MAgnetic Multiscale MOdelling Suite

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ABSTRACT

The goal of the MaMMoS project is to develop a MAgnetic Multiscale MOdelling Suite that will allow the design and optimisation of magnetic materials and devices based on multiscale modelling, characterisation, and numerical optimisation.

MaMMoS [1]-[3] will use artificial intelligence (AI) to fuse modeling and characterization data. AI methods will identify and correct systematic errors in the simulation data, enabling more accurate predictions. Moreover, AI models can fill gaps where measurements are not available. AI models can also serve as a surrogate in multi-objective optimisation.

By aligning with established data standards such as Materials Modelling Data (MODA), Characterisation Data (CHADA), and frameworks like the Elementary Multiperspective Material Ontology (EMMO), the MaMMoS project sets the stage for a transformative approach to magnetic material development and device performance optimization.

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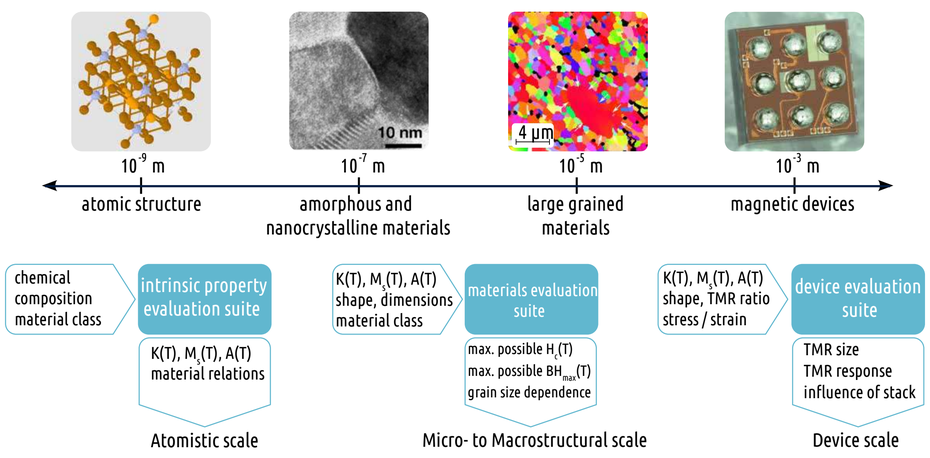
Sectors

