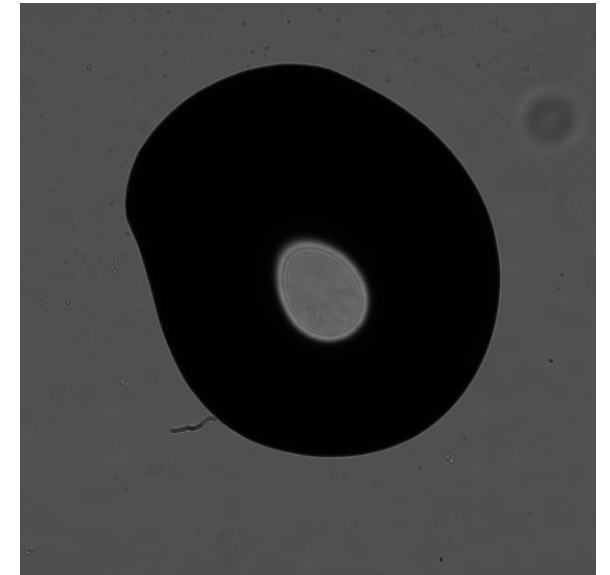
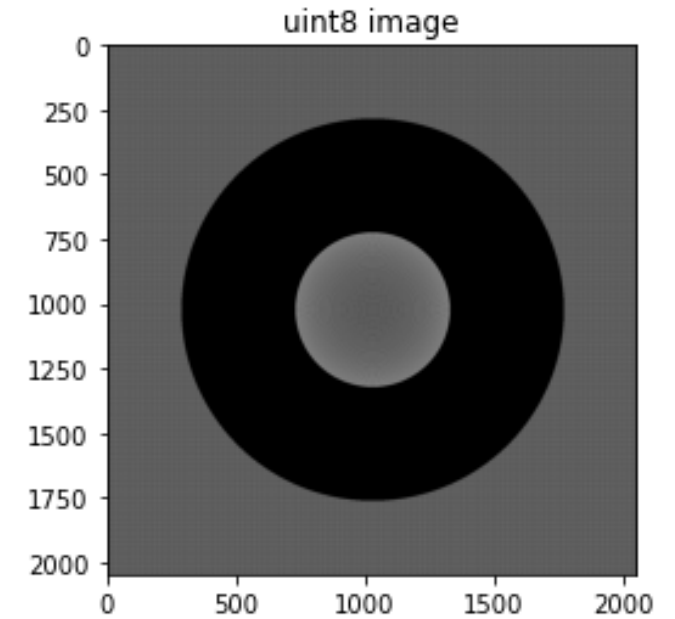
with coefficient values $\gamma = 1$, $\sigma = -2(\hat{\mathbf{I}} \cdot \hat{\mathbf{N}})$.



Simulated imaging



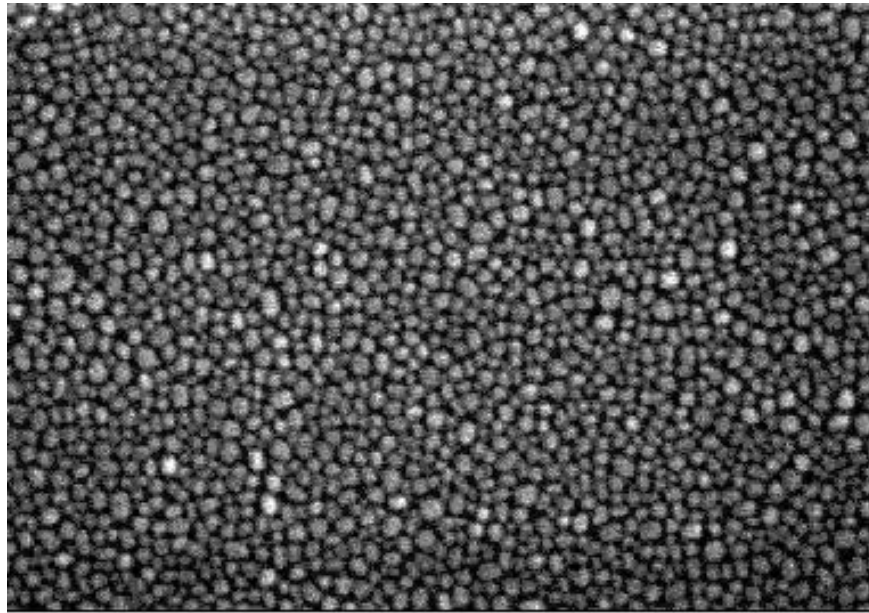
$$M_{\text{system}} = M_3 M_{\text{lens}} M_1 = \begin{bmatrix} 1 & z_2 \\ 0 & 1 \end{bmatrix} \begin{bmatrix} 1 & 0 \\ -\frac{1}{f} & 1 \end{bmatrix} \begin{bmatrix} 1 & z_1 \\ 0 & 1 \end{bmatrix} = \begin{bmatrix} 1 - \frac{z_2}{f} & z_1 + z_2 - \frac{z_1 z_2}{f} \\ -\frac{1}{f} & 1 - \frac{z_1}{f} \end{bmatrix}$$



BEM simulations of the optical response of metallic island films on dielectric substrates

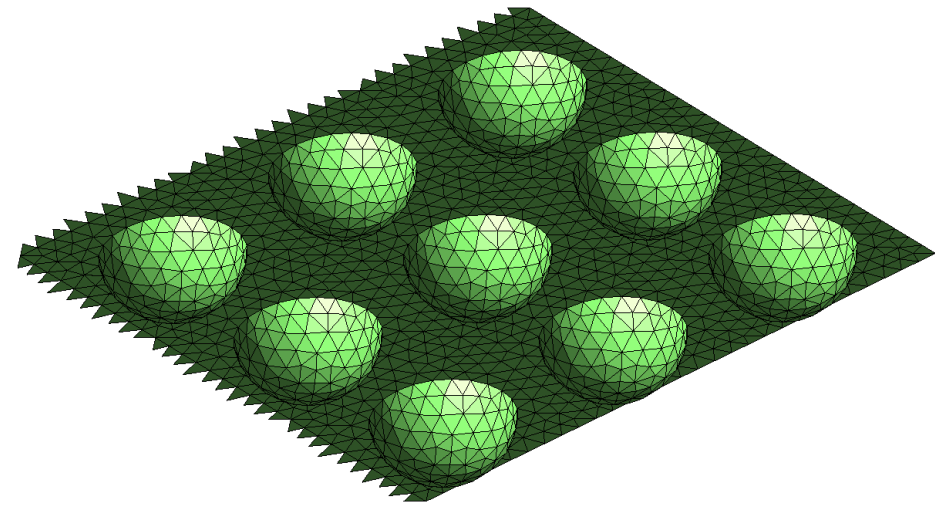
Tarjei Naadland Holo

System of interest: metallic island film on dielectric substrate



200 nm

From: I. Simonsen, R. Lazzari, J. Jupille, and S. Roux, *Numerical modeling of the optical response of supported metallic particles*, Phys. Rev. B 61, 7722 (2000)



z
x
y

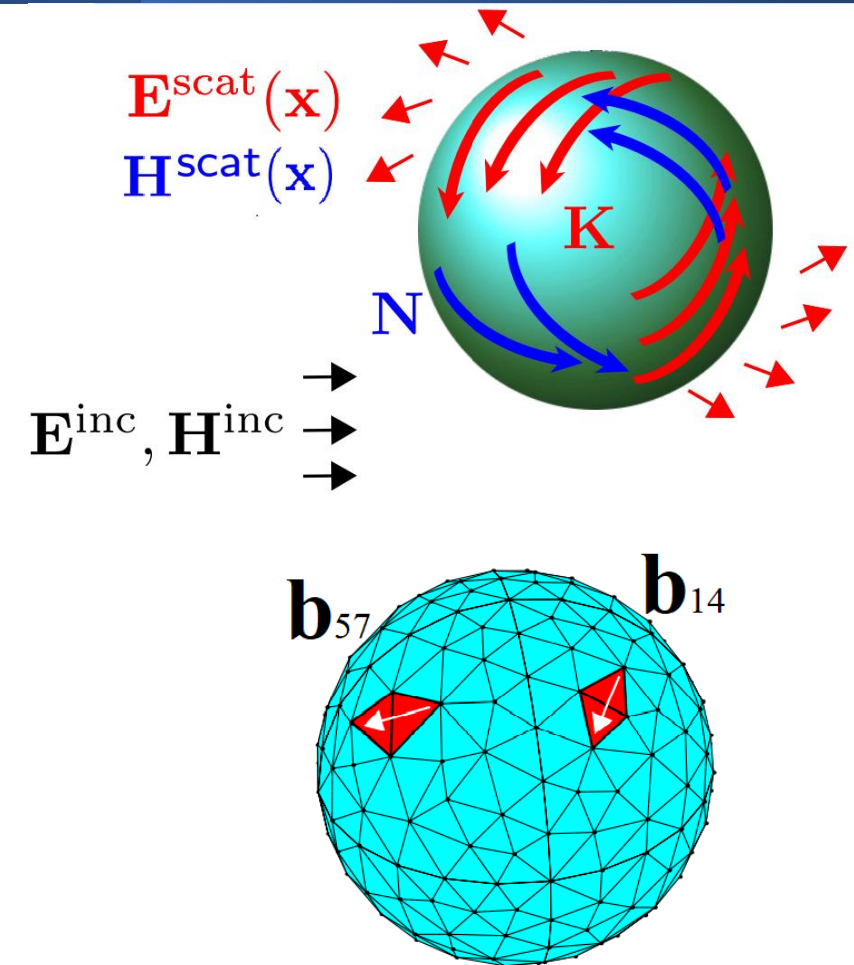
Boundary element approach to electrodynamics

$$\begin{pmatrix} \vec{E}(\vec{x}) \\ \vec{H}(\vec{x}) \end{pmatrix}_{\parallel}^{\text{scat}} = \left[\int_S \begin{pmatrix} \mathbf{G}^{\text{EE}}(\vec{x}, \vec{x}') & \mathbf{G}^{\text{EM}}(\vec{x}, \vec{x}') \\ \mathbf{G}^{\text{ME}}(\vec{x}, \vec{x}') & \mathbf{G}^{\text{MM}}(\vec{x}, \vec{x}') \end{pmatrix} \cdot \begin{pmatrix} \vec{K}(\vec{x}') \\ \vec{N}(\vec{x}') \end{pmatrix} d\vec{x}' \right]_{\parallel} = - \begin{pmatrix} \vec{E}(\vec{x}) \\ \vec{H}(\vec{x}) \end{pmatrix}_{\parallel}^{\text{i}}$$

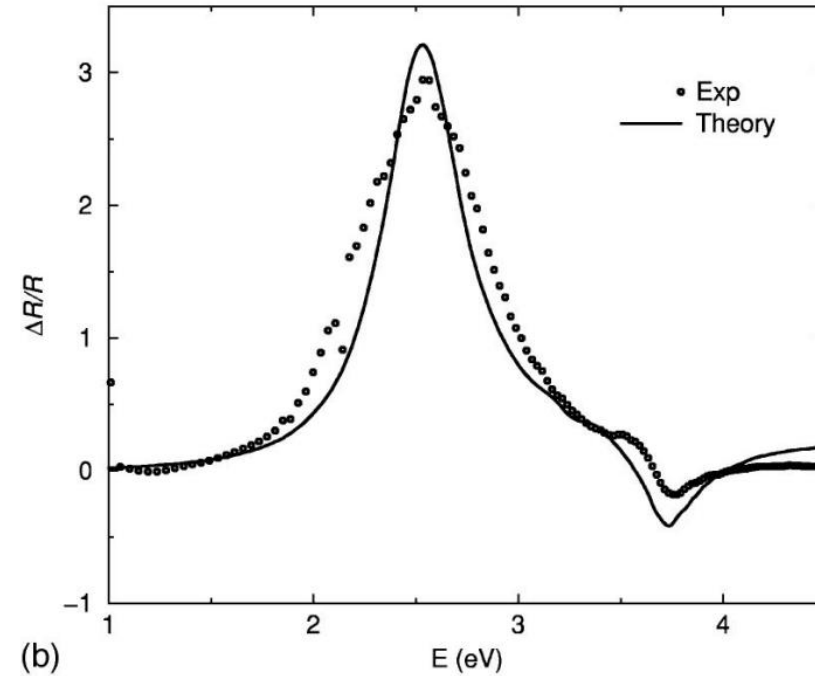
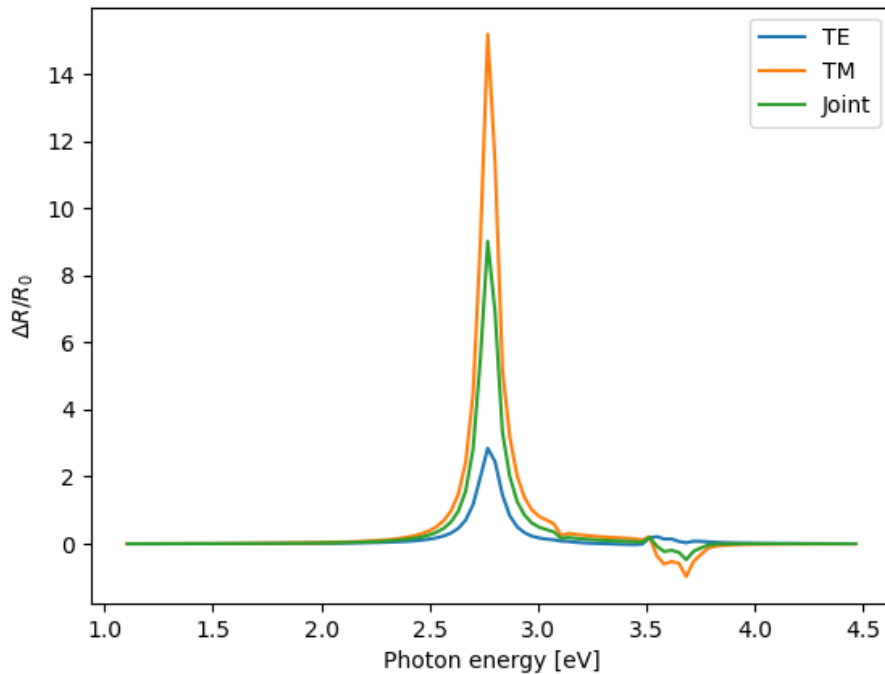
$$\begin{pmatrix} \vec{K}(\vec{x}) \\ \vec{N}(\vec{x}) \end{pmatrix} = \sum_{\alpha} \begin{pmatrix} k_{\alpha} \\ n_{\alpha} \end{pmatrix} \vec{b}_{\alpha}(\vec{x})$$

$$\mathbf{M} \vec{k} = \vec{v}$$

Linear system!!



Results: Ag on MgO



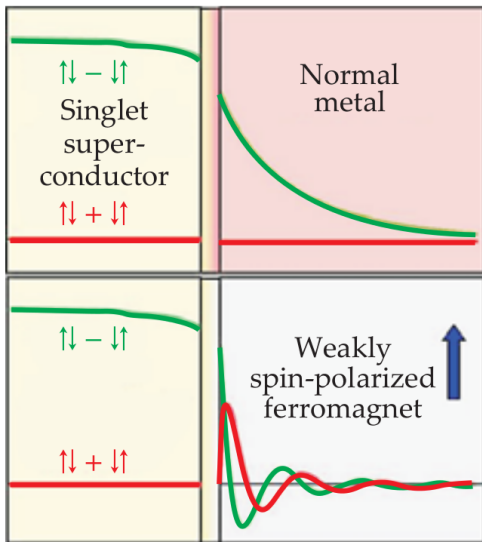
From: I. Simonsen, R. Lazzari, J. Jupille, and S. Roux, *Numerical modeling of the optical response of supported metallic particles*, Phys. Rev. B 61, 7722 (2000)

- Peak and valley due to localised surface plasmon resonances
- Different peak positions: not yet implemented size effects
- Different magnitudes: ????

Supercurrent-induced proximity effects at spin-orbit coupled interfaces

Sigrid Aunsmo
Veileder: Jacob Linder

Teori



Proximity effect

Singlett Cooper par:

$$|\uparrow\downarrow\rangle - |\downarrow\downarrow\rangle$$

Triplet Cooper par

$$|\uparrow\uparrow\rangle$$

$$|\uparrow\downarrow\rangle + |\downarrow\uparrow\rangle$$

$$|\downarrow\downarrow\rangle$$

Kvasiklassisk approksimasjon

Spin strøm og spin-bane koblende grensesjikt

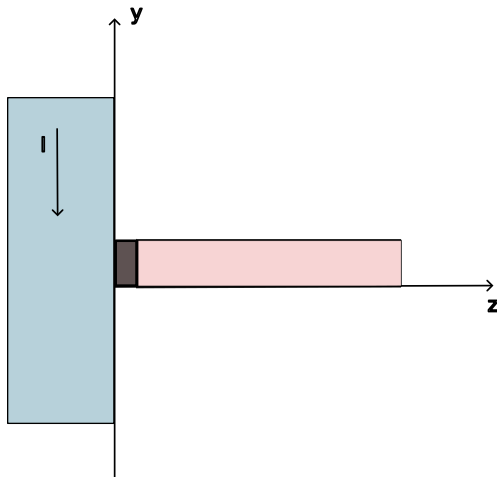
Venstre siden:

superledende spinstrøm

$$|\uparrow\uparrow\rangle e^{iJy} + |\downarrow\downarrow\rangle e^{-iJy}$$

Høyre siden:

både tripletter og singlett



Oppsummert

- Superledning kan lekke gjennom til andre materialer.
- Singlett-triplett miksing i grensesjikt mellom superleder og ferromagnet
- Min oppgave - superlednede spinstrøm grensende til normal metal

Ikke-likevekts virvler i superledende strukturer

Veileder: Jacob Linder, biveileder: Jabir Ali Ouassou

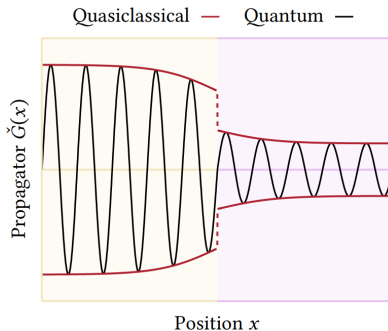
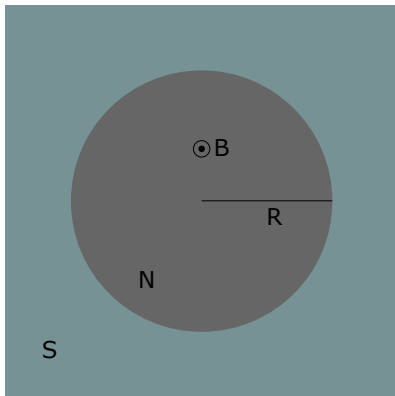
Håvard Falch

Norges Teknisk-Naturvitenskaplige Universitet
Institutt for Fysikk Center for Quantum Spintronics



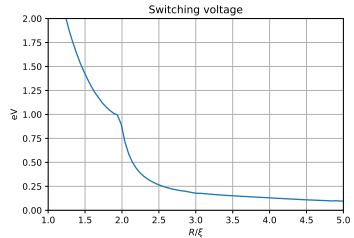
Superledere og proximity effekt

- Null resistans og ekspulsjon av magnetfelt
- Superledende egenskaper lekker til vanlig metall
- Kvasiklassisk approksimasjon: $\check{\mathbf{g}}(\mathbf{r}, \hat{\mathbf{p}}_F, \epsilon, t) = \int d\xi_p \check{\mathbf{G}}(\mathbf{r}, \mathbf{p}, \epsilon, t)$
- Usadel likningen: $-D\tilde{\nabla} \cdot (\check{\mathbf{g}}\tilde{\nabla}\check{\mathbf{g}}) = i[\check{\mathbf{\Sigma}}, \check{\mathbf{g}}] -$

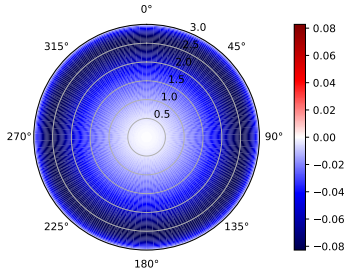


Resultater

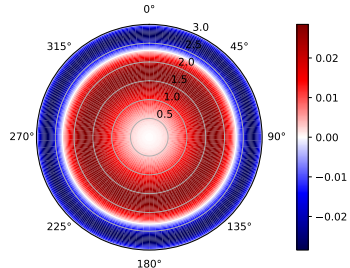
- Reversere skjermingstrømmen ved påtrykt spenning
- Lavere spenning for større radiuser



Current density j/e for $R = 3\xi$ and $eV = 0$



Current density j/e for $R = 3\xi$ and $eV = 0.5\Delta$



- Skjermingstrøm i normalmetall
- Kvasiklassisk teori
- Snu skjermingsstrømmen ved påtrykt spenning
- Se på en mer komplisert geometri numerisk

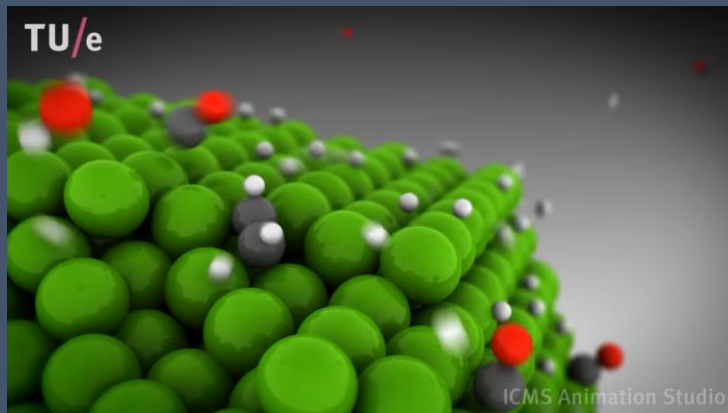
Simulering av Fisher-Tropcsch prosessen ved bruk av tetthets-functional-teori (DFT)

Navn: Christoffer Askvik Faugstad

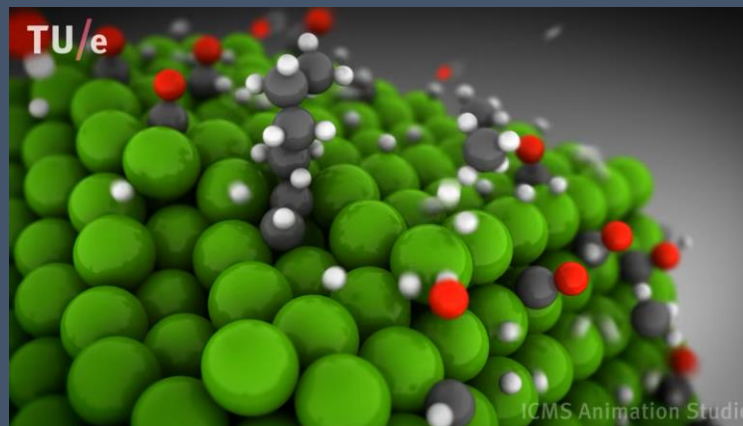
Veileder: Jaakko Akola

Katalyse

- Forstå mekanismer
- Bedre og andre katalytematerialer

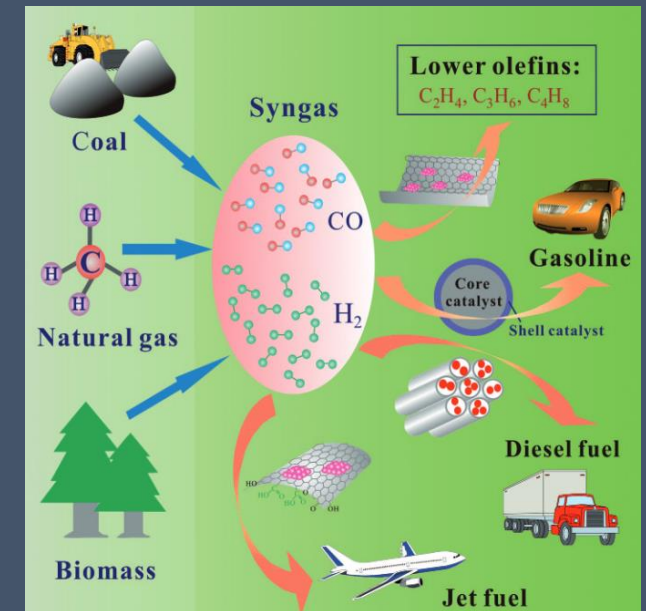


<https://doi.org/10.1039/C3CY00118C>



Fisher-Tropch

- Omgjøring CO og H₂
- Produksjon av drivstoff og kosmetiske produkter



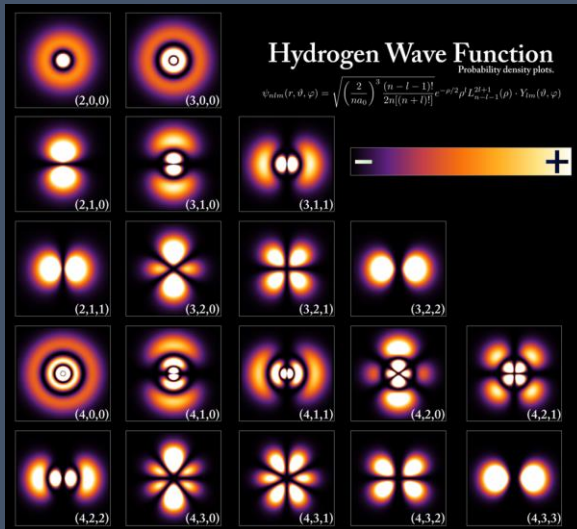
<https://doi.org/10.1002/cctc.201000071>

