Quantum Science and Technology in Ariel

Vision and Preparation

23.1.2018

PROF. AHARON FRIEDMAN, MR. DAN HARDON

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Existing Centers in Ariel

- Schlesinger Center for Compact Accelerators and Radiation Sources
  - Established as the Free Electron Laser Knowledge Center in 2001
  - Has been recognized in 2018 as a National Knowledge Center for Compact Accelerators.
  - Has three Accelerators
  - Personnel:
    - Eight Faculty
    - A Senior Research Associate
    - Four Engineers
    - In the last five years graduated three PhD students and 11 MSc students

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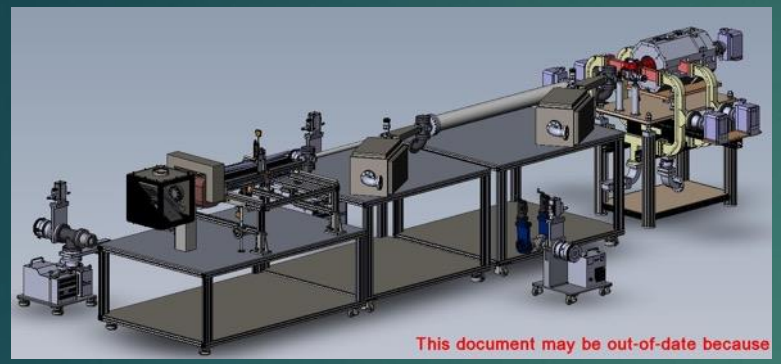
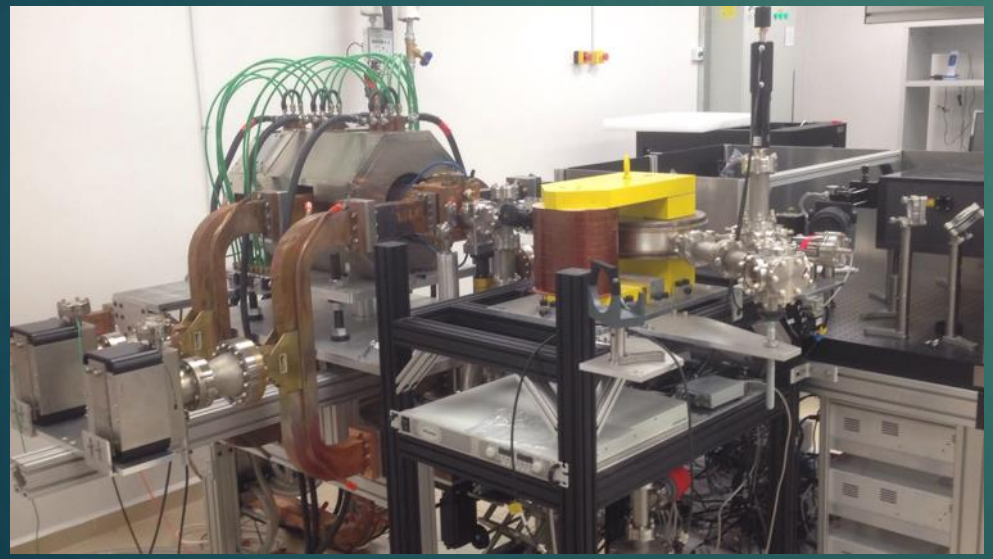
Schlesinger Center





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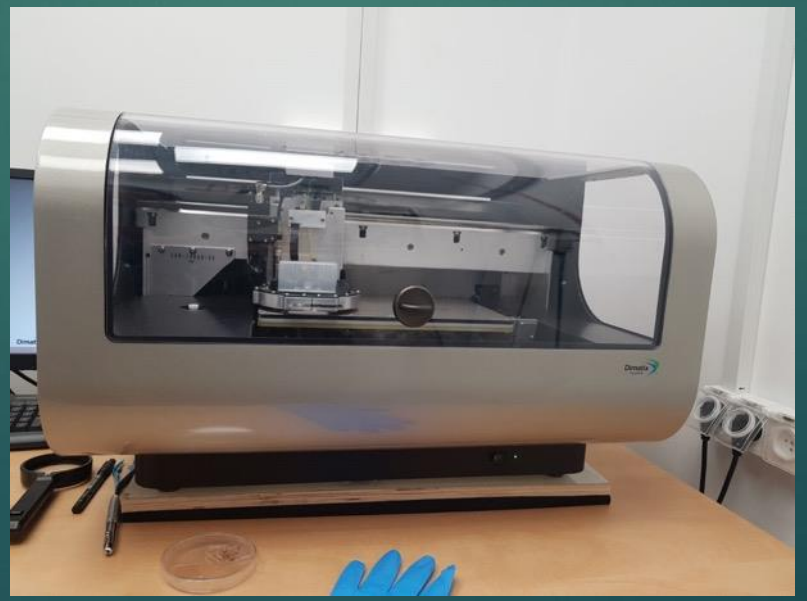
Existing Centers in Ariel (Cont.)

