

超伝導・超流動入門

Sato&Packard, Physics Today **10**, 31 (2012), R.Simmonds et al., Nature **412**, 55 (2001)

Figure 2. A superfluid interferometer. Two nanoaperture arrays (red) interrupt a torus filled with superfluid helium. In response to a pressure difference, fluid in both arrays oscillates at the same frequency. A gradient in the quantum phase within the torus alters the relative phase of the oscillations, which affects the total oscillation amplitude detected by the sensing coil.

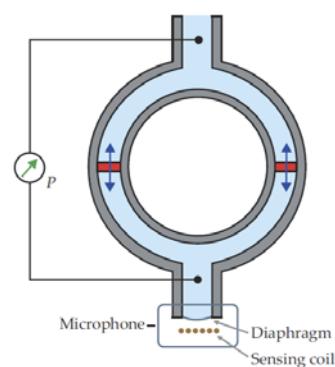
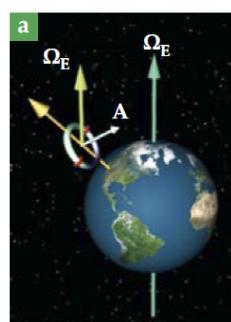
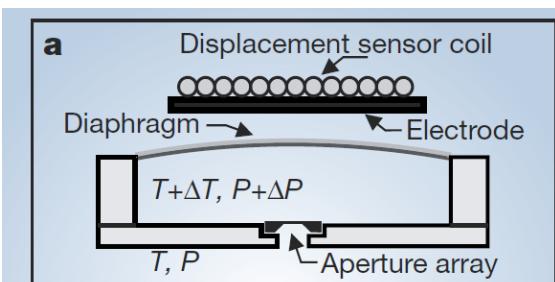


Figure 3. A superfluid gyroscope. (a) A superfluid interferometer is placed in Earth's rotating frame with its area vector \mathbf{A} at some angle with respect to Earth's rotation vector Ω_E . The quantum phase shift across the device is proportional to the so-called rotation flux, $\Omega_E \cdot \mathbf{A}$, so by varying the direction of \mathbf{A} one can measure Ω_E . (b) The modulation in the oscillation amplitude, experimentally observed here with a helium-3 interferometer, has the form of the absolute value of a cosine. (Adapted from ref. 9.)



SQUID作成方法

超流動ヘリウムの場合
小さな穴をナノテクであける



Coherence length

4He

$$\xi = \frac{\hbar}{\sqrt{2mgn_0}} \sim 1 \text{ Å}$$

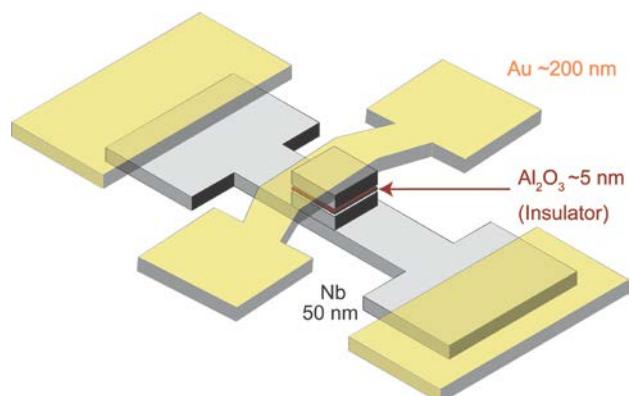
3He

$$\xi = \xi_0 / \sqrt{1 - T/T_c}$$

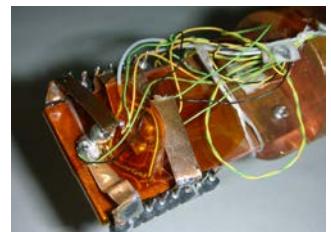
$$\xi_0 \sim 12 \text{ nm}$$

超流動転移温度近くに制御

超伝導体の場合
主に、ナノテク。Nbを使う。

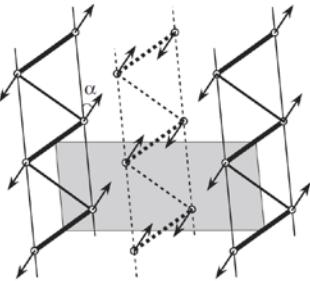


ローテク
でもOK。



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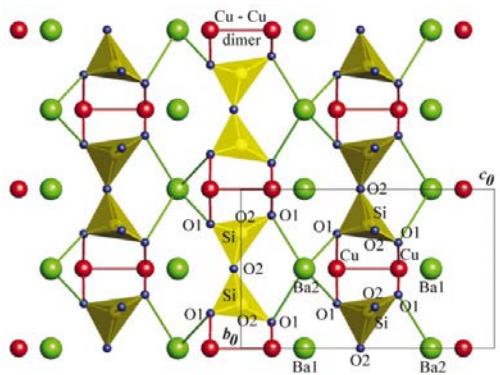
TlCuCl₃: Double chain along a-axis



