

# **MUSC3808**

6YWca]b['U'DYfZcfaYf

### 7ci fgY'Cj Yfj ]Yk

#### GHJZZ7cbHJWh8YHJ]`g

#### 7cbj Ybcfg

BUa Y	9a U]`	5j U]`UV]`] <b>m</b>	@cWJhjcb	D∖cbY
?]a '6i fk Y``	_"Vi fk Y``4 i bgk "YXi "Ui	Vm'Uddc]bha Ybh	KYVghYf*%%\$	

#### GWXcc`7cbHJWh = DZcfa Uhlcb

GVXcc``cZhXY`5fhg`UbX`AYX]U

Fcca " %&ž@Yj Y`" žFcVYfhK YVghYf'6i ]`X]b[ ff %( Ł

D\cbY. f\$&Ł'-',) '(,) \*

9a U]`. 'gUa 4 i bgk "YXi "Ui

K YVg]hY. k k k "Ufhg"i bgk "YXi "Ui #gUa

 $\label{eq:hamiltonian} $$HY'GW.cc``cZh,Y'5ftg'UbX'AYX]U'k ci`X``]_Y'tc'FYgdYWM\cong \cong m5W_bck``YX[Y'th,Y'HfUX]tjcbU``7i gtcX]Ubg\cong hY'6YXY[U'``fPYbg]b[tcb'WJa di g\cong \cong \cong \cong mUbX'5fti/'8Yg][b'7Ua di gYg\cong \cong \con$ 

## 5ggYgga Ybh

5XX]hcbu``]bZcfa Uhjcb`k]``VY`dfcj]XYX`cb`a ccX`Y"

#### 5ggYgga Ybh'HUg\_g'

5ggYgga Ybh'hJg_	K Y][ \h	8iY'8UHY	Gh XYbh@YUfb]b[ Ci hWca Ygʻ5ggYggYX
FYZYW¶jY'7f]njeiY'	* \$1	Bch5dd`]WUV`Y	%ž&
9ggUmi	(\$1	%\$#\$, #&\$%-`%%) - `DA	%Ž

#### 5ggYgga Ybh'8YHJ]`g

5ggYgga Ybh% FYZYWhjj Y 7f]hjei Y

GHJfhXUhY. Bch5dd`]WUV`Y

8YW]`q.

' \$\$\$"k cfXg"hcHJ""": YYXVUW\_"k ]``"VY"[ ]j Yb"j ]U"@A G

.

5ggYgga Ybh'& '9ggUm

GhUfhXUhY. Bch5dd`]WUV`Y

**@Yb[h**\. &**ž**\$\$\$ k cfXg

8YHJ]`g.

&\$\$\$`k cfXg"`: YYXVUW\_`k ]``VY`[ ]j Yb'j ]U'@A G

.

 $\label{thm:limit} \begin{tabular}{ll} Hi & fb \end{tabular} $$ Hi & fb \end{tabular} $$ h' \end{tabular} $$ I' Hi & fb \end{tabular} $$ h' \end{tabular}$ 

## 5 hm/b XUb WY F Yei ]fYa Ybhg

# 7ci fgY GWX YXi `Y

<u>J ]Yk "WUgg"hja YHUV"Y</u>

H]a YHJV`Y

K.WW_%;%sigbWP; sigteWfCtv3tutflsfftWjj ]tm A` (15/2000tfhfftk	8 UhY	HmdY	7 cbhYbh