Tetthets-Funktional-Teori

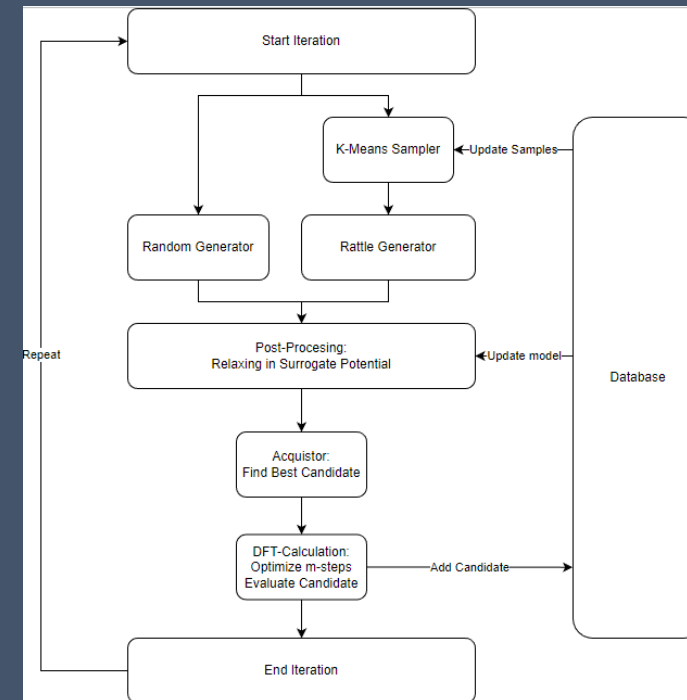
- Elektrontettheten gir alle egenskaper
- Kohn-Sham ligningene
- Tunge beregninger

Maskinlæring og Globale søk

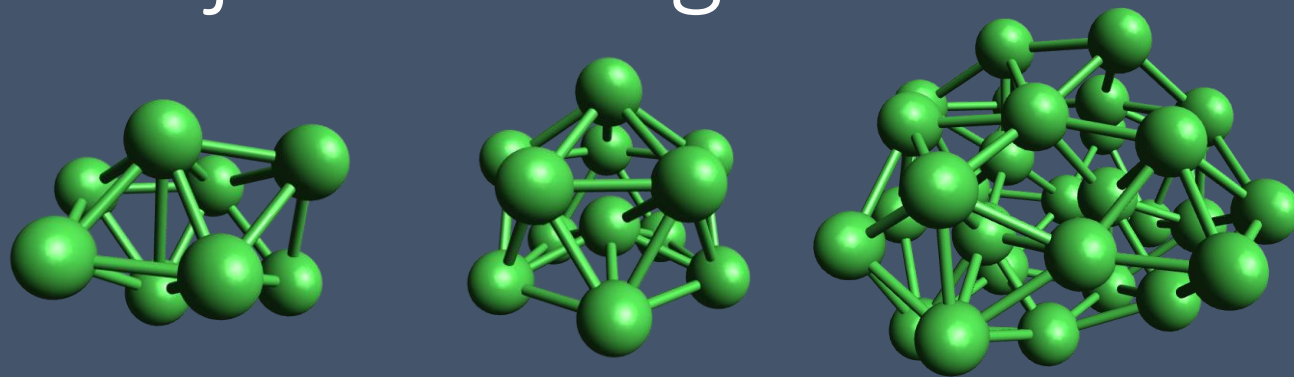
- Finne grunn tilstand
- Lært potensial
- Bedre og automatisk generering av strukturer



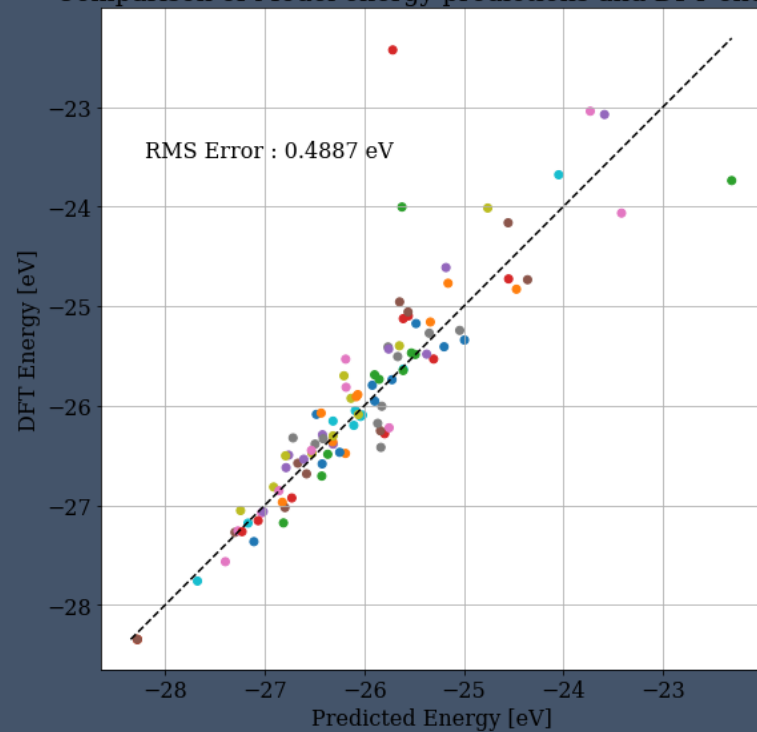
https://en.wikipedia.org/wiki/Atomic_orbital



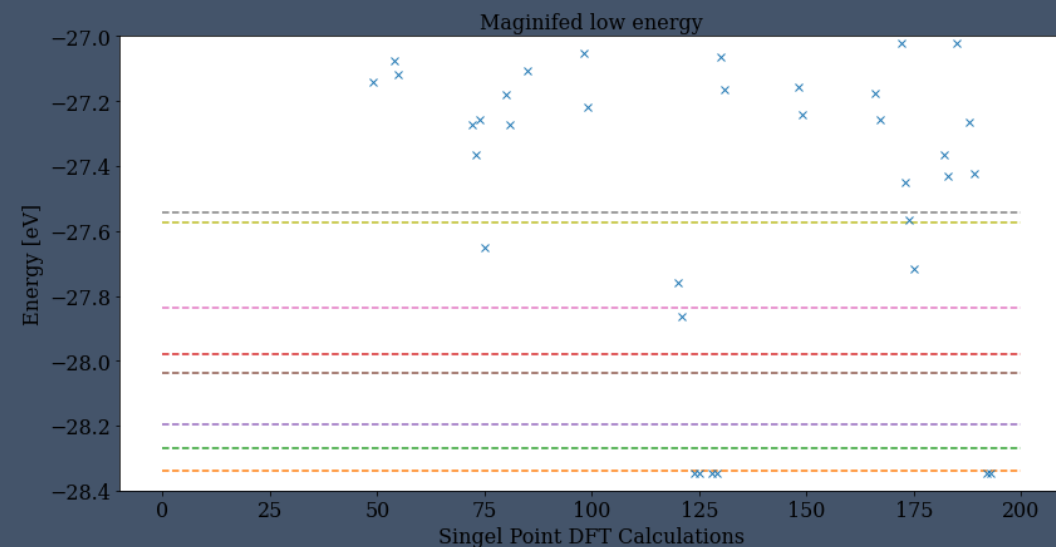
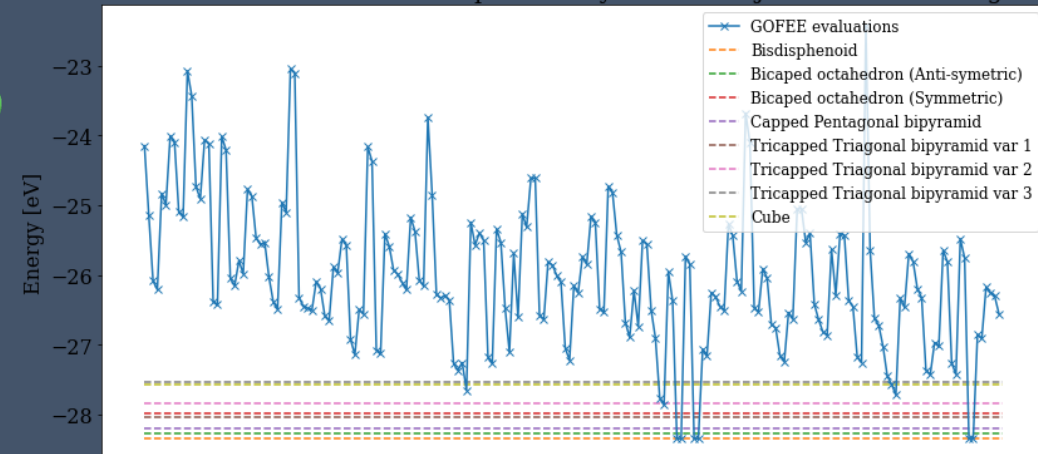
Gjort så langt



Comparison of Model energy predictions and DFT energy



Ni8 GOFEE 100 iterations 1 step with fully relaxed trajectories as training data



Kompakte stjerner

TOV-LIKNINGEN OG IDEELLE
NØYTRONSTJERNER

Carl Fredrik Andresen

Veileder: Jens Oluf Andersen



Bildet er hentet fra Kurzgesagts video om
nøytronestjerner

Modellering av nøytronstjerner

- Sterke gravitasjonsfelt: Trenger beskrivelse fra generell relativitetsteori
- Anta sfærisk symmetri – Schwarzschild-løsning for interiøret av en massefordeling
- Anta også ideelt fluid
- Leder til TOV-likningen
- Lukke systemet med en tilstandslikning: energitetthet som funksjon av trykk
- Eksempel på tilstandslikning: Ideell Fermi-gass
- Trykk og energitetthet uttrykt ved hjelp av dimensjonløs Fermi-impuls

TOV-likningsystem

$$\frac{dp}{dr} = -\frac{GM(r)\epsilon(r)}{r^2 c^2} \left[1 + \frac{p(r)}{\epsilon(r)} \right] \left[1 + \frac{4\pi r^3 p(r)}{M(r)c^2} \right] \left[1 - \frac{2GM(r)}{rc^2} \right]^{-1}$$

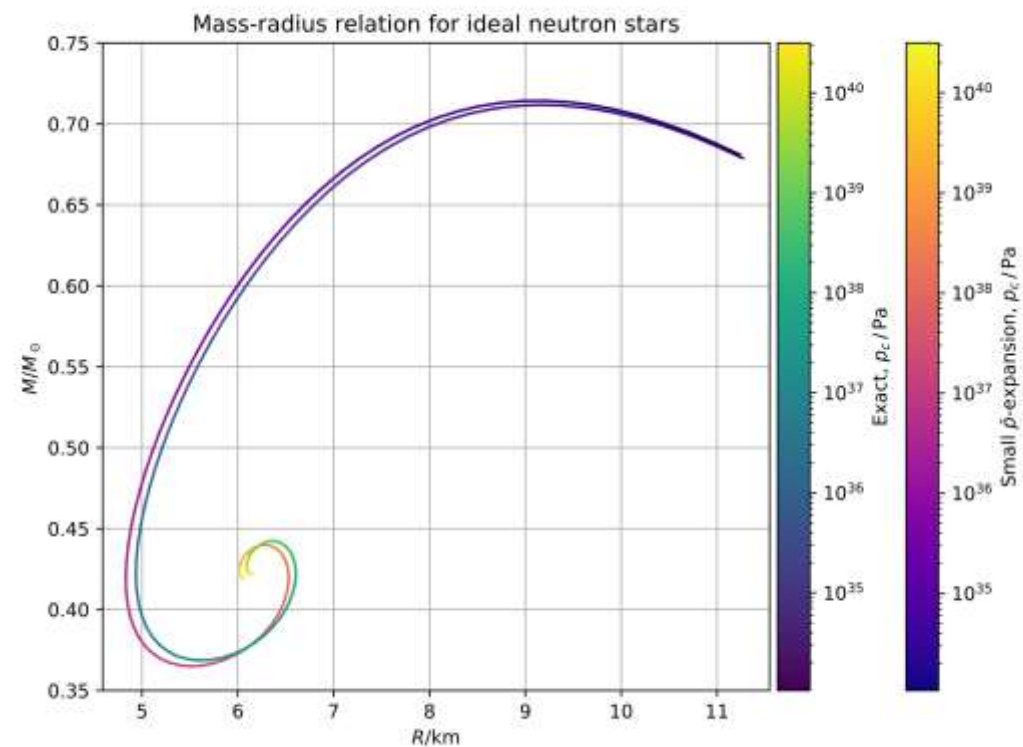
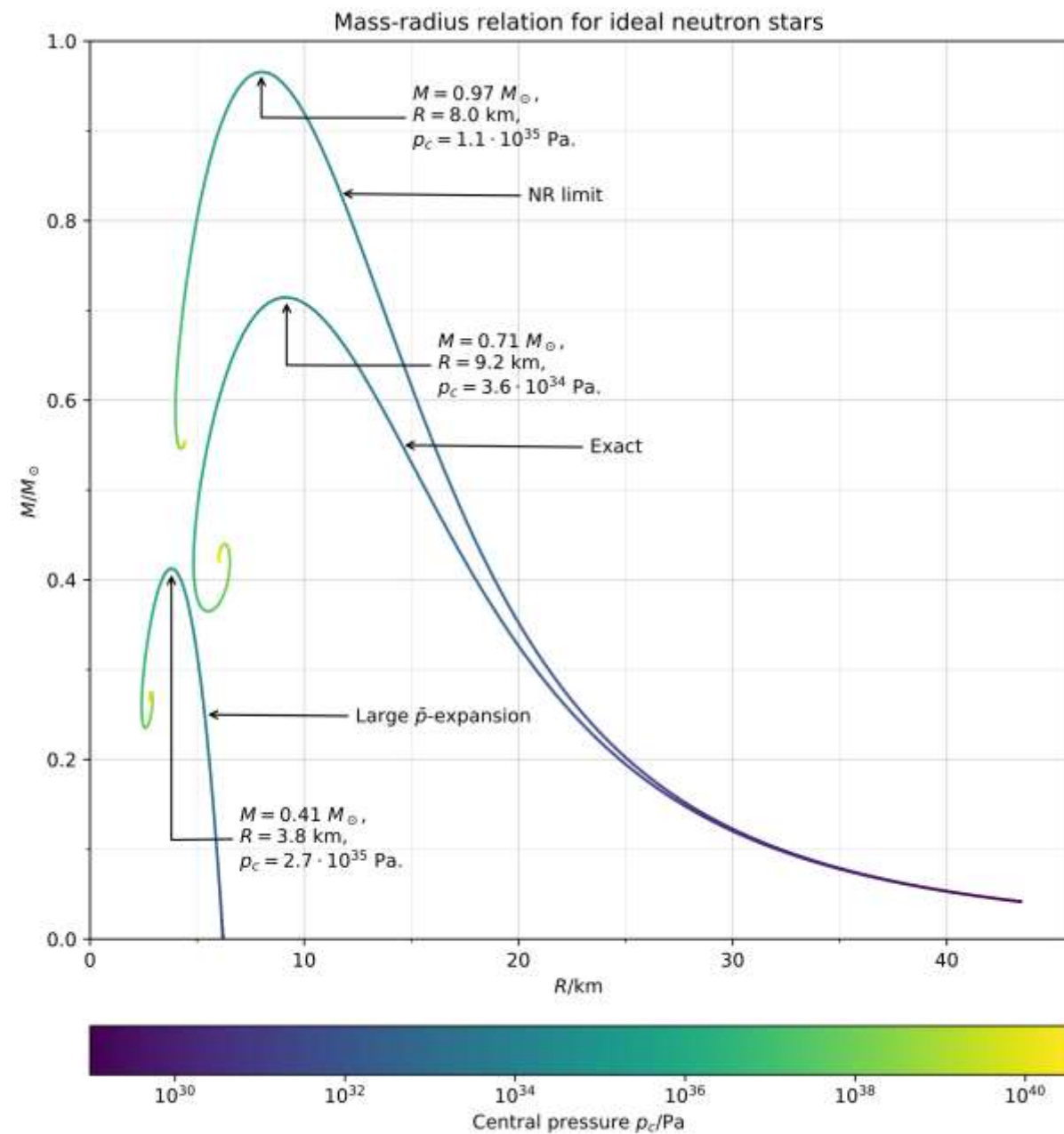
$$M(r) = \int_0^r dr' 4\pi r'^2 \rho(r') = \int_0^r dr' \frac{4\pi r'^2 \epsilon(r')}{c^2}$$

$$\epsilon = \epsilon(p)$$

Ideell Fermi-gass

$$p = \varepsilon_g \left[\frac{x_F^3 \sqrt{1 + x_F^2}}{12} + \frac{\operatorname{arcsinh}(x_F) - x_F \sqrt{1 + x_F^2}}{8} \right]$$

$$\epsilon = \varepsilon_g \frac{2x_F^3 \sqrt{1 + x_F^2} + x_F \sqrt{1 + x_F^2} - \operatorname{arcsinh}(x_F)}{8}$$

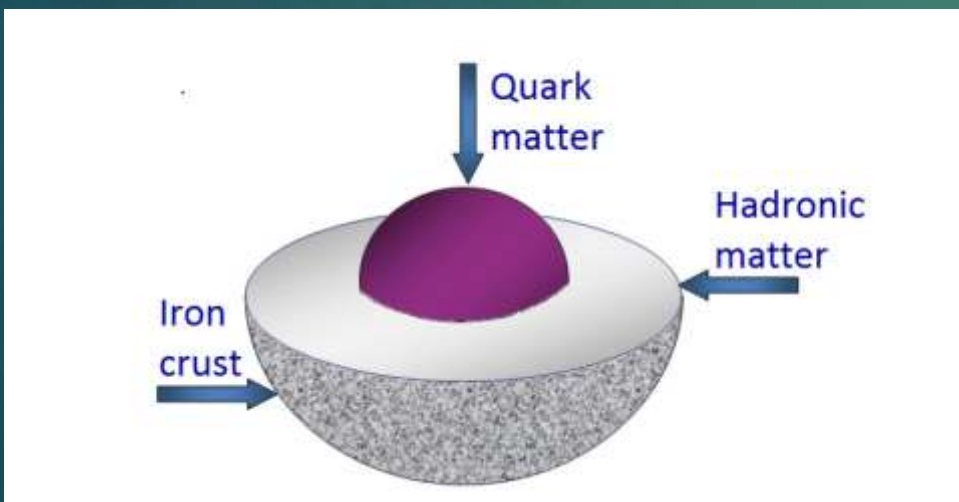


Masse-radius-relasjoner for ideelle nøytronstjerner

- Predikerer maksimal nøytronstjernemasse $M = 0.71 M_{\odot}$
- Stabilitet
- Det er observert nøytronstjerner som er over dobbelt så tunge
- Behov for en mer realistisk tilstandslikning

Oppgradert modell

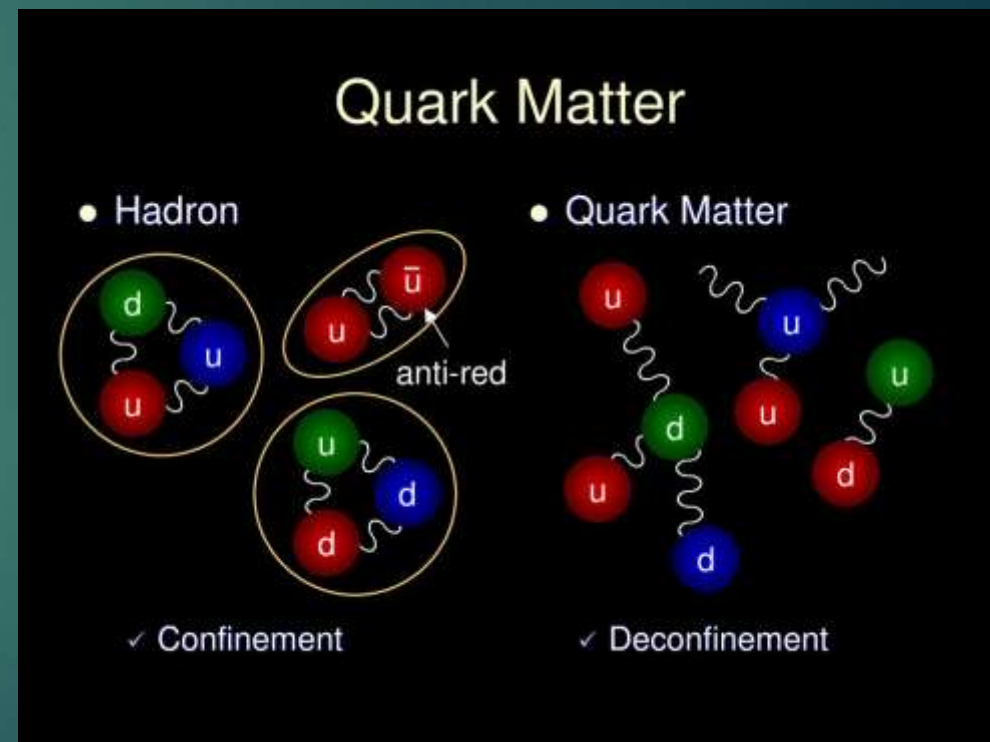
- Frigjøring av kvarker ved høy energitetthet (*deconfinement*)
- Tilstandslikning fra QFT
- Faseovergang fra hadronmaterie til frie kvarker
- Opphav til bedre masse-radius-relasjoner



Hentet fra:

<https://masterbloggen.no/blog/2013/09/05/17953/>

Forfatter: Inga Strümke



Hentet fra presentasjon av Tomohiro Inagaki ved Hiroshima University



Norwegian University of
Science and Technology

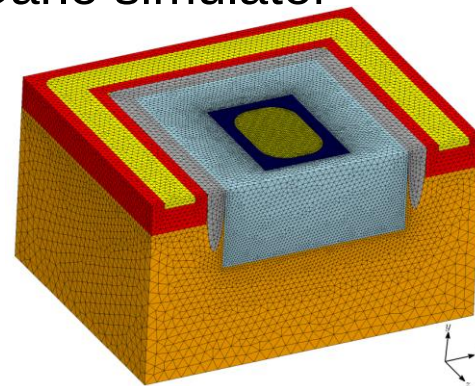
Simulation of a Three-Dimensional Mercury Cadmium Telluride-Based Avalanche Photodiode

Using a Particle-Based Self-Consistent Monte Carlo simulator
(FFI-MCS)

Julius Mihkkal Eriksen Lindi

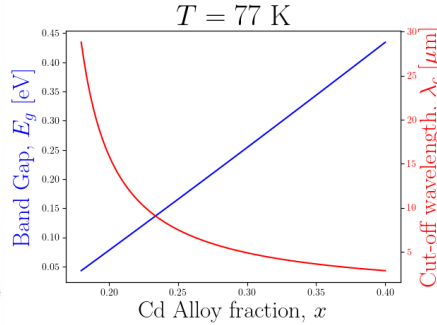
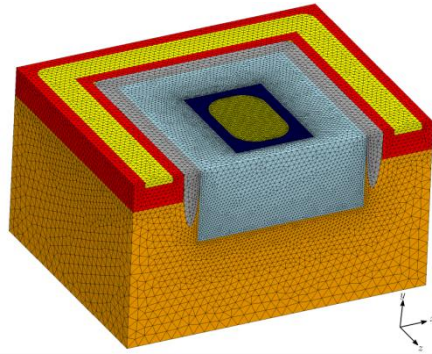
Supervisor @ FFI: Trond Brudevoll

Supervisor @ NTNU: Jon Andreas Støvneng



$\text{Hg}_{1-x}\text{Cd}_x\text{Te}$ e-APD

$Hg_{0.28}Cd_{0.72}Te$ Avalanche Photodiode

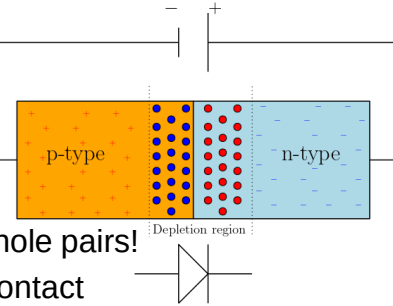


Dimensions: $5.4\mu\text{m} \times 3.0\mu\text{m} \times 4.2\mu\text{m}$

- Very small device! (convenient for computing time)

High **reverse bias** voltage of 7V applied at $N+$ contact

- Creates a larger **pn-junction** and multiplication region for electrons
- **Photogenerated** electrons in the absorption layer (lower P-)
- **Impact** and **ionize** new electron-hole pairs!
- Electrons continue upward to N-contact



- A read-out device (**ROIC**) detects the signal
- Applications: **Infrared**/Thermal imaging, night-vision devices

