PON-PhD presentation:

Surface physics for green technologies

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Tutors
Dr Alberto Verdini
Prof Giovanni Carlotti

Background

- Bachelor Degree at University of Bologna

Thesis in: Fabrication, characterization and application of OECT (organic electrochemical transistor)

- Working experience at Fiorital spa (VE)

From dishwashing to food-cost analysis

- Master Degree at University of Perugia

Thesis in: Dzyaloshinskii-Moriya interaction in thin films and its influence on skyrmion stability and dynamics

- 3 months post-graduate grant at University of Perugia

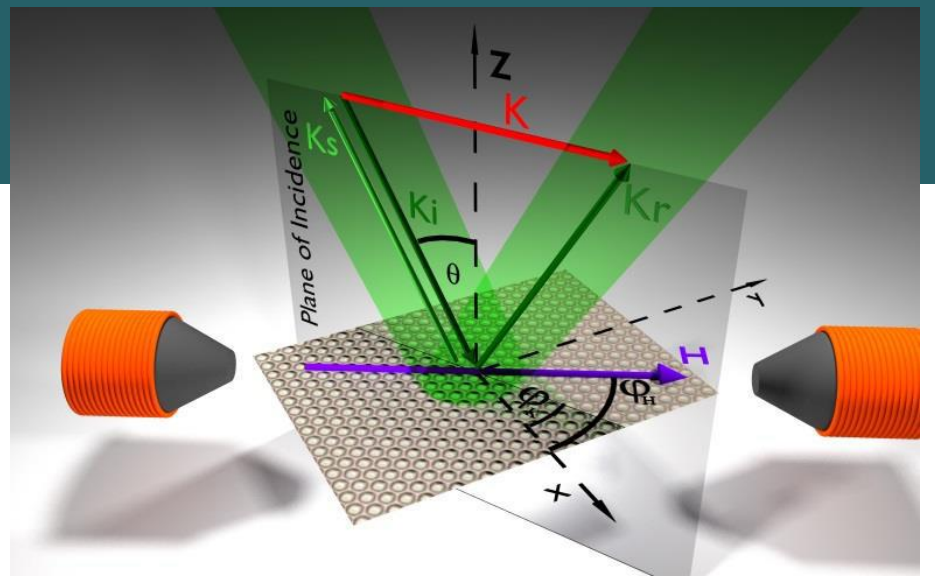
Micromagnetic simulations of skyrmion systems

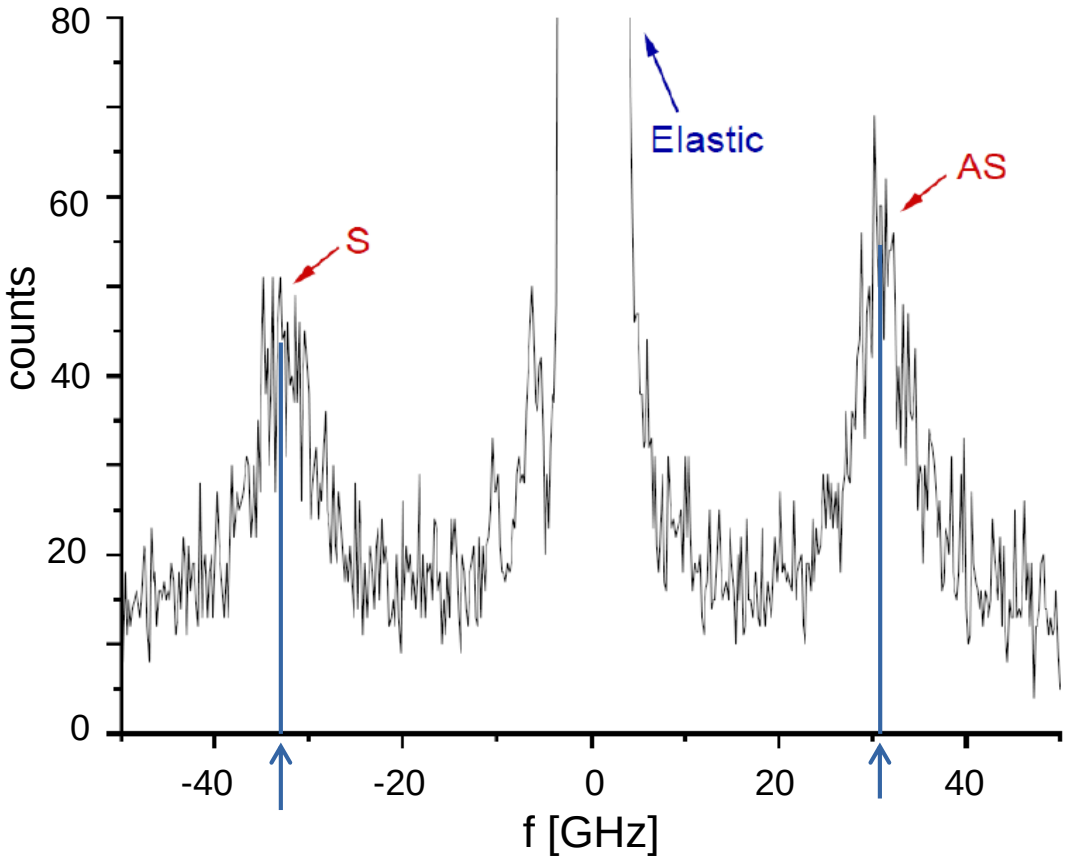
Paper accepted for publication in *IEEE Magnetics Letters*

