東京大学　G-COE プログラムー未来を拓く物理科学結集教育研究拠点ー
Global Center of Excellence for Physical Sciences Frontier
G-COE Seminar

「Magnon Bose-Einstein condensation」

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日時：　2011 年 12 月 13 日(火曜日)　15:00–16:30
場所：　理学部 1 号館 431 号室（Room 431, Bldg.1, Faculty of Science）

Abstract：

Superfluid ^{3}He can be considered as a quantum vacuum carrying various types of quasiparticles and topological defects. The structure of this system shows many similarities to that of our Universe.　It can act as a model system for the study of many types of general physics experiments, which are difficult or even impossible in Cosmology, Atomic or Nuclear physics. There is a complete analogy between the Bose-Einstein condensation of atomic gases and the Bose-Einstein condensation of magnons in superfluid ^{3}He. Five different states of magnon condensation have been found; the homogeneously precessing domain (HPD) in ^{3}He-B; the persistent signal, which is formed by a Q-ball in ^{3}He-B at very low temperatures; coherent precession with fractional magnetization in ^{3}He-B and coherent precession of magnetization in ^{3}He-A and ^{3}He-B in a squeezed aerogel [1]. All these cases are examples of the Bose-Einstein condensation of magnons with the interaction potential provided by specific spin-orbit coupling. The BEC phenomenon in the gas of magnons is readily accessible owing to the possibility of modifying the spin-orbit coupling. In some cases the BEC of magnons corresponds to almost 100% condensation.

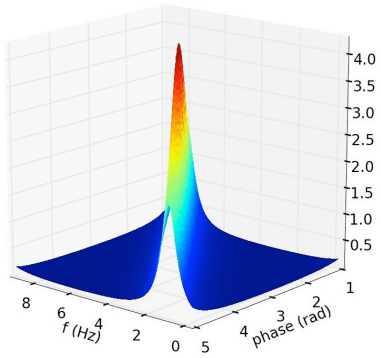

Fig. 1　Spin Waves condensation in superfluid ^{3}He-B.

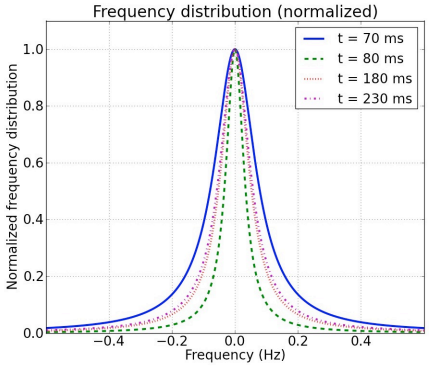

Fig. 2　The spectrum of BEC radiation after 70, 80, 180 and 230 ms after a RF pulse.

In Fig.1 the frequency and phase distribution of BEC radiation is demonstrated. The accuracy of phase and frequency measurements is mixed due to the analogy with the uncertainty. Fig 2 shows the BEC radiation broadening, which is about 0.2 Hz, the 4000 time smaller than it should be due to the inhomogeneity of magnetic field. The broadening of magnetic field on the sample corresponds to an 800 Hz!

Finally the magnon BEC state was found on a ^{55}Mn nuclear in antiferromagnetic $CsMnF_3$ [3].

[1] Yuriy M. Bunkov and Grigoriy Volovik, J. Phys.: Conds. Matt. **22** 164210 (2010).
[2] Ю. М. Буньков, УФН, 180, 884; Physics–Uspekhi, **53**:8, 848 (2010).
[3] Yu.M. Bunkov, E.M. Alakshin, R.R. Gazizulin, A.V. Klochkov, V.V. Kuzmin, T.R. Safin, M.S. Tagirov, JETP Letters, **94**, 68 (2011).

ブンコフ博士は、超流動 ^{3}He の NMR 実験において、homogeneously precessing domain（HPD）を発見して「超流動スピン流」の存在を実証した功績で、フリッツ・ロンドン賞を 2008 年に受賞されています。

紹介教員：福山 寛 教授　(物理学専攻)