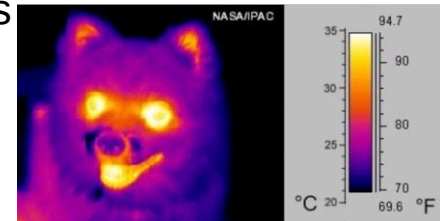
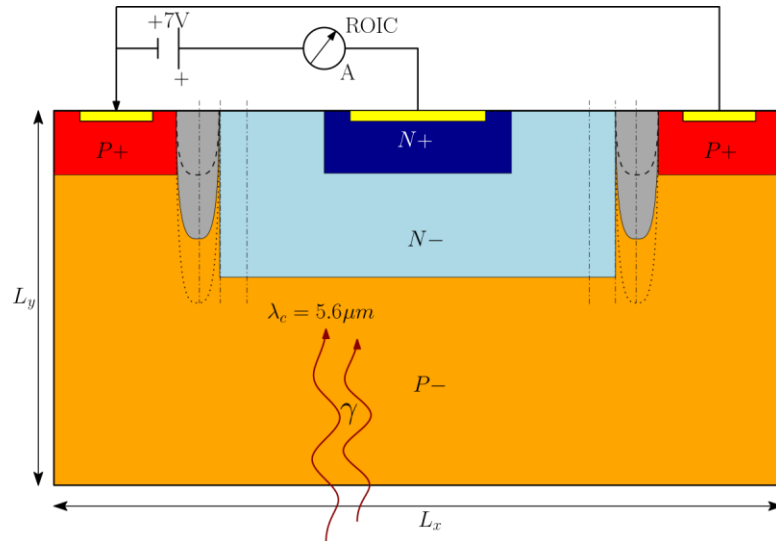
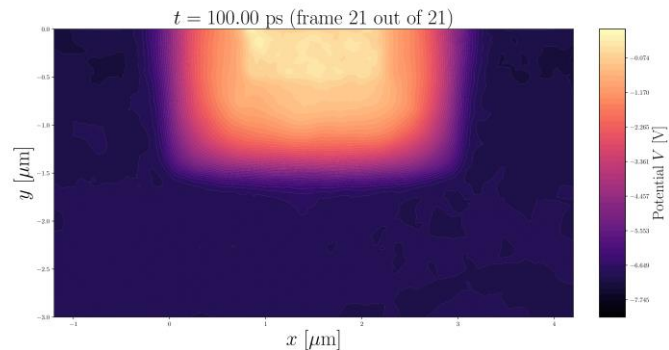
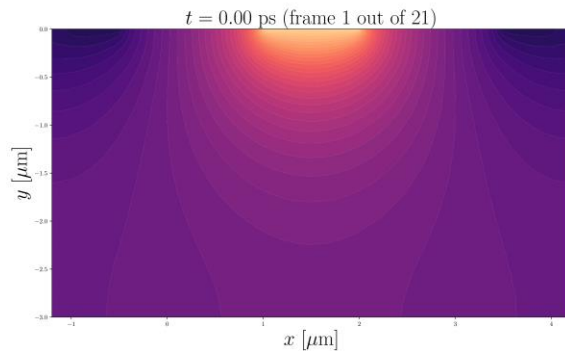
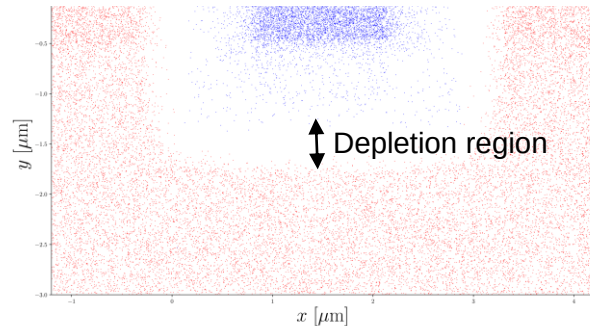
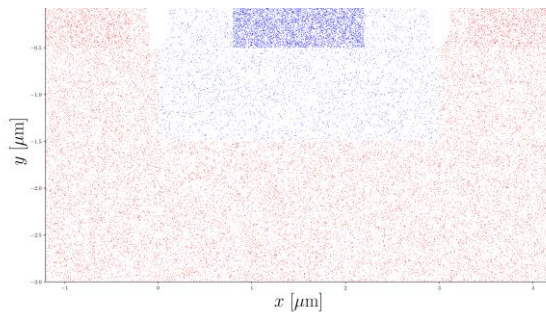


Figure 4. A dog as seen in the infrared spectrum.^[8]

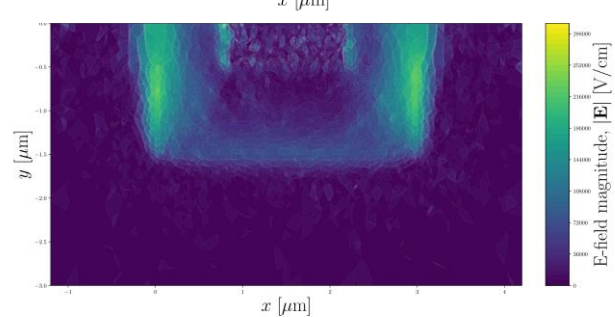
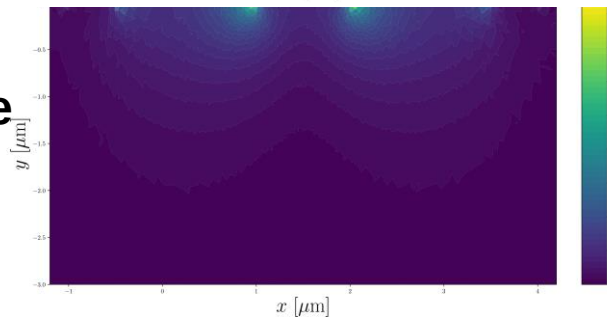
- **Potential plots**



- **Particle density plots**



- **Electric field magnitude**



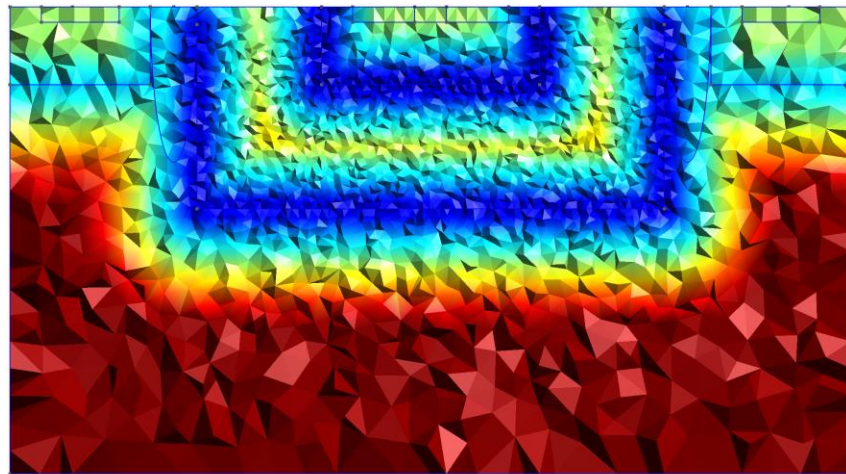
Summary of the project

- Only 2D devices have been extensively studied before
- Recent developments to FFI-MCS have paved way for simulating things easier and faster in 3D

Objectives:

- Construct a device with **complex 3D geometry**
- **Optimize mesh** & find **suitable parameters** that are reasonable to use in 3D simulation
 - E.g. simulation doesn't take too long and the results are physical & accurate
 - **Time resolution, mesh refinement, # of superparticles, etc.**
- Investigate geometry-dependent effects of **Guard Rings** (isolating grooves)
- Further work (master thesis): Study guard rings in a realistic device and optimize their geometry such that noise resulting from **dark currents** is minimized.

Mesh optimization



Field 11
0.035 0.118 0.2

Node/element density

Y
Z X

Maskinlæringsbasert søk etter nytt Z' -boson ved LHC med ATLAS-detektoren

Andreas Middelthon

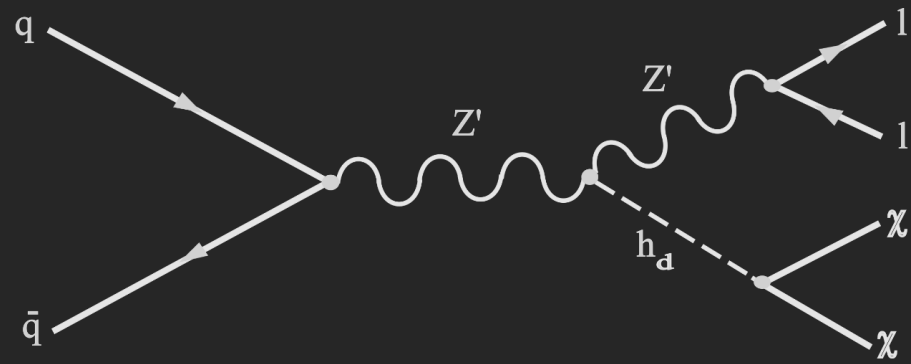
Veiledere:

Jon Andreas Støvneng

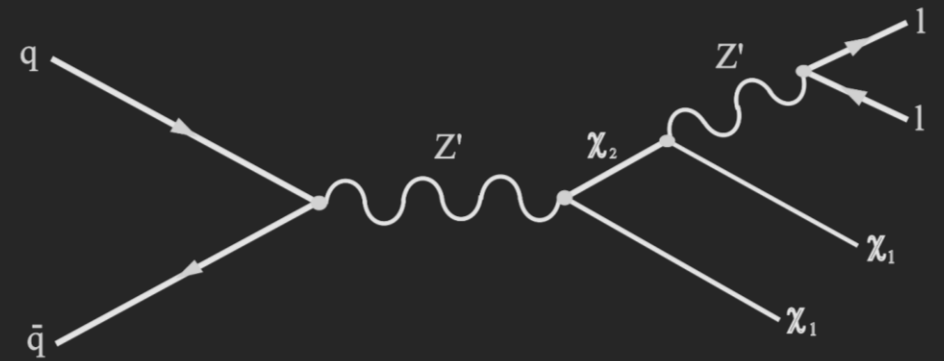
Farid Ould-Saada

MODELLER FOR Z' -BOSON

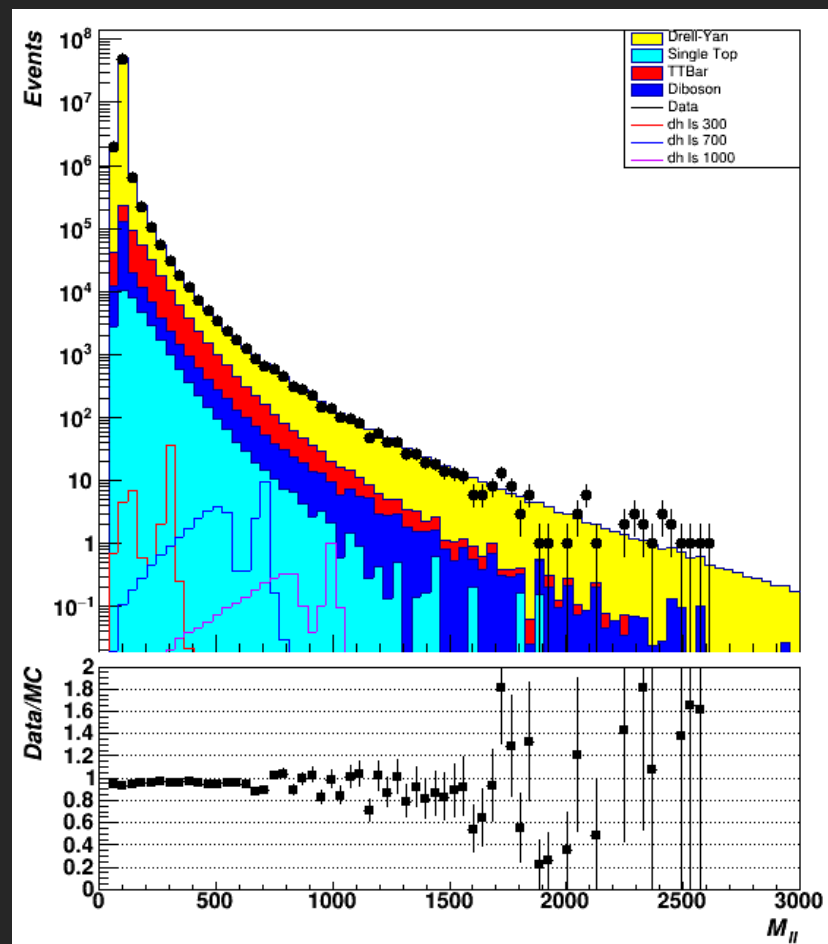
Mørk Higgs



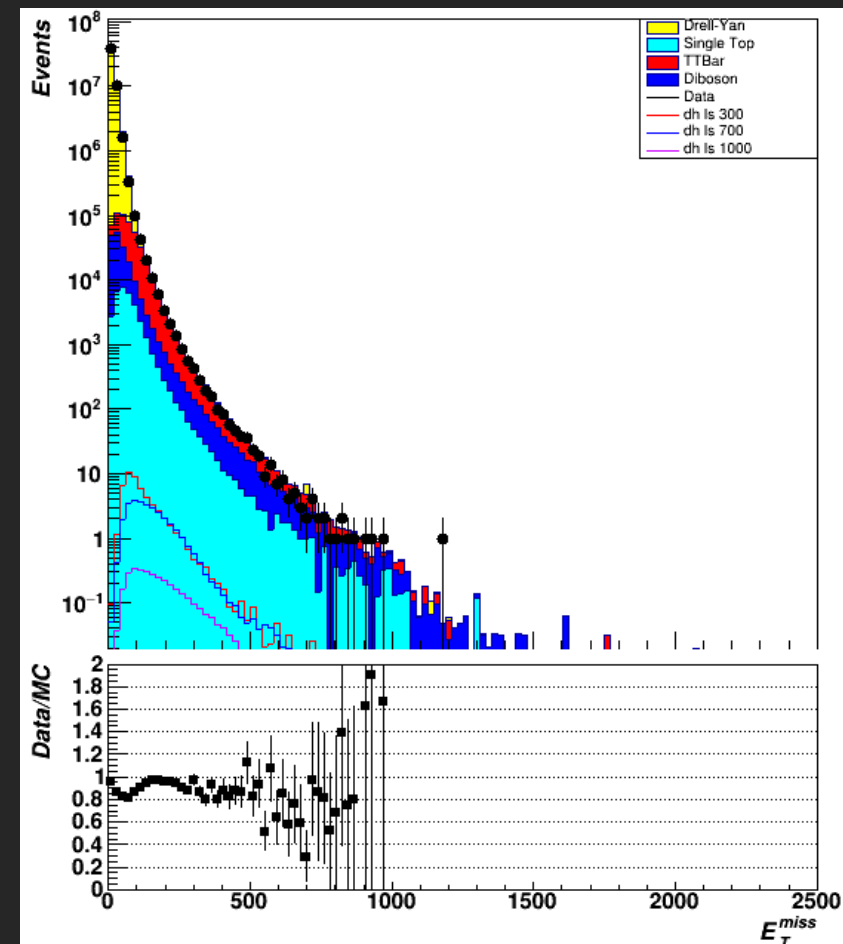
Light Vector



SAMMENLIGNING AV SIMULERING OG DATA



Invariant masse



Manglende energi (MET)

SPØRSMÅL



Multifysikk-modellering av PEM-elektrolyse for hydrogenproduksjon

Jenny Sandgren Østenstad

Veiledere:

Jon Andreas Støvneng

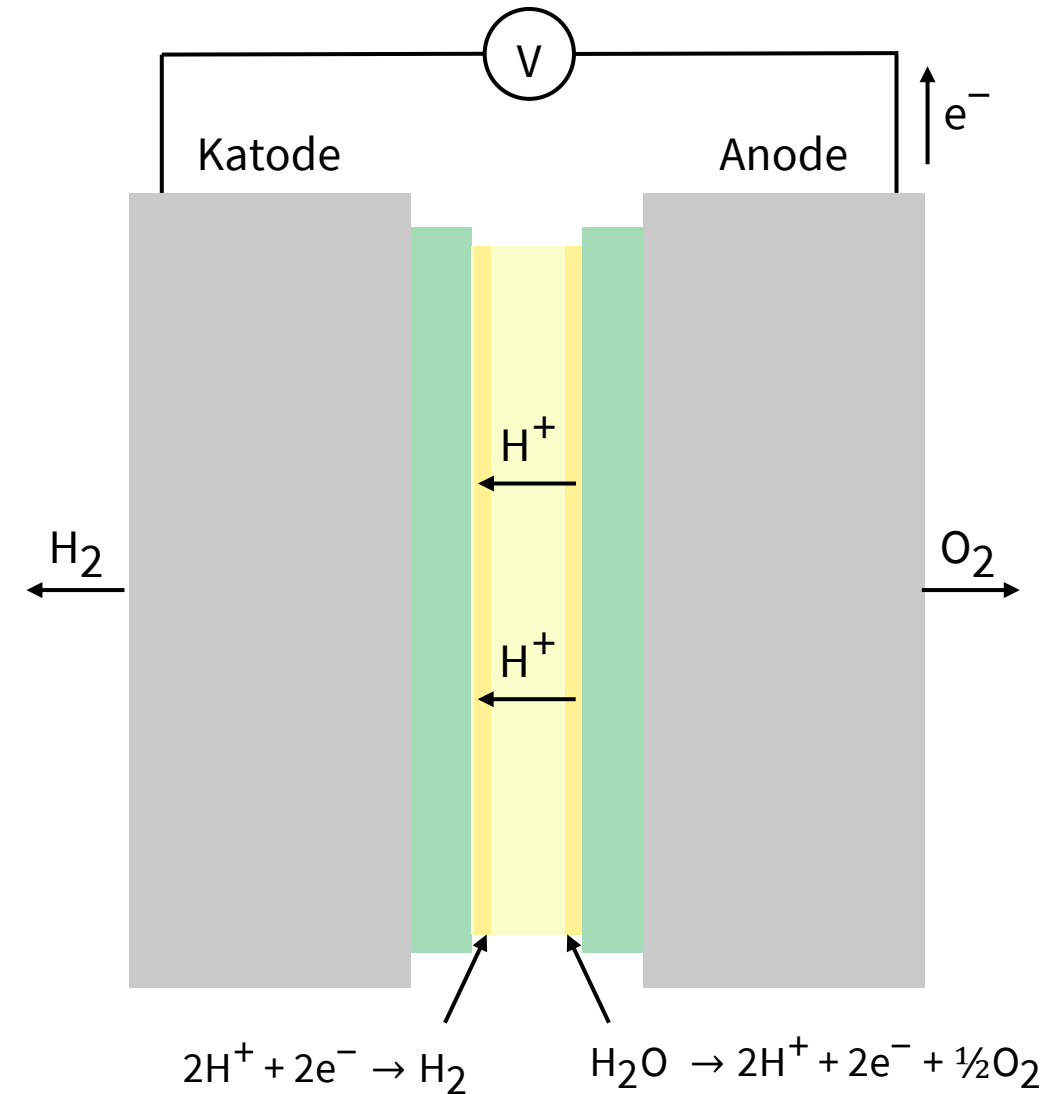
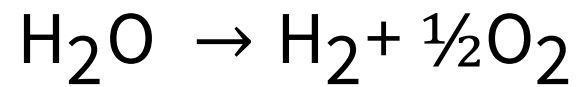
Alejandro Oyarce Barnett (Hystar)

Michael Gerhardt (SINTEF)



PEM-elektrolyse

PEM = Proton Exchange Membrane



○ Hvorfor PEM-elektrolyse?

- Dekarbonisere industrier der det er vanskelig eller umulig å erstatte med andre energikilder
 - Transport: tog, shipping, (bil)
 - Produksjon der selve prosessen krever hydrogen: stål, ammoniakk
- Potensiale for dynamisk drift



○ Stort behov for forskning på mer avansert modellering av PEM-elektrolyse

- Det finnes relativt lite forskning på PEM-elektrolyse
- Kun en liten andel publiserte artikler dreier seg om datamodellering, og modeller er i stor grad empiriske/forenklede
- Prosjektoppgave: gjennomgang av relevante fysiske prinsipper, review av eksisterende modeller



Derivation of sea ice parameters for design load calculations of offshore wind turbines – A case study in the Southern Baltic Sea

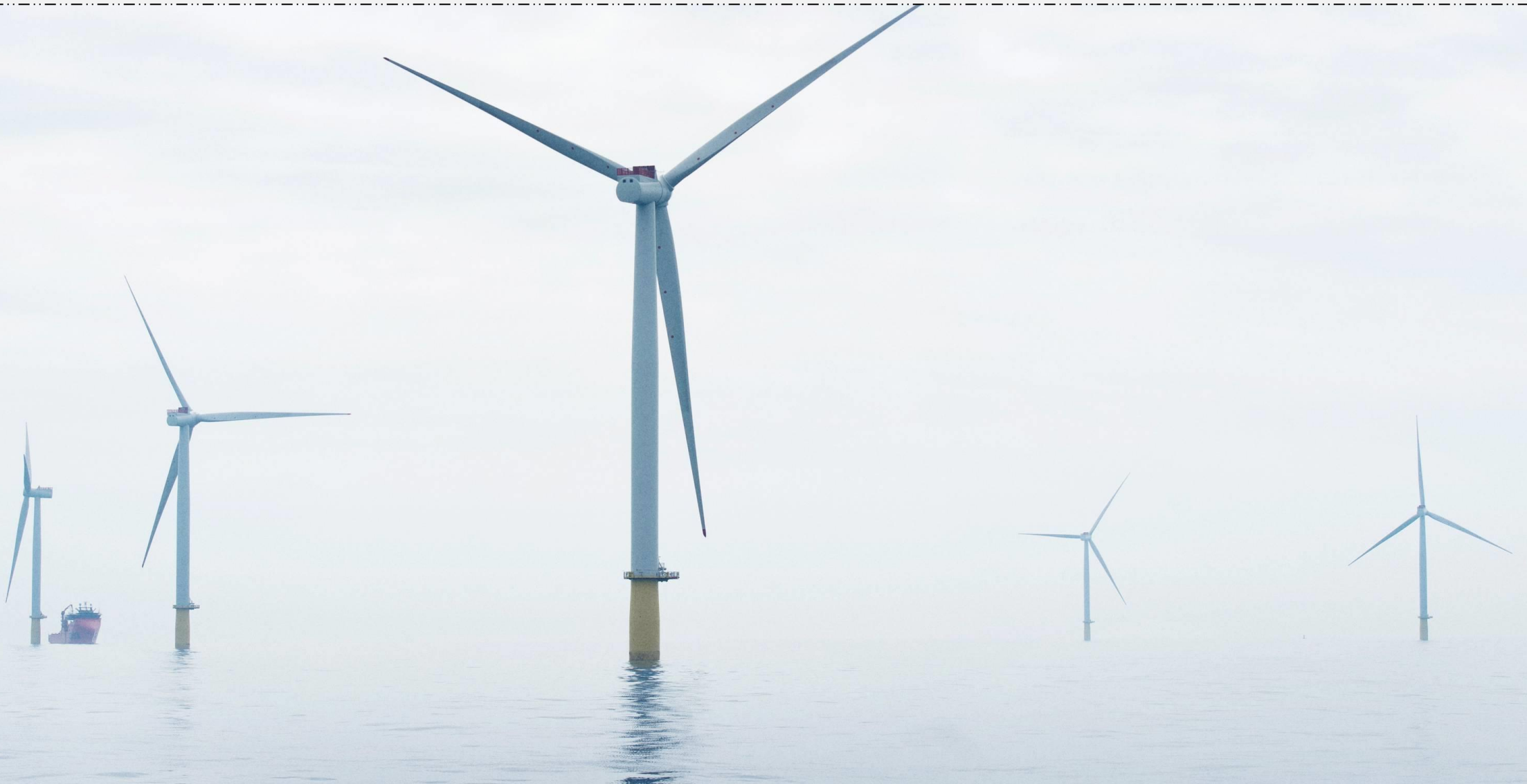
Amund Soland

Industry advisor:
Sigurd Henrik Teigen

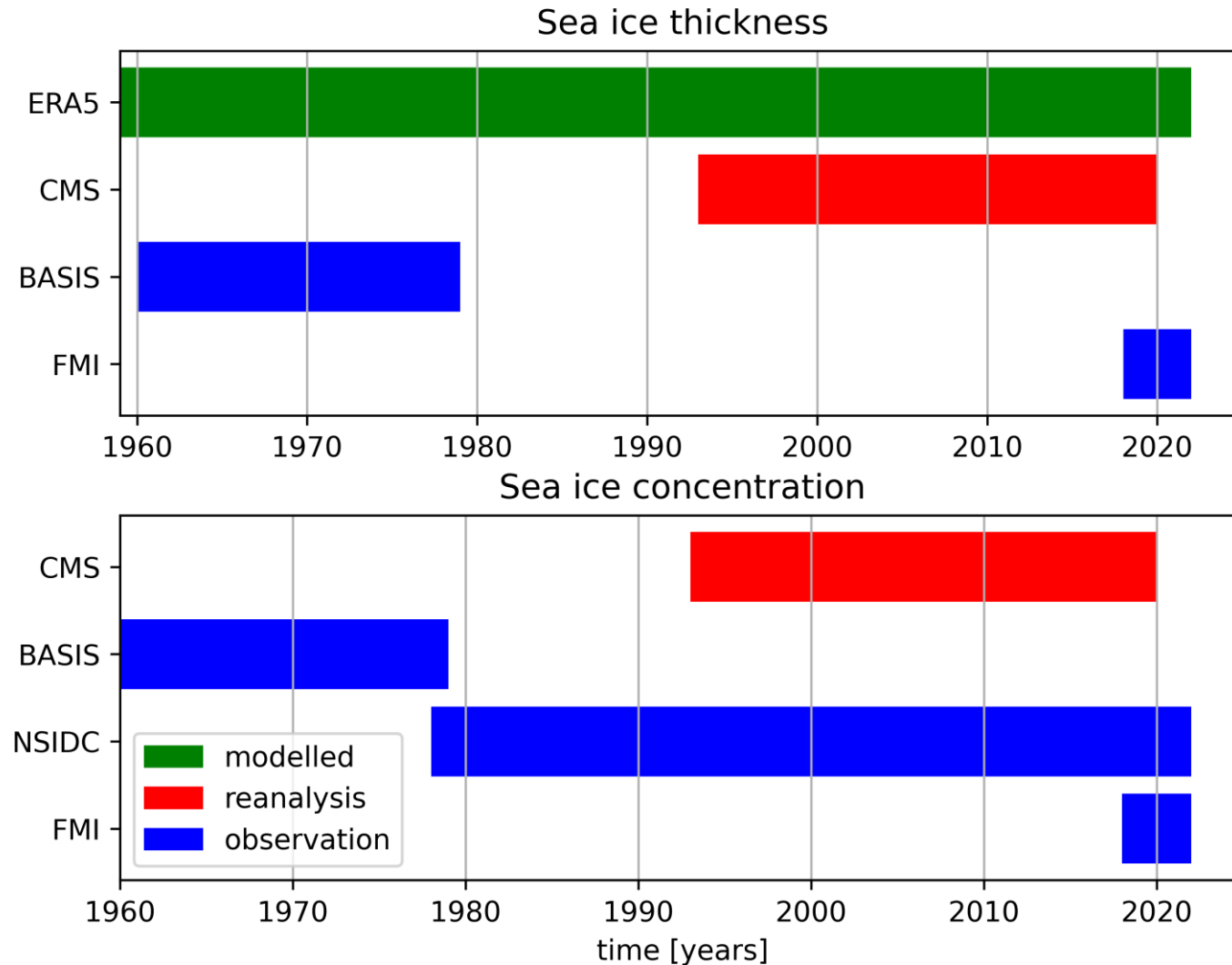
Internal supervisor:
Jon Andreas Støvneng