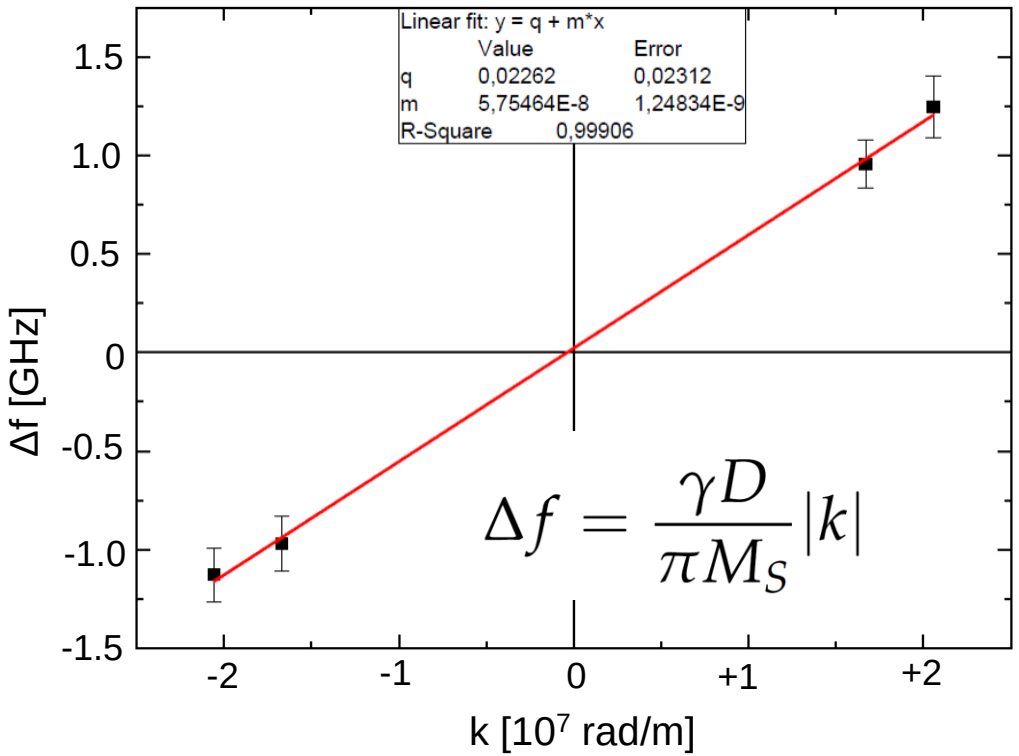
Thesis results -1

Measurement of DMI effective constant by BLS in 2 ferromagnetic multilayers of Ir/Co/Pt

