10:00
I10 11

**Determination of Gap Distortion and Longitudinal Resonance Frequency in Superfluid $^3$He-B.** M.R. RAND, D.T. SPRAGUE, T.M. HAARD, J.B. KYCIA, P.J. HAMOT, Y. LEE, D.M. MARKS, W.P. HALPERIN, *Northwestern University* — We have performed pulsed transverse nuclear magnetic resonance in superfluid $^3$He-B. We derived and then numerically solved the Leggett equations for the high field limit. From our experiments and our analysis of the Leggett equations we have determined the temperature dependence of the longitudinal resonance frequency and the distortion of the energy gap. Numerical solutions show that the tipping angle dependent precession frequency generally differs substantially from the prediction of stationary solutions and depends on the magnitude of the transverse tipping field. However, for tipping angles of $\bar{\phi} < 60°$ and also for $\phi \approx 125°$, the precession frequency agrees with the stationary solution, being insensitive to the magnitude of the tipping field. This work is supported by the National Science Foundation through grants DMR-9314025 and DMR-9311918.

10:12
I10 12 Theory of Pulsed NMR Studies in Solid $D_2$ T. DINESEN, B. C. SANCTUARY, Mc. Gill U. and H. MEYER, Duke U. Density matrix theory is used to calculate the response signal of o-$D_2$ (with rotational angular momentum J=0 and nuclear spin I=2) in two- and three-pulse NMR experiments. A closed-form method has been successfully applied[1] to the solid echo properties of o-$H_2$ and p-$D_2$ (both with J=1 and I=1), but had not previously been developed for the I=2 spin system. We find, as expected, similar functional dependence upon the experimental parameters of both ortho and para systems and arrive at a detailed account of the intermolecular dipolar field. While this closed-form method considers individual contributions to the echo amplitude, greater physical insight is gained by considering the rotational invariance properties of the line shape. Results from a spherical tensor and product operator basis are then compared with one another as representations of the quadrupolar solid echo response problem. Finally the predicted solid echo amplitude ratio of the I=1 and I=2 components, expressed as a function of the time $\tau$ between the pulses and their respective phases $\Phi$, is compared with that observed[1] for several $D_2$ crystals of various J=1 concentrations. We also discuss the satellite echoes, predicted for the I=2 system, which have been observed[2] in $D_2$ adsorbed on MgO but not[1] in solid $D_2$.

1) I.Yu et al., J. Low Temp. Physics **51**, 369 (1983) for $H_2$.
D. Clarkson, X. Qin and H. Meyer, J. Low Temp. Physics **91**, 119 (1993) for $D_2$.
2) M.P. Volz et al. Phys. Rev. Lett. **63**, 2582 (1989)

## SESSION I11: DAMOP: ATOMIC AND MOLECULAR STRUCTURE AND SPECTROSCOPY

**Thursday morning, 20 April 1995**
**Room 3 at 8:00**
**R. Pratt, presiding**

8:00
I11 1 **Rovibronic Spectroscopy of the Ethoxy Radical in a Supersonic Jet Environment** PRABHAKAR MISRA, *Howard University* — The ethoxy ($C_2H_5O$) radical is generated as a chemical intermediate in combustion and atmospheric processes. It belongs to the $C_s$ point group and has 18 fundamental vibrational frequencies. $C_2H_5O$ was produced in situ by photolyzing freshly synthesized $C_2H_5ONO$ in a pulsed supersonic expansion with KrF (@ 248 nm) excimer laser pulses. A frequency-doubled Nd:YAG-pumped dye laser with a nominal linewidth of 0.07 $cm^{-1}$ served as the probe beam for excitation of the radical. Extensive laser excitation spectra of jet-cooled $C_2H_5O$ have been recorded in the 310-350 nm region with 0.15 $cm^{-1}$ resolution. Wavelength-resolved emission spectra have also been obtained with an Optical Multichannel Analyzer system, which employed CCD detection in conjunction with a 0.275 m monochromator equipped with a 1200 grooves/mm grating that provided a resolution of 0.5 nm. Several new vibrational frequencies have been identified for the $C_2H_5O$ radical.

*Supported by EPA grant R81-9720-010, NASA grant NAG3-1677 and CSTEA (NAGW-2950).

8:12
I11 2 $^{151}$Eu Mössbauer Investigation on a Bismuth High-$T_c$ Superconductor. F. W. Oliver, E. Hoffman, D. Tarleton, Morgan State Univ., L. May, The Catholic Uni. of America, C.E. Violet, LLNL, and M. S. Seehra, West Virginia Univ. We report on Mössbauer studies on Bismuth high -temperature superconductors with a particular emphasis on our findings on the superconductor $Bi_2Ca_{0.5}Eu_{0.5}Sr_2Cu_2O_x$ using $^{151}$Eu. Magnetic susceptibility measurements show a transition temperature of 87 K. Mössbauer measurements were performed between liquid nitrogen and room temperature. Isomer shift measurements show the Eu to be trivalent and is similar to those found for Eu based 1,2,3 high-$T_c$ superconductors. Evidence of phonon softening is observed about the Eu atom during transition to the superconducting state. A discussion on the isomer shift and f factor as a function of temperature will be reported and compared with previous results found in Eu based high-$T_c$ superconductors.

Supported by NASA - NAG 5-2375.

8:24
I11 3
Microwave Dielectric Behavior of Transition Metal Oxides. J. N. DAHIYA, Southeast Missouri State University.--A microwave resonant cavity in the $TE_{011}$ mode is used to study the dielectric properties of a sample of cobalt oxide and nickel oxide. The microwave data of these crystals is taken as a function of frequency and temperature. A fixed length of the sample is inserted into the resonant cavity and the perturbation of the signal are recorded in terms of the frequency shifts and width changes. Slater's perturbation equations are used to calculate the real and imaginary parts of the complex dielectric constant. A very sensitive heating and cooling technique is used to study the dielectric behavior of these crystals at various temperatures. Debye's theory is used to calculate the relaxation times of these crystals.

Supported by a grant from Grants and Research Funding Committee at Southeast Missouri State University.

8:36
I11 4 Quantized Magnetic Flux in Atomic Systems, R.L. COLLINS, retired, HCO1 Box 106C, Rockport, TX 78382. -- Magnetic flux within a superconducting ring is quantized in units of $\Phi$=h/2e. (1,2) This same flux quantum also plays a role within atomic systems. An oscillating charge "q" creates, about itself, an encircling and transient magnetic field. The Schrodinger equation requires correction of the <p> operator, $-i(h/2\pi)\nabla$ becoming $-i(h/2\pi)\nabla - qA$ (where A is the vector potential). Following Feynman (3), a wave function written as $\Psi(r)=[\rho(r)]^{1/2}\exp[i\theta(r)]$ leads to a current density $J=(h/2\pi m)(\nabla\theta-(2\pi q/h)A)\rho$ or $mv=(h/2\pi)\nabla\theta - qA$. On integrating this last equation along the displacement between turning points of the motion, the magnetic flux $\Phi$ is readily obtained. The first term is