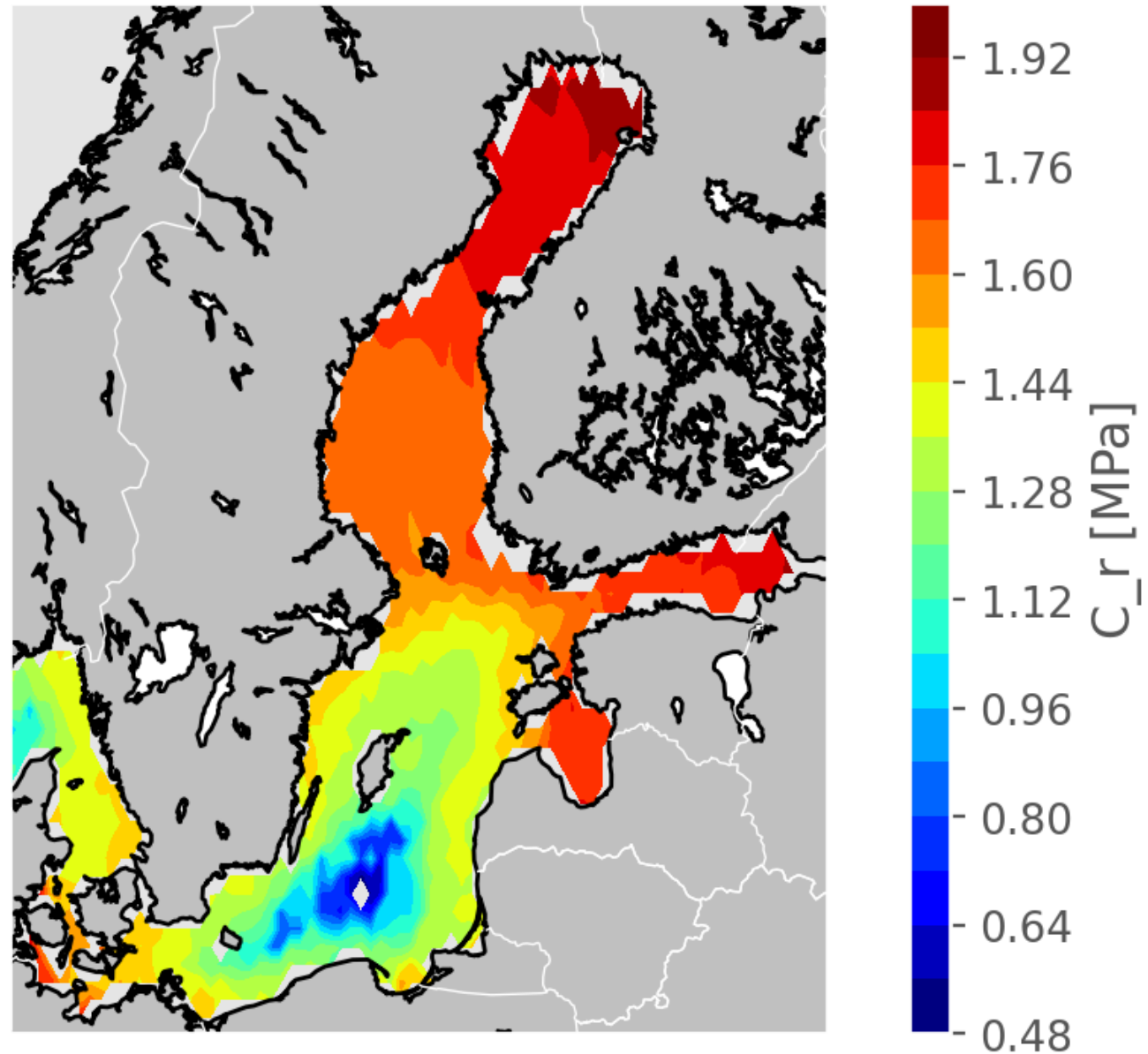
Energiunderskudd og dekarbonisering



To viktige parametre

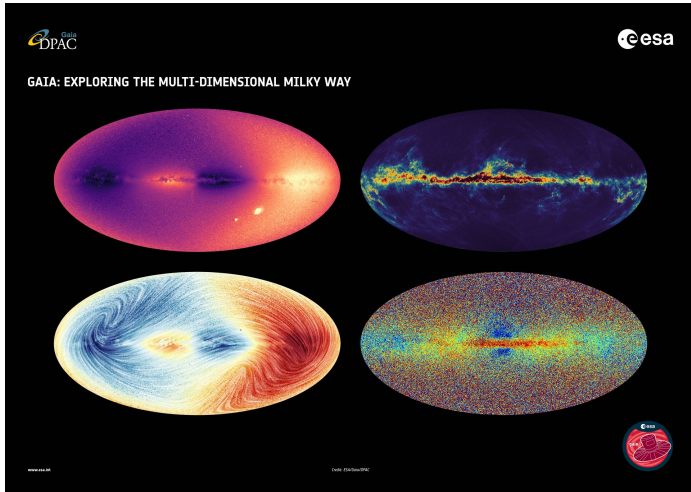


Havisens styrkekoefficient



Dormant compact objects

Use of data from GAIA to verify stellar evolution simulator SEVN



GaIA mission

Gaia is an ESA operated telescope, performing a survey of the sky from Earth orbit to create the largest, most precise, three-dimensional map of our Galaxy. The data gathered includes high-precision measurements of positions, distance and proper motions— of more than one billion stars in our Milky Way galaxy. revealing the composition, formation and evolution of the Galaxy.

A binary star with an invisible companion will display different kinematics than a single star, but we're unable to see the companion meaning it has to be a dormant compact object: either a black hole, white dwarf or neutron star.

SEVN simulator

SEVN is a stellar population synthesis code developed by 'Formation and Dynamics of Stars' (ForDyS) research team at the Astronomical Observatory of Padova. The simulator uses hydro-dynamics to model the initial stars, and the dynamics of them to simulate the evolution of stars and binary systems and is written in C++.

Work so far

Thus far the work has been encompassing seeking out the correct initial conditions to model the Milky Way, so we can simulate what the galaxy should look like today. Achieving this lets us filter out for binary kinematics, letting us confirm by comparing the simulated results with the Gaia data, that it is a dormant companion. The next step is to categorize what the companion is.

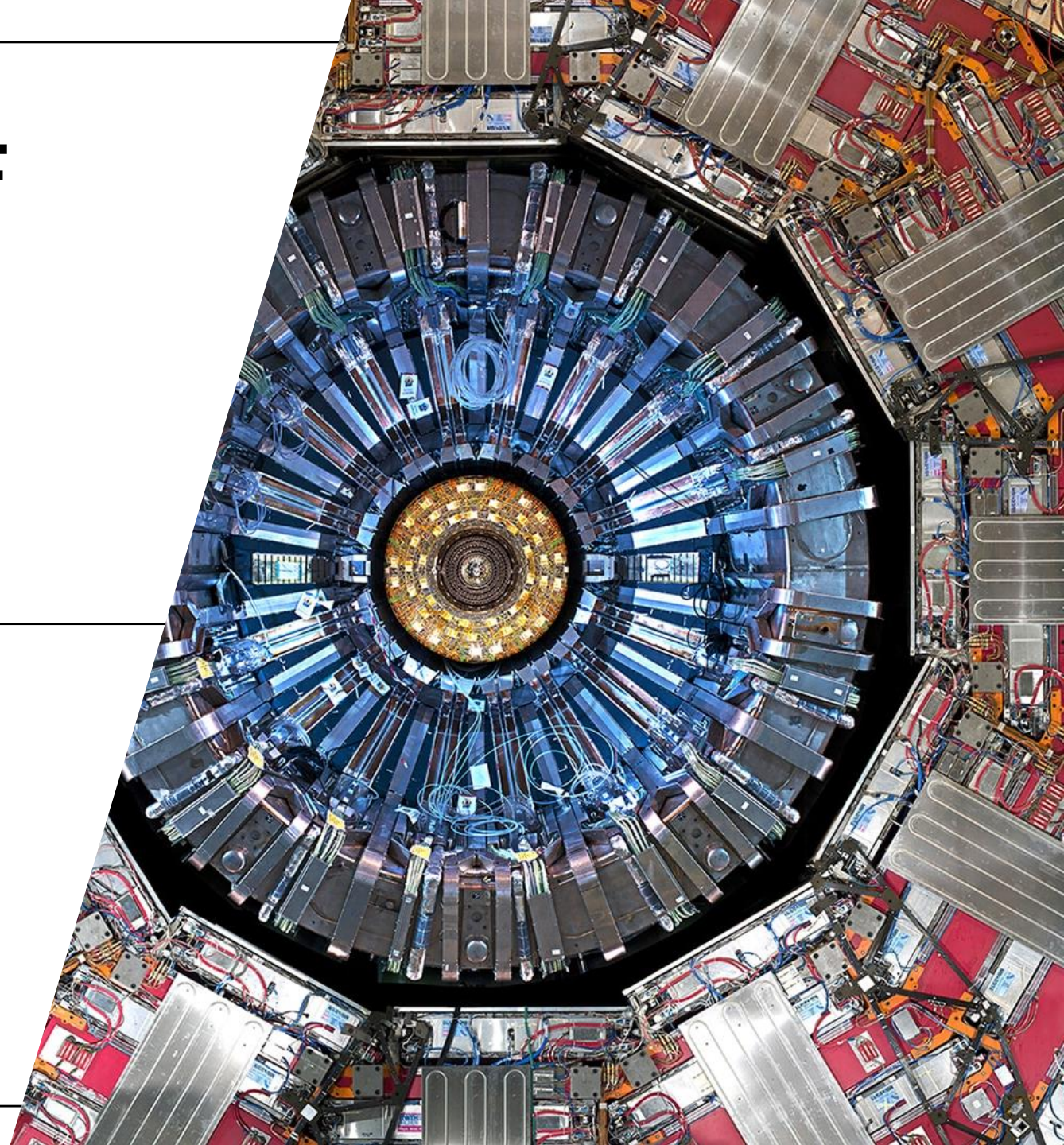
DEVELOPMENT OF CMS TRACKER MONITORING SOFTWARE AND DATABASE

Jenny Lunde

Supervisor NTNU: Jon Andreas Støvneng

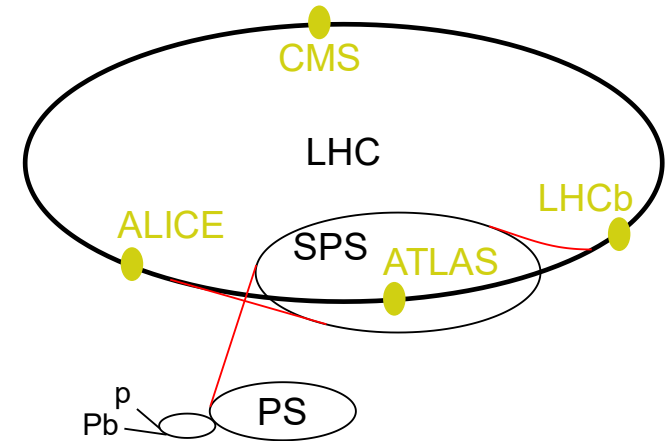
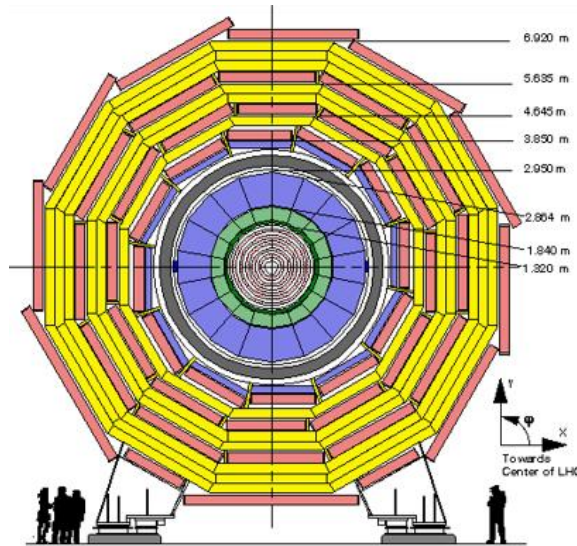
Supervisor CERN: Giulia Negro, Annapaola de Cosa, Stefano
Merci

EP-CMX-DA

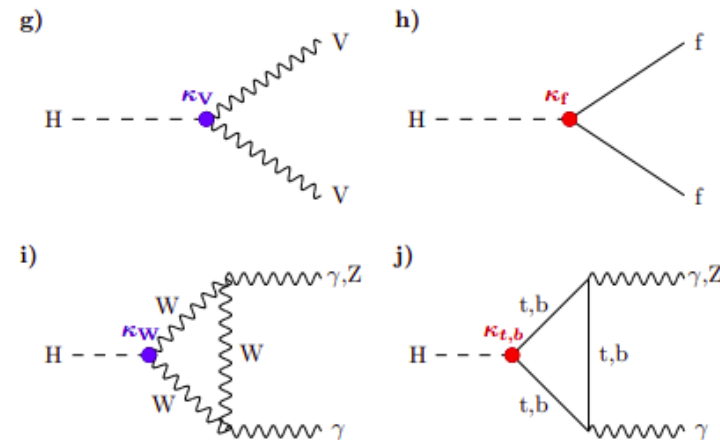


CMS Detector

- Multi purpose particle detector
- Detected Higgs boson in 2012
- Testing theories from SM
- Dark matter
- Extra dimensions



Higgs boson decay channels



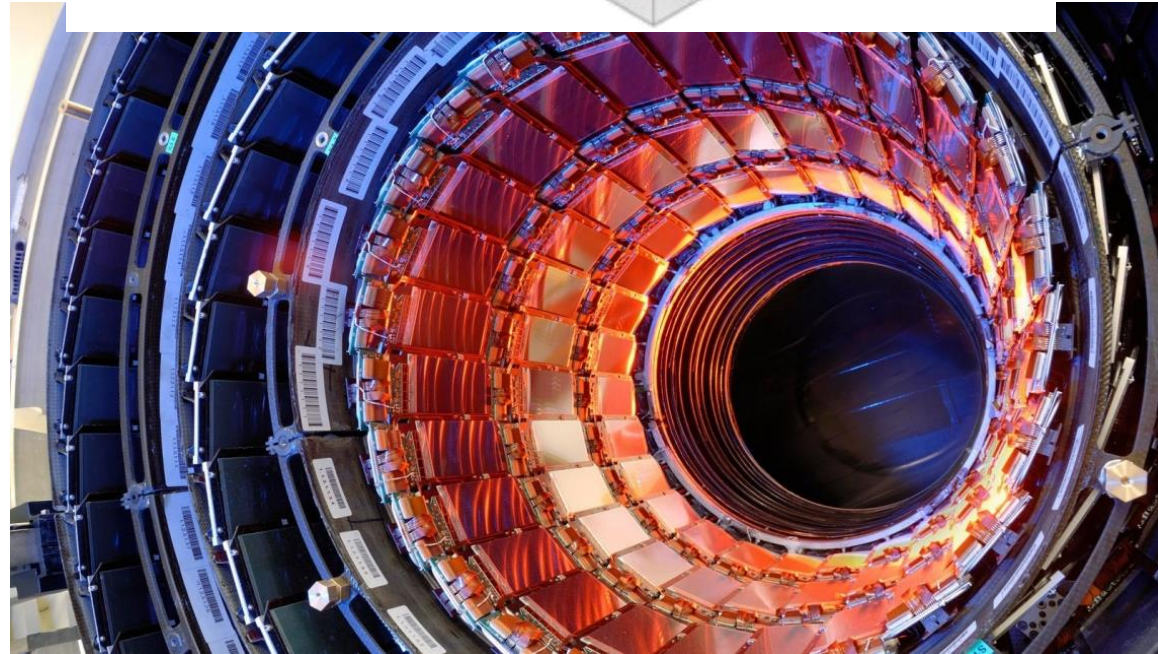
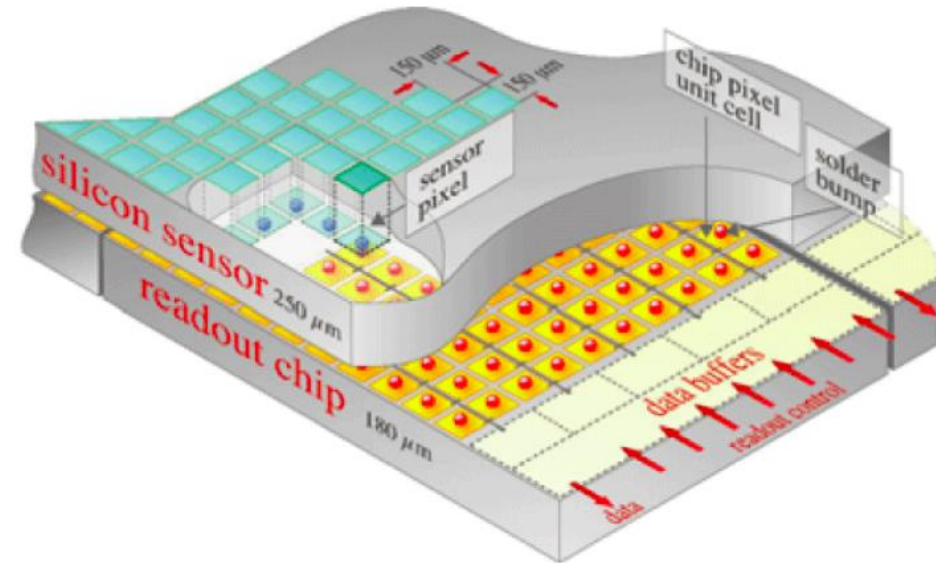
https://www.researchgate.net/figure/Transverse-view-of-the-CMS-detector_fig7_37678004

https://ht.wikipedia.org/wiki/Large_Hadron_Collider

<https://cds.cern.ch/record/2814513/files/CMS-HIG-22-001-arxiv.pdf>

CMS Tracker

- Traces the position of particles
- Silicon pixels
- Reconstructs the path of particles as they move through a magnetic field
- Have to handle high radiation over time

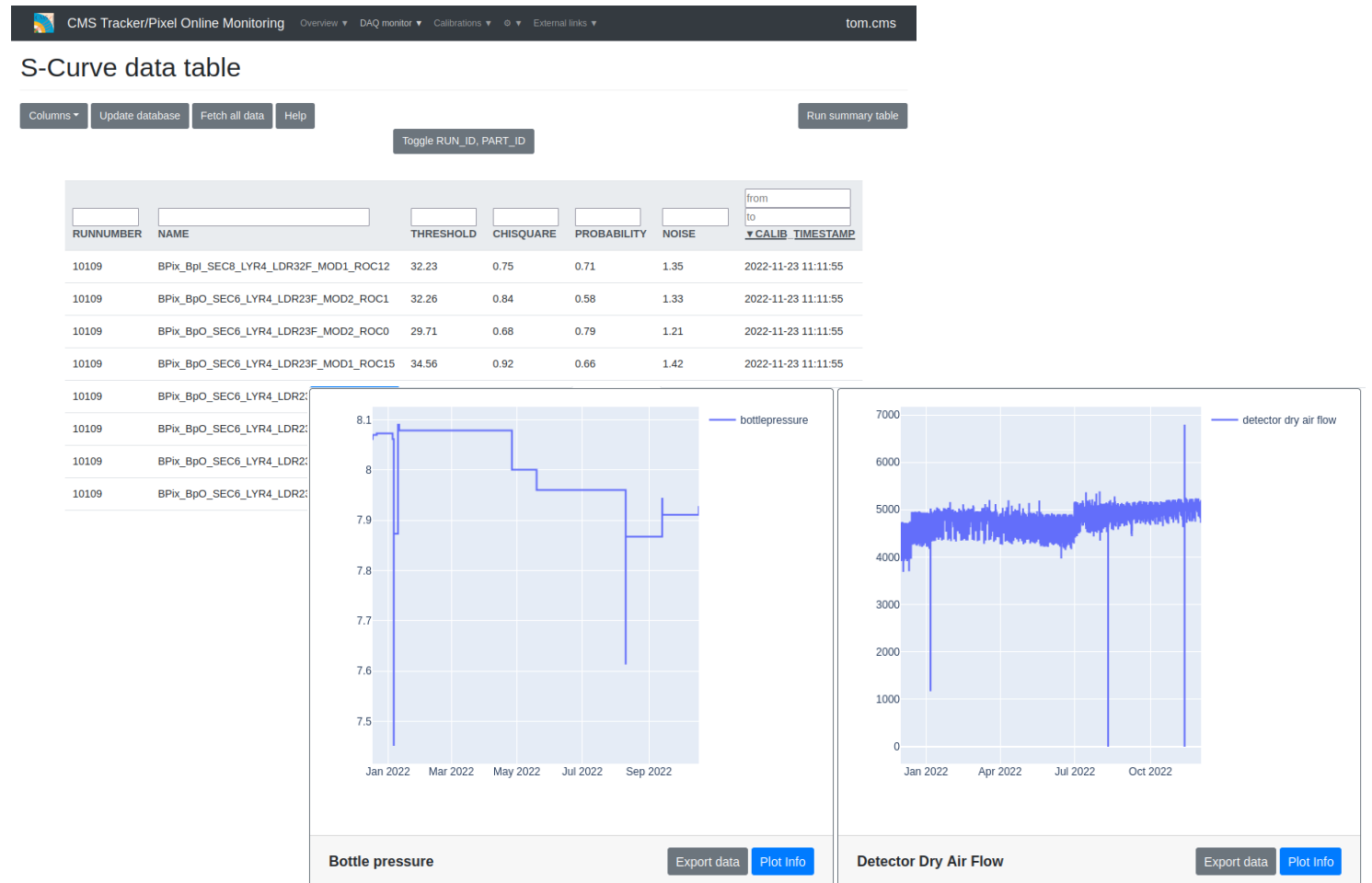


<https://cms.cern/detector/identifying-tracks/silicon-pixels>

<https://cms.cern/detector/identifying-tracks>

CMS Tracker Monitoring

- Calibrations
- Ensure all pixels are working
- Avoid accidents
- Radiation damage

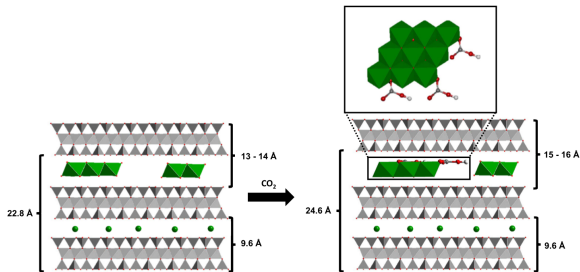


Competitive CO₂ capture using clay minerals: From science to innovation

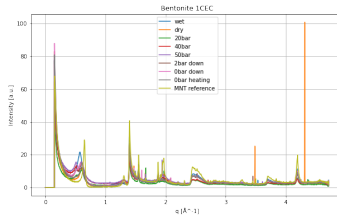
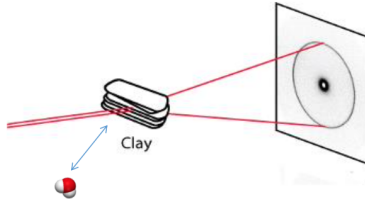
Sunniva Omdal

December 5, 2022

Adsorption mechanism



X-ray scattering

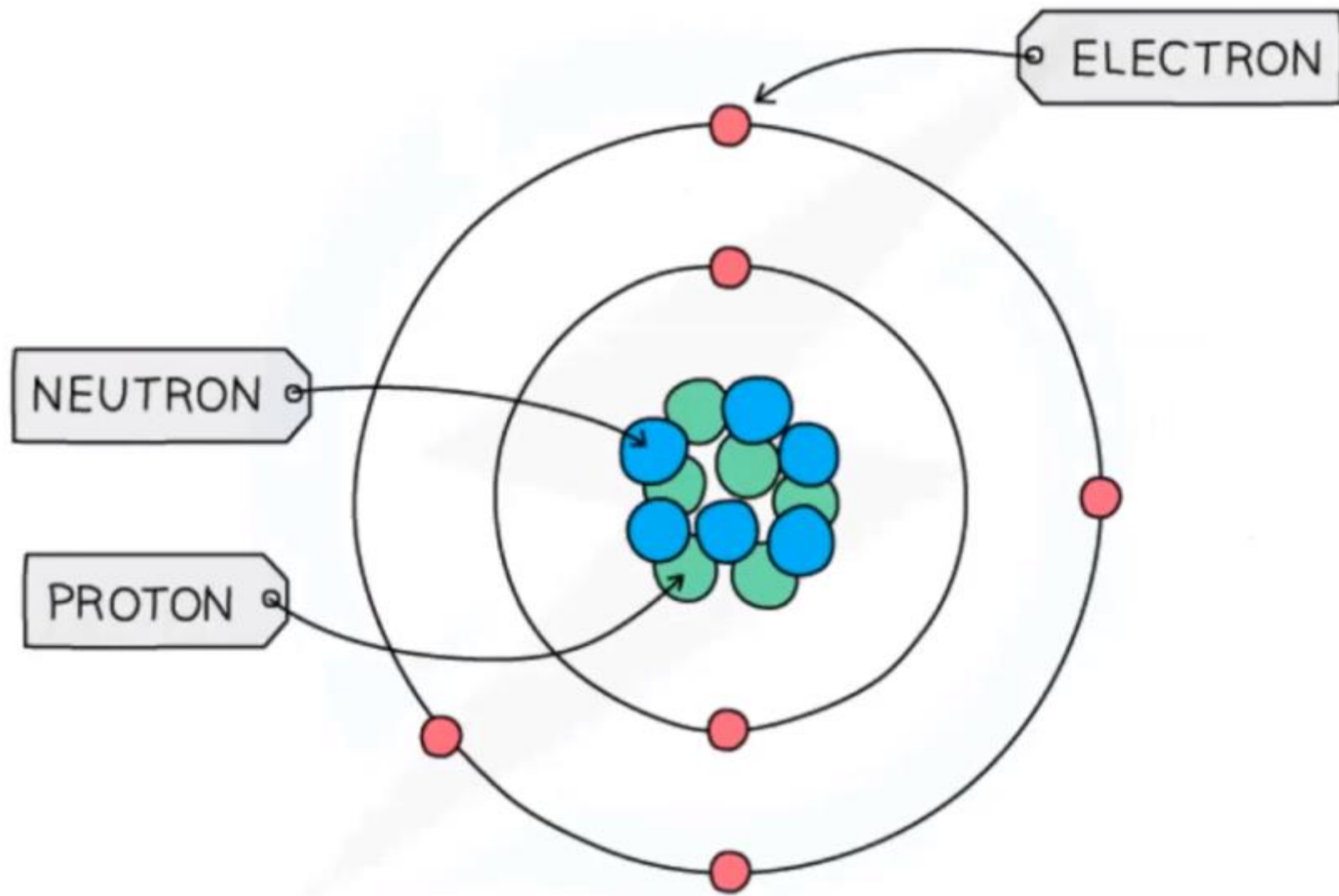


Summary

Computation of the hyperfine structure constant
in $^3P_{1,2}$ and 1D_2 of $^{207}_{82}\text{Pb}$ $6p^2$ using a
Multi-Configurational Dirac-Hartree-Fock
approach with the General Relativistic Atomic
Structure Package 2018 [3]

Martin Kinden Karlsen

December 2022



rnucleus - define nuclear data (Z, mass, spin, dipole+quadrupole moment)

rcsfgenerate - generate CSF basis, within an active space of one- e^- orbitals

rcsfinteract - remove weakly interacting CSFs

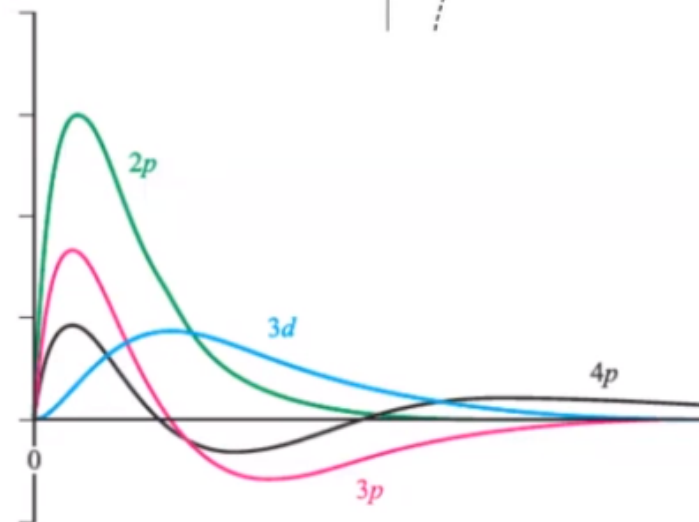
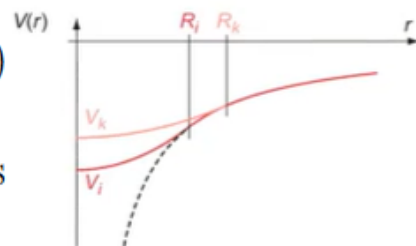
rangular - pre-compute spin-angular integrals

rwfnestimate - initial estimates of the radial orbitals

rmcdhf - Dirac-Coulomb self-consistent field procedure

rci - configuration-interaction with Breit+QED

rhfs - compute magnetic dipole and electric quadrupole hyperfine structure constants, and Landé g_J -factors.

