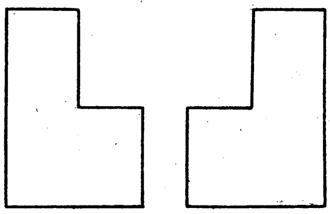
朱耀煌

Flux Quantization in A Superconductor

A very interesting phenomena of flux quantization in a doubly connected superconductor, which was first noticed by F. London in 1935, has recently found experimental evidence (B. S. Deaver Jr. and W. M. Fairbank 1961, also R. Doll and M. Naebauer 1961). A rigorous proof for this fact was given by N. Byers and C. N. Yang 1961, But there is some problems left, which was first noticed by the author 1970. Let us consider a doubly connected superconductor with varying inner radius as shown in the figure,

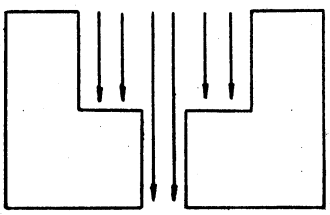
figure 1.



When the field is turned on before it is superconductorized, we can change the ratio of the two radii and the field strength making the flux in the upper part be $m\phi_{\circ}$, and that in the lower part be $\phi_{\circ}$, $m > 1$ and is integer and $\phi_{\circ}$ is one flux unit which is equal to 2×10^{-7} $G - cm^2$. According to C. N. Yang's theory, both states are stable. Then, there is a tendency that neither of them will change the flux that passes through their respective hole when we superconductorized the material.

If things were going this way, we have an apparent paradox. The field lines will be as shown in figure 2,

figure 2.



which terminate on the boundary of these two part. This means $\nabla . B \neq o$

However, if things do not behave this way, what will then be the case? Actually, I don't think this problem can be solved by some trivial and simple calculations. Visiting prof. Y. H. Kao of SUNY at Stony Brook suggests that it is best to the determined by experiment. The auther would like to find the result by experiment too. Since this is the true spirit of physics. This experiment may begin in July.

The author also asked C. N. Yang for his comment on this subject. C. N. Yang said, through his personal correspondence with the author, that he believes "The trapped flux in the upper part cannot be different from that in the lower unless a bundle (or bundles) of flux penetrates the lower superconducting part. In that case the flux in the larger hole and in the smaller hole would both be integral multiples of the flux unit, but some quantized flux bundles would distribute themselves within the superconducting material in the lower part as shown in the accompanying diagram."

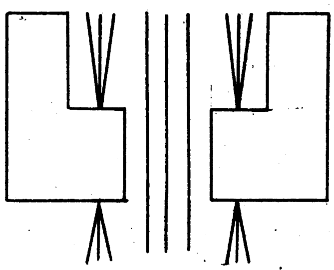


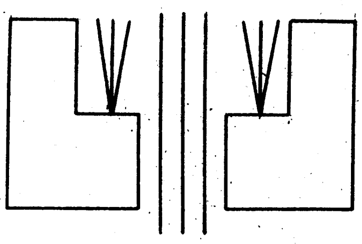
figure 3.

However, the author do believe that we need an experimental verification for the determination of various possibilities. Finally, the author would like to comment on the following two things:

(a) There exists no magnetic monopole in a set up like this if originally there is no monopole. The proof is based on the fact that all current generated magnetic field must be dipole in nature. (This can be easilly shown by taking the divergence of the generalized Biot-Savart law).

(b) There seems to be a connection between the quantized flux and the magnetic monopole. Please compare the flux unit and the magnetic charge unit predicted by J. Schwinger. From which we have the possibility of capturing the magnetic monopole by this superconductor, because $\nabla \cdot \mathbf{B} = 4\pi \rho m$

$\Phi = n\Phi_0 + 4m\Phi_0$



$\Phi = n\Phi_0$

$$\Phi_0 = 2 \times 10^{7}\ Gauss\text{-}cm^2$$

$$\rho m = n\frac{\hbar c}{e}\,\delta\,(r - r')$$

Any furthur comment will be welcome.
May 1970

在門檻上

陳順強

假如大學是一間「遊樂場」，裏面五花八門，兼容並蓄，只要有了一張門票，誰都可以自由觀賞，甚至偶而還可以試兩手，那麼現在我的感覺就好像是站在標有「出口」兩個大字的門檻上，回頭看看，摸摸口袋，千思萬緒。

我剛由窮鄉僻壤踏進崇高神聖的學術聖地時，茫然無措，既不知要作些什麼？也不知該作些什麼？但由外界的導引和自己的摸索，雖然一事無成，眼界卻廣闊了些，大概誰也免不了經過這些階段，只不過有時是漸受潛移默化而不自覺罷了。

底下我想依序談些我個人的親身感受，只不過是野叟獻曝。其中或許批評多於讚美，但是我想台大物理系的盛譽絕非因具有這些我認為可以改進的地方而受到絲毫影響，而且我的感受或許也是國內教育界的一般現象。

首先我談到課程，就一般而言，四年的課程，用書及質、量都是首屈一指的，比之國外一流大學，據悉亦未之遜色。但是少數課程用書似乎太深了些，或許是由於同學中有若干「高手」存在的緣故。但我本人對一年級的普通物理因為缺乏基礎，對課內所授吸收不够理想。二年級的電磁學尤其後半部也頗感難入廟堂。三年級的應用電子學則體會不多，量子力學則覺措手不及；光學則覺「剪不斷，理還亂」。而對大多實驗（實驗物理除外），則覺個人用功不勤，配合未必理想，實驗時或因儀器限制，或因乏人可問，而乏善可陳，又因經費的關係，有些儀器也得添購或更新。

因此我覺得如果普通物理能隨便用一本Halliday之類的書，雖然簡單些，但對初逢原版書的「新鮮人」或更理想。而如電磁學、理論力學我以為以用一本書為原則，如 Reitz 或 Purcell，Synge 或 Marion，因為大一、二的課程都是相當基本的課程，目的在求基本觀念的建立，而不一定要很深入或很廣泛，只要基礎穩固，有志者自可自習，而感游刃有餘了。電子學我始終毫無心得，我目前還不知道對一個念物理的人來說，要怎樣涉獵這方面的知識？所需為何？不過恐怕實際的經驗更重要些；對於量子力學，我一竅不通，但我覺得這門學問實在是太必須也太重要了，大概除了普通物理外，當推此門了，也是一張王牌。我覺此門課宜受很大重視，而其訓練則一如上述之電磁學。而且我覺三年級不一定講授許多，而宜在四年級加開一門量子力學II，至於其範圍深度我未能置喙，幾何光學很多人都說不大需要，且可放在大一普通物理中略作講授，但宜加強物理光學部份，我覺White 的書這部份收容雖很廣，但對很基本的原理的探討似不十分理想，而僅重現象之陳述，是否可以考慮換一本？四年級時似可另加開些數學方面的課程，因為平庸如筆者，實在不敢問津於數學系。而客座教授的課