$$E_{DMI} = \vec{d}_{ij} \cdot (\vec{S}_i \times \vec{S}_j)$$

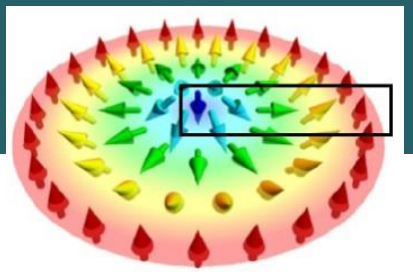




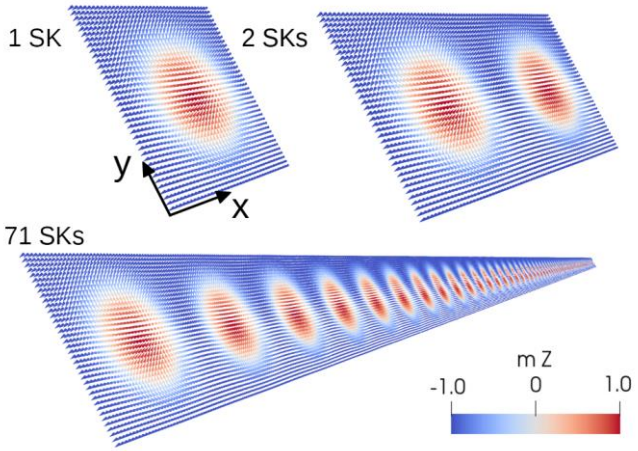


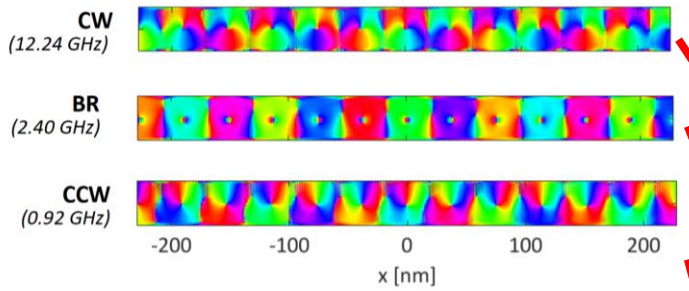
Thesis results -2

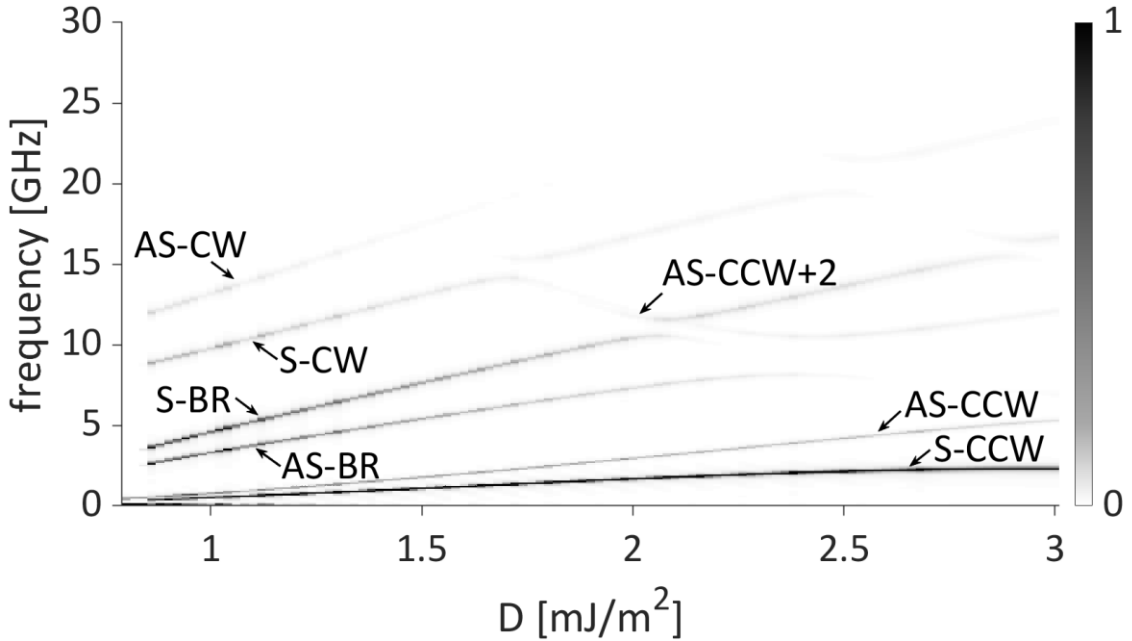
- **Skyrmions → topologically protected spin structures;**