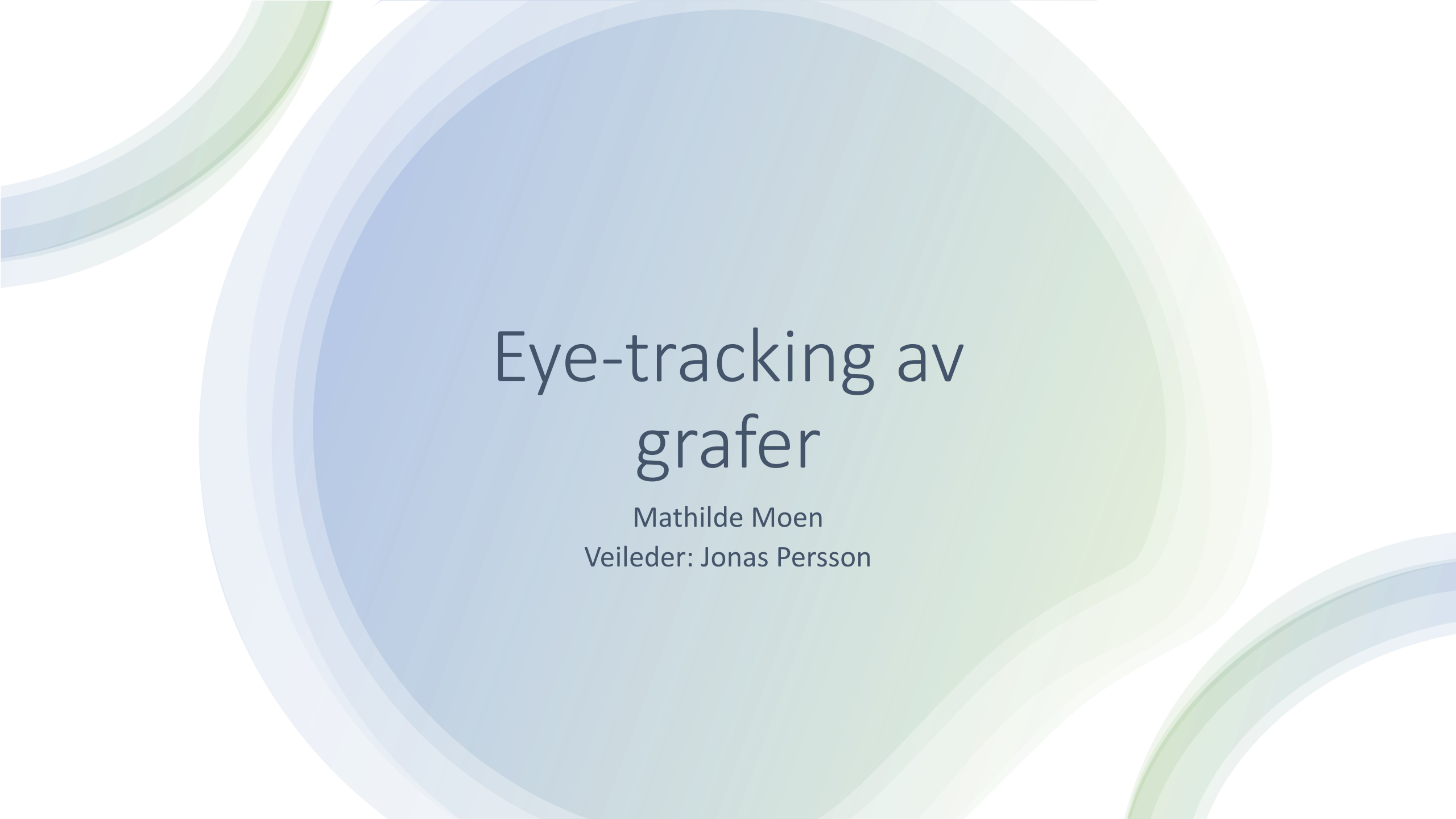


$$\phi_{n\kappa m}(\vec{q}) = \frac{1}{r} \begin{bmatrix} P_{n\kappa}(r) \Omega_{\kappa m}(\theta, \phi) \\ i Q_{n\kappa}(r) \Omega_{-\kappa m}(\theta, \phi) \end{bmatrix}$$

Optimizes the radial orbitals

$$\Psi(\gamma J^\pi M) = \sum_{i=1}^N c_{\gamma_i} \Phi(\gamma_i J^\pi M)$$

and mixing coefficients

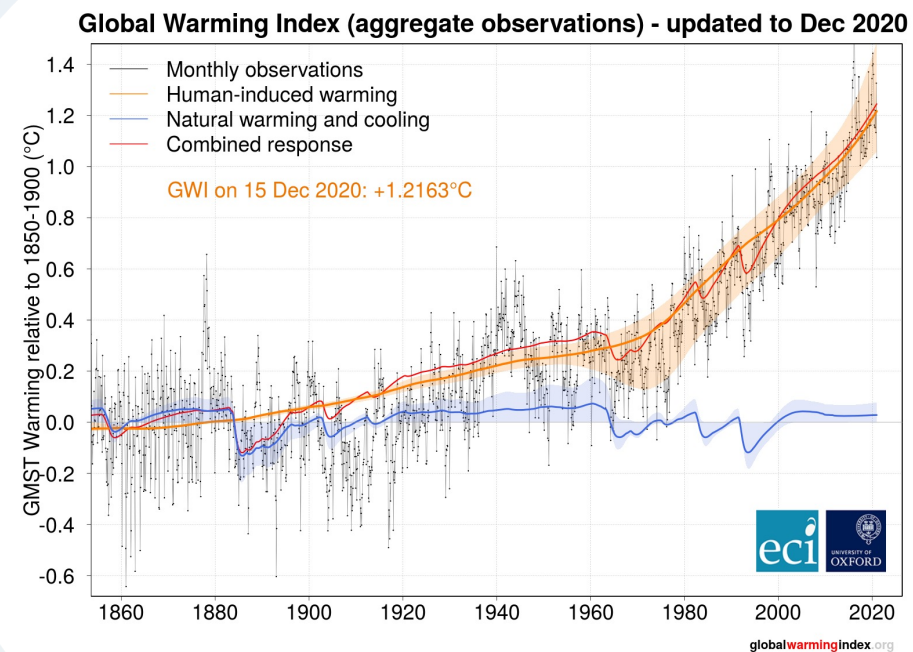


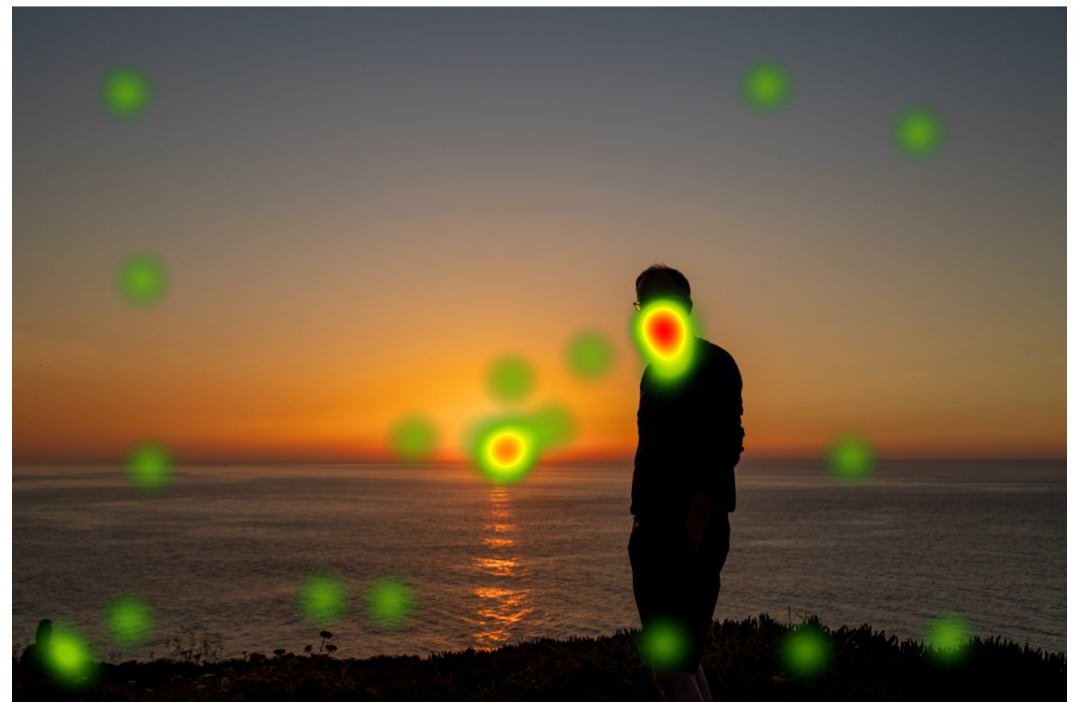
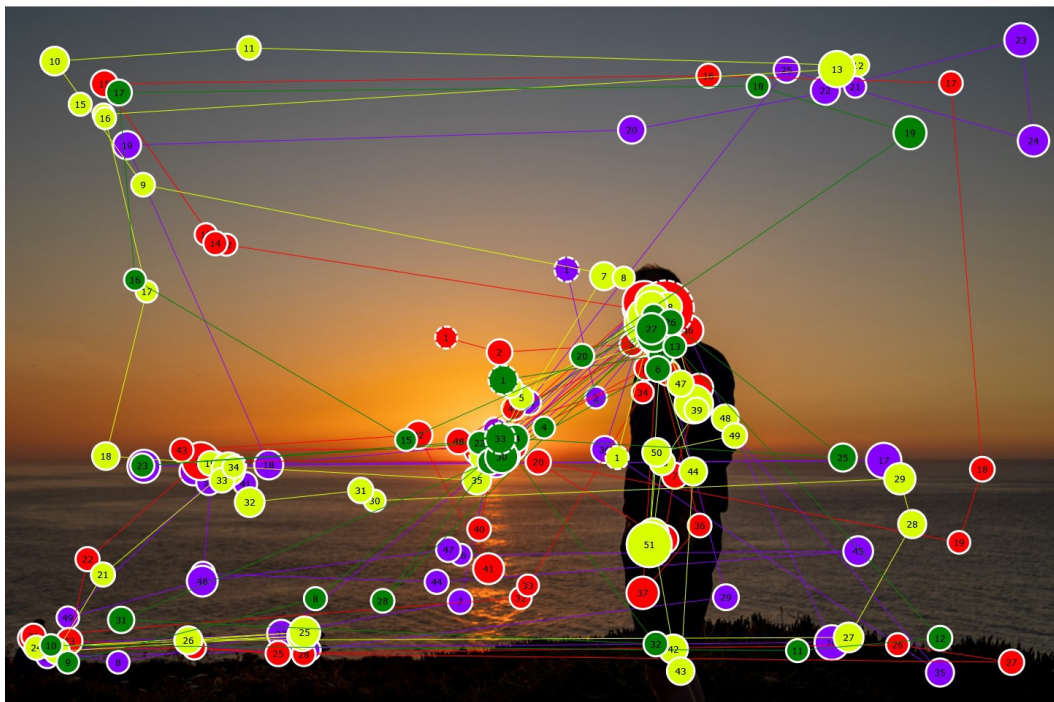
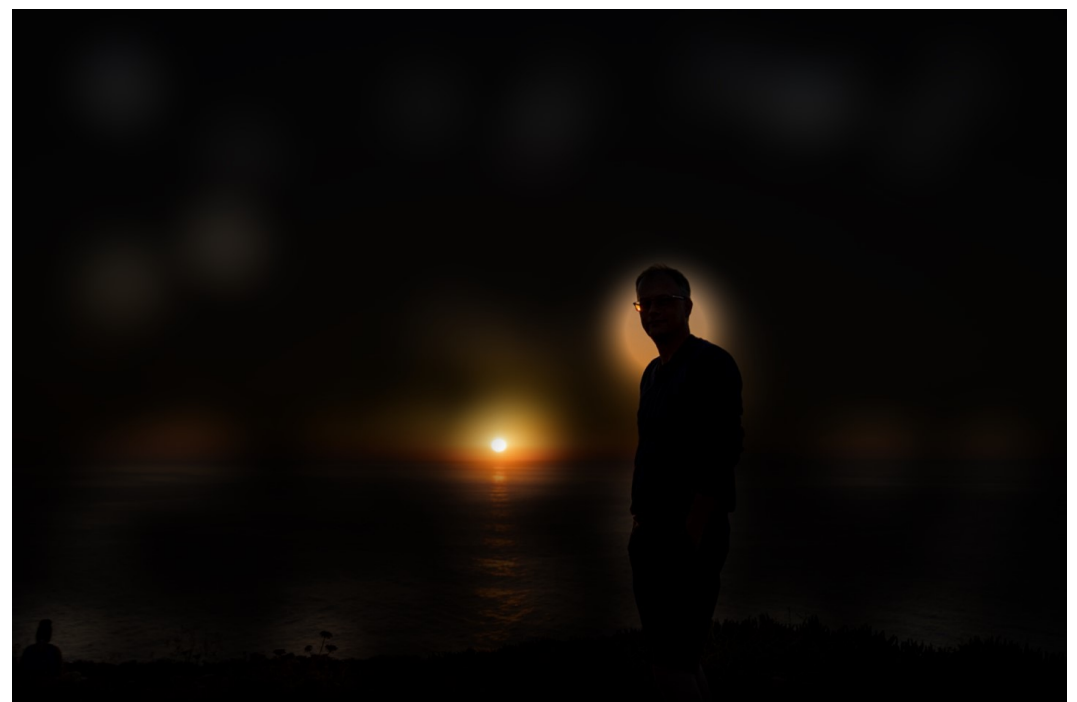
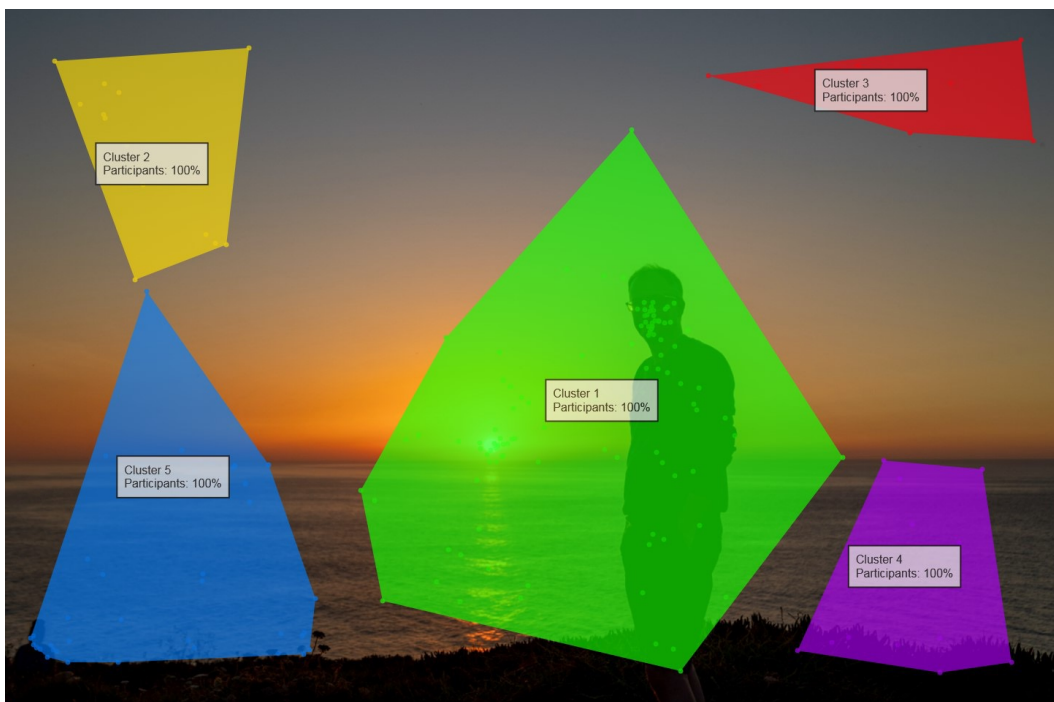
Eye-tracking av grafer

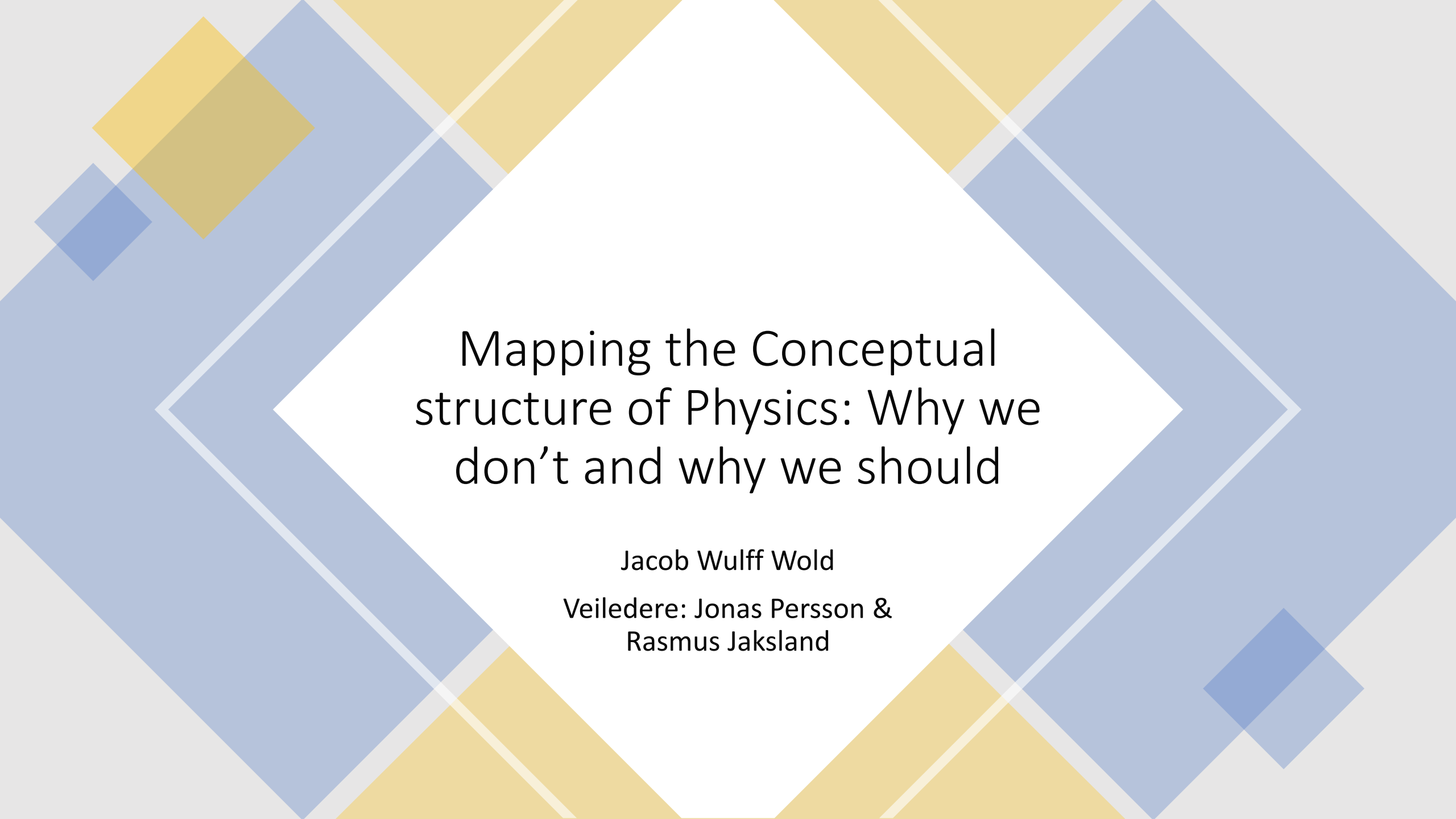
Mathilde Moen

Veileder: Jonas Persson

- Hvordan leser studenter grafer?
- Er det noen forskjell mellom nye og eldre studenter?





