低温物質科学研究センターセミナー報告

日時：2004 年 9 月 17 日（金）　午後 3 時 30 分～
場所：理学研究科 5 号館　物理学教室 411 号室
講師：松木　征史　氏
所属：立命館大学（元・京都大学 教授）
題目：リドベルグ原子と空胴量子電気力学(Cavity QED)
要旨：

イオン化限界近くまで励起された高励起原子，いわゆるリドベルグ原子状態は，寿命が長く，隣りあう準位間の電気双極子遷移確率が大きい，という特徴を持つ．従ってまた，極めて敏感に外部電場の影響（シュタルク効果）を受ける．共振空胴中にリドベルグ原子を導入して，単一空胴モードとリドベルグ原子を結合させると，上記のリドベルグ原子の特徴から，自由空間では得られない量子系が実現出来て，空胴量子電気力学 (Cavity quantum electrodynamics; Cavity QED)と呼ばれるユニークな研究が展開されて来た．ここでは，リドベルグ原子，特にアルカリ・リドベルグ原子の構造・シュタルク特性・検出方法などをまず明らかにし，それに基づいて空胴量子電気力学研究の一端を紹介する．

日時：2004 年 10 月 14 日（木）　午後 4 時～
場所：理学研究科 5 号館　物理学教室 519 号室
講師：Harry Kojima
所属：Rutgers University and ISSP
題目：Spin-Polarized Superfluid Helium Three
要旨：

The spin-polarized superfluid A_1 phase appears, when a high magnetic field is applied on superfluid helium three. Some of the interesting properties and hydrodynamics of the A_1 phase will be introduced. Our recent and on-going experiments on the magnetic fountain effect will be briefly described. The mechanical fountain pressure detector serves as a spin density detector. After the brief introduction, the talk will be devoted to reviewing our experiments on the spin-entropy wave propagation (second sound) in A_1 phase.

The spin-entropy wave is the second sound (normal-superfluid counterflow mode) propagation in the spin-polarized superfluid ^{3}He A_1 phase. Measurement of the propagation velocity gives the anisotropy components of the superfluid density. The perpendicular anisotropy component of superfluid density was measured as a function of magnetic field up to 12 tesla at 21.5 bar. The attenuation in bulk A_1 fluid was measured and was compared with theory on the spin diffusion and other dissipative coefficients. An anomalous diverging attenuation was observed at the lower transition temperature of the A_1 phase. When the superfluid flow accompanying the spin-entropy wave was

directed parallel to the anisotropy ***l*** vector texture, the flow field distorted the texture. The distortion resulted in an unusual non-linear propagation phenomena in which the non-linearity was greatest at intermediate flow velocities but reverts back to linear propagation at larger flow velocities. A mechanical system of mass attached to a "soft" spring was developed to model the non-linear propagation. An experiment was devised to control the ***l*** vector texture in a rectangular cell with one SEW resonance mode and to observe texture transitions with another mode. The transitions of ***l*** vector texture appeared to be of first order.

日時：2004 年 11 月 26 日（金） 午後 4 時～
場所：理学研究科 5 号館 物理学教室 第 4 講義室
講師：Prof. D. D. Osheroff
所属：Department of Physics, Stanford University
題目：Evidence that Low Density Aerogels Stabilize a New Superfluid ^{3}He State Near T_c
要旨：

My group has measured in detail the NMR spectra of superfluid ^{3}He inside two different silica aerogels, one with a porosity of 99.3% and the other 98.7%. From these spectra we are able to determine the equilibrium A-B transition temperatures in both aerogel samples as a function of hydrostatic pressure. We find that the slope of the reduced A-B transition temperature, $1-T_{AB}/T_C$, vs. pressure is only about one third that seen for the bulk A-B transition, despite the fact that T_c for the two samples is suppressed only very modestly, by only 4% and 8% at 34 Bars. We argue from this that the presence of the aerogel stabilizes an equal spin pairing state which is distinct from that stable in the bulk.

日時：2004 年 12 月 9 日（木） 午後 4 時～
場所：理学研究科 5 号館 物理学教室 439 号室
講師：Prof. Alex Ya. Parshin
所属：P. L. Kapitza Institute for Physical Problems Moscow, Russia
題目：Facet Growth of ^{3}He Crystals
要旨：

We have performed the first quantitative investigation on the growth dynamics of the basic (110) facets of ^{3}He crystals in the temperature range of 60-110mK. The obtained values of the step free energy suggest an extremely weak coupling of the liquid - solid interface to the crystal lattice which we show to be the result of quantum fluctuations of the interface. The renormalization group approach by Nozieres and Gallet, modified to incorporate quantum fluctuations, explains well the temperature dependence of the step energy measured at this work and at ultra low temperatures by Tsepelin et al, where the coupling is known to be strong. We have thus shown that, paradoxically, the role of quantum fluctuations is at higher temperatures much larger than at low temperatures. We have extended the measurements of Tsepelin et al at 0.5mK to the temperature range up to 1.2mK. In addition to the previously observed growth mode we found a few of new, more slow growth modes which we relate to the motion of non-elementary steps of larger heights and lower mobilities. The effect of bulk antiferromagnetic transition is also clearly seen.