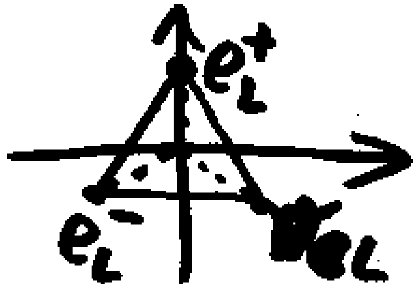
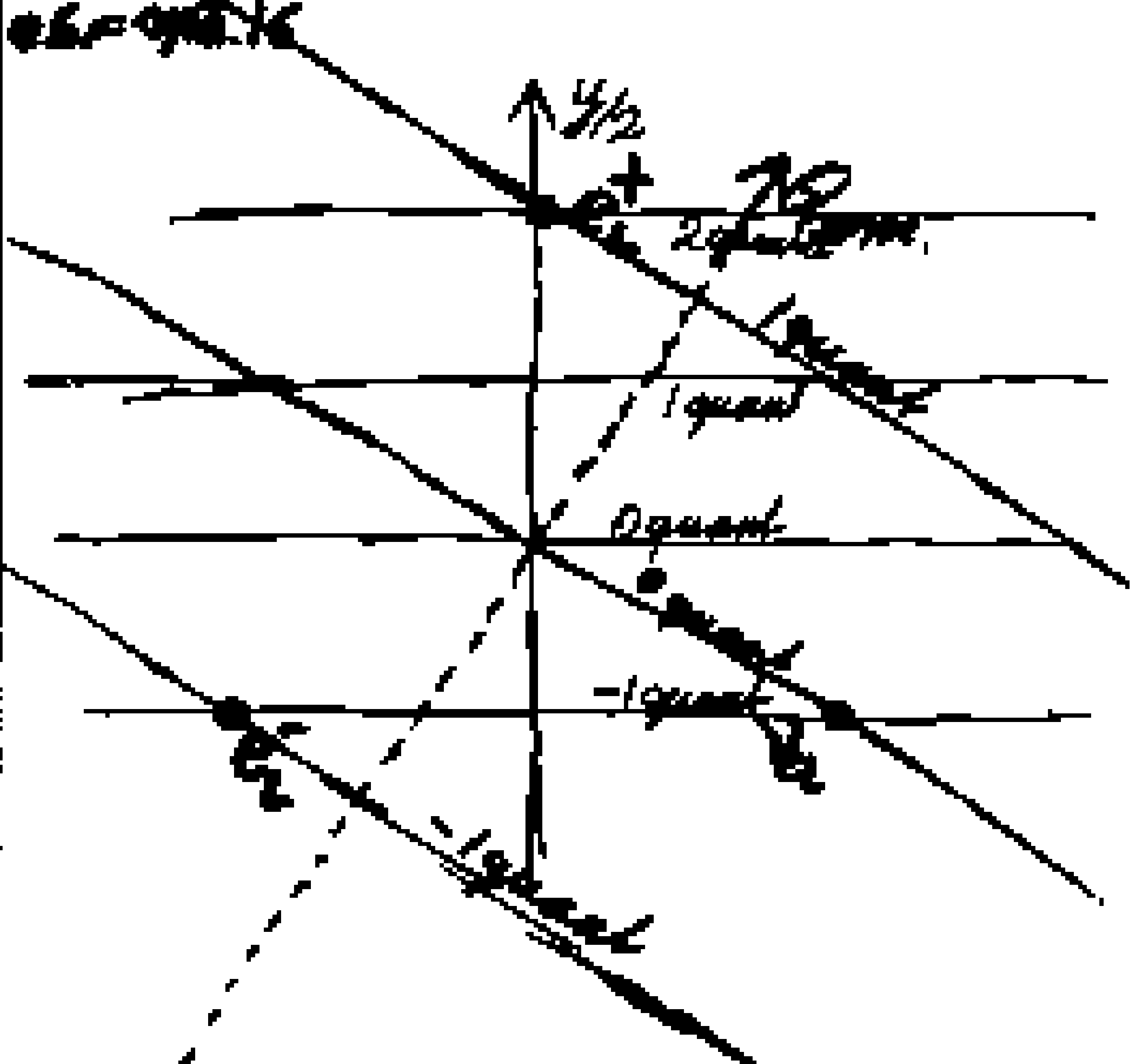
e.5. IF "TOTAL COUPLING STRENGTH" WERE GIVEN BY THE DISTANCES TO CENTER IN AN EQUILATERAL TRIANGLE

