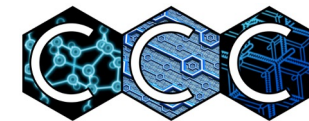Dr. Abderrezak Torche | 30.11.2023

High temperature superconductivity

Introduction

Superconductivity (SC) refers to the phenomenon where the electric resistivity of a material drops to zero at a certain temperature. The electrons are then promoted to a collected quantum state in which the electric current flow without dissipation. The Challenge was and still the realization of room temperature superconductivity (RTSC). 5 Nobel prices have been awarded to works related to SC.

BCS Theory

Theory of Superconductivity

J. Bardeen, L. N. Cooper, and J. R. Schrieffer
Phys. Rev. **108**, 1175 – Published 1 December 1957

Physics

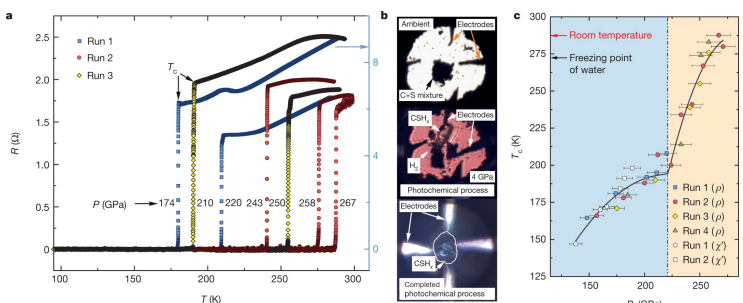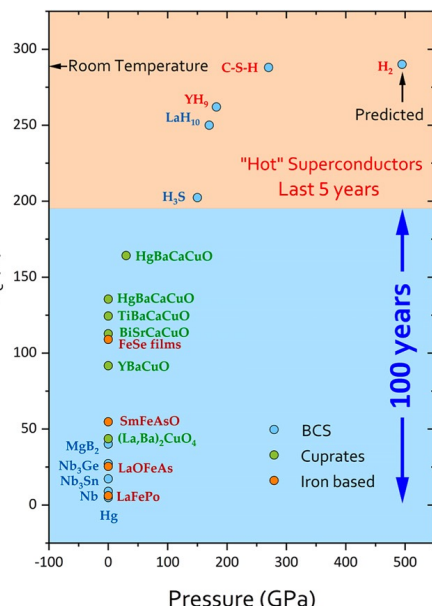| Article	References	Citing Articles (9,265)
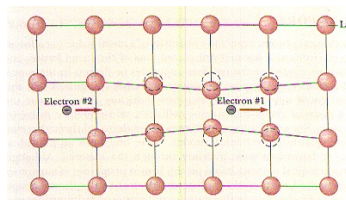
BCS mechanis

1. Status of RTSC, records and trends

Hydrogen rich materials can achieve RTSC But requires extraordinary pressure. The challenge now is reducing the pressure rather then increasing the temperature

World record: 288 K at 260 GPa

Nature volume 586, pages373–377 (2020).
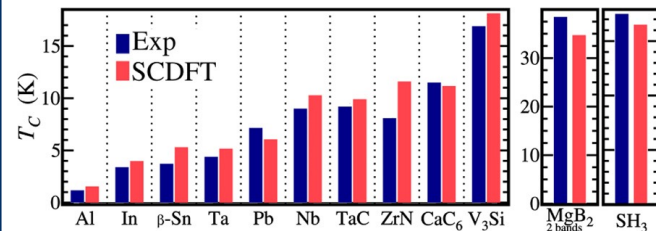This article still under strong debate.

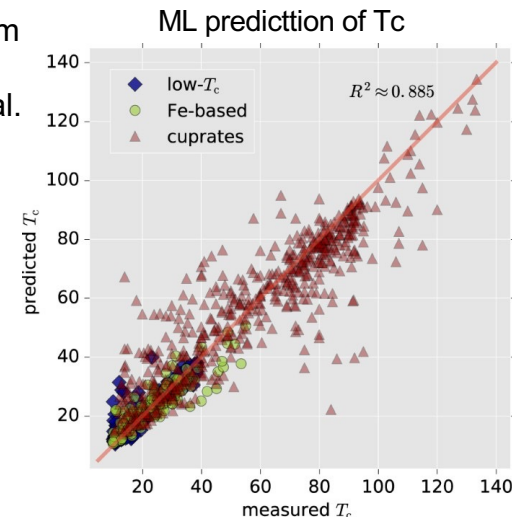Boeri Lilia et al 2022 J. Phys.: Cond. Matter 34 183002

2. New theoretical paradigms to understand and predict RTSC

SC is a highly complicated many-body problem involing physics beyon the BOA and electron correlation beyond the LDA (PBE) xc functional. Most recent theoretical developenmt are :
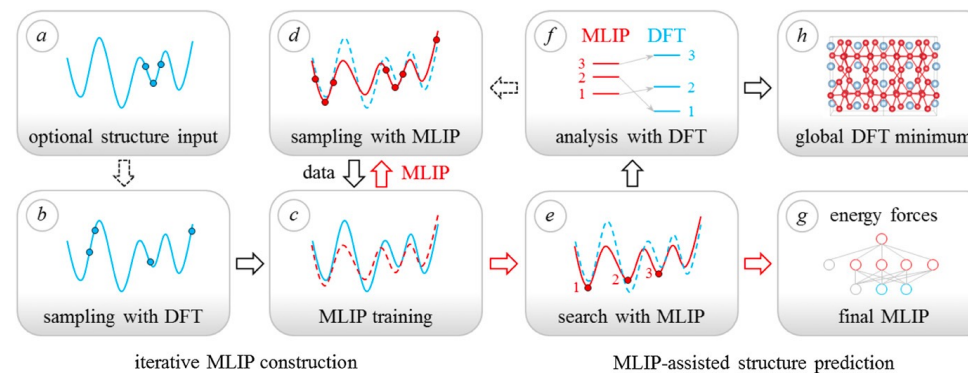
SCDFT and ML

Phys. Rev. Lett. 125, 057001 (2020)

ML predicttion of Tc

npj Comput Mater 4, 29 (2018)

3. New approaches to design RTSC

Ab initio structure prediction accelerated with machine learning interatomic potentials (MLIP) using MAISE: Module for ab initio structure evolution (**evolutionary algorithm**)

iterative MLIP construction   MLIP-assisted structure prediction

Hajinazar S, et al. Comput. Phys. Commun. 259 107679 (2020).