Dr. Abderrezak Torche | 30.11.2023

# Room-temperature superconductivity

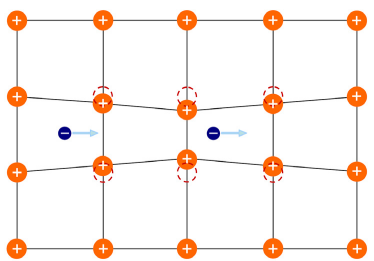
**Superconductivity (SC) refers to the phenomenon where the electric resistivity of a material drops to zero at a certain temperature.**

The electrons are then promoted to a collected quantum state in which the electric current flows without dissipation. 5 Nobel Prizes have been awarded in the field of SC.
The challenge was and still is to realise the room-temperature superconductivity (RTSC).

Theory of Superconductivity

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

BCS mechanism of SC



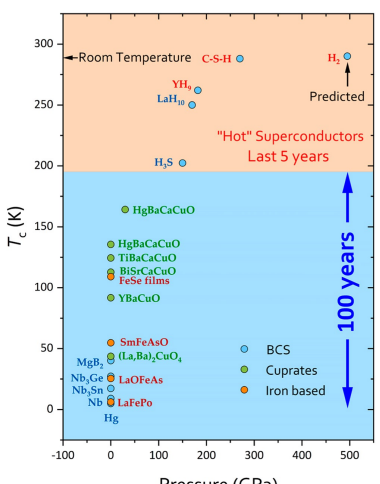
## 1. Status of RTSC, records and trends

Hydrogen-rich materials can achieve RTSC but require extraordinary pressures. The challenge nowadays is to reduce the pressure rather than increase the temperature.
Yet, many initial reports are subject to harsh scrutiny and even retractions.

**RETRACTED ARTICLE: Room-temperature superconductivity in a carbonaceous sulfur hydride**

**RETRACTED ARTICLE: Evidence of near-ambient superconductivity in a N-doped lutetium hydride**

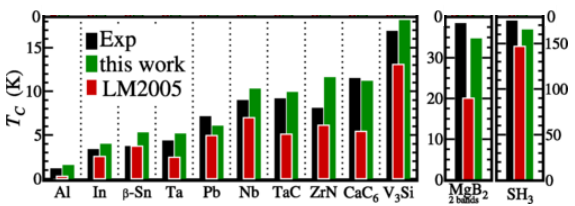
**LK-99 isn't a superconductor – how science sleuths solved the mystery**



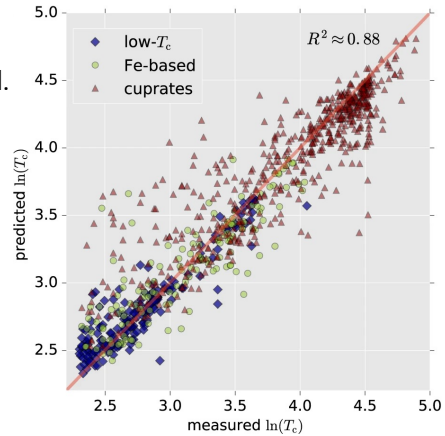

*J. Phys.: Condens. Matter* **2022**, *34*, 183002. OA (CC BY 4.0).

## 2. New theoretical paradigms to understand and predict RTSC

SC is a highly complicated many-body problem involving physics beyond the BOA and electron correlation beyond the LDA (PBE) xc functional. Key theoretical developments are superconductor density functional theory (below) and machine learning (right).



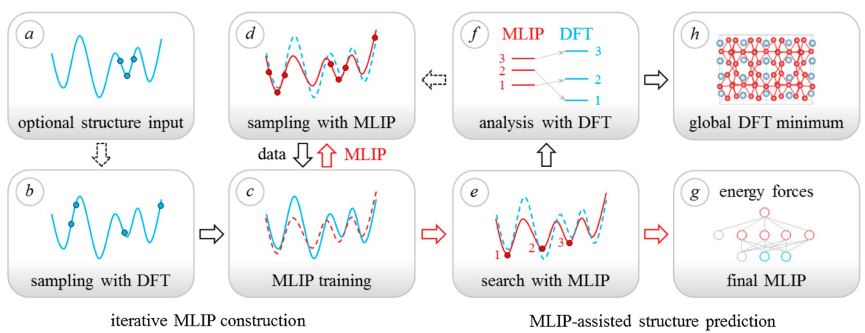

*Phys. Rev. Lett.* **2020**, *125*, 057001. OA (CC BY 4.0).




*npj Comput. Mater.* **2018**, *4*, 29. OA (CC BY 4.0).

## 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.




*Comput. Phys. Commun.* **2020**, *259*, 107679. Image *J. Phys.: Condens. Matter* **2022**, *34*, 183002. OA (CC BY 4.0).