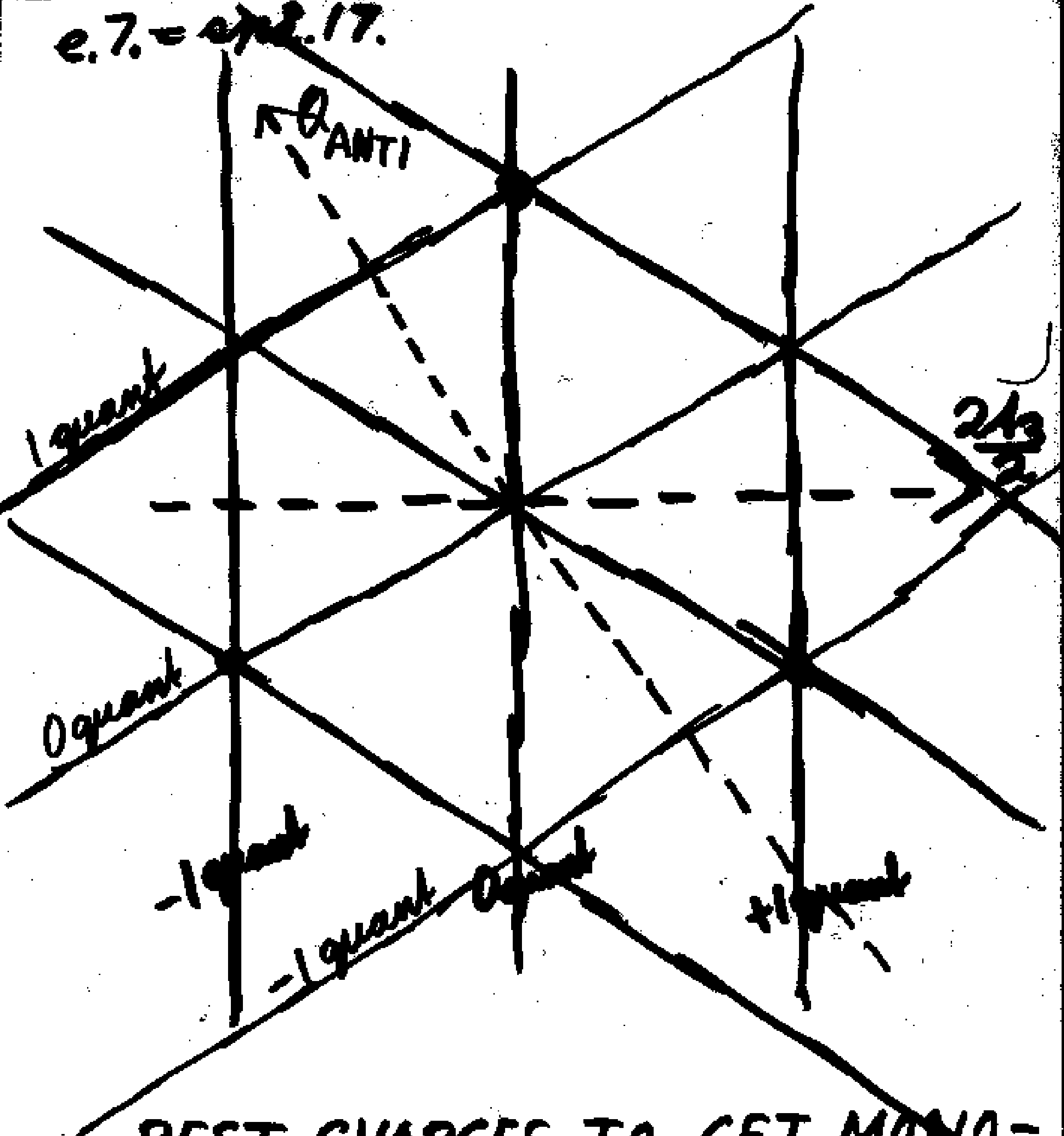


AS IS ROUGHLY TRUE SINCE SU(3) UNIFICATION OF SU(2)×U(1) COULD BE SERIOUSLY PROPOSED THEN CHARGES TO BE QUANTIZED BY DIRACS MONOPOLE WAY ARE GIVEN BY THE PROJECTIONS ON CHARGE AXIS OF THE EQUILATERAL TRIANGLE FIGURE. THEN Q_{qrg} GIVES WEAKER COUPLED MONOPOLES THAN $e/2$ BY A FACTOR 3 IN [illegible].



IF FIGURE TO SCALE
THE WEAK HYPERCHARGE $Y/2$
HAS SMALLER QUANTA BY
A FACTOR $\sqrt{3}$ THAN THE
ELECTRIC CHARGE $Q_{em} = \frac{Y}{2} + \frac{\tau_3}{2}$
SO A MONOPOLE FOR $Y/2$ COUPLES
STRONGER THAN ONE FOR Q_{em}.

e.7. = epd.17.



BEST CHARGES TO GET MONO-
POLES WEAKER COUPLED:

$$Q_{ANTI} = \frac{y}{2} - \frac{\lambda_3}{2}$$

$$Q_{em} = y/2 + \lambda_3/2$$ (=ORDINARY ELECTRIC)

$$\frac{2\lambda_3}{2} = \lambda_3$$ (SCALED THIRD COMPONENT OF WEAK ISOSPIN)

e.8. = eqn. 18.