	W"@YWfi fY"]bdi h"H\Y"XmbUa ]Wg"cZghi X]c""Yggcbg
	X"'Gh XYbh'YX'gYa ]bUf'fl fci d'8Ł
K YY_').'&-'>i bY'!'' '>i `m Cb`]bY'5Wfj]lm	76@7E63K # <g1k, #fivgwz<="" *="" 5="" 6="" 9="" d[f="" dagbe="" th=""  =""></g1k,>
	: F=85M" '>i `m
	U"'@YWn fY']bdi h'AcXY``]b['UbX']a]hUn]cb
	V"'Gh XYbh'YX'gYa ]bUf'fl fci d'9Ł
	W"@YWn fY"]bdi h"7 ca a i b]WUn]cb"]b"h\Y"ghi X]c
	X"'Gh XYbh YX'gYa ]bUf'fl fci d'5Ł
K_YY_'*.'*'>i `m!'%\$'>i `m	A ]X!hYfa 'VfYU_
K YY_`+.`% `>i `m!`%+`>i `m C b`]bY`5W¶j ]hm	76@7E63K #' <g1k, #fi<math="" 9dagbe75df="">35df/\$fi<math></math>9fi<math></math>9gWz</g1k,>
	: F=85M'%+'>i `m
	U"'@YWn fY']bdi h'Ghi XYbh'UddfcUVXYg'hc'dfUWnW
	V"'Gh XYbh'YX'gYa]bUf'fl fcid'6Ł
	W75WMjj]hmFYZYWMjb[~cb~UddfcUVXYg~hc~dfUWMjWY
	X"'Gh XYbh'YX'gYa ]bUf'fl fci d'7Ł
	·
K YY_', .`&\$'>i `m!`&( '>i `m C b`]bY'5Wfjj ]lm	$1.76@7E63K$ \$\$ < g^k, 9 dagbe 4 $^{\circ}$ 5 \ 5 \ f \ f \ f \ f \ V g \ W z
	:F=85M1&('>i`m
	U"'@YWn fY']bdi h'DfcV`Ya Uh]Wgh X]c'fY`Uh]cbg\]dg
	V"'Gh XYbh'YX'gYa]bUf'fl fcid'8Ł
	₩°9ggUmihjdg:/ 'gi [[Yghjcbg
	X"'Gh XYbh'YX'gYa ]bUf'fl fci d'9Ł
K_YY_'`&+`>i `m!'' %'>i `m	$1.76@7E63K $+ < g^{1}k, 9 dagbe 6 ~ 7 + 5 df / $fiVgWz$
	: F=85M" %'>i `m
K. YY_`%\$.'' '5i [igh!'+ Cb`]bY'5W1jj]hm	: F=85Mi+'5i [i gh
5i [i gh	U"'±blfcXi Wgcb'hc'a i g]Wh\YfUdmifk ]h\'5`]gcb'G\cftŁ

Fygci fWyg

DfYgWf]VYX F Ygci fWYg

FYWca a YbXYX FYgci fWyg

7ci fgY '9j U`i Uh]cb 'UbX '8Yj Y`cda Ybh

9j U`i Uhjcb'k]```VY'WcbXi WhYX'h\fci [\'h\Y'A m9l dYf]YbWY'gi fj YmUh'h\Y'YbX'cZhYfa "

### Gi Va ]gg]cb cZ5ggYgga YbhHUg\_g

#### Hi fb]h]b Gi Va ]gg]cb

Image: Ybwei bhyfu'dfcv'ya k \yb'uhhya dhjb[ 'hc'gi va ]hmci f'Ugg][ ba Ybhh\fci [ \ 'Hi fb]h]bž'd'YUgY

Hy'Yd\cby'9| hy'fbu''Gi ddcfhcb'-', ) '' ' ' %cf'Ya U]''h\Ya 'cb'Y! hy'fbu'hy'hgi ddcfh4 i bgk "YXi "Ui "''Gi ddcfh
\ci fg'UfY', .\$\$Ua '-'%\$.\$\$da 'cb'k YY\_XUmg'UbX'-.\$\$Ua '-').\$\$da 'cb'k YY\_YbXg'fl \*) 'XUmg'U'mYUft"'=Z'mci
UfY'i bUV'Y'hc'gi va ]hmci f'Ugg][ ba YbhXi Y'hc'U'ZJi 'hk ]h\ 'Hi fb]h]b'mci 'a UmUdd'mZcf'Ub'Y! hy'bg]cbž'Vi hmci
a i ghfYhJ]b'mci f'h]W\_Yhbi a VYf'Zfca '9! hy'fbU''Gi ddcfhfU'cb[ 'k ]h\ 'Ubmch\Yf'fy'Yj UbhXcW a Ybhgt'hc
]bWi XY'Ug'Yj ]XYbW' 'hc'gi ddcfhmci f'Y! hy'bg]cb'Udd']WUh]cb"'=Zmci 'Ya U]''9! hy'fbU''Gi ddcfhmci 'k ]'`
Ui hca Uh]WJ'`mfYW']j Y'U'h]W\_Yhbi a VYfZ'Vi h]Zmci 'hY'Yd\cbY'mci 'k ]``bYYX'hc'gdYW]Z]WJ'`mUg\_'Zcf'cbY''
Hi fb]h]b'U'gc'dfcj ]XYg'i dXUhy'g'cb'h\Y]f'gmghYa 'ghUh' g'cb'Hk]hyf''

