#### Electronic instabilities





room-temperature superconductivity





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Advanced Solid-State Physics, WS 24/25

Electronic instabilities

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#### PHYSICAL REVIEW LETTERS

23 December 1968

#### METALLIC HYDROGEN: A HIGH-TEMPERATURE SUPERCONDUCTOR?

N. W. Ashcroft

Laboratory of Atomic and Solid State Physics, Cornell University, Ithaca, New York 14850 (Received 3 May 1968)

Application of the BCS theory to the proposed metallic modification of hydrogen suggests that it will be a high-temperature superconductor. This prediction has interesting astrophysical consequences, as well as implications for the possible development of a superconductor for use at elevated temperatures.

Debye temperature: 3500 K

Coupling:  $g_n(0)V > 0.25$ 

Superconducting hydrogen may occur in the core of Jupiter!



#### Toward room temperature

### Conventional superconductivity at 203 kelvin at high pressures in the sulfur hydride system

A. P. Drozdov<sup>1</sup>\*, M. I. Eremets<sup>1</sup>\*, I. A. Troyan<sup>1</sup>, V. Ksenofontov<sup>2</sup> & S. I. Shylin<sup>2</sup>



Nature 525, 73 (2015)

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#### Toward room temperature



Superconductivity at 250 K! Highest  $T_c$  so far lsotope effect  $\longrightarrow$  electron-phonon coupling

Nature 569, 528 (2019)

#### At room temperature

### Room-temperature superconductivity in a carbonaceous sulfur hydride Ellot Snider<sup>14</sup>, Nathan Dasenbr

Elliot Snider<sup>16</sup>, Nathan Dasenbrock-Gammon<sup>26</sup>, Raymond McBride<sup>16</sup>, Mathew Debessai<sup>2</sup>, Hiranya Vindana<sup>2</sup>, Kevin Vencatasamy<sup>2</sup>, Keith V. Lawler<sup>4</sup>, Ashkan Salamat<sup>5</sup> & Ranga P. Dias<sup>12</sup>



The New York Times

October, 14, 2020

## Finally, the First Room-Temperature Superconductor

It conveys electricity in the climate of a crisp fall day, but only under pressures comparable to what you'd find closer to Earth's core. The New York Times

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#### Comment on Nature 586, 373 (2020) by E. Snider et al.

D. van der Marel<sup>a</sup> and J. E. Hirsch<sup>b</sup>

In Ref. [1] Snider *et al.* reported room temperature superconductivity in carbonaceous sulfur hydride (CSH) under high pressure. Recently the data for the temperature dependent susceptibility shown in figures of Ref. [1] have appeared in the form of tables corresponding to different pressures [2]. Here we provide an analysis of the data for a pressure of 160 GPa. We conclude that the published data have been manipulated, making it impossible to draw any conclusions about the susceptibility of the material from the reported numbers. arXiv:2201.07686 (2022)

#### Retraction Note Published: 26 September 2022

## Retraction Note: Room-temperature superconductivity in a carbonaceous sulfur hydride

The editors of *Nature* wish to retract this paper. Following publication, questions were raised regarding the manner in which the data in this paper have been processed and analysed, which the authors and *Nature* have been working to resolve.

The authors maintain that the raw data provide strong support for the main claims of the original paper. Nevertheless, we are of the opinion that these processing issues undermine confidence in the published magnetic susceptibility data as a whole, and we are accordingly retracting the paper. All authors disagree with this decision. An earlier version of this note stated that not all authors expressed their opinion, but the editors have since been contacted by the missing authors.

#### Next attempt



Lu-N-H sample of unknown composition, low pressures

Nature 614, 244 (2023)

#### Next attempt



Nature 614, 244 (2023) and Peziza proteana

Next attempt



# *Nature* retracts controversial superconductivity paper by embattled physicist

This is the third high-profile retraction for Ranga Dias. Researchers worry the controversy is damaging the field's reputation.

NEWS FEATURE 08 March 2024

# Superconductivity scandal: the inside story of deception in a rising star's physics lab

Nature News: November 2023 and March 2024



Image credit: Laurenz Rettig

#### Charge-density wave (CDW)



Nature Mater. 7, 960 (2008) and Nature Comm. 12, 5873 (2021)

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#### CDW vs. superconductivity



Nature Mater, 7, 960 (2008)

Advanced Solid-State Physics, WS24/25 Electronic instabilities

#### CDW vs. superconductivity



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