- Center for Material Research
  - Established 2000 and moved to its new housing in 2017
  - Personnel:
    - 9 Faculty
    - 5 engineers
  - Organizes the International MMT Conference since 2000
  - Organized a binational Israel – Russia workshop since 2002
  - **7 Ph.D. and M.Sc. Students and one Post-Doc**

Center for Material Science

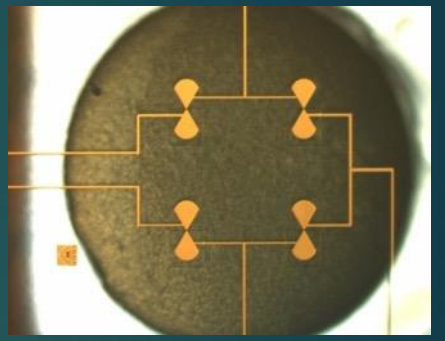


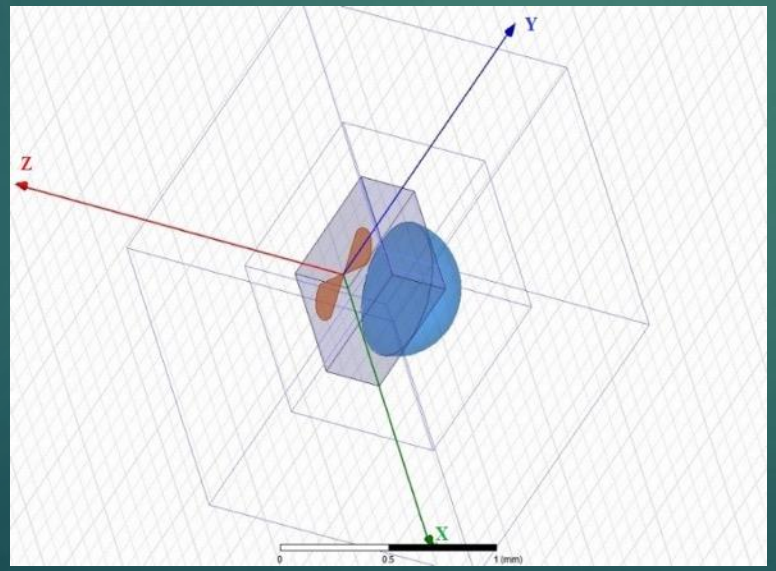
Existing Centers in Ariel (Cont.)

- Laboratory for Low temperature strongly correlated electron systems and high temperature superconductivity
  - Eliyahu Farber
  - Shmuel Schacham

Laboratory for Low temperature strongly correlated electron systems and high temperature superconductivity

Superconducting antenna array based on Josephson junction as an extremely sensitive detector in the THz frequency range





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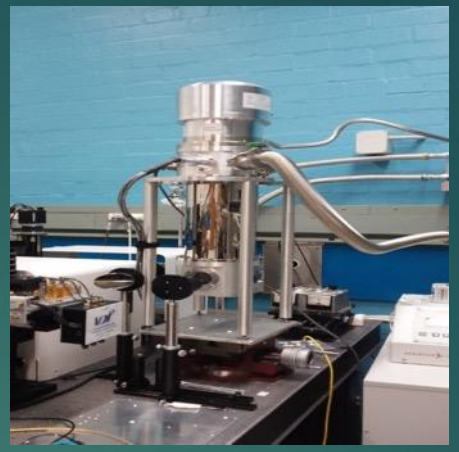
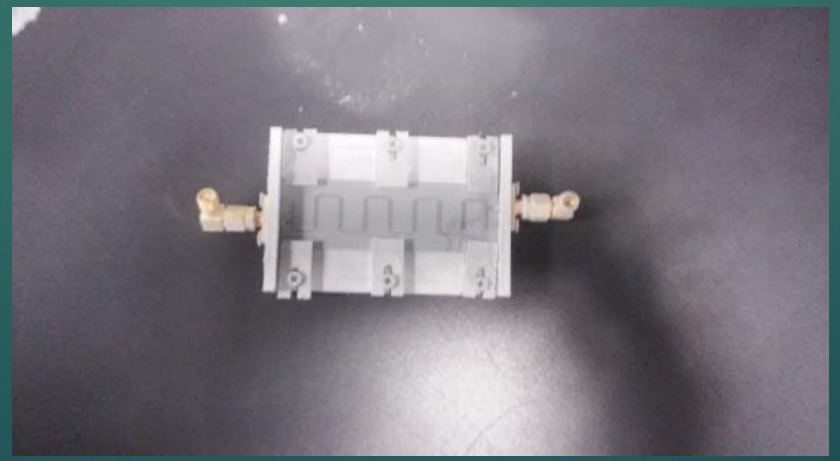