Oosawa (2004) JPSJ 73, 1446

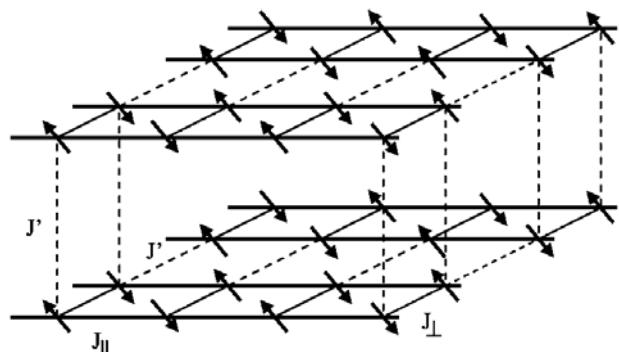
Kudo (2004) JPSJ 73, 2358

BaCuSi₂O₆: “Han purple”



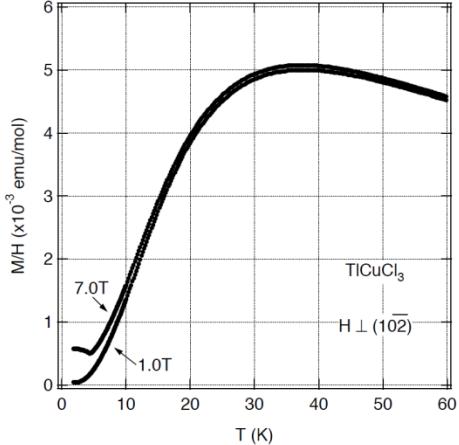
Sparta&Roth (2004) Acta Cryst. B60, 491-495

