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Experiments on H Tunnelling in Metals: Understood and Open Questions*

By G. Cannelli[1], R. Cantelli[1], F. Cordero[2] and F. Trequattrini[2]

[1] Università di Roma "La Sapienza", Dipartimento di Energetica, Via Scarpa 14, I-00161 Roma, Italy
[2] CNR, Istituto di Acustica "O. M. Corbino", Via Cassia 1216, I-00189 Roma, Italy

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Most of the experimental research have been focused on H tunnelling within the O–H pair in Nb, the data being consistent with the present theory of a two-level tunnel system (TLS). Other examples of H tunnelling have been discovered, mainly by acoustic measurements, which sometimes display significantly different behaviours. The various cases are compared.

1. Introduction

The description of the dynamics of interstitial H needs a fully quantum mechanical treatment. Even its long range diffusion via overbarrier hopping only approximately follows the Arrhenius law and strongly depends on the isotope mass in a completely non-classical way. Under certain circumstances, H can perform coherent tunnelling between two or more sites, but band-like long range delocalization has never been observed, even for the much lighter positive muon.

At present, tunnelling states have been observed for H and D trapped by substitutional or interstitial impurities in the bcc transition metals Nb and Ta and for free and trapped H in the hcp rare earths Y and Sc. In most cases H is confined within two nearly equivalent sites, forming a so-called two-level tunnel system (TLS). Figure 1 presents the transition rates of H and D within some of the above tunnel systems, as estimated by anelastic relaxation and neutron spectroscopy experiments. For NbO_xH_y (P1) the

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