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Letter of Intent

1) STUDIES OF MUONS AND HYDROGEN IN PALLADIUM.

2) MUONIUM IN VACUUM NEAR Pd SPONGE AND OTHER FINELY DIVIDED MEDIA.

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We shall present a detailed proposal to the next PSCC meeting.
On the one hand we wish to study the solid state physics of Pd.
On the other hand we wish to search for muonium in vacuum.
The formation of a collaboration with some of the authors of references 3 and 4 (Griessen et al, Barnett et al) is now being finalised.

The remarkable properties of the palladium-hydrogen system make possible the following two interesting experimental investigations, which to a great extent use the same apparatus:

1) Studies of μ^+ and H in Pd.

μ^+ are a powerful probe of the structure of solids[1]. Measuring the spin relaxation rates and Knight shifts[2] in elements, compounds and alloys as a function of temperature, chemical and physical composition (or concentration), and other parameters is an active and fruitful field. Our experiment will try to answer the following questions -

a) μ^+ diffusion in real, imperfect crystals is dominated by minute concentrations of impurities which act as traps. Can we saturate the traps with a small amount of hydrogen?

b) Cheap, safe rapid H_2 storage would have a great impact on the world energy supply problem. To what extent can one combine cheap, slow bulk storage materials with the fast surface physics of thin films of the costlier metals and alloys ($LaNi_5$, Pd)? Can we separate surface and volume effects better than has been done until now with hydrogen studies? (Low-energy μ^+ should be ideal for this).

c) H fills up the octahedral sites in the Pd fcc lattice[3]. If we saturate the Pd with H, to what extent do we force a stopping μ^+ into the tetrahedral sites?

2) Search for Muonium in vacuum near Pd sponge, etc.

It is important to narrow down the limits on muonium-to-antimuonium conversion[4,5], to clarify the nature[6] of the muon conservation law. We can get information on this by comparing the Pd single crystals with the finely-divided forms of Pd, as a function of O_2 admixture. In most materials, muonium formed in the first 2 or 3 atomic layers may get into vacuum easily in 2 μs; one may hope that in Pd, the first 200 layers will do so.

Refs.

1) See Proceedings of the First International Topical Meeting on Muon Spin Rotation, 1978, Rorschach (to be publ. in Hyperfine Interactions)
2) Camani et al, Rorschach Meeting, paper 5.18.
3) Griessen et al, J. Phys. F 7, L133 (1977).
4) Barnett et al, Phys. Rev. A15, 2246 (1977).
5) Kiefl et al, Rorschach Meeting, paper 4.9.
6) Sundaresan et al, Phys. Rev D 17, 703 (1978).