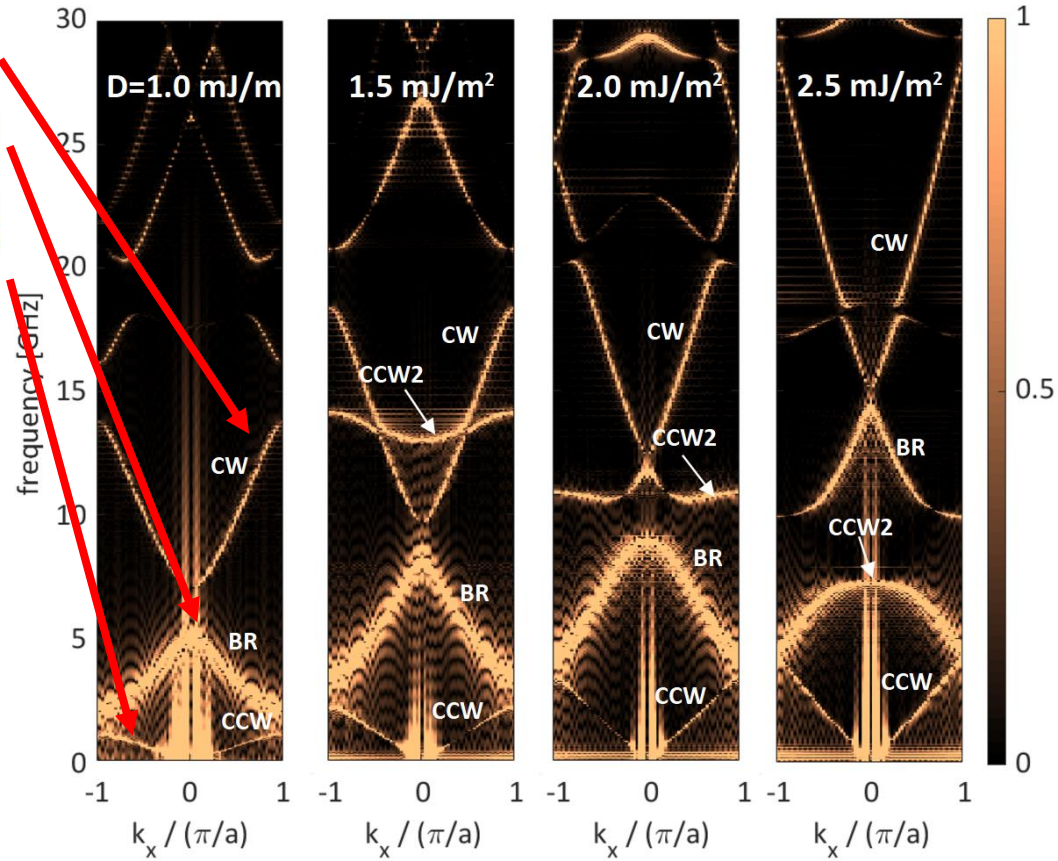


Skyrmion dynamics investigated by micromagnetic simulations









Why surface physics?

The good stuff for a researcher:

→ From bulk to 2D materials: new interesting phenomena;
→ Strong interdisciplinarity (chemistry, biology, engineering, science materials, ..);
→ A multitude of growth and analysis techniques available.