Dimerが並んだような配置
～ Coupled two-leg ladder



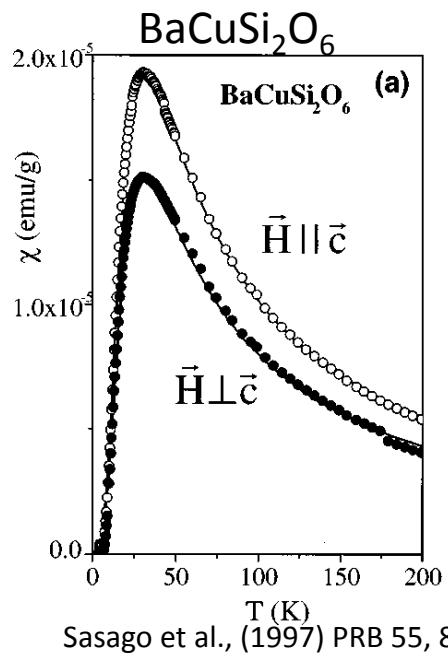
磁化率のデータ

TlCuCl₃



Oosawa et al., (1999) J. Phys. Condens. Matter 11, 265

BaCuSi₂O₆



Sasago et al., (1997) PRB 55, 8357

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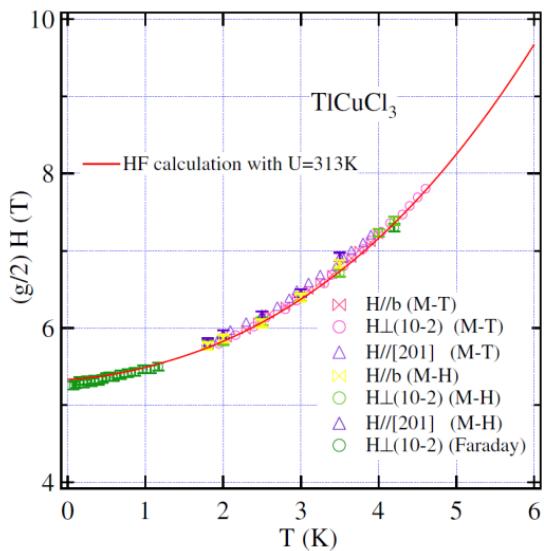
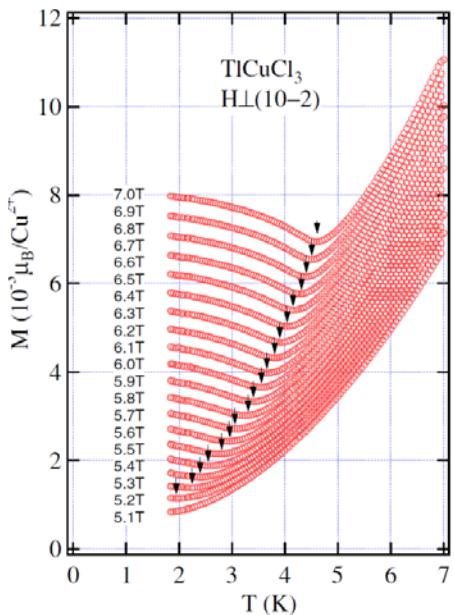
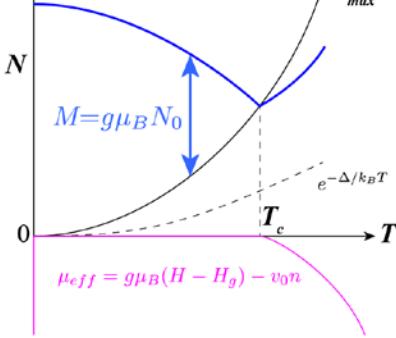
Yamada (2008) JPSJ 77, 013701

M in TiCuCl_3

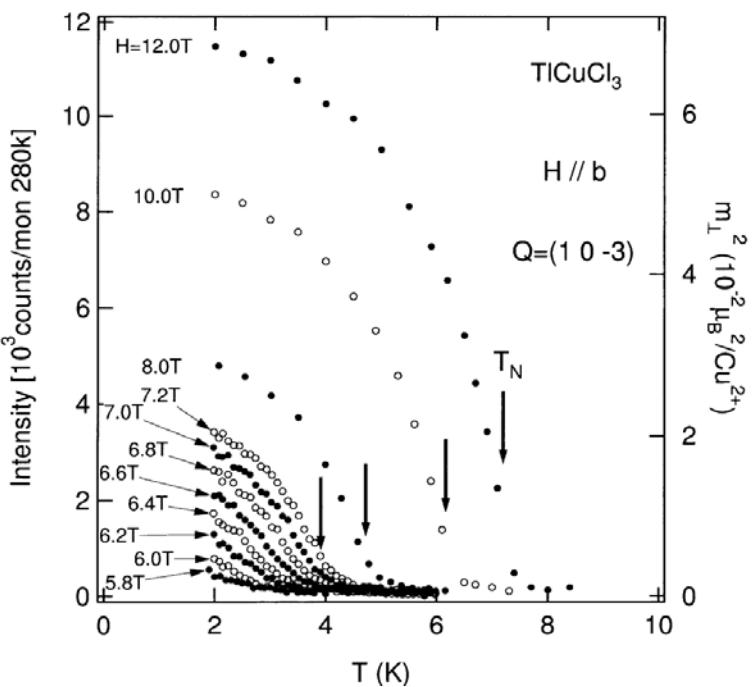
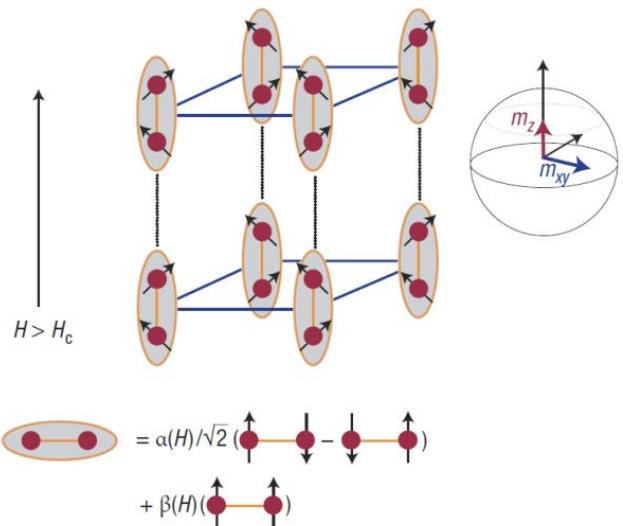
In d-dimensions,

$$T_c \propto (H - H_c)^{d/2}$$

$$H_c - H_g \propto T^{3/2}$$



Transverse staggered magnetic moment in magnon BEC



Tanaka et al., (2001) JPSJ 70, 939