Optical setups: CRYO Industries (left), JANIS Company (right) optical cryostats

- **Superconducting RF front end for wireless communication based on YBCO integrated circuit.**



Research Subjects in QST

1. Quantum Communications
2. Quantum Detectors
3. Quantum Computing
4. Quantum Encryption
5. Quantum Materials

Research Subjects in QST (Cont.)

6. New Principles in Quantum Mechanics
7. Quantum Interaction between EM Wave and Matter
8. Quantum Interaction between EM Wave and Particles
9. Quantum Theory and Applications of Super Conductivity
10. Electrical and optical characteristics of topological materials
11. Two dimensional materials and super conductors

Goals and Needs

- Ariel University has already budgeted research and new faculty in the subject of QST.
- It is planed to establish a QST Center in Ariel under the auspices of the Compact Accelerator Center.
- If the center becomes a reality, Ariel University will match the budget it receives from outside sources with its own budget.

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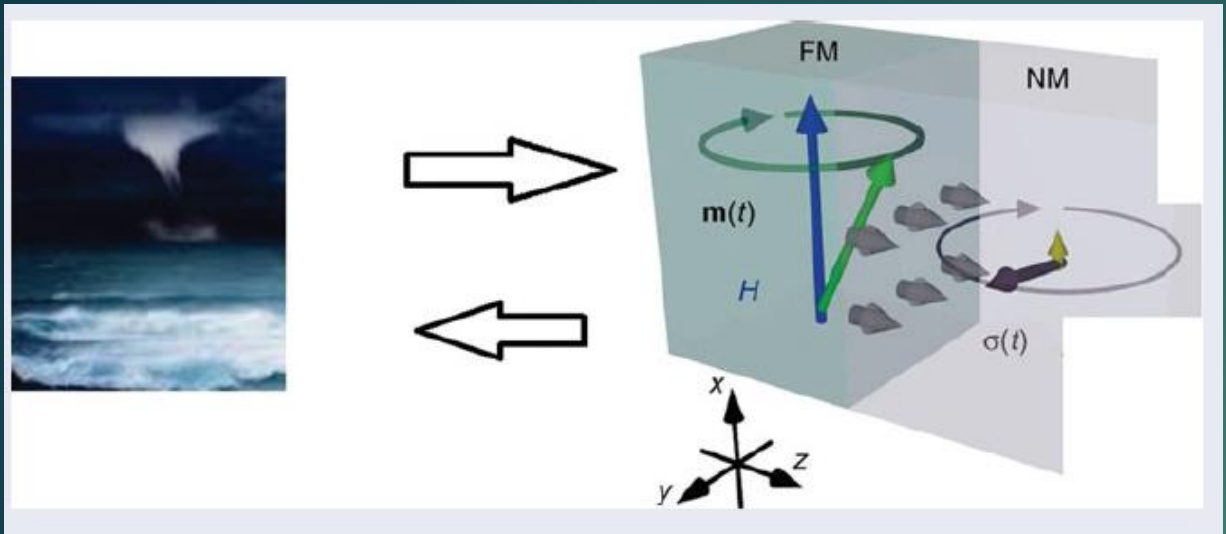
פרופסור אשר יהלום