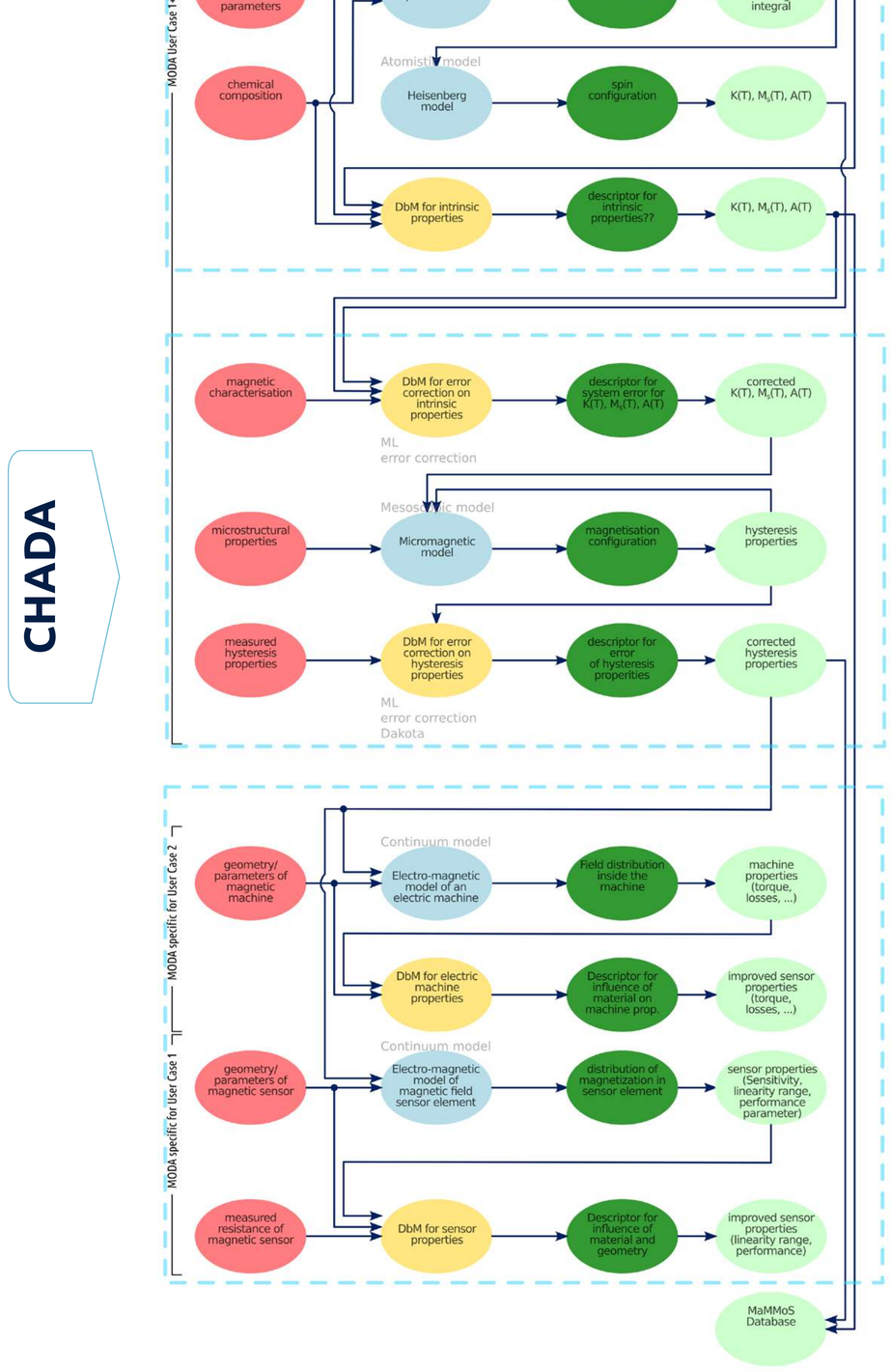
- **Magnetic materials**
  Power generation, energy conversion, e-mobility reduction of critical raw materials
- **Magnetic sensors**
  Consumer and industrial applications higher linear range and better integration capabilities

Challenges

MaMMoS's breakthrough is the integration of a complete set of modelling and characterisation techniques needed to describe magnetic materials and devices - from the atomic length scale to the macroscopic - into a single modelling suite (a set of programming tools used to perform a complex task), with the data freely available in a standard format and with clear descriptions provided in the metadata.