WHEN WE SEEK TO DEFINE CHARGES SO AS TO GET THE LARGEST QUANTA/UNITS NOT UNEXPECTED WE TEND TO GET VERY FEW — ACTUALLY ONLY −1, 0, OR 1 — QUANTA/UNIT ON EACH OF THE PARTICLES e^+_L, e^-_L AND ν_{eL} — WHILE WITH $y/2$ WE HAD NUMBER OF QUANTA −1, 2 (= y) i.e. UP TO 2 UNITS —

	$Q_{ANTI} = \frac{y}{2} - \frac{t_3}{2}$	$Q_{\text{[illegible]}} = \frac{y}{2} + \frac{t_3}{2}$	$\frac{2t_3}{2}$
e^+_L	1	1	0
e^-_L	0	−1	−1
ν_{eL}	−1	0	1

e.g. = spå. 19.

WHAT DID WE LEARN FROM THE EXCERCISE WITH "OLD" ELECTROWEAK THEORY (i.e. STANDARD MODEL WITHOUT Q.C.D.)? CARTAN ONLY:

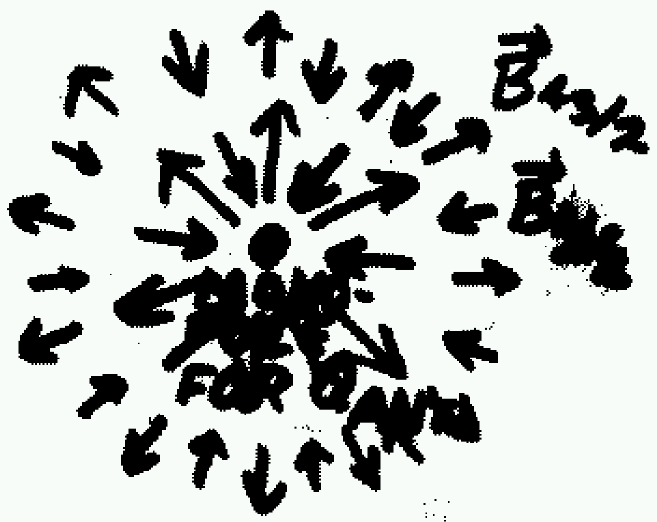
- WE <u>COULD FIND</u> CHARGES GIVING SOMWHAT WEAKER COUPLED MONOPOLES THAN WEAK HYPERCHARGE $y/2$ i.e. y ITSELF, NAMELY $Q_{em} = \frac{y}{2} + \frac{\lambda_3}{2}$, $Q_{ANTI} = \frac{y}{2} - \frac{\lambda_3}{2}$ AND $\frac{2\lambda_3}{2} = \lambda_3$.
- WE FOUND 3 ABOUT EQUALLY GOOD RATHER THAN 2 AS NEEDED ONLY, FORMING HEXAGONAL PATTERN
- IN "RIGHT CHARGES" Q_{em}, Q_{ANTI}, $\frac{2\lambda_3}{2}$ THE NUMBER OF UNITS "[illegible]": 1, −1, 0.

e.12 = spå.20.