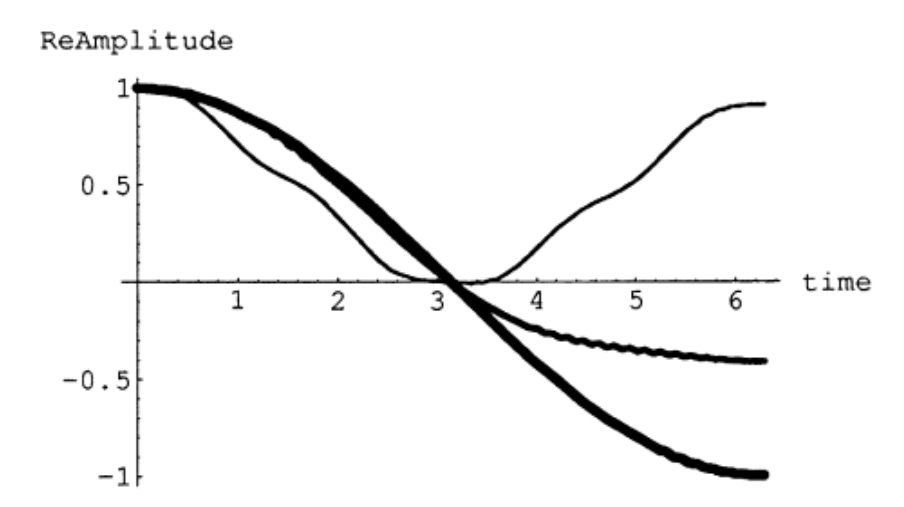
אוניברסיטת אריאל

הפקולטה להנדסה

המחלקה להנדסת חשמל ואלקטרוניקה

1. פעילותי בנושא





- אפקט יאן טלר
- מיתוג קוונטי
- כאוס קוונטי
- קשרים בין התיאורים הקוואנטים והקלאסיים
- אפקט אהרונוב-בוהם ופאזה גיאומטרית
- קשרים בין פאזה לאמפליטודה

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- Michael Suleymanov, Lawrence Horwitz and Asher Yahalom “Second quantization of a covariant relativistic space-time string in Steuckelberg–Horwitz–Piron theory” (arXiv: 1612.04193). Frontiers of Physics, First Online: 29 April 2017. 12(3), 121103 (2017). Pages 121103-1 - 121103-10. DOI 10.1007/s11467-017-0666-x.
- Y. Strauss, L. P. Horwitz, J. Levitan and A. Yahalom “Quantum Field Theory of Classically Unstable Hamiltonian Dynamics” Journal of Mathematical Physics 56, 072701 (2015). (arXiv:1407.5263 [math-ph])
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- A. Yahalom & R. Englman, "Phase-Modulus Relations for a Reflected Particle”, J. Phys. Chem. A, 107 (37), 7170 - 7174 (2003). [Los-Alamos Archives -quant-ph/0406197]
- A. Yahalom & R. Englman, “Switching of Geometric Phase in Degenerate Systems” Physics Letters A, 272, 166-173 (2000). [Los-Alamos Archives - cond-mat/0007204]

2. תרומתה למאגד.

- ליווי תיאורטי
- חישובים
- סימולציות

3. מה רוצים לקבל מהמאגד.

- שיתוף פעולה עם קבוצות ניסיוניות.
- יישום פיזי ובדיקה של רעיונות תיאורטיים

Quantum Accelometers and Quantum Transistors

Er'el Granot and Gilad Zangwill (PhD student)
Department of Electrical and Electronics Engineering, Ariel University

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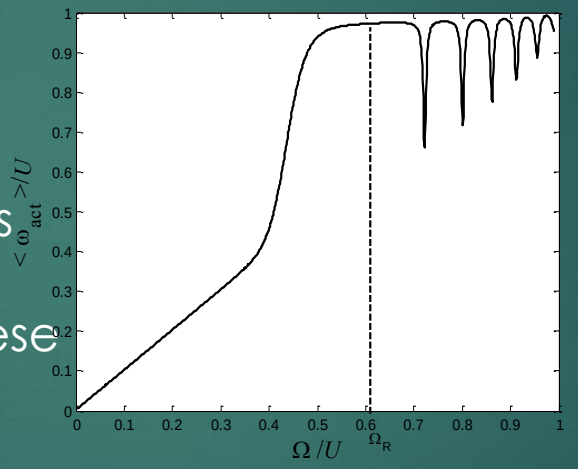
QUANTUM ACCELOMETERS AND QUANTUM TRANSISTORS

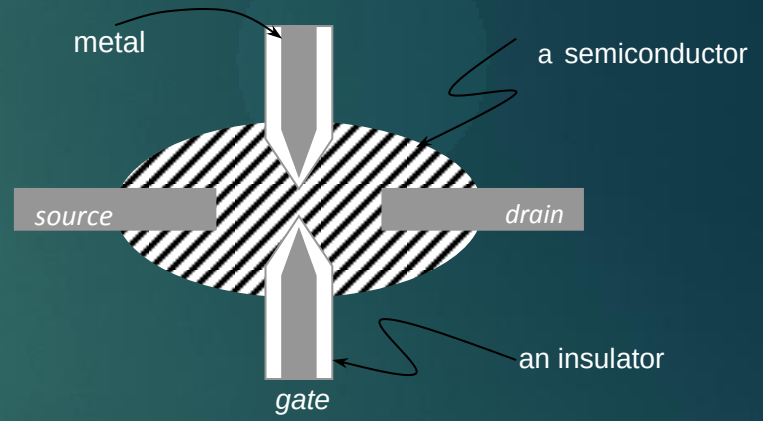
ER'EL GRANOT AND GILAD ZANGWILL (PHD STUDENT)

DEPARTMENT OF ELECTRICAL AND ELECTRONICS ENGINEERING, ARIEL UNIVERSITY

The shrinking dimensions of accelometers and transistors requires quantum analysis.
We have investigated thoroughly the Dynamic Resonant processes, where the resonance state varies in time.

