



1. Introduction

DFSZ axion model: two Higgs doublets + singlet scalar

- provides QCD axion resolving strong CP. (NGB of $U(1)_{PQ}$).
- requires 2HDM and is testable by, e.g., ILC. (HPNP!)
- predicts a string-like soliton called axion string due to $U(1)_{PQ}$.

We found a novel type of axion string, which has a special property, superconductivity.

2. Setup

$$-\mathcal{L}_{mix} = \left(\kappa S^2 H_1^\dagger H_2 + \text{h.c.} \right)$$

$$+\kappa_{1S} |H_1|^2 |S|^2 + \kappa_{2S} |H_2|^2 |S|^2$$

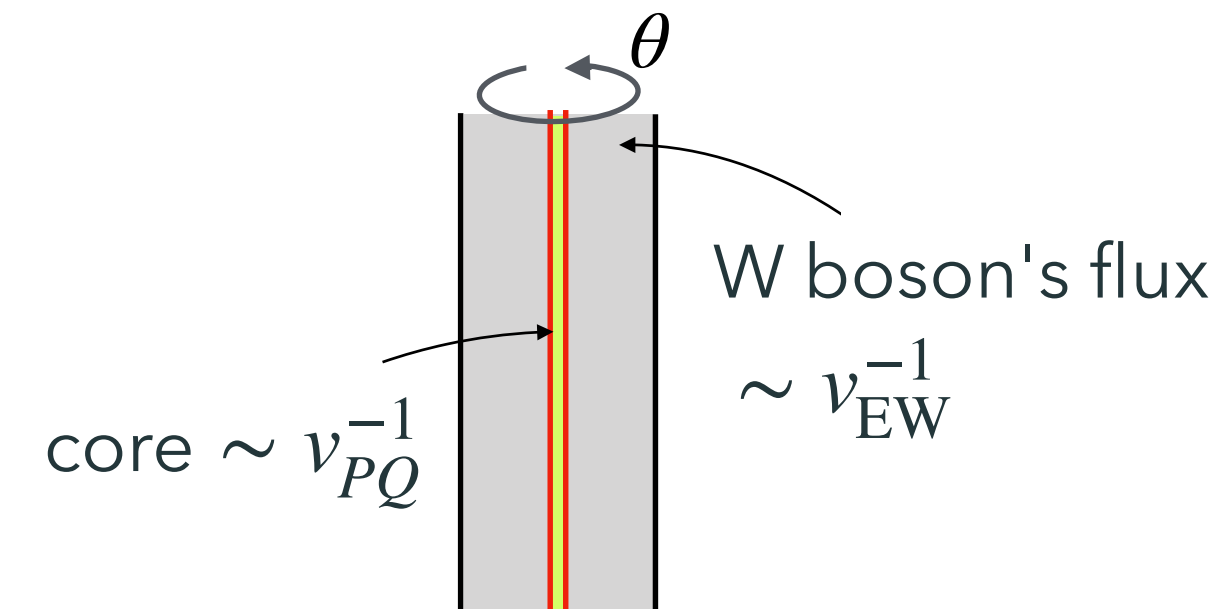
	H_1	H_2	S
$SU(2)_W$	2	2	1
$U(1)_Y$	1	1	0
$U(1)_{PQ}$	1	-1	1

$\langle S \rangle = v_{PQ} \simeq 10^{9-12} \text{ GeV} \rightarrow$ SSB of $U(1)_{PQ}$ and **axion appears.**

$\langle H_1 \rangle = \begin{pmatrix} 0 \\ v_1 \end{pmatrix} \quad \langle H_2 \rangle = \begin{pmatrix} 0 \\ v_2 \end{pmatrix} \rightarrow SU(2)_W \times U(1)_Y \rightarrow U(1)_{EM}$
 $v_{EW}^2 = 2(v_1^2 + v_2^2) \simeq (246 \text{ GeV})^2$

3. Electroweak axion string

- **High temperature:** $v_{EW} \ll T \lesssim v_{PQ} \rightarrow$ ordinary axion string
- **Low temperature:** $T \lesssim v_{EW} \rightarrow$ **Electroweak axion string (new!)**



$$S \sim v_{PQ} e^{i\theta}$$

$$H_1 \sim e^{i\theta} e^{i\theta\sigma_1} \begin{pmatrix} 0 \\ v \end{pmatrix}$$

$$H_2 \sim e^{-i\theta} e^{i\theta\sigma_1} \begin{pmatrix} 0 \\ v \end{pmatrix}$$

$U(1)_{PQ} \quad U(1)_{W1}$

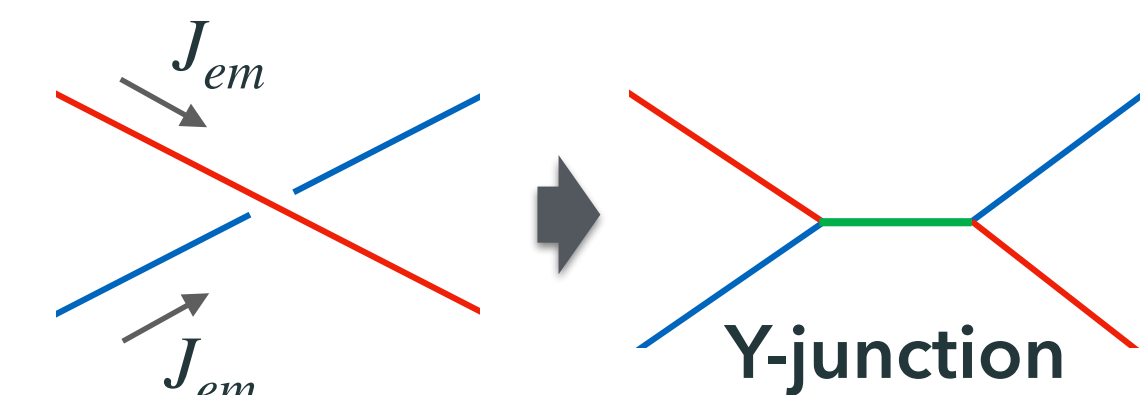
Charged components acquire VEV in the string and break $U(1)_{EM}$ sym! \rightarrow **superconducting string**

4. Discussion

- The string is a stable solution of EOM in some parameter space.
- Large amount of electric current can flow on the string.

\rightarrow Y-junction is formed with probability 1/2 when the strings collide.

The standard cosmological scenario for the strings might breakdown!



Outlook:
new constraint on DFSZ model?