Session 27aA

Critical Casimir Effects **27aA1**

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It is predicted that long-ranged order parameter fluctuations near a fluid's critical point will mediate a critical Casimir force between two interfaces confining the fluid. This force is a direct analog of the Casimir force in electromagnetism, a force between two metal plates that is mediated by the confined quantum zero-point fluctuations. Measurement of dielectric constant of helium films adsorbed on Cu electrodes show evidence for the existence of the critical Casimir force near the superfluid transition in He-4 and near the tricritical point in He-3-He-4 mixtures. In pure He-4, we find the force is attractive but near the tricritical point the force appears to be repulsive. This change in the sign of the force is explained by a change in the boundary conditions of the order parameter.This work was done in collaboration with Rafael Garcia and funded by NASA's Office of Biological and Physical Research under NAG8-1761.

Test of a New Field-Theoretical Crossover Equation-of-State **27aA2**

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A new field-theoretical crossover equation-of-state model provides a bridge between the asymptotic behavior close to a liquid-gas critical point, obtained by the Guida and Zinn-Justin parametric model [J. Phys. A: Math. Gen. 31, 8103 (1998)], and the expected mean field behavior farther away. The crossover is based on the beta function for the renormalized fourth order coupling constant and incorporates the correct asymptotic, crossover, and mean field exponents. Experimental measurements of the heat capacity at constant volume, isothermal susceptibility, and coexistence curve near the ^{3}He critical point were compared to the predictions of this model. The results of these comparisons will be presented.

27aA3 Surprising Behavior of the Superfluid Fraction for ^{4}He and ^{3}He-^{4}He Mixtures in 18.5 nm Channels.

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We have used Adiabatic Fountain Resonance to obtain the superfluid density ρ_s of ^{4}He and mixtures confined in channels 0.0185μm$\times 1.08\mu$m$\times\sim\infty$. We compare these results with existing data in L$\times\infty\times\infty$, and data for channels $0.0483\times 3.0\mu$m$\times\sim\infty$. We find that the behavior of the data in the smallest channels is quite different from what one might expect for a planar film of a given thickness. The transition is shifted to a lower temperature than expected; and, the overall behavior of ρ_s does not follow the trend observed with other confined films. This suggests that the *lateral* dimension plays a significant role in the behavior. Thus, one may view the helium in the smallest channels as a realization of finite-size, two-dimensional confinement.

27aA4 Experimental evidence for the weak turbulence on the surface of liquid hydrogen

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We present new results of experimental investigations of nonlinear capillary waves on the charged surface of liquid hydrogen. The results can be explained within the framework of the theory of weak wave turbulence. It is found that the correlation function of the surface deviation from the equilibrium state $\langle|\eta_\omega|^2\rangle$ depends on conditions of excitation of waves: $\langle|\eta_\omega|^2\rangle\sim\omega^{-3.7}$ for the surface excited by harmonic force at one frequency and $\langle|\eta_\omega|^2\rangle\sim\omega^{-3}$ for the double frequency excitations. The high-frequency boundary of the inertial interval has been observed for the first time. The boundary frequency ω_b is shifted towards higher frequencies with increasing the wave amplitude η_p at a pumping frequency ω_p in accordance with the theory of weak wave turbulence, $\omega_b\sim\eta_p^{4/3}\omega_p^{23/9}$.

27aA5 Thermomechanical effect in normal liquid ^{3}He in Anopore

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The thermomechanical effect (TME) has been measured in normal liquid ^{3}He, using the regular 200 nm diameter cylinders of Anopore as the constriction. The TME is the pressure difference resulting from a temperature difference across the constriction, analogous to the Seebeck (thermoelectric) effect in metals. The TME was nearly temperature independent at $\Delta P/\Delta T$=25 Pa/mK over the temperature range 0.6–12 mK, 3$\times$ the earlier result with a packed powder constriction (D. Sawkey et al., Can. J. Phys. 76, 183 (1998)) and 100$\times$ the theory of Edwards et al. at 1 mK. Pre-plating the cylinders with 2 monolayers of ^{4}He to remove the surface monolayers of magnetic solid ^{3}He did not affect the TME; with 4 monolayers of ^{4}He the thermal resistance across the constriction was too small for the TME to be measured. Thermal and mass conductivities through the Anopore agreed with theory to within a factor 2.