WHAT HAPPENS TO THE 3 SUGGESTED MONOPOLES IN "OLD ELECTROWEAK TH." WHEN CARTAN ALGEBRA EXTENDED TO NONABELIAN $U(1) \times SU(2) \sim U(2)$?

- THE MONOPOLE FOR $\frac{2\lambda_3}{2} = \lambda_3$ IS NO LONGER NEEDED FOR QUANTIZATION OF $\frac{2\lambda_3}{2}$ BECAUSE THE QUANTIZATION DUE TO NON-ABELIAN GROUP $SU(2)$ DOES THE JOB INSTEAD.
- THE MONOPOLES FOR $Q_{em} = \frac{Y}{2} + \frac{\lambda_3}{2}$ AND FOR $Q_{anti} = \frac{Y}{2} - \frac{\lambda_3}{2}$ GET UNITED TO ONE.

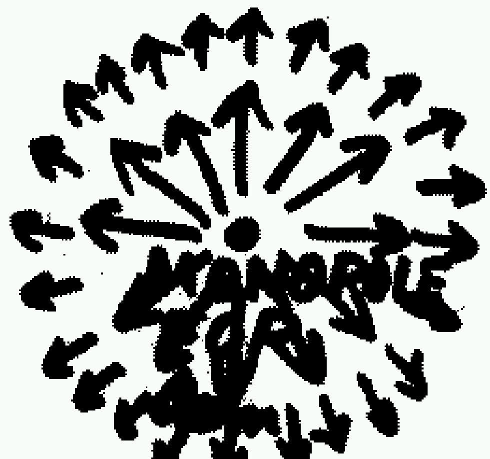
THE MONOPOLE ENSURING QUANTIZATION OF THE $Q_{ANTI} \doteq \frac{y}{3} - \frac{I_3}{2}$ IS SURROUNDED BY A MAGNETIC FIELD RADIATING OUT LIKE A COULOMB FIELD BOTH OF WEAK ISOSPIN TYPE AND OF WEAK HYPERCHARGE TYPE, BUT OF OPPOSITE SIGN:



SO THE EFFECT WOULD CANCEL WHEN ACTING ON THE LEFT ELECTRON e_L^- THAT HAS $Q_{ANTI}(e_L^-) = 0$.

e12 = api 22.

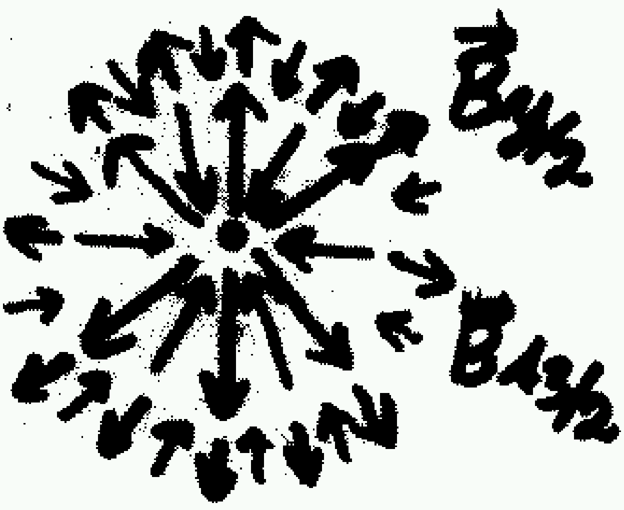
THE MONOPOLE ENSURING THE QUANTIZATION OF THE ORDINARY ELECTRIC CHARGE $Q_{em} = \frac{\gamma}{2} + \frac{d_3}{2}$ IS SURROUDED BY COULOMB-LIKE RADIATING MAGNETIC FIELDS OF BOTH $d_3/2$ AND $\gamma/2$ TYPE WITH THE SAME SIGN:



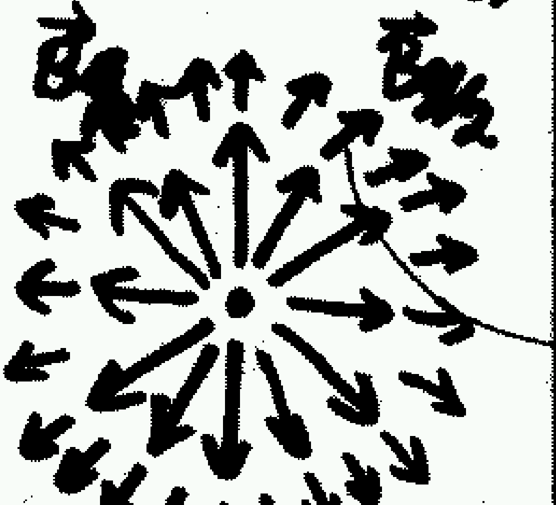
SO THE EFFECT WILL CANCEL WHEN ACTING ON THE NEUTRINO ν_{eL}.

e.13. = apri 23.

BY A (GLOBAL) GAUGE ROTATION IN THE WEAK ISOSPIN SU(2) THE TWO MONO-POLES, FOR RESPECTIVELY $Q_{ANTI} = \frac{Y}{2} - \frac{h}{2}$ AND $Q_{em} = \frac{Y}{2} + \frac{h}{2}$,



MONOPOLE FOR Q_{ANTI}



MONOPOLE FOR Q_{em}

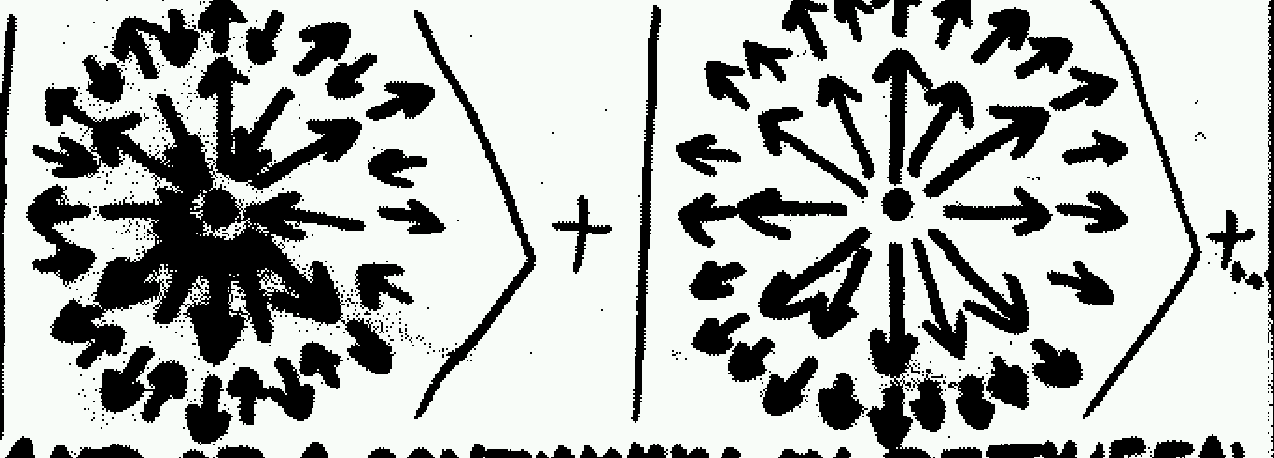
CAN BE ROTATED, ONE INTO THE OTHER ONE.

a.M. = apr 24.