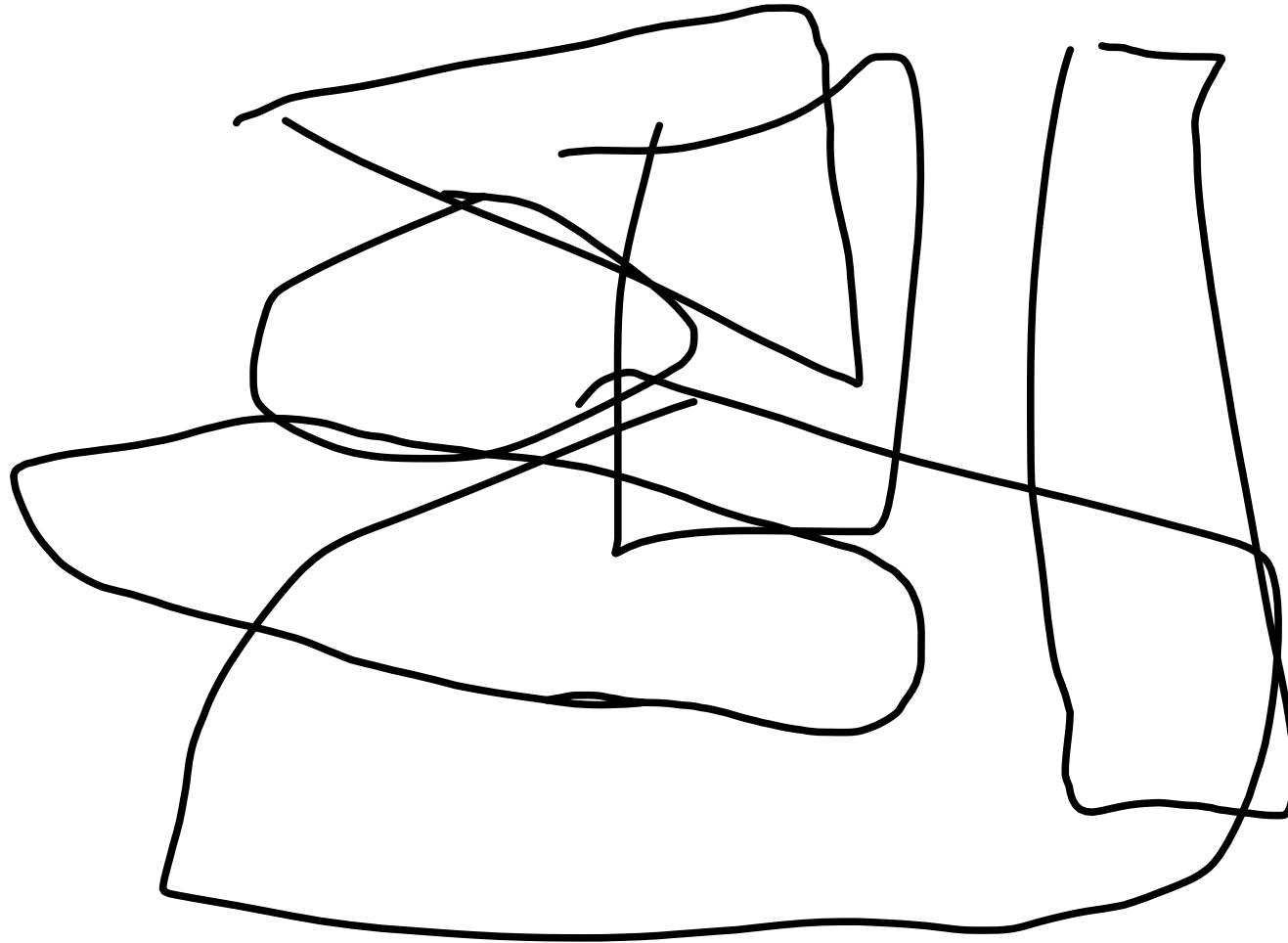


Mapping the Conceptual structure of Physics: Why we don't and why we should

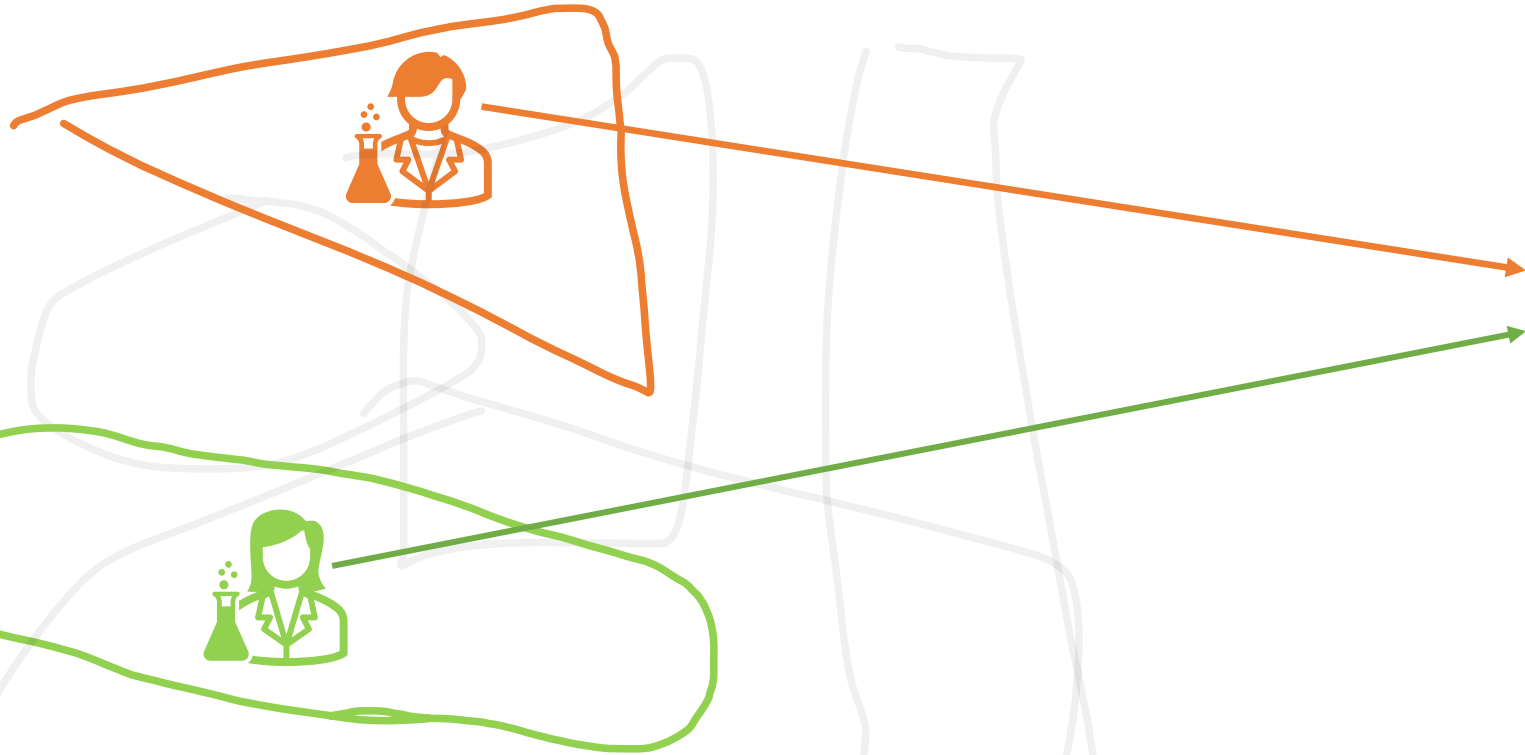
Jacob Wulff Wold

Veiledere: Jonas Persson &
Rasmus Jaksland

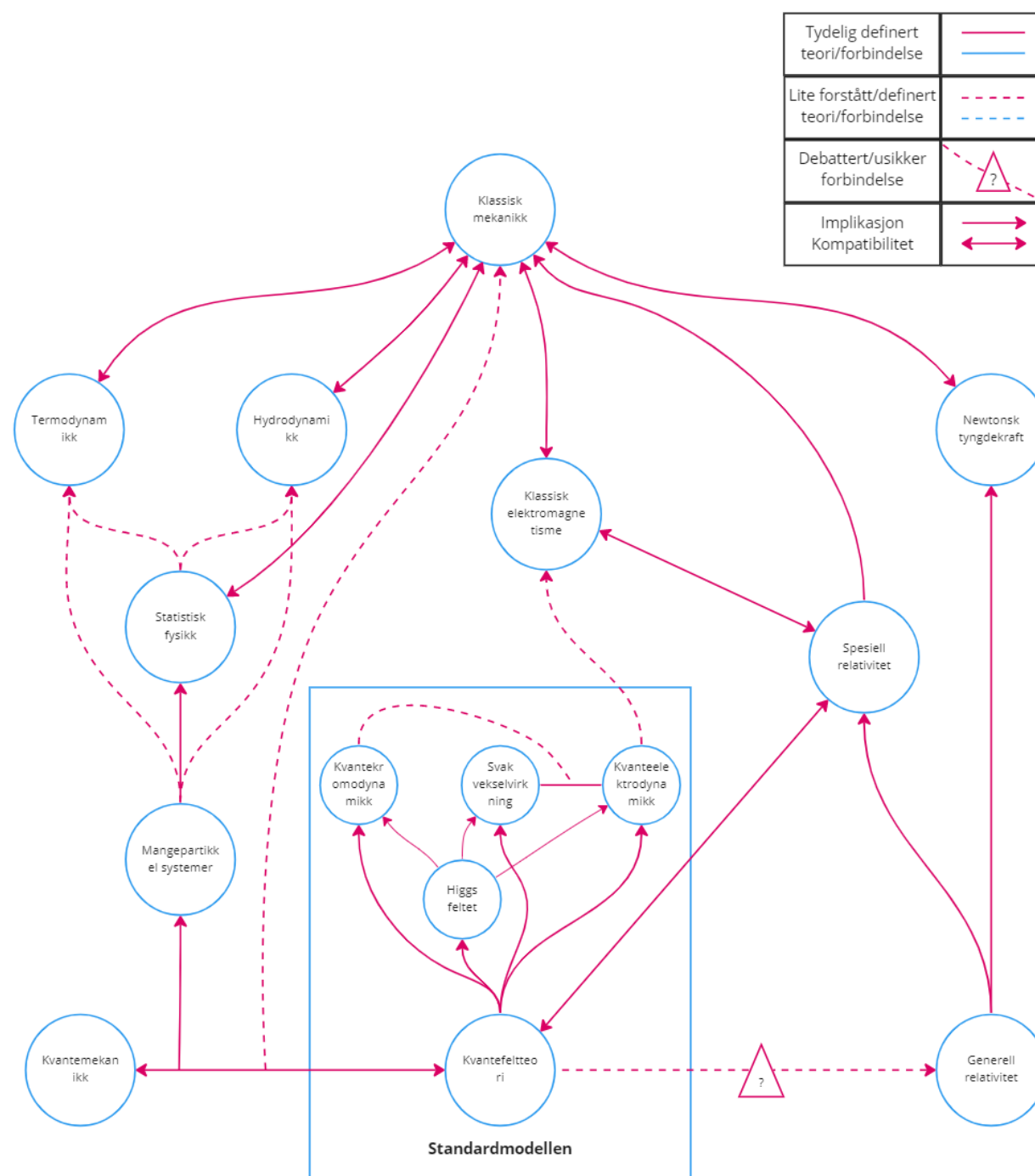
Oversikt over fysikk



Fysikkundervisning



Men faktisk?



Utvikling av et spektroskopisk, polarimetrisk mikroskop for karakterisering av metaoverflater

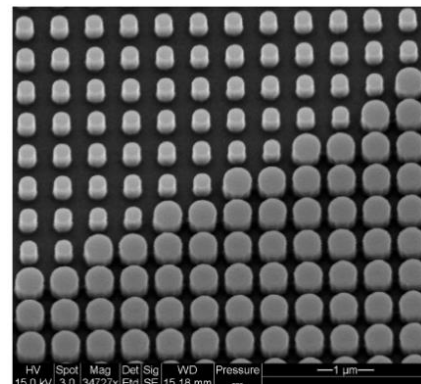
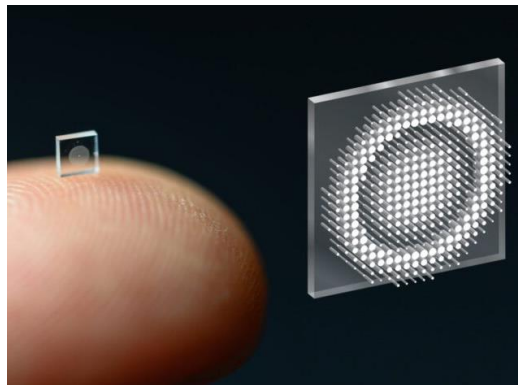
TFY4510 Fordypningsprosjekt Grand Prix, 5.12.2022

Vilde Vraalstad

Veileder: Professor Morten Kildemo

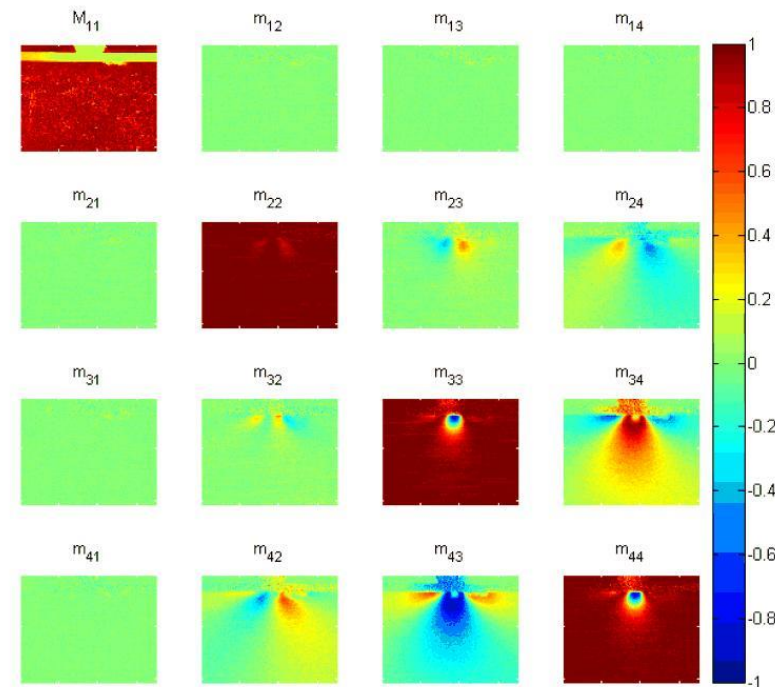
Metaoverflater

- Nanostrukturerte tynnfilmer med struktur som gir spesielle optiske egenskaper
- Små, tynne, flate og akromatiske, og kan erstatte stor, klumpete og dyr optikk
- Kan gjøre integrerte optiske kretser mindre, billigere og raskere, og muliggjør ny bruk av optikk
- Spådd en enorm rolle fremover i optikk- og fotonikk-verden



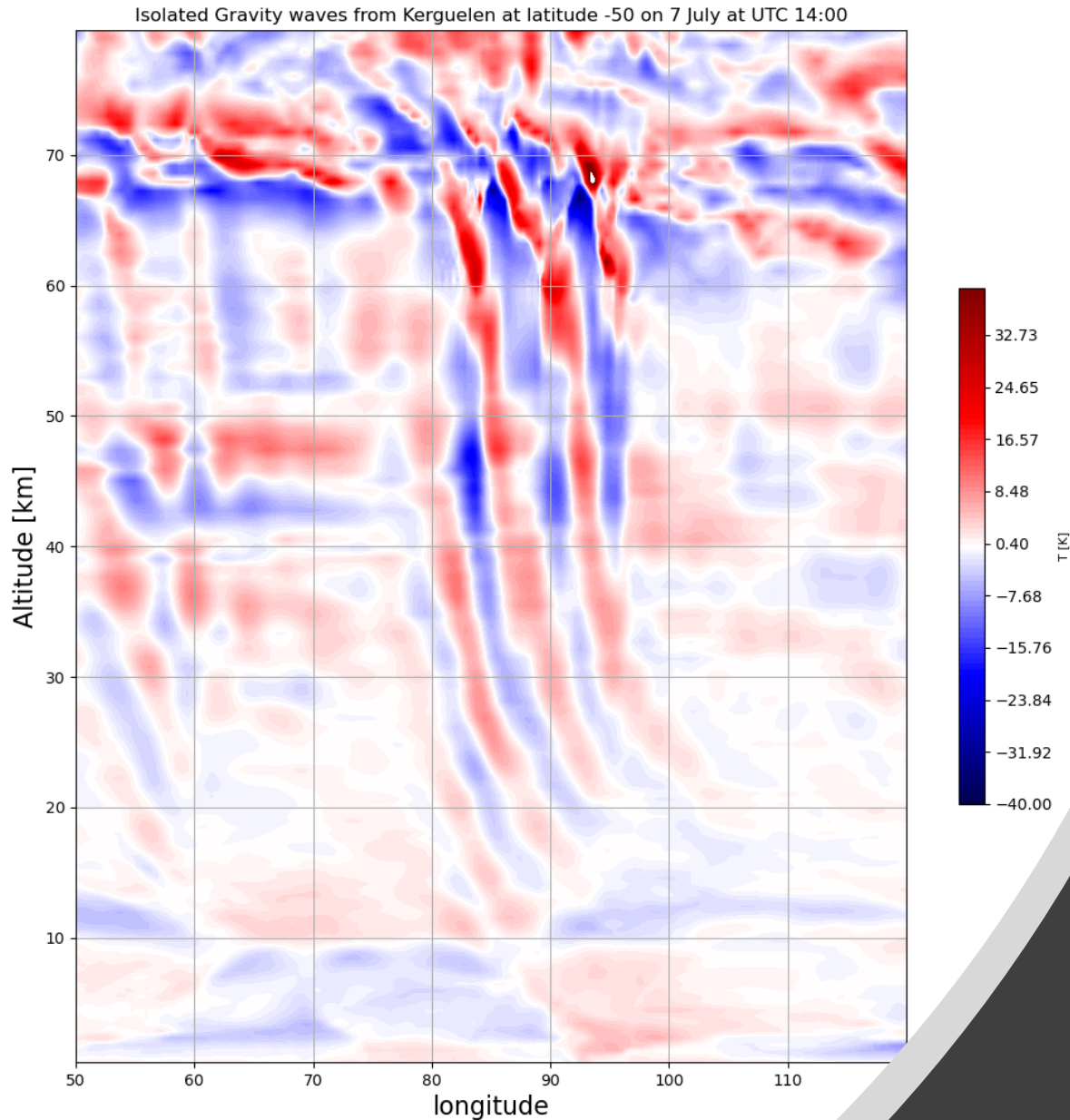
Spektroskopisk Mueller matrise avbildning

- Et sensitivt verktøy for å analysere de optiske egenskapene til blant annet nanostrukturerte overflater
 - Nyttig for å kontrollere produksjonen og designet av metaoverflater
- Vi utvikler et slikt multimodalt mikroskop, med høy romlig og spektral oppløsning over et stort frekvensområde i NIR og VIS-UV
 - Opererer både i det reelle rommet og Fourier rommet, samt både for refleksjon og transmisjon



Oppsummering

- Utvikling av et multimodalt mikroskop som kombinerer avbildning, spektroskopi og polarimetri
 - Dette er vanskelig, og lite gjort tidligere
- Håper det vil gi nøyaktig og bred karakterisering av blant annet metaoverflater, og bidra til forbedret design og fabrikering



Separasjon av atmosfæriske tyngdebølger i en høyoppløselig atmosfæremodell

Kristoffer Sosulski Moen

Veiledere:

Patrick J. Espy, professor, NTNU

Yvan J. Orsolini, seniorforsker, NILU

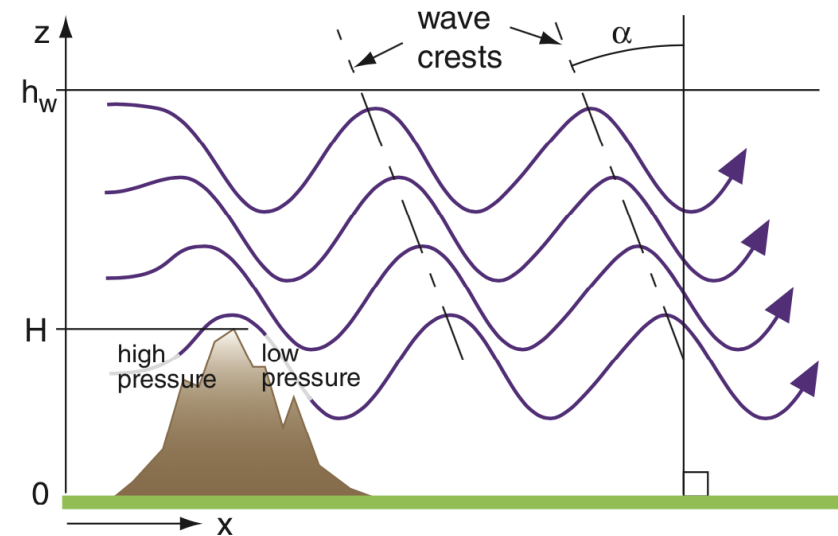
Tyngdebølger - hva og hvorfor?

- Genereres av fjell og stormer
- Propagerer oppover
- Amplitude øker med høyde $\rightarrow$ bølgebrytning
- Avgir energi $\rightarrow$ bremser opp vinder
- Påvirker vær og klima globalt

Problem:

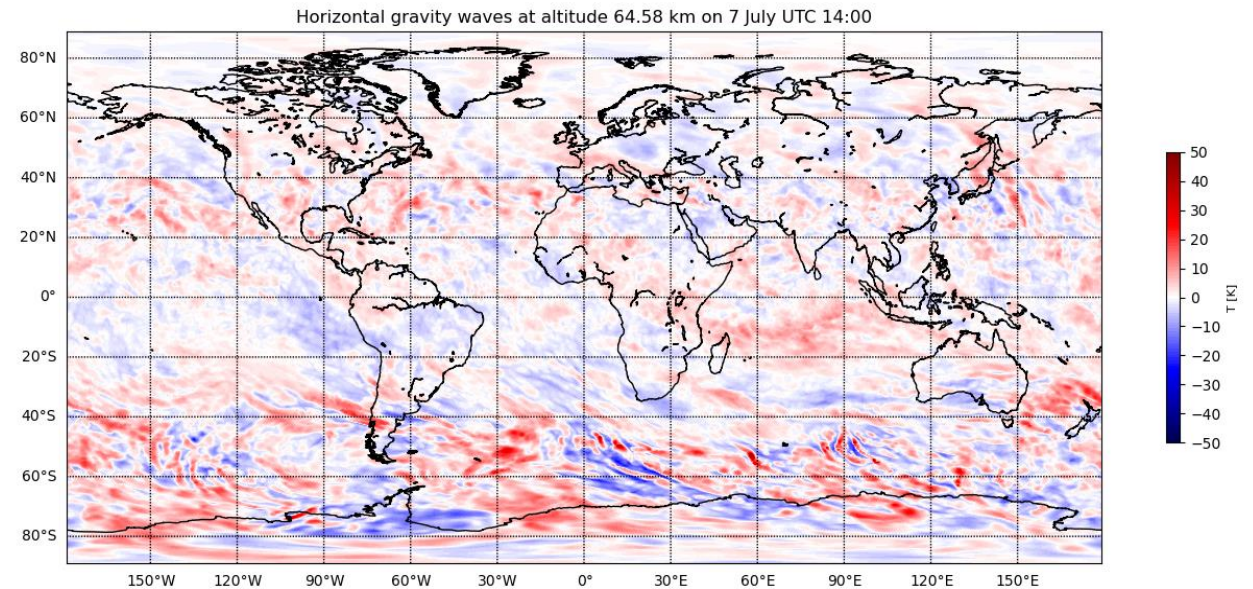
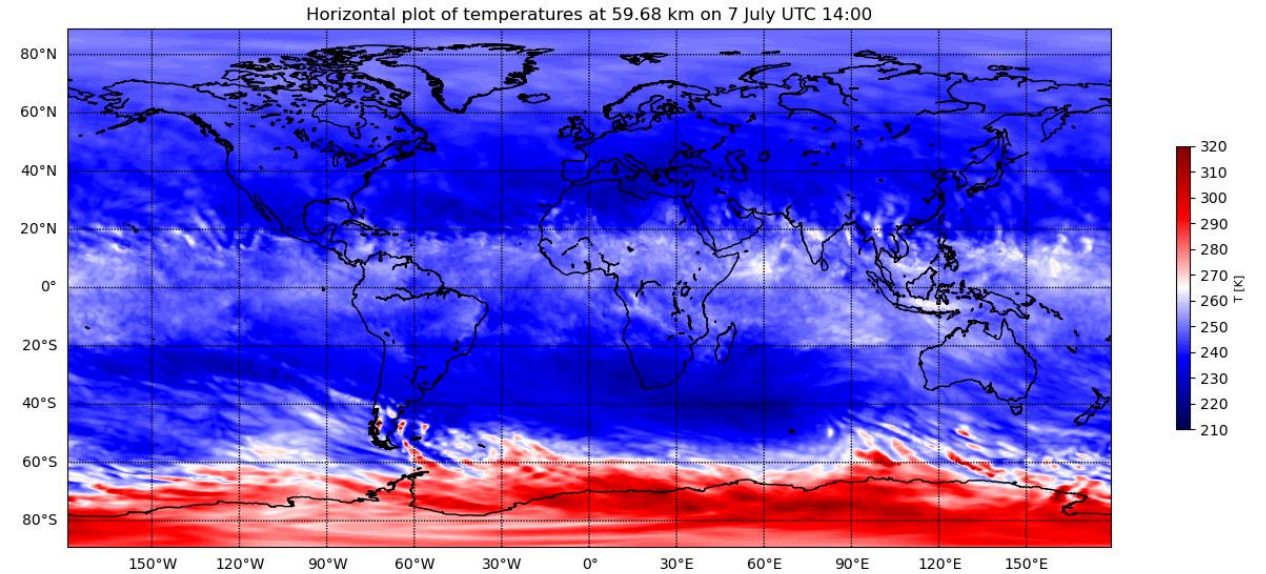
- Småskalaprocess – må modelleres i klimamodeller
- Energi fra bølger underestimert i modeller
- Feilkilde i vær- og klimavarsling

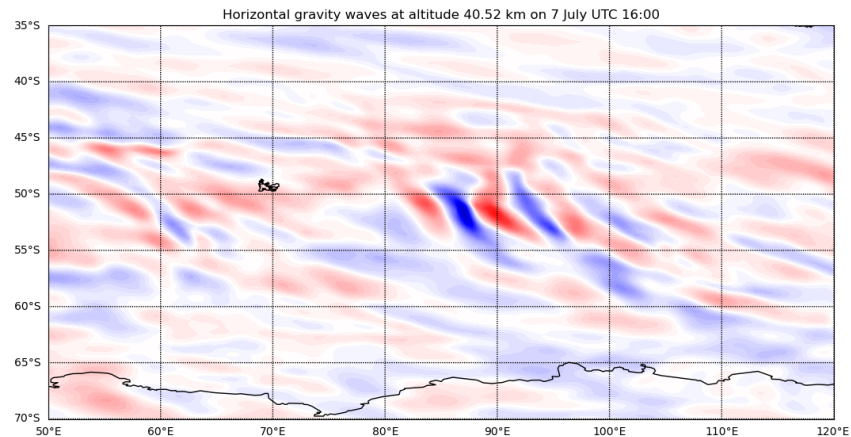
**Bedre forståelse av bølgene $\rightarrow$
bedre vær- og klimamodeller $\rightarrow$
bedre varsling av værekstremer**