MODA and CHADA

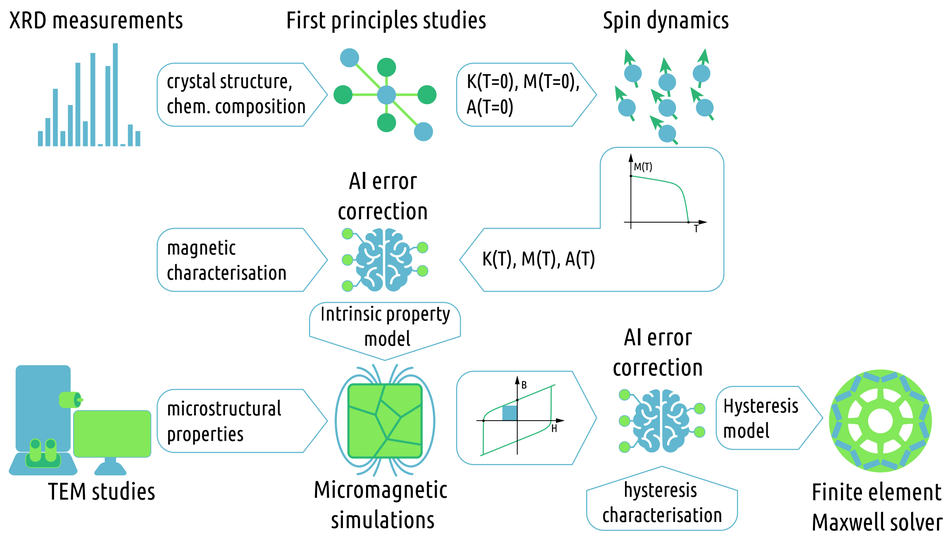


Objectives

- **Data fusion**
  Make magnetic materials data useable
- **Multiscale modelling suite**
  Enhance material knowledge at all length scales
- **Interpretable machine learning**
  Accelerate magnetic materials development
- **Materials evaluation and optimisation**
  Design magnetic materials and devices
- **European integration**
  Embed MaMMoS software in EU materials platform

Methodology

Interplay of characterisation techniques, magnetic modelling and AI for error correction to incorporate magnetic properties on all length scales into a device level suite.

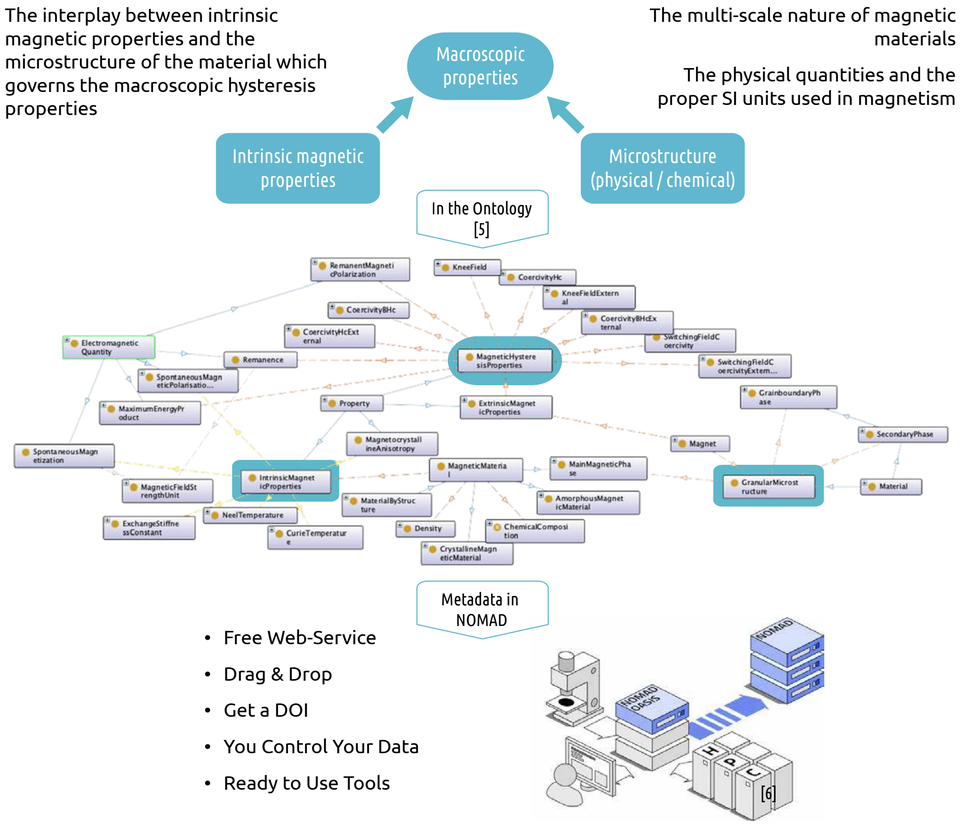


Magnetic Materials Ontology and NOMAD

The interplay between intrinsic magnetic properties and the microstructure of the material which governs the macroscopic hysteresis properties

The multi-scale nature of magnetic materials

The physical quantities and the proper SI units used in magnetism



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