

Appunti di Fisica '25

18 Dicembre ore 15:30

Sala seminari, CNR-IPCF

Metal-Organic Frameworks for a Thirsty Planet: From Fundamentals to Atmospheric Water Harvesting

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Metal-organic frameworks (MOFs) are a versatile and rapidly expanding family of crystalline porous materials assembled from metal nodes and organic linkers. Their modular, "Lego-like" design enables precise control over pore size, topology and surface chemistry, leading to record-high surface areas and highly tunable adsorption and transport properties. In the first part of this seminar, I will introduce the fundamental structural features of MOFs and discuss the most common synthetic strategies, including solvothermal and ambient-temperature syntheses, as well as emerging green and scalable routes. Particular attention will be paid to defect engineering, post-synthetic functionalisation and shaping (beads, pellets, coatings), as these aspects are crucial for translating MOFs from ideal powders to robust, application-ready materials. A concise overview of key application areas, gas storage and separation (with emphasis on CO₂ capture), catalysis, sensing, and energy- and environment-related processes, will illustrate how structure-property relationships guide MOF design.

The second part of the seminar will focus on the use of MOFs in atmospheric water harvesting (AWH) as decentralised, low-energy water sources, particularly relevant for arid and semi-arid climates. I will present recent results on MOF-polymer composite beads based on MIL-101(Cr) and MIL-100(Fe) embedded in sodium alginate and graphene oxide, highlighting how compositing and photothermal additives can tailor the water uptake step, maintain or enhance working capacity, and enable solar-driven regeneration. Finally, adsorption-desorption behaviour, cycling stability and practical considerations for integrating MOF-based sorbents into AWH devices will be discussed.