It was found that the activated energy is very sensitive on the time scale and the incoming electrons energy. Thus, the current Is extremely sensitive on these Parameters.





Er'el Granot and Gilad Zangwill, "Dynamic Resonant Tunneling" chapter in the book *Quantum Dynamic* Editor: Paul Bracken, Chapter 3, pp 55-78 (INTECH, Rijeka, 2016).
Gilad Zangwil and Er'el Granot, "Eigenstate suppressed activation", Physica B, **461**, 140–146 (2015);
Er'el Granot, "Total Reflection of Optical Beams by Weakly Oscillating Dielectric Scatterers" Physical Review A, **94**, 063828 (2016)
Er'el Granot, "The Tunneling Current through Oscillating Resonance and the Sisyphus Effect." Advances in Condensed Matter Physics, **2017**, 2435857 (2017)
Er'el Granot, "Exact Model for Single Atom Transistor", to appear as a chapter in the book *Quantum Dots* (INTECH, Rijeka, 2017).

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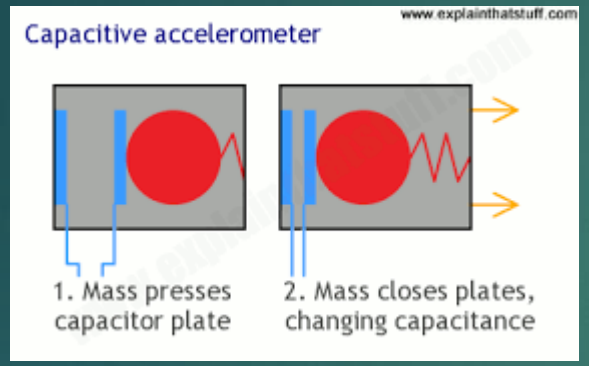
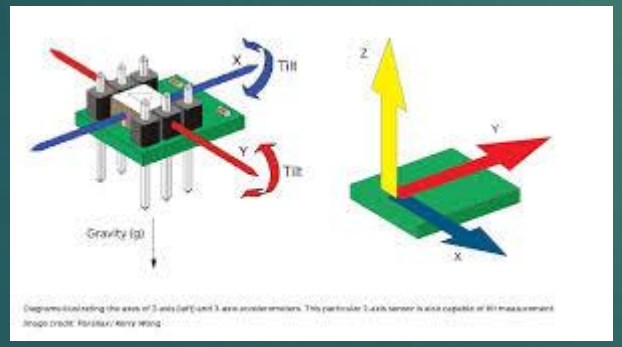
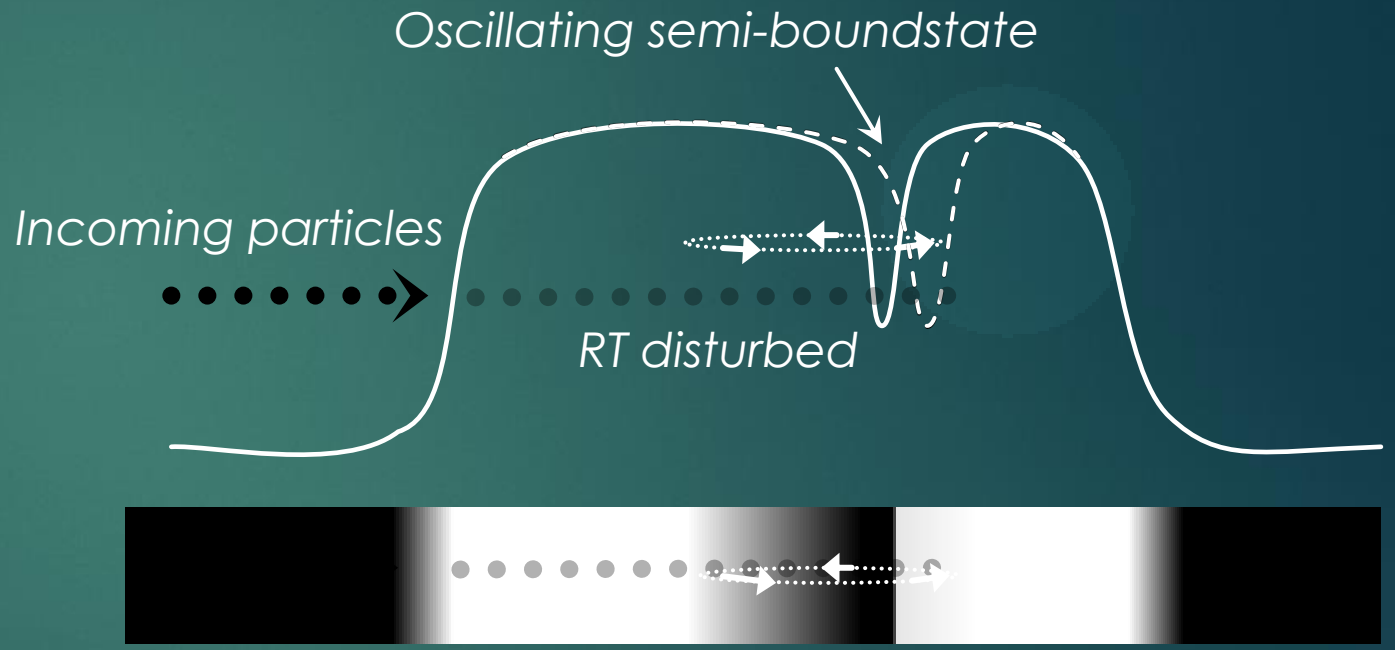
We believe we have the tools to analyze an exact model of a quantum accelometer. In this scenario the resonance exhibit spatial oscillations. These accelometers have the potential to be extremely sensitive. Moreover, we believe we can integrate models of contaminated nanowires to model quantum field effect transistors.