The applications:

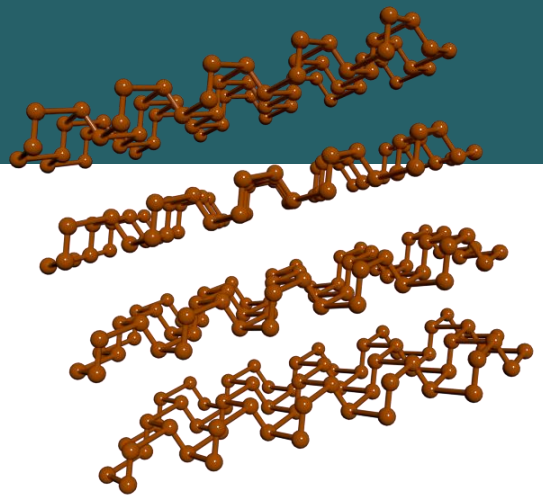
→ Photovoltaics;
→ Catalysis;
→ Low-energy consumption electronics;

The goals:

→ Investigating and searching for **novel low-dimensional materials** with interesting **properties** in view of improving green technologies.

Materials

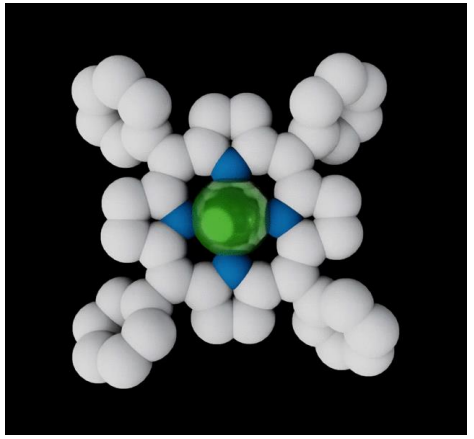
→ **Phosphorene, black phosphorus**



As a 2D monoatomic material that shows:

- Band gap tunability;
- Anisotropy in heat and electron transport properties.

→ Organic Tetrapyrroles: **Porphyrin**



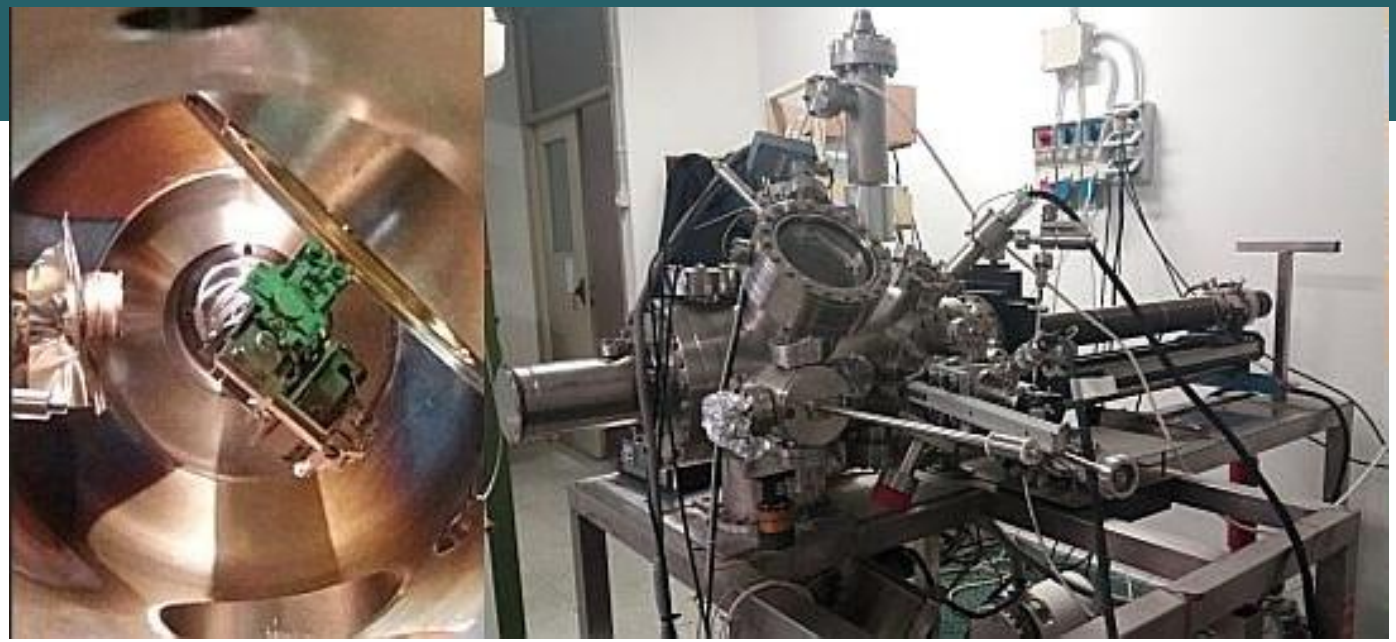
As a “nature’s choice” molecule that shows:

- High functionalization;
- Self-assembly property.

<u>..And the combination of the two.</u>

→ Find the **best deposition substrate** and **growth parameters** to bring out the most interesting physical properties from the system

Analysis techniques



Structural and morphological properties:

- Electron diffraction (LEED, RHEED)
- Atomic force microscopy (AFM)

Physical and chemical properties:

- Inverse photoemission spectroscopy (IPES)
- Auger electron spectroscopy (AES)
- Ultraviolet photoemission spectroscopy (UPS)

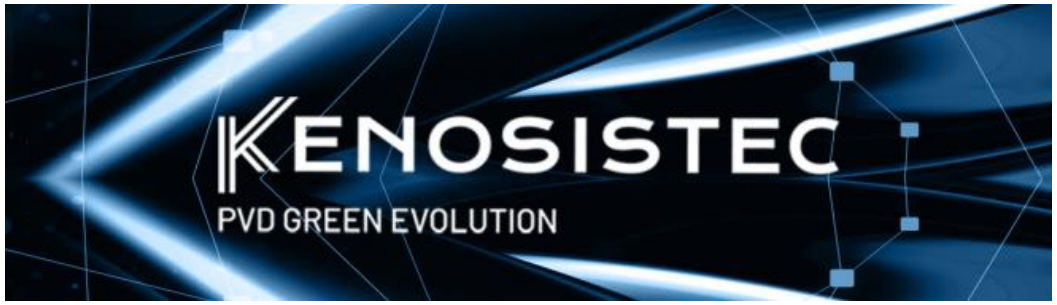
ACROSS experimental chamber, at the “Laboratorio Congiunto Superfici e Nanostrutture“ (4° floor)

..and for the most promising samples → **Synchrotron light** measurements (Electra, Soleil)

Stage at the company

Industry: **Kenosistec** at Binasco (MI)

- PVD coating systems and tailored services
- R&D in thin film processes and surface engineered solutions
- Collaborations with institutional, public and private costumers



For ENEA

Company meets PhD

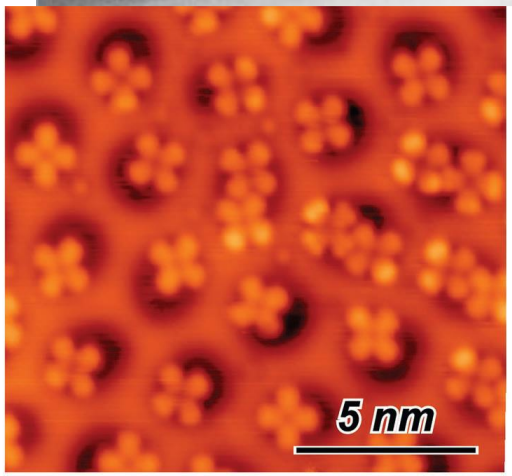
- R&D on **perovskites** and **dichalcogenide** materials;
- Optimize the growth parameters;
- Combine industrial view with university knowledge
- Provide the Know-How …

Abroad experience

UNIVERSIDAD SAN SEBASTIAN

“Ultra-Low Temperature Scanning Tunneling Microscopy” laboratory

→ characterization of materials at the atomic scale



Metal-free phthalocyanine on exagonal Boron-Nitrade nanomesh

Thank you!