; YbYfU`mž'UggYgga YbhiHug\_g'a i ghVY'gi Va ]hhYX'Y`YVWfcb]\WJ``mij ]U'Y]h\Yf'Hi fb]h]b'cf'U'A ccX`Y Ugg][ ba Ybh''=b']bgHJb\W'g'k \YfY'h\]g']g'bchdcgg]V`Yž']hk ]```VY'gHJhYX'cb'mci f'\\circ i fgY'g'A ccX`Y'g]hY'k ]h\U`hYfbUh]j Y'gi Va ]gg]cb'XYHJ]`g"

cfi]bZcfa Uhjcbicbi\ckihcigi Va ]hUgg][ ba Ybhgicbi]bYij ]UiA ccXiY.i\hdg.#gh XYbhi bgk "YXi "Ui #\ck! gi Va ]hUgg][ ba Ybha ccXiY

### 5 WUXYa ]W<cbYghmUbX D`U[]Uf]ga

D`U[]Uf]ga `]g`i g]b[ 'h\Y`k cfXg`cf`]XYUg`cZch\Yfg`UbX`dfYgYbh]b[ 'h\Ya `Ug`mci f`ck b"`±hWJb`hU\_Y`a Ubm Zcfa gžZfca `XY`]VYfUhY`W\YUh]b[ 'hc`UWW]XYbhJ``mWcdm]b[ 'Zfca `U`gci fWY`k ]h\ci hUW\_bck `YX[ Ya Ybh'

IBGK [fcidg'd'U[]Uf]ga ]bhc'h\Y'Zc``ck]b[ 'WUhY[cf]Yg.

 $7 \text{ cdm}b[...i g]b[...h\Y.gUa Y.cf.j Yfmig]a] \Uf'k cfXg'hc'h\Y.cf][]bU''hYl h'cf']XYU'k]h\ci h'U\V_bck `YX[]b[...h\Y.cf][]bU''hYl h'cf']XYU'k]h'cf']$ 

- i bXYfgfUbX mci f'f][\hg'UbX'fYgdcbg]V]`]hJYg'Ug'U'gh XYbhUhl BGK
- VY`Uk UfY`cZd`U[]Uf]ga ž`Wcdmf][\hz'l BGK `Gh XYbh7cXY`cZ7cbXi WhUbX`5VWWdhUV`Y`l gY`cZ I BGK `=\forall H`F Ygci f\W\g`Dc`]\m\m
- VY 'Uk UfY 'cZh\Y 'ghUbXUfXg 'cZVY\Uj ]ci f'Yl dYWYX 'cZYj YfmcbY ']b 'h\Y 'l BGK 'Wca a i b]hm
- `cWUHY 'gYfj ]WYg'UbX ']bZcfa UH]cb'UVci hI BGK 'UbX'I BGK '@]VfUfm

Gca Y'cZh\YgY'UfYUg'k]``VY'ZJa]`]Uf'hc'mci ž'ch\Yfg'k]``VY'bYk"'; U]b]b['U'gc`]X'i bXYfgHJbX]b['cZU``h\YfY`UhYX'UgdYWng'cZ9@+69'k]``\Y`d'mci 'a U\_Y'h\Y'a cghicZmci f'ghi X]Yg'UhI BGK "'\\hd.##qi VYWfi |XYg"`]VfUfm'i bqk "YXi "Ui #\`]qY#JVci hY`]qY

# 5WUXYa]W±bZcfaUhjcb

: cf'YggYbhJU`ghi XYbh]bZcfa UhJcb'fY`UhJb['lc.