Classical accelometers



Exact quanum model of an accelometer

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- ביכולתנו לבצע עבור המאגד סימולציות של תהליכי דינמיים של מנהור קוונטי (Dynamic Resonant Tunneling). ברכיבים בהן יש תאוצות, כגון באקסלומטרים, לא ניתן להשתמש במודלים קוונטים סטטיים, ויש צורך להכניס את גורם הזמן (תהליכים בהם הפוטנציאל או הרזוננס עצמו משתנה בזמן). סימולציות הראו שרכיבים אלו מראים רגישות מדהימה לתדר ולכן ניתן לרתום אותם עבור טרנזיסטורים הנשלטים ע"י תדר. טרנזיסטורים אלו יהיו מדוייקים ביותר.

- אנו מעוניינים להפיק מהמאגד גישה למעבדות דרך שיתופי פעולה עם חוקרים ניסויים, שיסייעו לנו לבצע במעבדה ולאשש את התחזיות של הסימולציות של אקסלומטרים וטרנזיסטורים קוונטיים.

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Nanooptics Lab

Prof. Shmuel Sternklar, Dr. Gorodetski Yuri

Relevant Research topics

- Plasmonic Fano interference
- Plasmonic spin-orbit interaction
- RF plasmonics

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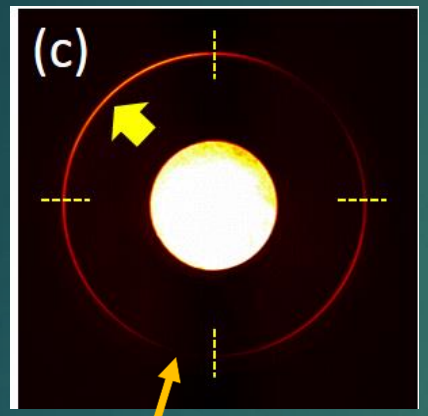
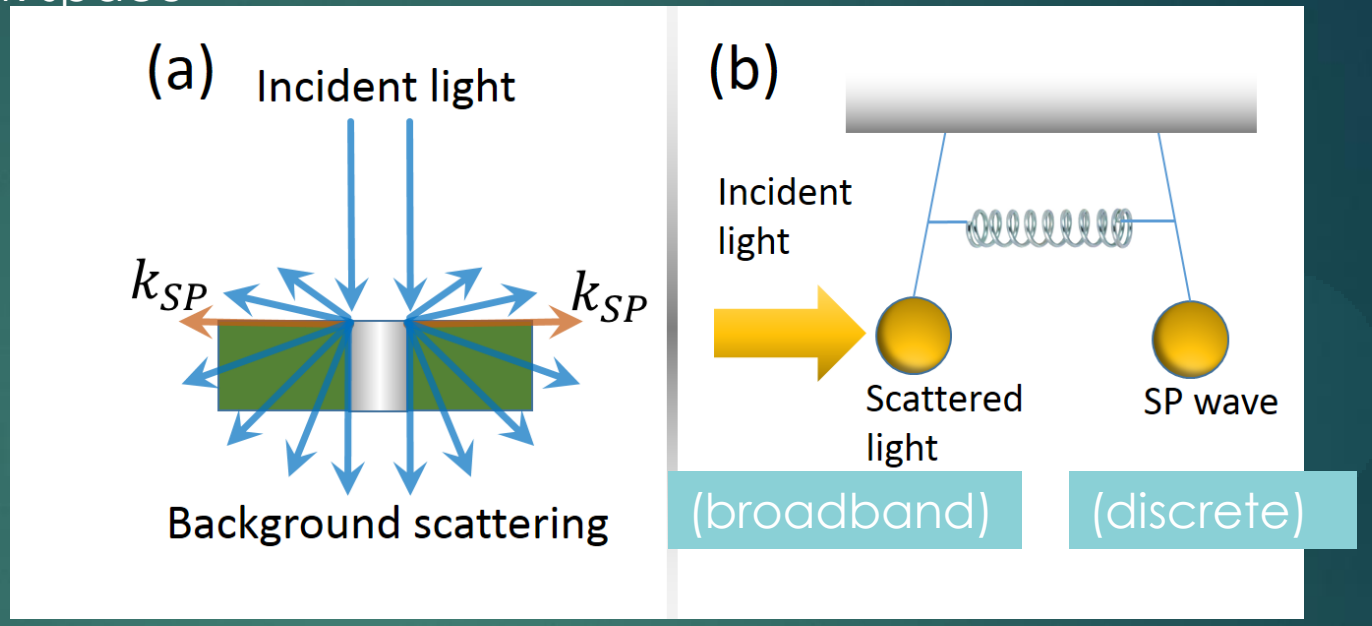
Fano Interference in plasmonic scattering

