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Proposal to measure UCN absorption on surfaces coated with deuterated plastic relevant to the LANL search for a neutron edm at RCNP Osaka University

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1 Introduction

The search for a non-zero electric dipole moment (edm) of an elementary particle such as the neutron (n) is generally felt to be one of the most promising places to look for physics beyond the standard model.

The experiment being developed under the leadership of Los Alamos National Laboratory, (R. Golub and SK Lamoreaux, Physics Reports **237**, 1, 1994 and http://p25ext.lanl.gov/edm/edm.html)

to search for a nedm is based on the production and storage of Ultra Cold Neutrons (UCN) in superfluid He^4 containing a dilute solution of polarized He^3. The He^3 will serve as a polarization analyzing detector for the UCN. The UCN will be detected by their interactions with the He^3 which will cause the He^4 to scintillate in the ultra-violet.

The walls of the measurement cell must satisfy several conditions:

1. The walls must a low UCN absorption.
2. They must have a small relaxation rate for polarized He^3.
3. They must contain wavelength shifter to convert the extreme vacuum u-v scintillations to visible wavelengths.

Over the years we have developed a coating consisting of deuterated Tetra-Phenyl Butadiene (TPB) dissolved in deuterated polystyrene (dPS) that can satisfy all these conditions.

Properties 2) and 3) have been demonstrated experimentally.

We have previously carried out a measurement program at the RCNP UCN superthermal UCN source. However there were some technical problems which prevented our achieving the desired level of reliability of the results. In the mean

time we have altered some details of our coating procedures so it seems it will be wrothwhile to repeat the measurements with some new (and old) samples.

2 Proposed Experiment

We propose to measure the UCN absorption on selected surfaces by adding samples of known area to the Osaka UCN variable height storage measurement apparatus. Then we would measure the storage time in the device vs height of the adjustable disk to gain some insight into the energy dependence of the UCN absorption on our samples.

The table shows the surface area of the chamber as a function of disk height

h-cm	S(h)-cm^2
20	2000
30	2600
60	4500
90	6500

So we see that if we added 4000 cm^2 of sample there would be a significant change in surface area of the trap.

In the previous measurements (see Appendix) the storage times were measured with statistical accuracy of better than 3% for heights of 20 cm or greater at a current of 200 nA.

Preliminary analysis of the data indicates loss coefficients for the sides of the chamber in the range $\eta \sim$2-4 $\times 10^{-4}$.

Thus we should be able to easily detect $\eta \sim 10^{-5}$ for our samples which is much better than can reasonably be expected at room temperature.

2.1 Sample preparation

Ideally we would prepare the samples at RCNP and install them in the apparatus as soon as possible after preparation. One problem with this is that we would have to transport our inflammable solutions from our lab in Raleigh to Osaka. Another possibility is to prepare all the samples here and transport them in a sealed vessel with a controlled atmosphere.

We would like to prepare three different sets of samples, using

a) what we call the swinging technique

b) our conventional technique of letting the solution run down a vertical surface

and

c) applying the coatings with a brushing technique as has been used at Los Alamos.

2.2 Measurement cycle

We should normalize each measurement to a measurement of the empty apparatus before and after each sample change. This will allow us to monitor any

changes in surface contamination of the apparatus.

We would produce about 4000 cm^2 of sample using each of the three techniques. We would then introduce say 1330 cm^2, 2660 cm^2 and 4000 cm^2 in succession. With each sample change we would measure at 3 different heights.

This will require about 5 days of measurement time.