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Superconductivity in metallic hydrogen

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Superconductivity, the amazing phenomenon of lossless transmission of electric current through metallic wires, requires cooling of the wire to low temperatures. Metallic hydrogen is considered as the most likely candidate for superconductivity at very high temperatures, possibly even room temperature. However, as a result of various approximations used, conflicting theoretical predictions exist for the range of temperatures where superconductivity is expected to occur. Here we avoid those approximations and confirm that metallic hydrogen is indeed a superconductor, but this is limited to temperatures far below previous estimates. We exploit the "jellium" model proposed in 1966 by De Gennes, where superconductivity is caused by the combination of Coulomb repulsion between the electrons and Coulomb attraction between the protons and the electrons. We find that the superconducting order develops over an energy range far exceeding the characteristic phonon energy, and that the phase of the order parameter flips 180 degrees at the characteristic phonon energy above and below the Fermi energy.