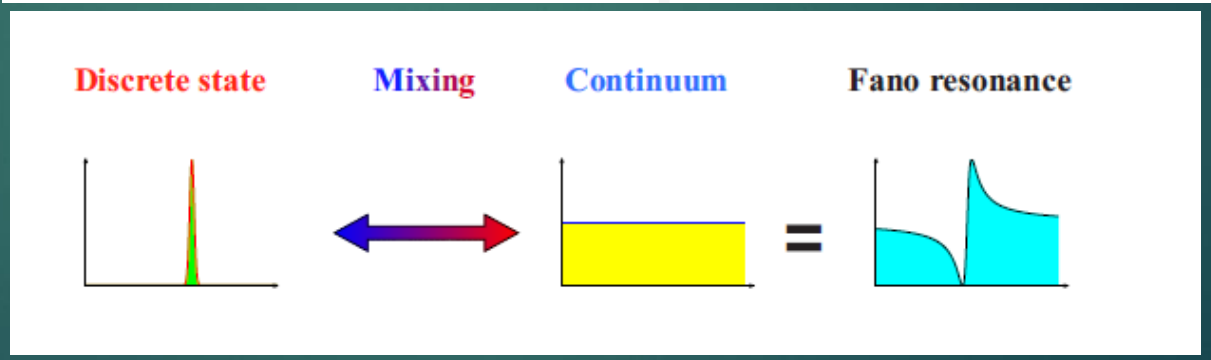
Leakage image in k-space



Phase dependent dislocation



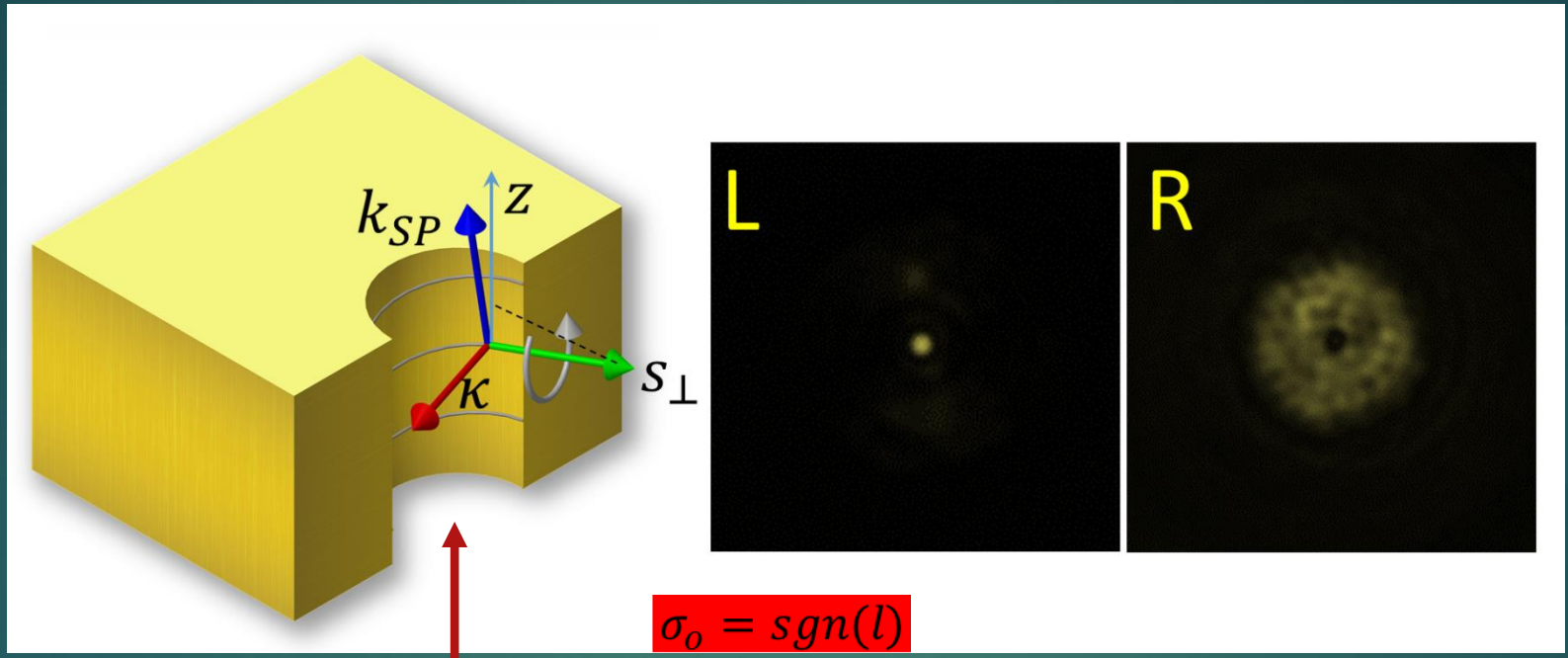
The dislocation point depends on the phase of the plasmonic scattered wave.



The size, shape and the composition of the scaterrer leaves a signature in the form of the Fano dislocation.

Plasmonic spin-orbit interaction

Emitted circular polarization



Light with OAM