A CONSTRAINT ON "PHYSICAL STATES"

$\Longrightarrow$ PHYSICAL STATES CONTAIN/IS A SUPERPOSITION OF ALL THE STATES OBTAINED BY GAUGE ROTATIONS

$\Longrightarrow$ PHYSICAL STATE SHOULD CONTAIN A SUPERPOSITION OF THE MONOPOLES,



AND OF A CONTINUUM IN BETWEEN.

e.15. = opi.25

IN THE SENSE THAT WE SHALL ALWAYS HAVE THE SUPERPOSITION OF MONOPOLES NEEDED FOR PHYSICAL STATE WE ONLY HAVE ONE MONOPOLE PLAYING THE ROLE OF THE ONE FOR $Q_{em} = \frac{y}{2} + \frac{\lambda_3}{2}$ AND THE ONE FOR $Q_{ANTI} = \frac{y}{2} - \frac{\lambda_3}{2}$.

NO MONOPOLE IS NEEDED FOR $2\lambda_3/2 = \lambda_3$ SINCE SU(2) NON-ABELIANNESS DOES THE JOB. "DAVID OLIVE"

SO ONLY ONE MONOPOLE NEEDED TO QUANTIZE PROPERLY THE CHARGES OF $U(2) = SU(2) \times U(1)$.

THE IDEA THAT CAN BRING DOWN THE MONOPOLE COUPLING STRENGTH:

LET THE $U(1)$ GAUGE GROUP SAY BE BUILT IN AS THE DIAGONAL SUBGROUP

$$U(1) = \{(U,U) \mid U \in U(1)\} \subseteq$$

$$\subseteq U(1) \times U(1) = U(1)_1 \times U(1)_2$$

(OF A CROSS PRODUCT $U(1) \times U(1)$)

AND LET EACH OF THE CROSS PRODUCT FACTORS BE WITH QUANTIZED CHARGES DUE TO A MONOPOLE FOR EACH — OF THE $U(1)$'S —, $U(1)_1$ and $U(1)_2$:

$$\frac{1}{\alpha_{DIAG}} = \frac{1}{\alpha_{U(1)_1}} + \frac{1}{\alpha_{U(1)_2}}$$

BECAUSE OF THE RELATION BETWEEN THE COUPLINGS OF A DIAGONAL SUBGROUP α_{DIAG} AND THE CROSS PRODUCT FACTOR COUPLINGS α_1 FOR $U(1)_1$ AND α_2 FOR $U(1)_2$,

$$\frac{1}{\alpha_{DIAG}} = \frac{1}{\alpha_1} + \frac{1}{\alpha_2}$$

THE α_1 AND α_2 GET STRONGER THAN α_{DIAG} AND THUS THEIR MONOPOLE COUPLINGS $\tilde{\alpha}_1 = \frac{1}{4\alpha_1}$ AND $\tilde{\alpha}_2 = \frac{1}{4\alpha_2}$ GET WEAKER.

A $F^{(1)}_{\mu\nu} F^{(2)\mu\nu}$-TERM CAN FURTHER HELP.

nr. 1 = opg 28.

PRESENTATION OF MODEL

OF COURSE AT THE END THE MODEL IS MOTIVATED BY FITTING WELL THE PARAMETERS OF STANDARD MODEL.

A) A CHARACTERISTIC FEATURE IS THAT VACUUM CAN BE IN MANY STATES, CORRESPONDING TO MANY MINIMA IN SCALAR FIELD EFFECTIVE POTENTIALS WITH IN FIRST APPROXIMATION SAME, NAMELY $\simeq 0$, ENERGY DENSITY. (ANALOGUE MICRO CANONICAL ENSEMBLE) [MOTIVATED BY m_{HIGGS}, M_{t} AND FINE STRUCTURE CONSTANT "FITTING"]

IN EACH PHASE – i.e. FOR EACH MINIMUM – WE THEN HAVE

B) AT – AND ABOVE IF THERE IS ANY ABOVE – THE PLANCK ENERGY SCALE WE HAVE VERY COMPLICATED PHYSICS WITH MANY DIFFERENT TYPES OF PARTICLES AND THE COUPLING AND MASS PARAMETERS ALL OF ORDER UNITY (IN THE PLANCK UNITS)

C) BELOW PLANCK SCALE A GAUGE GROUP WHICH IS A CROSS PRODUCT OF SEVERAL REPLICA OF STANDARD MODEL GAUGE GROUP $SMG = U(1) \times SU(2) \times SU(3)$.

