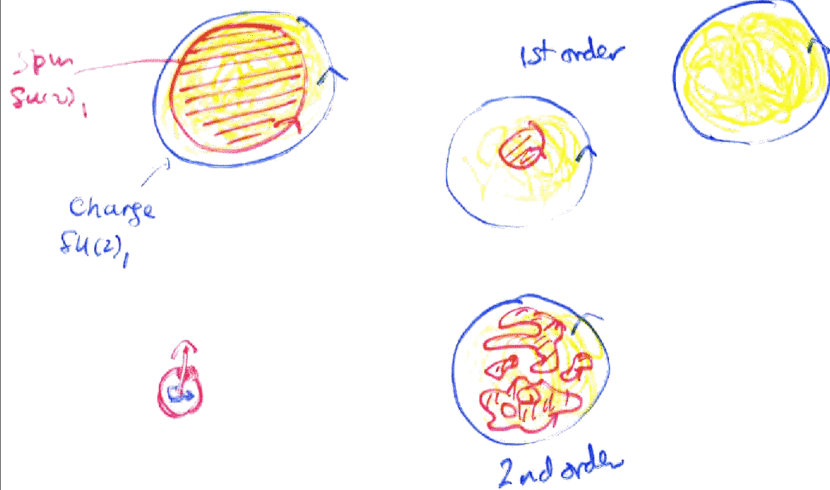


Haldane KITP 6/11/04 ①

- String theory of "2nd order" transitions in 2+1d?

(can domain wall surface (line) tension become negative)?

Chiral case: Feshbach resonance
 for $\nu=2$ spin-1/2 fermions (charge e) \Rightarrow $\nu=1/2$ charge $2e$ molecules



• making the $\nu=2$ wavefunction for fermions "look like" $\nu=1/2$ bosonic pairs

$$\textcircled{1} \Psi = \sum_{\sigma_i = \pm 1/2} \prod_{i < j} (z_i - z_j)^{\text{antisymmetric}} e^{i \sum_{i < j} \text{spin}(\sigma_i - \sigma_j)} \prod_{i=1}^N u_i^{1/2 + \sigma_i} v_i^{1/2 - \sigma_i}$$

$L=1 \dots N$ \rightarrow $z_i = x_i + iy_i$ complex coordinate in xy plane
 $u_i = \uparrow$, spinor "coordinate" for atomic spin
 $v_i = \downarrow$

$$\textcircled{2} \bar{\Psi} = A \left\{ \prod_{i < j} (z_{2i-1} - z_{2j-1})(z_{2i} - z_{2j}) \prod_{i=1}^N u_{2i-1} v_{2i} \right\}$$

\uparrow antisymmetrizer

$$\textcircled{3} \bar{\Psi} = A \left\{ \prod_{i < j} (z_{2i-1} + z_{2i} - z_{2j-1} - z_{2j})^2 \prod_{i=1}^N (u_{2i-1} v_{2i} - v_{2i-1} u_{2i}) \right\}$$

$L=1 \dots N/2$ \rightarrow
 center of mass of pair: z_{2i-1}, z_{2i}
 center of mass of pair: z_{2i-1}, z_{2i}
 explicitly spin singlet

\Downarrow Feshbach

$$\textcircled{4} \bar{\Psi} = \prod_{i < j} (z_i - z_j)^2 \text{ (molecules)}$$

Laughlin $\prod_{i < j} (z_i - z_j) = \det_{i,j} (z_i^{j-1})$
 vandermonde

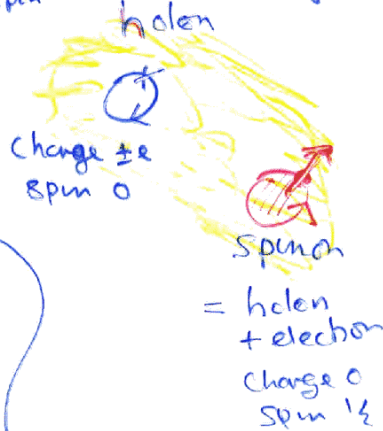
like rewriting BCS wavefunction in various ways...

confined fermion



(Chiral) String picture of hole
(charge $\pm e$ (pseudospin $1/2$)
Spin $-1/2$
in $\nu=2$ state

deconfined semion + semion¹
Spin charge³



$\nu=1/2$
"molekular state"

- Always first order (positive line tension)?
- Counter example (according to Read + D. Green)

Haldane-Rezayi "dimer" pairing state
© 1985

$\nu=1/2$
Spin singlet

$$Pf \left(\frac{u_i v_j - v_i u_j}{(z_i - z_j)^2} \right) \prod (z_i - z_j)^2$$

$u = \uparrow$
 $v = \downarrow$

"Hollow-core pseudo potential"
($V_0 = 0$ $V_1 = 1$ $V_{m>2} = 0$)

* original (Pre-Read Moore) paired state with exact Hamiltonian

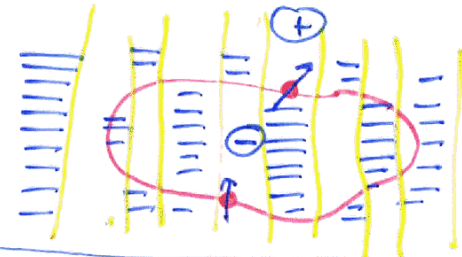
Haldane-Rezayi is at critical point (quantum no's of zero energy states of torus)

Bulk gapless neutral "fermions" (?) $e \sim k^2$ $Z=2$
Strings?

Non chiral pictures

Néel $\rightarrow Z_2$ (dimer / v6)

domain wall = spin chain spins = semions on chain

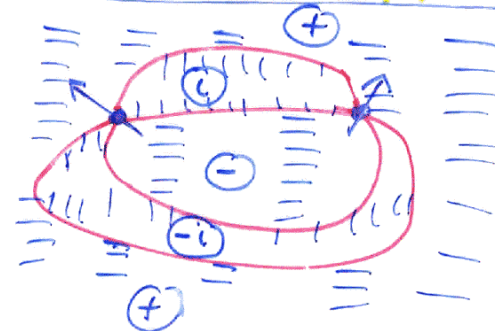


columnar dimer without square sym

? Fermionic

Z_4 vortices

Sentil Vishwanath Fisher... etc



Special Square case

non chiral