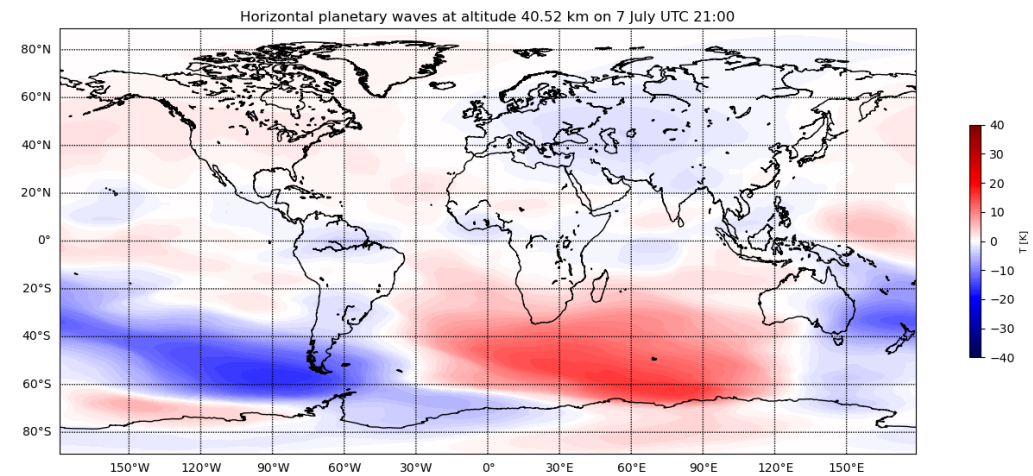
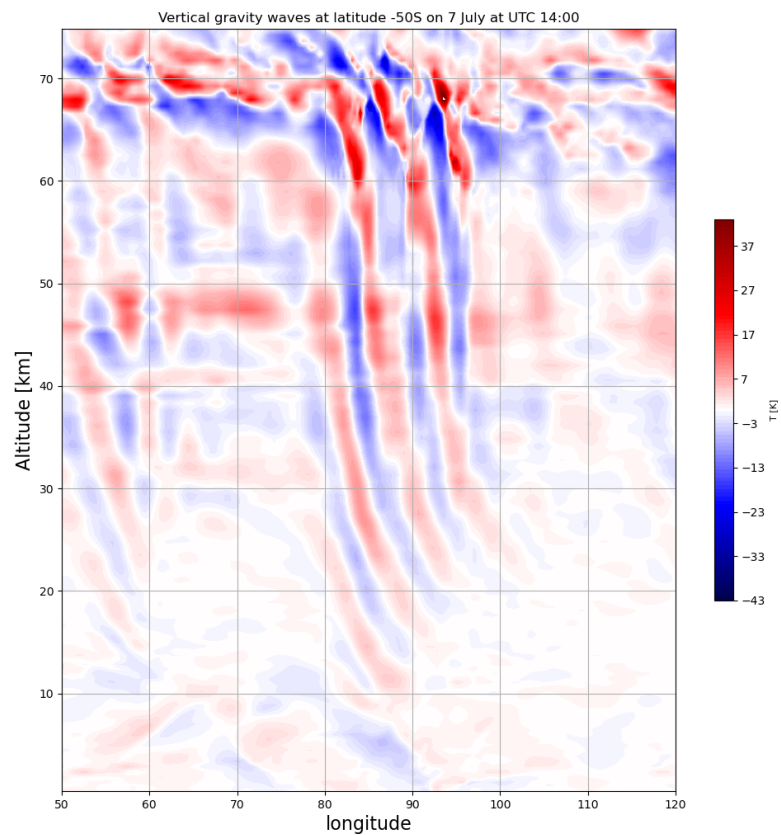
WACCM-modellen

- Høyoppløselig modell for atmosfæren
→ kan oppløse flere bølger
- 7 dagers simulering
- gir innblikk i komplekse interaksjoner
- **Prosjekt: isolere bølgetyper ved filtreringer**
- **Master: studere interaksjonen mellom isolerte tyngdebølger, vinder og andre bølgetyper**

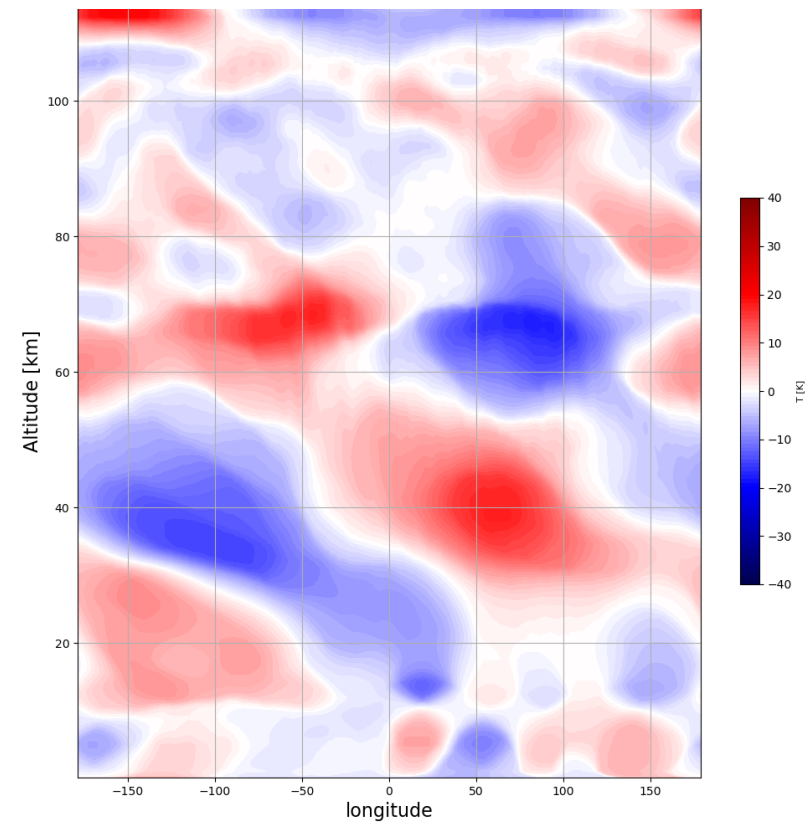




Tyngdebølger (nærbilde av Kerguelen)



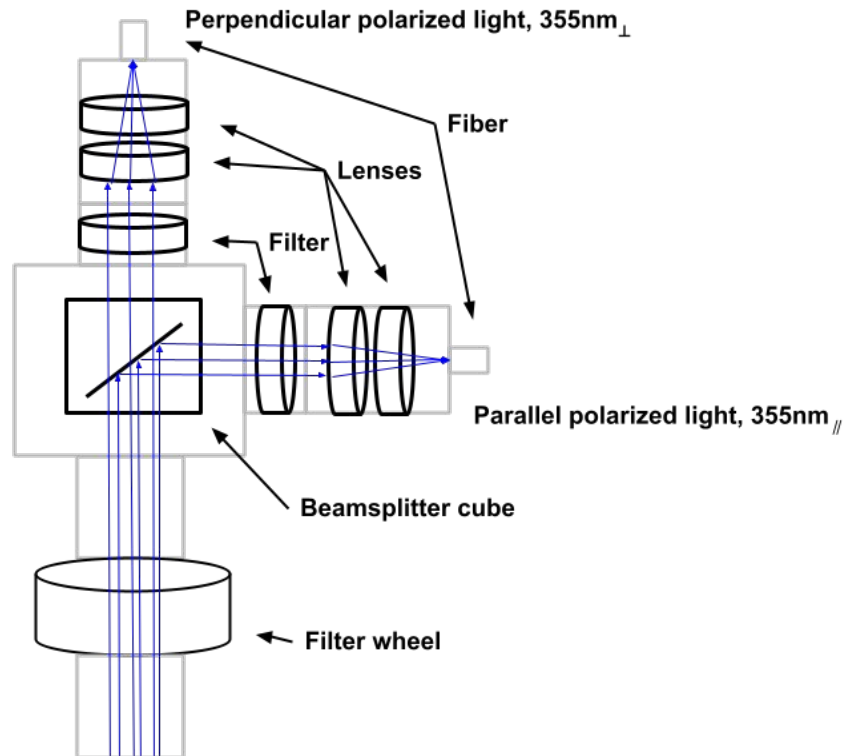
Planetære bølger



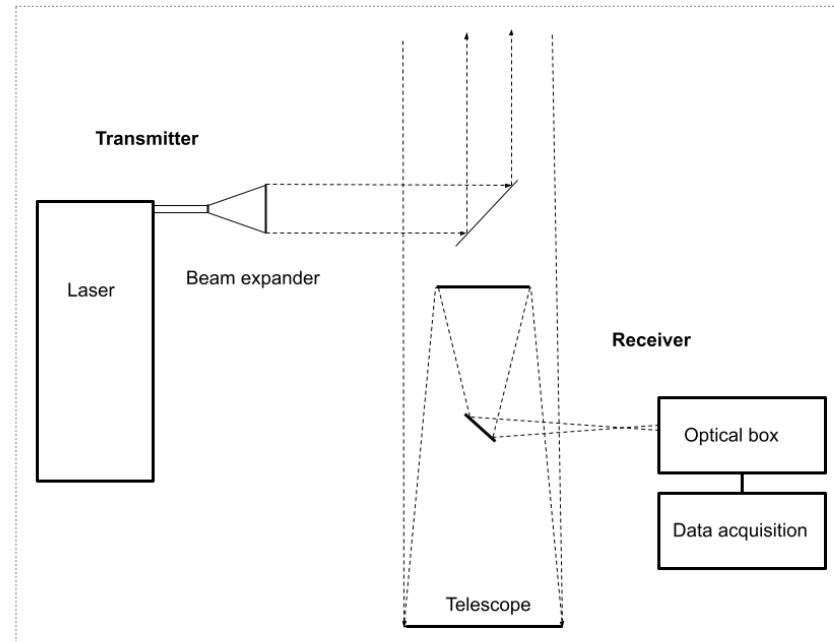
Design and raytrace of a UV 355nm LIDAR depolarization channel to characterize particles in the atmosphere above ALOMAR

Jørgen Salvesen

December 1, 2022



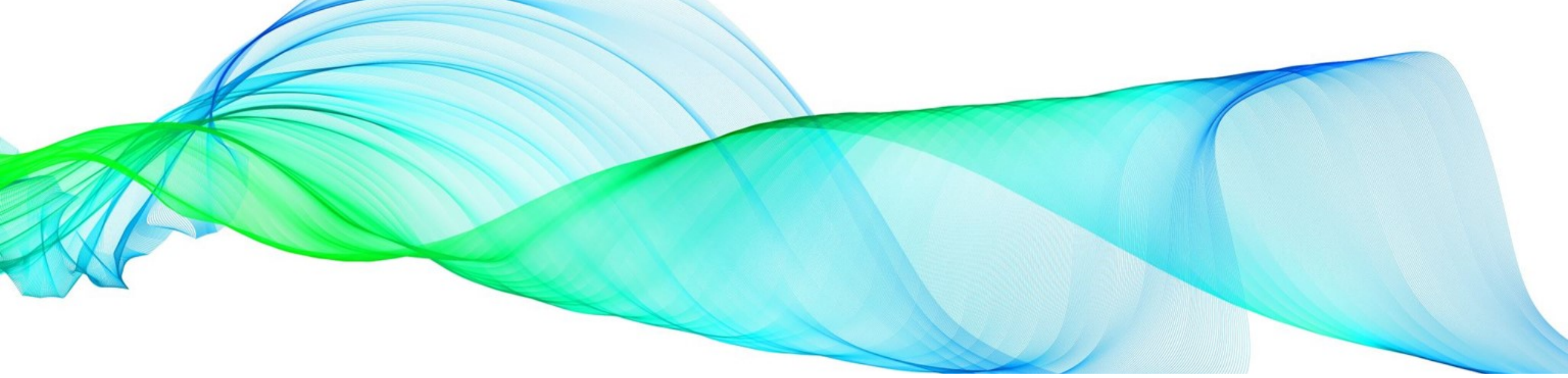
Laser, Nd:YAG - 355nm channel





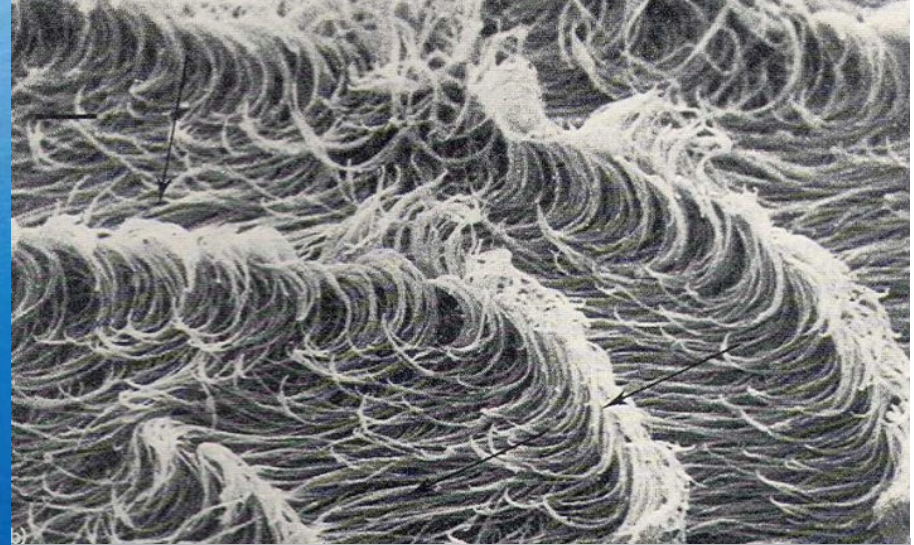
Summary

- Design and Raytrace of UV depolarization channel
- 355 nm in combination with pre-existing 532 nm channel;
 - Atmospheric and cloud composition
 - Particle size and shape indication
 - Temperature profiling

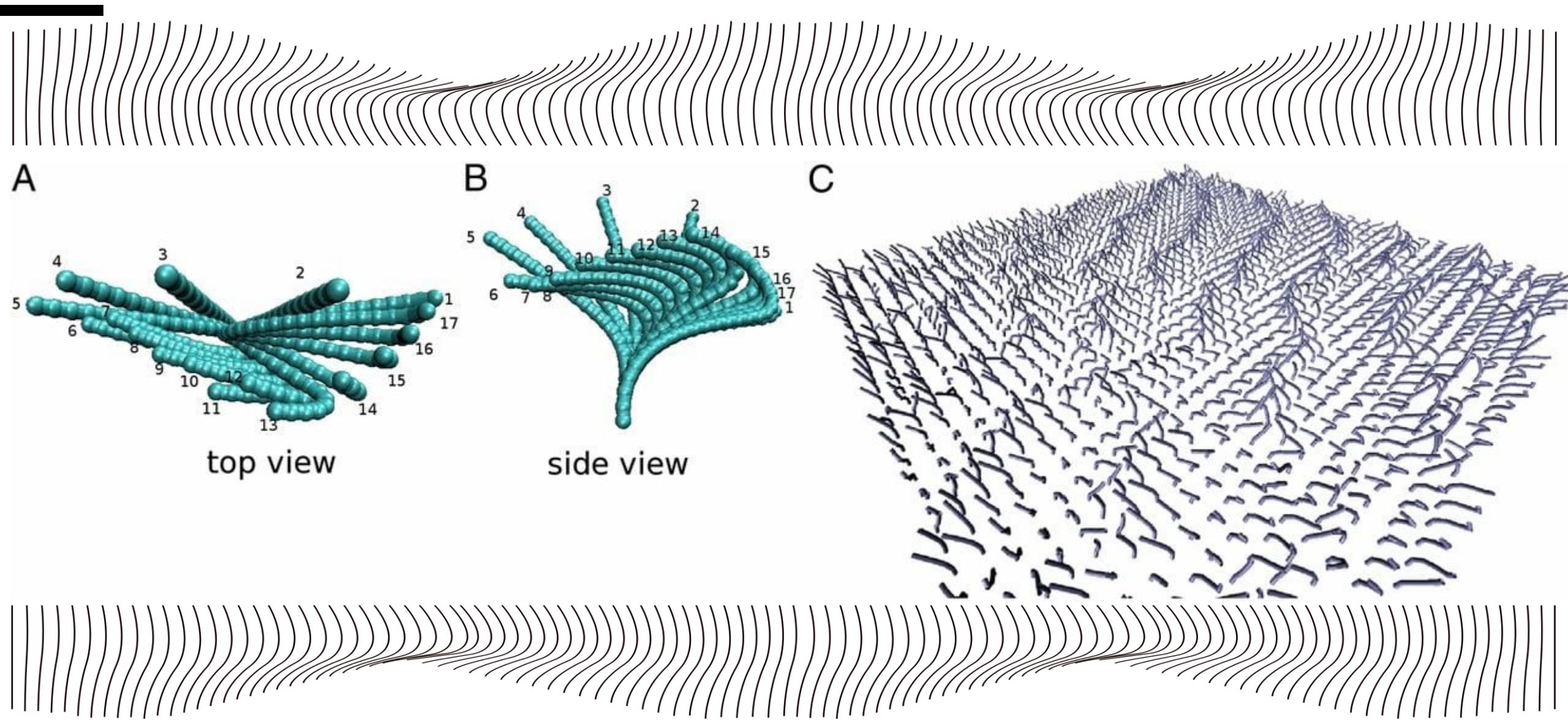


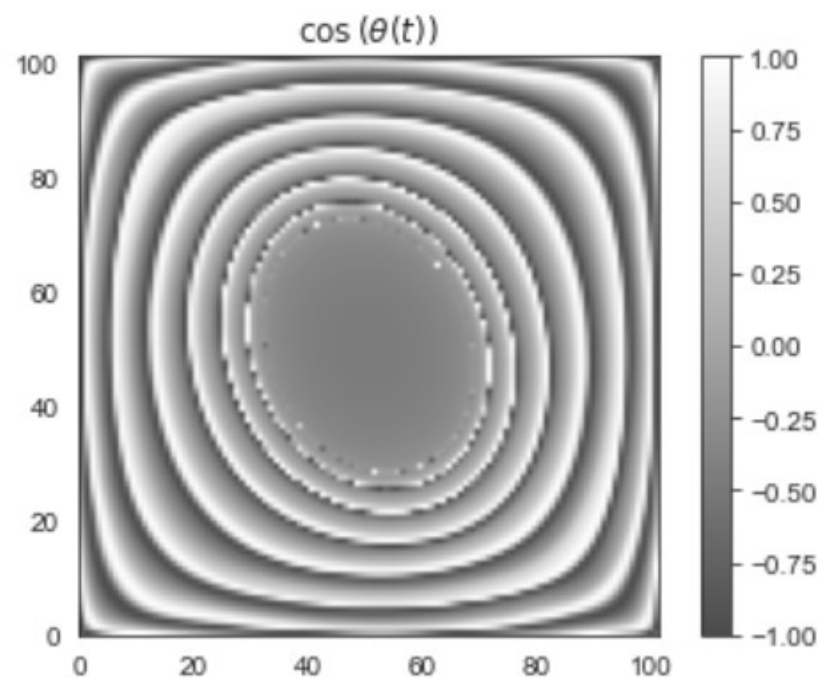
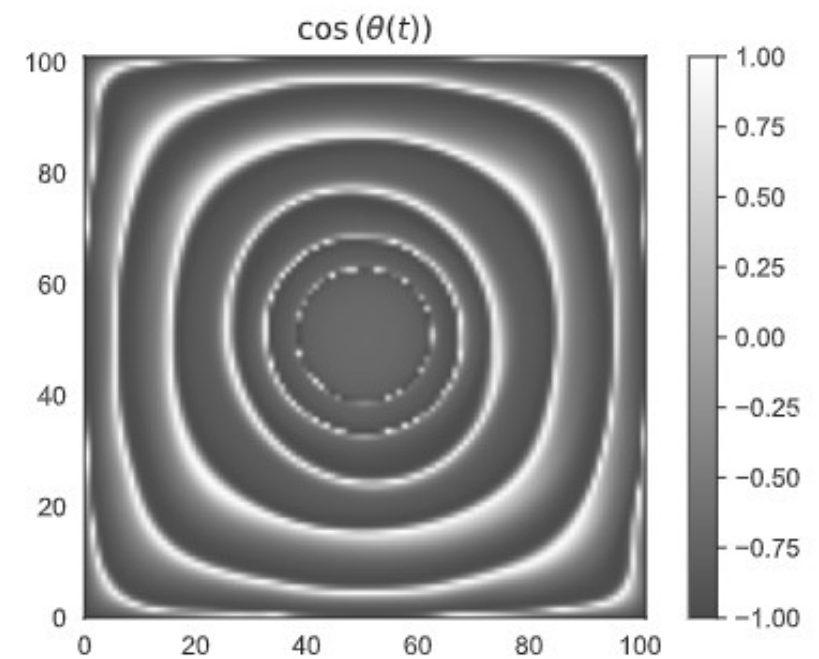
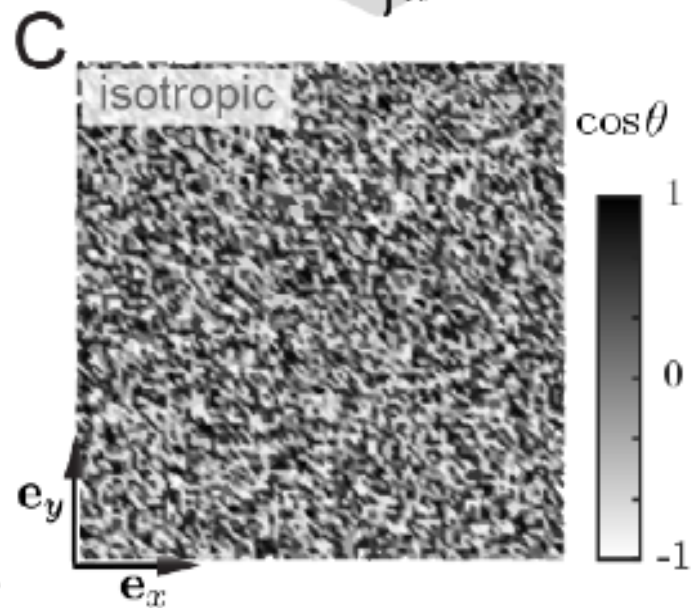
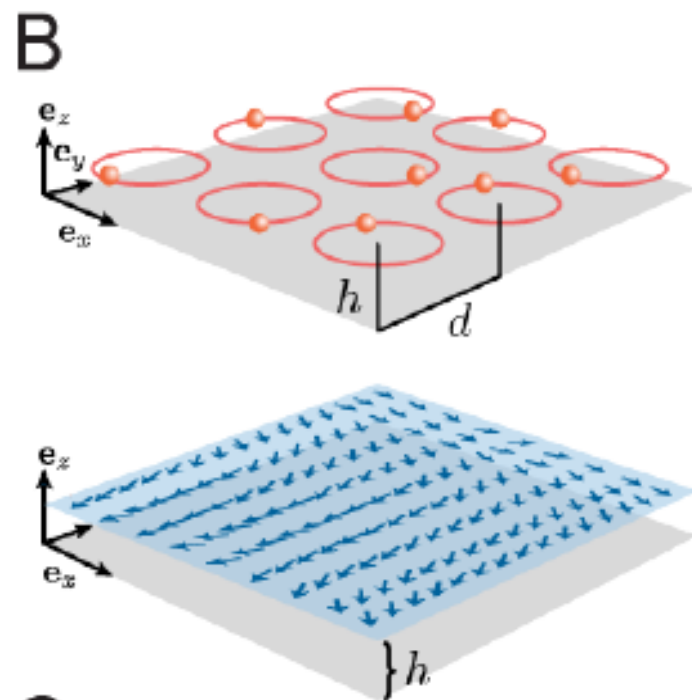
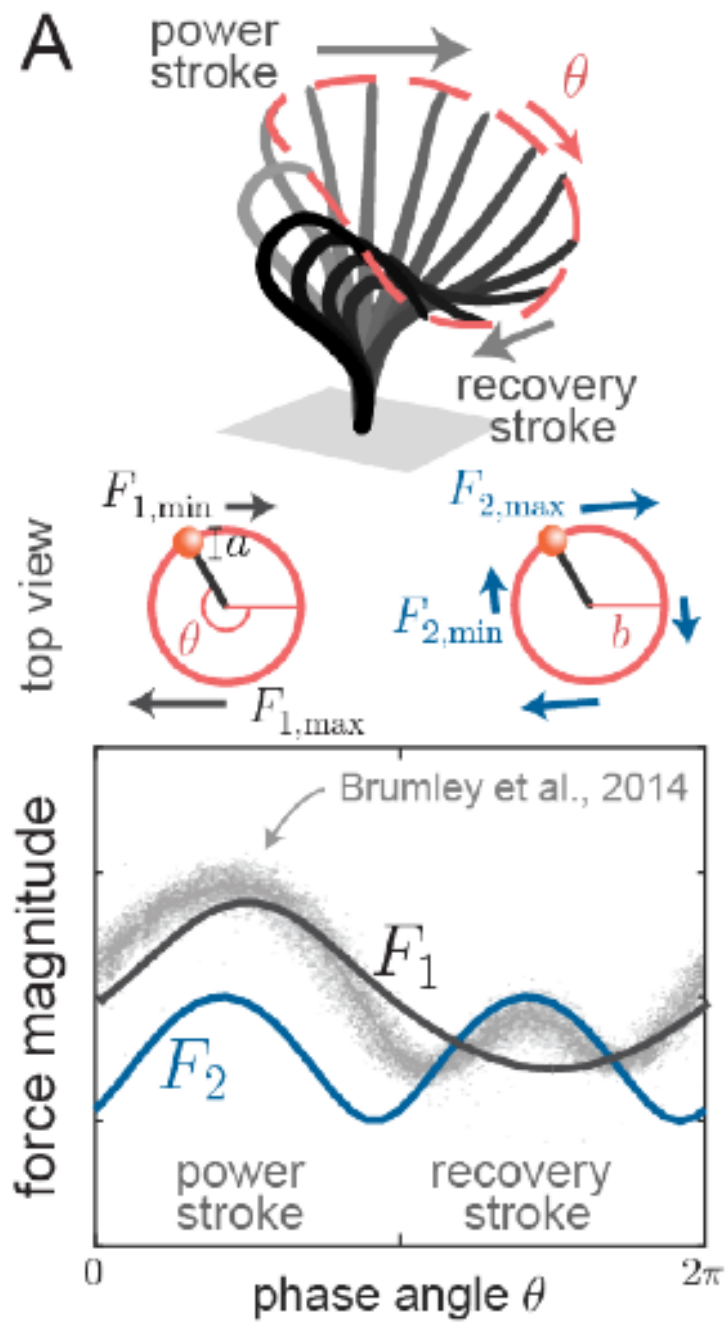
RADIAL METACHRONAL WAVES IN FINITE SYSTEM OF SIMPLIFIED CILIA WITH HYDRODYNAMIC INTERACTIONS

COLLECTIVE MOTION AND SYNCHRONIZATION



CILIA



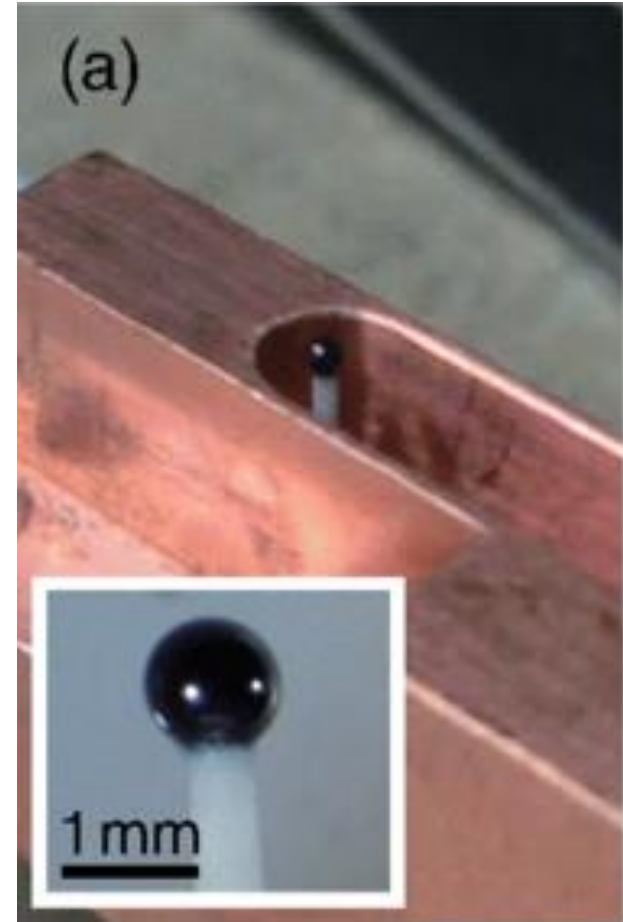


Elektromagnetisk-Kavitet

Veileder: Sol Jacobsen og Henning Hugdal

Hva er en EM-Kavitet?