(c) continued:)

IN FACT IT WOULD BE ELEGANT, AND HELPFULL TO MAKE DIFFERENT FAMILY LEPTONS AND QUARKS GET ORDERS OF MAGNITUDE DIFFERENT MASSES (~ YUKAWA COUPLINGS) TO GIVE JUST EACH FAMILY ITS OWN SET OF GAUGE FIELDS — i.e. ITS OWN $SMG_i =$ $= U(1)_i \times SU(2)_i \times SU(3)_i$ — WHEN WE ANYWAY NEED THE REPLICA OF $SMG = U(1) \times SU(2) \times SU(3)$ TO REDUCE MONOPOLE COUPLINGS.

D) IN ADDITION WE GIVE A GAUGED $U(1)_{B-L\,i}$ COUPLING TO B-L = BARYON-LEPTON NUMBER TO EACH FAMILY.

THE "TRUE" PHASE. | MANY OTHER PHASES

ENERGY

"ALL" ~ 1, "ALL" EXIST

PLANCK MONOPOLES

$(SMG \times U(1)_{B-L})$

$\rho, \omega \sim 0.3$ [illegible]

$T, W, X \sim 0.1$ [illegible]

DIAGONAL
SUBGROUP
$SMG \times U(1)_{B-L}$

ϕ_{B-L} SEE-SAW
SCALE $10^{[illegible]}$

$SMG =$
$U(1) \times SU(2) \times SU(3)$
DESERT.

ϕ_{WS} WEAK SCALE
~100 GeV

QCD SCALE
~1 GeV

"ALL" ~ 1
"ALL" EXIST

"FREE"
MONOPOLES
A BIT LOW-
ER DOWN.

"ALL" ~ 1
"ALL" EXIST

MONO-
POLES
CONDEN-
SE, QUARKS
LEPTONS
CONFI-
NED AT
HIGH NEW
ENERGY.

c.l. = apri 93

CONCLUSION

PRESENTED A MODEL FITTING ORDER OF MAGNITUDEWISE MOST OF THE STANDARD MODEL PARAMETERS, AND GAUGE COUPLINGS AND LEP-HIGGS MASS MORE ACCURATELY, HAVING AS ONE OF THE BASIC ASSUMPTIONS THAT AT PLANCK SCALE ALL COUPLINGS AND (MASS) PARAMETERS ARE OF <u>ORDER UNITY</u>, <u>EXCEPT</u> SCALAR/HIGGS MASSES AND VACUUM EXPECTATION VALUES, <u>VEV's</u>.

CONCLUSION (continued)

- WE GOT VERY GOOD FIT OF ORDERS OF MAGNITUDE FOR ALL QUARK AND LEPTON MASSES INCLUDING NEUTRINO-OSCILLATIONS IN A SEE-SAW MODEL IN TERMS OF FITTING 5 VEV's FOR SCALES RATHER NEAR PLANCK SCALE + 1 VEV GIVING SEE-SAW SCALE, WHILE WEINBERG-SALAM HIGGS VEV IS ALREADY MEASURED.
- FOR HIGGS MASS AND TOP-QUARK MASS AND FINE STRUCTURE CONSTANTS MORE ACCURATE PREDICTIONS. (using MPP).

[illegible]

c. 3. = [illegible] 35

CONCLUSION ([illegible] continued)

- MOTIVATION FOR GAUGE GROUP – BEING EACH FAMILY ITS OWN S.M.G. $\times U(1)_{B-L} = U(1) \times SU(2) \times$ [illegible] $\times U(1)_{B-L}$ – THAT WE NEED A WAY TO MAKE MONOPOLES (AT PLANCK SCALE) NOT COUPLE MUCH STRONGER THAN OF ORDER UNITY.
- GAUGE GROUP ALSO MOTIVATED BY NEED FOR SEPARATING THE 3 FAMILIES IN MASS-ORDER-OF-MAGNITUDES (USE DIFFERENT GAUGE FIELDS NEED TO BRING DOWN MONOPOLE COUPLINGS ANY WAY)