Helical phase:

E

Optical vortex with AM

A simple hole behaves as an AM sensor for the vortex beams

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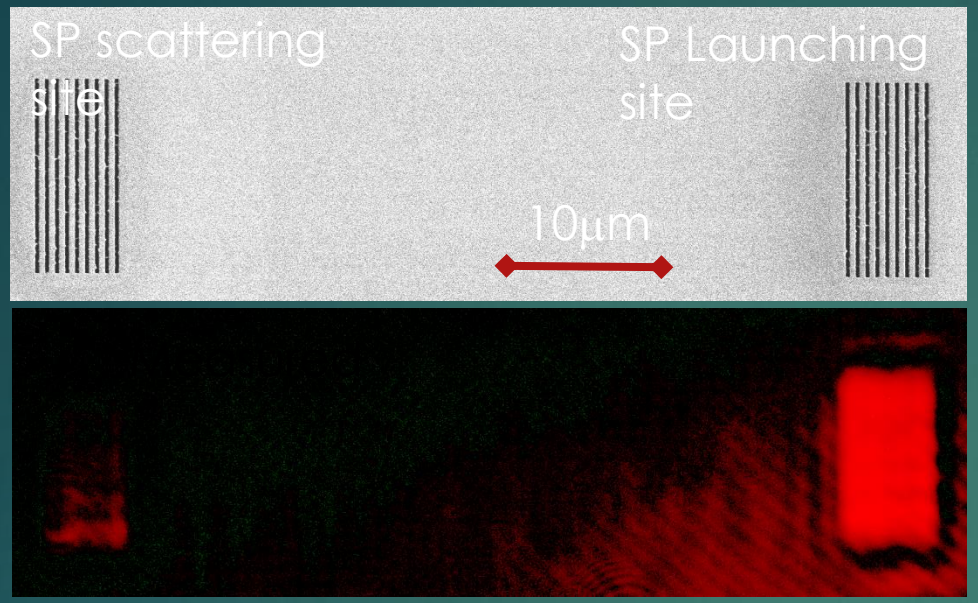
RF plasmonics



By measuring the phase lag and the amplitude change one can measure the dispersion of the SP wave and therefore achieve an accurate estimate of the refractive index of the plasmonic medium.