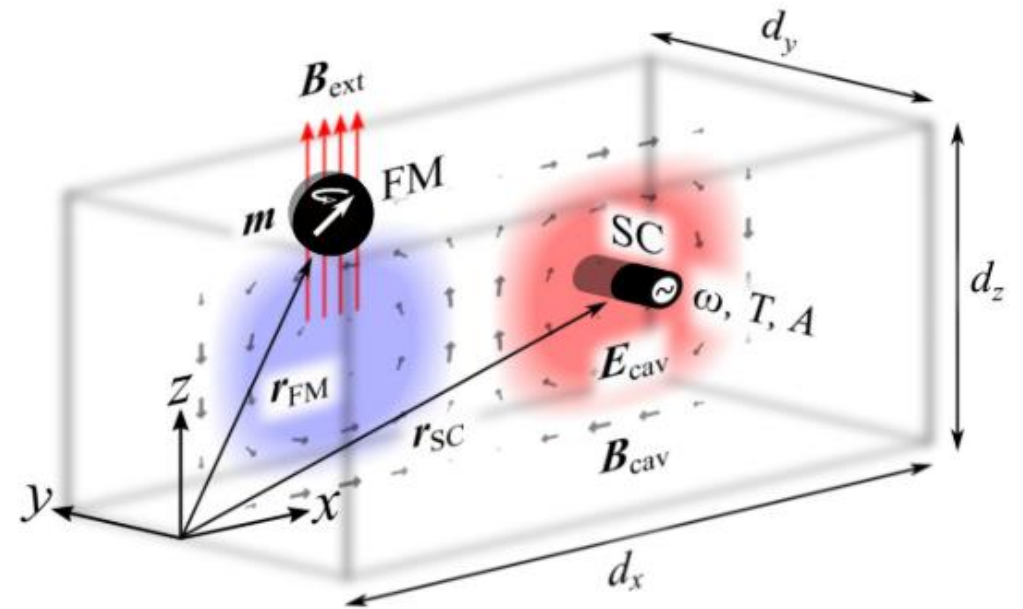
- Boks med speil som vegger
- Kvantiserte fotoner
- Høyt antall fotoner
 - resonans
- Brukt i presise posisjon sensorer
 - Måle endring i resonansfrekvens
- Interaksjon mellom faste stoffer og fotoner



PhysRevLett.113.083603

Interaksjon over store avstander

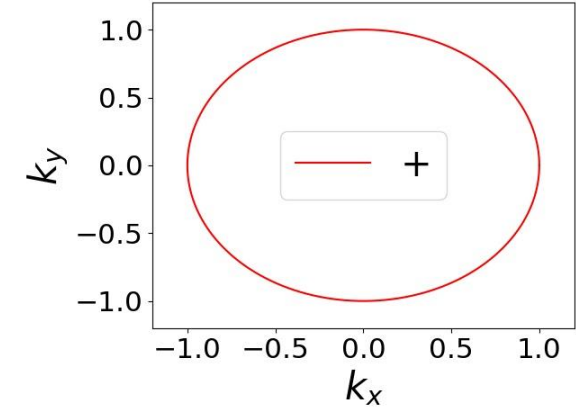
- Andreas Jansøn phd: Interaksjon mellom superleder og magnet
- Superleder- $\rightarrow$ foton- $\rightarrow$ magnet
- Interaksjon på millimeter skala
 - Kontrast til nano/mikrometer skala av nærhetsinteraksjon



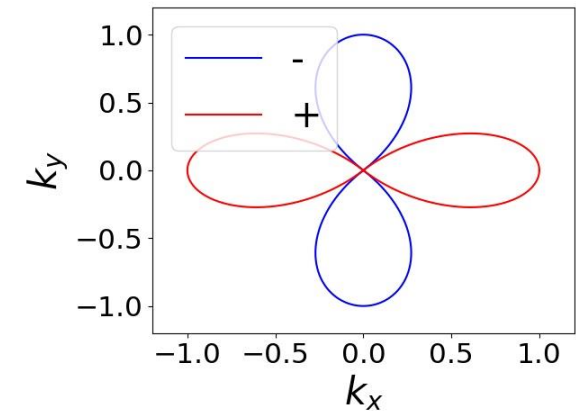
PhysRevB.102.180506

Mitt prosjekt

- Basert på Jansønn sitt Ph.d. arbeid
- Se på superleder – foton interaksjon
- Kan man studere superlederen ved å se på fotonene?
 - Gap symmetri



s-wave



d-wave

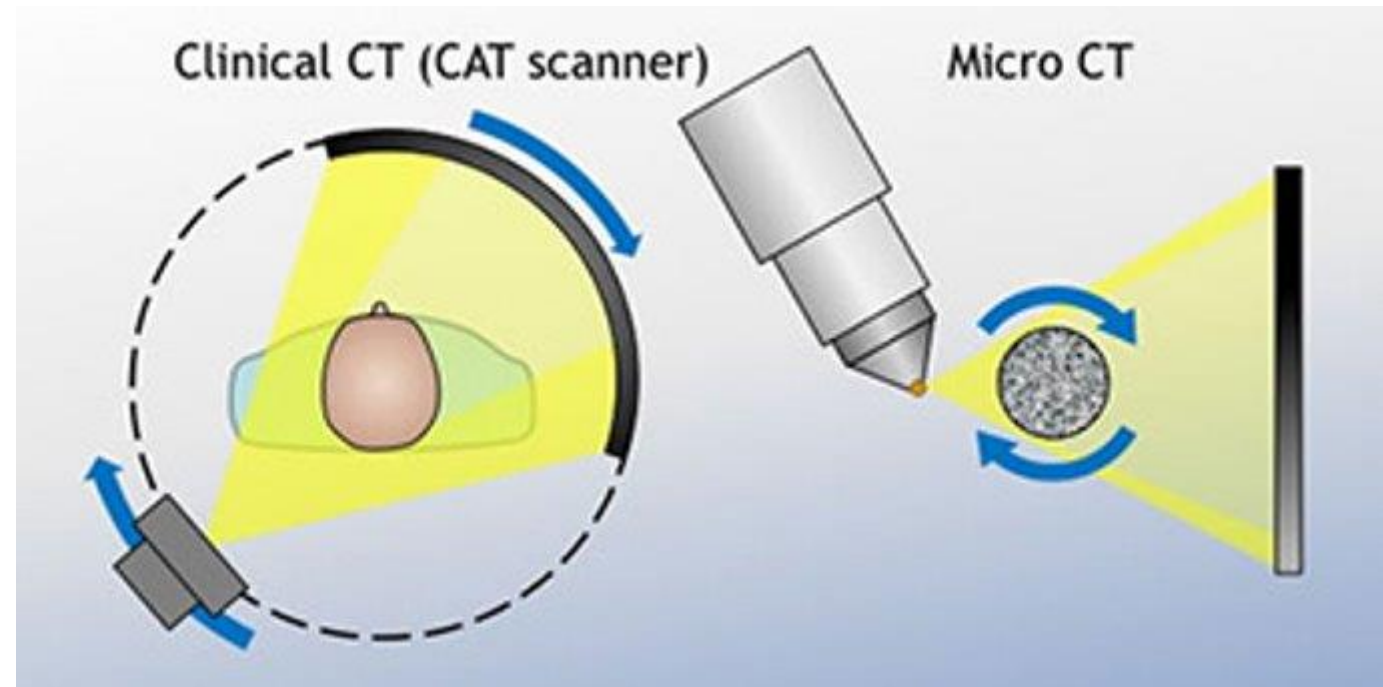
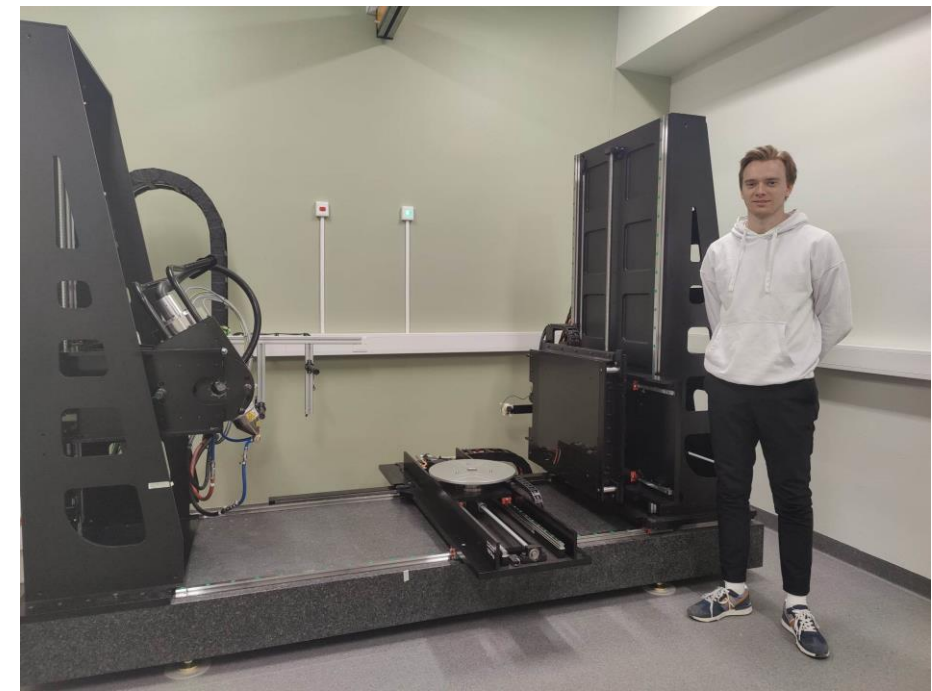
3D-avbildning av dynamiske systemer med X-ray CT

Av: Mats-Johan Fagerheim

Veiledere: Ragnvald Mathisen og Amir Ghaderi (SINTEF Industri)

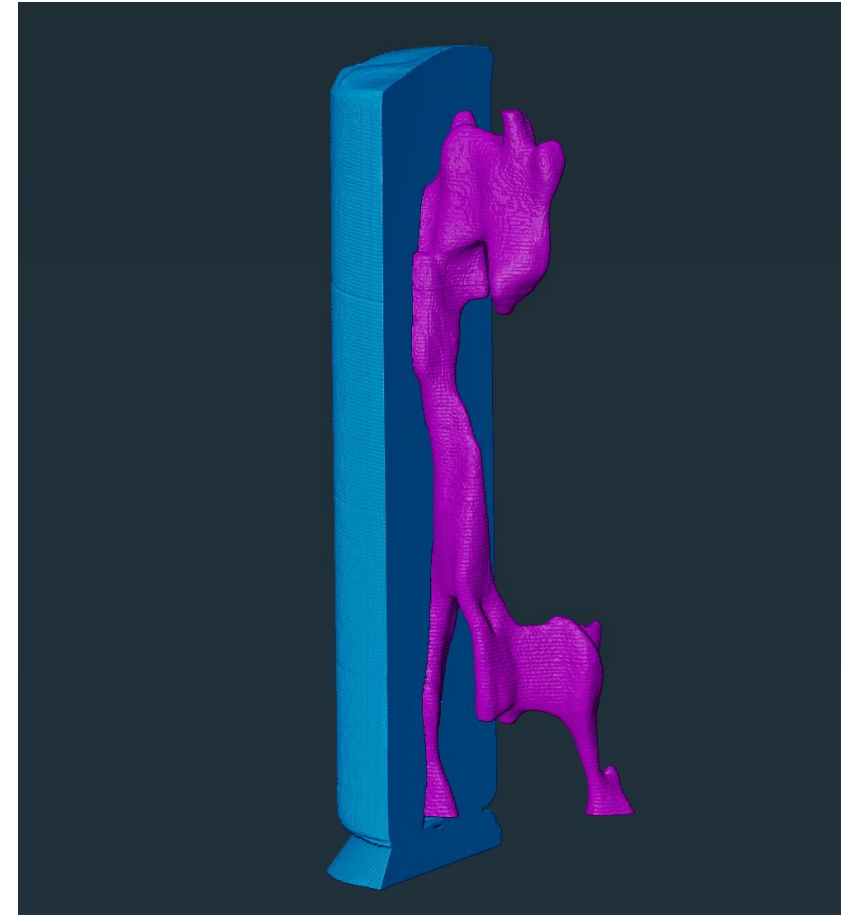
Computed tomography (CT)

- Projesjoner av objektet (X-ray)
- Attenuasjon
- Filter back projection
- Redusere antall projeksjoner
- Avbildningsmetoder
- Forhåndskunnskaper



Porøse medier

- 3D printet
- Pore hentet fra sandstein
- Mål på feil

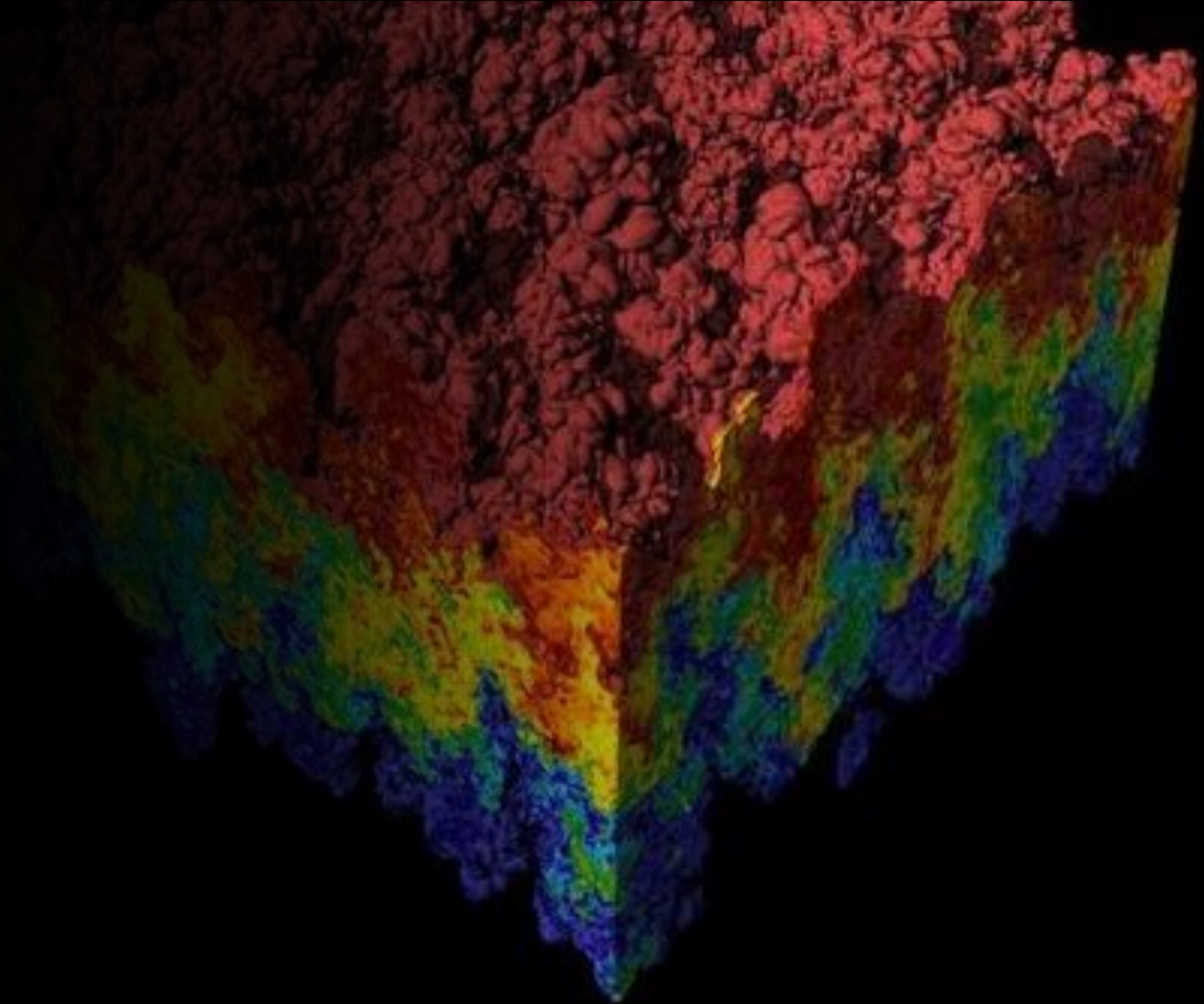


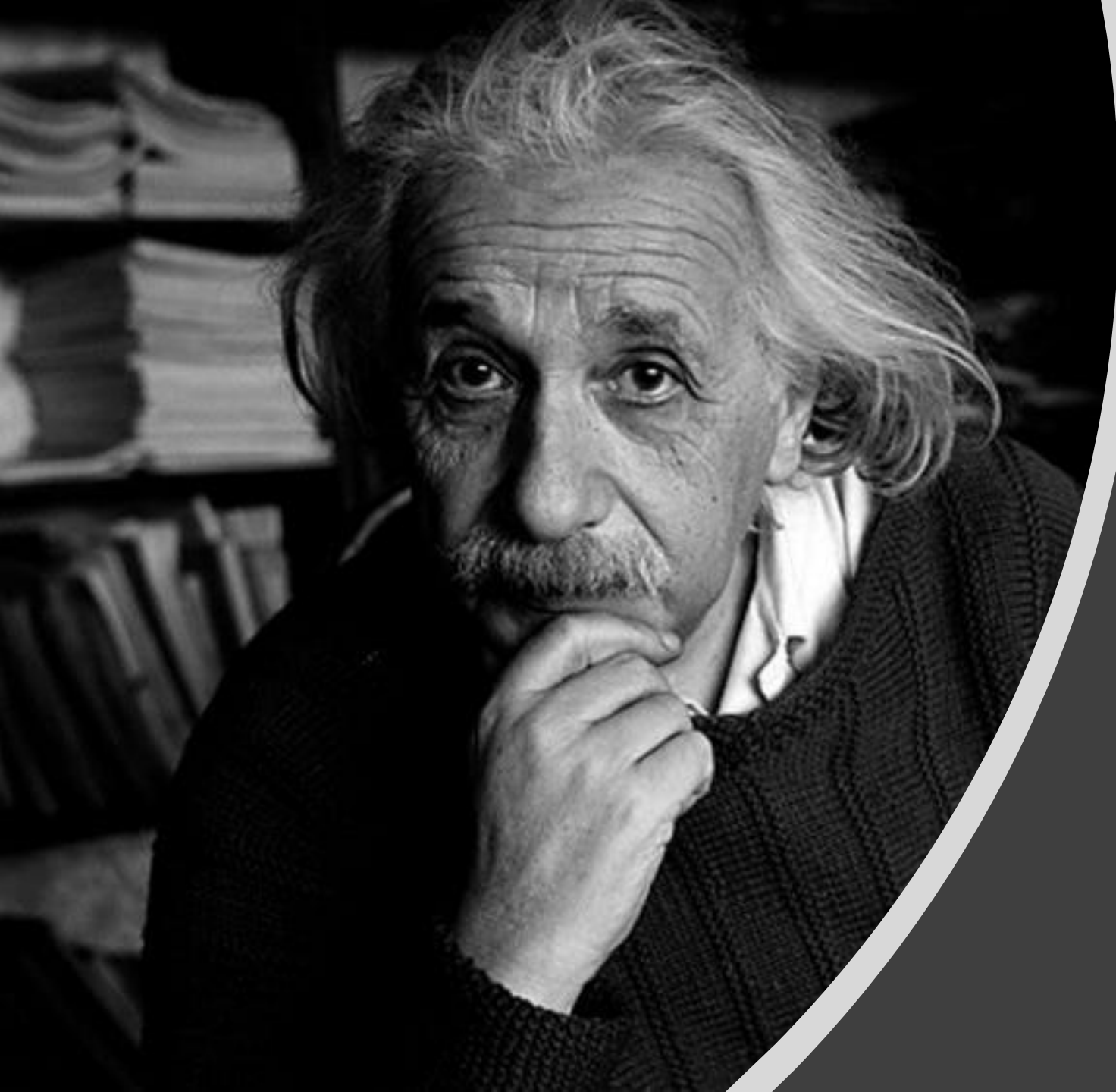
Spørsmål ?



Simulating thermodynamical properties of noble gases using molecular dynamics

Arne Kristian Kramprud Hjelt
Under veiledning av Raffaella Cabriolu





← That guy again...

«Gedankenexperiment»

- Imagine an experimental setup
- Do the experiment mentally by applying the physics you know
- Evaluate

Benefits

- You can do big experiments that would be expensive or impossible to do in real life
- You can get interesting results that push your understanding further

Challenges

- Systems with many individual elements that cant be approximated to a few big entities can get to complex to keep track of
- Complex systems might generate a lot of data which can be labour intensive to analyze



Molecular Dynamics

- The computer-age extension of the thought experiment

No longer any problem to make many calculations on complex systems

Cheap compared to doing the actual physical experiments

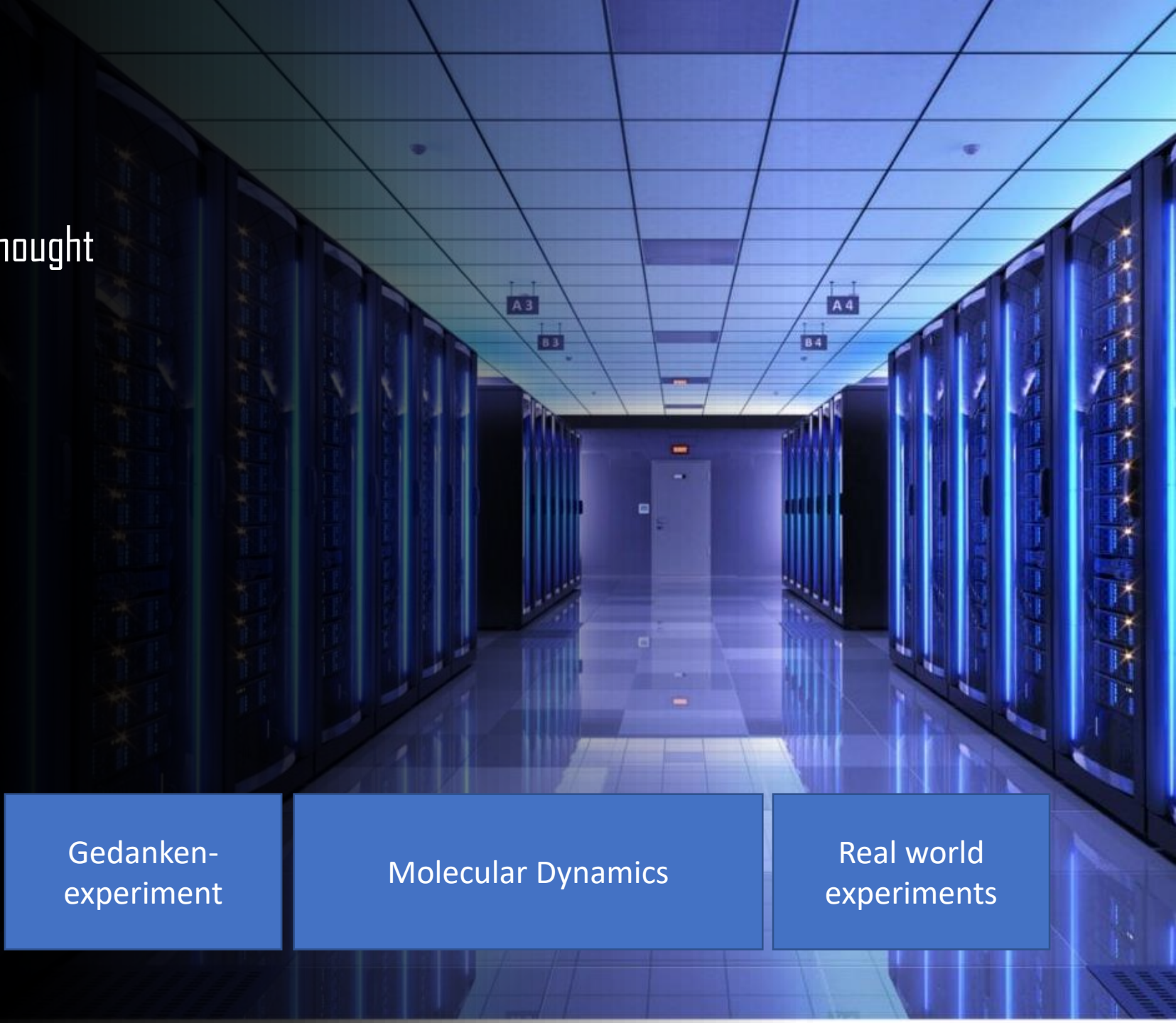
Can analyze vast amounts of data quickly

Results can be graphically represented

Gedanken-
experiment

Molecular Dynamics

Real world
experiments



Simulation of a
4,47 km/s diamond Nano-
Astroid Impacting a Graphene
Sheet

HPC (High Performance
Computing)

LAMMPS

Lennard-Jones potential

